Stretching Water in the Sprague River Valley

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Introduction

During any given moment of the day, someone in the Sprague River Valley is talking about the lack of precipitation or the uncertain future of irrigation water. It is the topic of many ranchers, farmers, tribal folks, agency types and policy makers. Water shortages, whether the result of climate or regulation are a constant threat to the agricultural economy and survival.

Drought is becoming all too commonplace in the already semi-arid Sprague River Valley. Not only are landowners facing climatic droughts as the result of decreased precipitation and the timing shifts from early winter storms to late winter storms but, there is the increasing threat of regulatory droughts. Regulatory droughts are those imposed as a consequence of over allocated water rights with the added burden of endangered aquatic species and tribal trust issues.

Over the years landowners have been told that improving surface water irrigation efficiency would mean that less river water would need to be diverted for the purpose of irrigation. But this assumes that every drop of water diverted is used effectively or in a way that produces a desired result.

The primary goal of this manual is to encourage landowners to consider their current operations and to consider how soil health and or alternative cropping might provide some security into the future. This document discusses conventional methods (like tillage); to address compaction and also explores some non-conventional methods.

For many landowners in the Sprague, the future might look a good deal like the past. Prior to the availability of electric power, much of the Sprague River Valley was dryland country. Now with power pumping rates profoundly affecting profit margins and uncertain irrigation water availability many landowners may be living in the past once again. So, how do landowners face the unknown surface water availability? When it comes to irrigated pastures there are three components that affect success; water availability, soil conditions and plant species. If water is limited then designing your operation to maximize the soil water holding potential and selecting the plant species adapted to drier conditions is the path to the future.

The preparation and implementation of any management change requires additional time and resources. So, why bother? Do you know the answers to any of these questions?

- Do you know if you will have irrigation water next year or 10 years from now?
- Will you be able to make future land management decisions based on an unknown quantity of irrigation water?
- Do you know how much it will cost you to pump irrigation water?

But, the even more important questions are:

- Have you hand dug a hole in your fields lately?
- Was it like digging in rock?
- How did your grass roots look?
- Were the roots confined to the top three or four inches of soil?
- Were the roots bent to an almost 90 degree angle?

The above questions directly relate to the soils' health. The plant roots are the best indicator of soil health and specifically soil compaction. Clay textured soils are the most easily compacted, while sandy soils are the least. Alluvial soils in bottom lands and fine textured silt loams which are typical in the

Sprague River Valley are also easily compacted. What are alluvial soils? Rivers, streams and floods carry rock debris/sediment downstream. Along the course of the river, sediment is deposited on the floodplains or banks. This fine grained fertile deposited soil is alluvial soil.

So, what is meant by soil compaction?

Soil Health

A healthy soil is the correct combination of different factors. The correct combination includes approximately 50% pore space and 50% organic matter and mineral particles (silt, sand and clay). (**Figure 1**)The pore space provides the porthole for air and water to enter the soil layers. With pore space accounting for about half the overall value in soil health, as pore space diminishes; referred to as compaction, soil health diminishes.

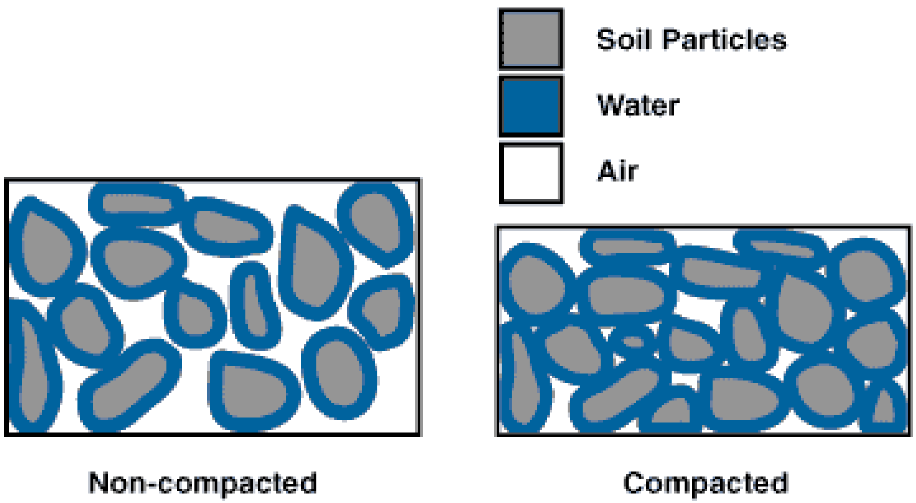


Figure 1. Pore spacing difference between non-compacted and compacted soil.

It is also important to realize that soil compaction occurs at different levels in the soil. The cause and treatment is dependent on the location within the soil profile. Some soils are predisposed to compaction simply due to the parent material. The Klamath-Ontko-Dillman soil series is common throughout the low laying areas of the Sprague River Valley and consist of a silty clay loam or a sandy clay loam which are poorly drained and contain various amounts of ash. These soils, because of their clay component are predisposed to compaction, so exposing these soils to activities which increase compaction exacerbates the situation. Figure 2 provides a general picture of the compaction zones. Surface compaction, restricted to the upper soil layers (the first 1-6 inches) is typically the result of repeated equipment or livestock traffic. Plow or tillage pans, and hardpan compaction, are usually caused by repeated soil disturbance by the same equipment at the same depth (plow, disk, or chisel plow).

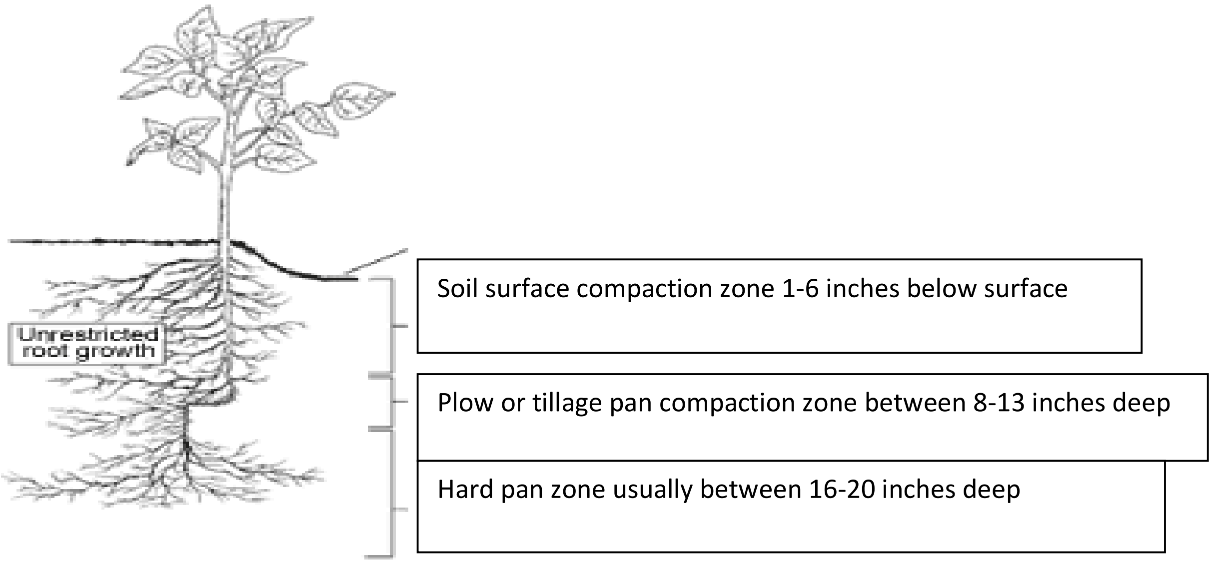


Figure 2. Compaction zones

Traffic over the soil is the major contributor to soil compaction. For example, a moist soil could reach 75% maximum compaction the first time it is stepped on, and 90% by the fourth time it is stepped on (**Figure 3**). Soils are more prone to compaction when wet. Soil water acts as a lubricant allowing the soil particles to readily slide together reducing large pore space. Weight distribution and frequency play a significant role in the depth of compaction. For example, a cow stepping one time onto one dry spot will have almost no impact. However, a tractor using the same path over and over (especially on wet soils), can create compaction which transfers from surface to plow pan and then to hardpan.

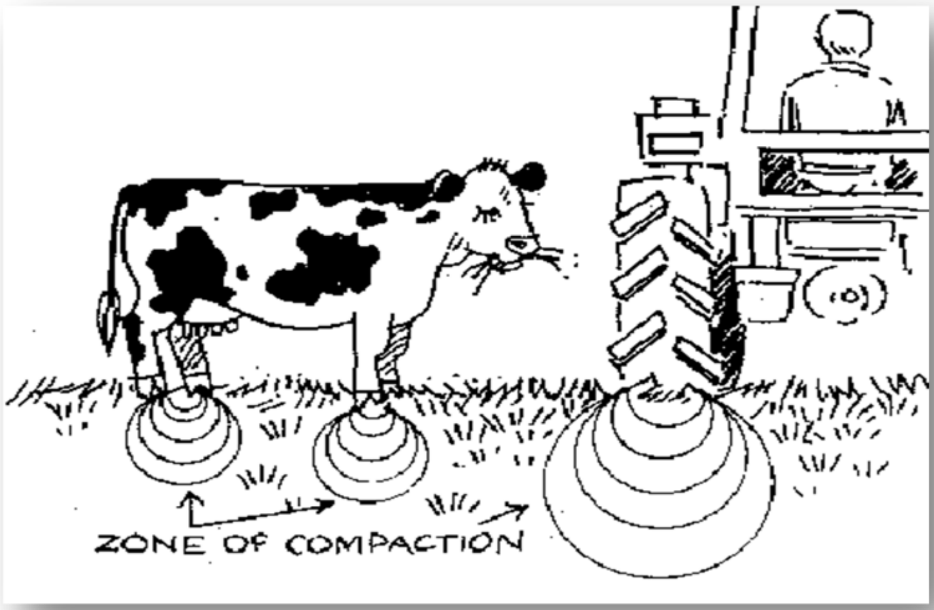


Figure 3. Zone of Compaction. Greater degree of compaction in wet fields.

Why is soil compaction a problem**?**

- ✓ Very dense soil makes it difficult for plants to grow properly. Roots cannot penetrate the soil layers to obtain the nutrients, water, and the structural support they require for survival.
- ✓ Compaction prevents water from infiltrating properly through the soil, forcing it to runoff the surface thus providing no benefit to the plant.

Soil compaction leads to many cycles of change including soil temperature. Compacted soils take longer to heat up in the spring thus delaying plant growth and these soils tend to retain heat in the summer. The fibrous grass roots are not able to penetrate into the deeper, cooler and moister soils so these roots stay in the upper soil zones and dry out during the hot summers. So, more irrigation water is applied to the pasture and more water runs off.

In the Sprague River Valley the accelerated expansion of invasive species (weeds) could be a direct result of soil compaction in many locations. As the desired grasses start to die off because of compaction, weeds take over.

Figure 4. This should look familiar to everyone in the Sprague River area. The Canada thistle with its taproot is outcompeting pasture grasses.

Weeds are aggressive and efficient at getting established. Many of the worst problem weeds are broadleaf weeds (**Figure 4**). These types of weeds exhibit taproot systems which can outcompete pasture grasses for water and nutrients. Weeds can survive in compacted conditions better than grasses because taproots can penetrate compacted soils. Also, weeds adapt to drier soils. As the weeds continue to thrive, the grasses suffer and go dormant. The tendency is to apply herbicides for weed control. This is an expensive way of addressing the effects of compaction and not addressing the cause of compaction.

How to determine if soil compaction exists

Managing soil compaction can be time consuming and in some cases costly if landowners lack the equipment. There is also a fuel cost associated with the equipment necessary to pull various tractor implements to reduce compaction. So, landowners should consider if the degree of compaction warrants the cost to reduce the compaction.

How does a landowner determine if the soil is compacted?

The easiest way is to look for:

- ➢ Badly formed plant roots (enlarged, stubby or twisted roots, or roots that grow horizontally);

- Standing water may indicate a drainage problem;
- Physically dense(**Figure 5)** soil that is hard to dig whether wet or dry; and/or
- Plants with nutrient deficiencies, as seen by stunted growth, discolored leaves and drought stress.

However, a good look at the soil layers or soil profile will provide the best information. This is a relatively simple procedure that should be done in the spring when the soil is moist; otherwise it may be impossible to distinguish compacted layers from the non-compacted ones.

- First, dig a hole about 2 feet in diameter and 2 feet deep. If the digging is like digging in rock then there is a clue! Dig on just three sides, so one face of the hole is essentially free of shovel marks. (A shovel can be a compactor)
- Then stick a pocketknife blade into the unblemished side at 2-3 inch intervals from top to bottom of the hole. If you encounter a soil layer where knife penetration is more difficult than the zone below it, this is evidence of soil compaction.

The image on the left **(Figure 5**) shows a classic example of compacted topsoil. Note how the soil structure in the upper part of the profile has completely collapsed. This limits root growth and effective use of soil water and nutrients by crops. Grass roots in the upper layer of soil will typically display an almost 90 degree turn and run horizontally just below the soil surface.

Figure 5. Top layer of soil showing signs of compaction

Compaction Remedies

There are many compaction solutions. However, repairing the compaction does not necessary address the cause. If the cause of the compaction is limited to soil properties such as a primarily clay soil, the ability to reduce compaction might not be an option. However, although most soils in the Sprague River Valley do posses some amount of clay this does **not** mean any effort to reduce compaction is a waste of time. There is (of course) risk associated with any management change, but those risks must be weighed against the risk of doing nothing. Soil compaction is a compounding problem. By doing nothing, the compaction will not go away but, will most likely worsen every year. It is also important to realize that soil compaction occurs at different levels in the soil. The cause and treatment is dependent on the location within the soil profile.

The next section discusses conventional methods of addressing compaction including various equipment types specific to the location of the compaction within the soil profile. For the purpose of this document the discussion of surface compaction will refer to the top 8 inches of soil. Tillage or (plow pan) and deep compaction refer to soils below the 8 inch depth. After conventional (tillage) methods are discussed, some non-conventional yet viable alternatives are presented.

Surface Compaction

One commonly used method to reduce surface soil compaction is to aerate. What is soil aeration? Aeration is a process by which soil is mechanically disturbed. Soil aeration often is used to renovate established pastures. There are many types and styles of aeration equipment including**:**

- Aerators with coulters, which makes narrow slits in the soil (**Figure 6)**;
- Aerators with spikes that punch into the soil to make indentations; and
- Aerator with prongs.

If your compaction is limited to the surface soil, the best time to aerate is in the spring or early summer (not while soils are wet) when grasses are actively growing and fill in rapidly.

Figure 7 shows a pull-type pasture aerator designed for agricultural conservation tillage and pasture renovations. The heavy-duty, knife-like prongs on the aerator are designed with a twist in them to break-up compacted soil horizontally and vertically as they slice into the ground in a twisting fashion. This breaking action promotes proper water infiltration which increases oxygen and water supplies to the plant roots.

Figure 7. A pull-type soil surface aerator. Optional concrete weights help aerator prongs penetrate the ground at their maximum depth.

Figure 6. Coulters make narrow slits in top soil

The risks associated with aeration are fairly small and mostly limited to increasing the chance of weeds growing where the soil has been disturbed.

Aeration does not directly address a compacted plow pan or a natural hardpan at greater depths. To address deeper compaction issues (also known as "subsurface compaction"), will require either subsoiling equipment for deep tillage or the use of tap-rooted plants (discussed in more detail under biological ripping), to create fractures in the plowpan or hardpan.

Subsurface Compaction
One way of removing deep compaction layers in the soil is by using subsoiling equipment to rip below the compaction layer using a shanked chisel plow **(Figure 8**) or ripper. If the compaction layer is quite deep, this may require a number of passes to ensure the deeper layers are loosened rather than moved sideways and compressed. Subsoiling should only be done when the soil is dry.

The decision to use subsoiling equipment should be made with great caution. Deep tillage can be beneficial under specific soil conditions but its use can also have very serious negative effects on soil quality. Making a plan prior to ripping fields should be the landowners' first move. Before attempting to deep rip a field, carefully consider the potential negative consequences. Ideally, a landowner should try ripping in several test strips in a field to evaluate the benefits and risks over one or even two years before deep ripping an entire field. Subsoiling should be a landowner's last alternative, other methods (which disturb the soil less), are available and discussed in the subsoiling alternatives section below.

Potential concerns:

- Some rippers cause greater mixing of surface soil with subsoil. This results in the deterioration of soil structure, reduction in soil organic matter, reduced soil fertility and increased potential for surface soil crusting. These conditions can be much worse than minor soil compaction problems.
- Loss of plant available moisture can occur.
- Soluble salts in subsoil can be intermixed with surface soil, increasing salt levels and reducing pasture potential.
- Subsoiling can make the ground surface rough and lumpy and can pull rocks to the surface. Some manufacturers and sales representatives of subsoilers claim their equipment causes minimal surface damage but it is important to use caution and confirm these claims prior to purchase or use.
- If high or excessive amounts of moisture are received after subsoiling, the fractured soil zones can become waterlogged and unmanageable until dry.

Figure 8—A three-shank subsoiler which attaches to a tractor's three-point hitch.
It can fracture compacted layers 12 to 22 inches below the soil surface.

So, let's talk a little about shanks. Winged tips cost more than conventional tips (**Figure 9**). Typical winged tips are 6 to 16 inches wide with 1 to 4 inches of lift, and a 40 to 60 degree sweep angle. Winged tips are designed to fracture the soil uniformly without lifting or furrowing the surface excessively.

Shanks with winged tips require 25 to 55 percent more horsepower to pull, but often the shanks can be farther apart. Winged tips set behind the leading edge of the shank improve efficiency and reduce the amount of horsepower needed to pull the subsoiler. If you consider the volume of soil loosened per horsepower, shanks with winged tips may be more efficient than shanks with conventional tips **(Figure 10**).

Figure 9. Winged tips on subsoiler shanks (left) come in various shapes and designs. Conventional tips (right) are wedge shaped.

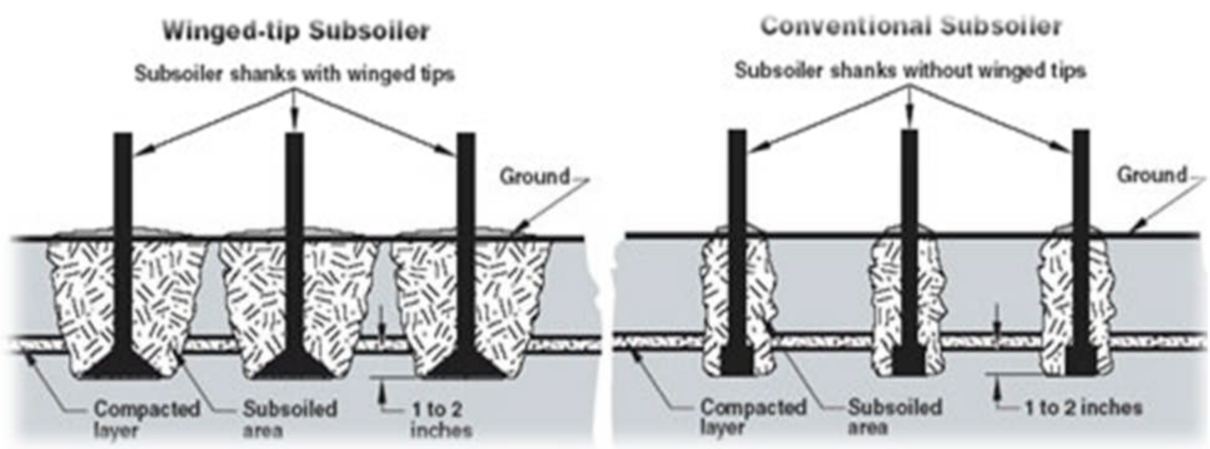


Figure 10. Winged tips on subsoiler shanks wing-tip (left)and conventional (right)

Shank Designs

There is a large selection of shank designs, each design serving a slightly different purpose. Shanks are commonly redesigned so you should check with equipment manufacturers for the most current design application and the required horsepower to pull. Parabolic shanks (**Figure 11**) require the least amount of horsepower to pull. However, in some cases, parabolic shanks may lift too many stumps and rocks, disturb surface materials, or expose excess subsoil. Swept shanks tend to push materials into the soil and sever them. They may help keep the subsoiler from clogging up, especially in areas where you might expect to hit brush and/or stumps. Straight or "L" shaped shanks have characteristics that fall somewhere between those of the parabolic and swept shanks.

Shanks are designed to handle rocks, large roots, and highly compacted soils.

Shanks usually are from ¾ to 1½ inches thick. Thinner shanks are more suited for agricultural use. Thicker shanks hold up better in rocky conditions, but require larger, more powerful equipment to pull them and disturb the surface more. Bent offset shanks, such as those found on Paratill subsoilers, have a sideways bend (**Figure 12**). Some testing has shown that bent offset shanks disturb surface material less than straight shanks.

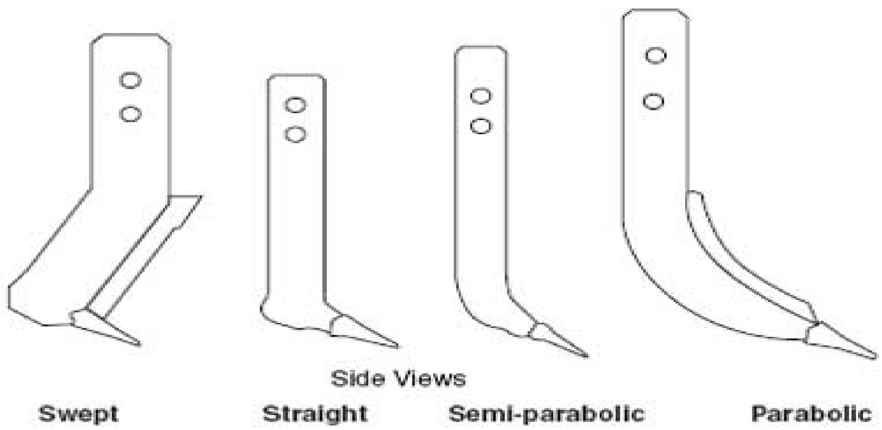


Figure 11. Shank designs include: swept, straight or "L" shaped, semi-parabolic, and parabolic.

The typical spacing is 30 to 42 inches between shanks. Shanks should be able to reach 1 to 2 inches below the deepest compacted layer.

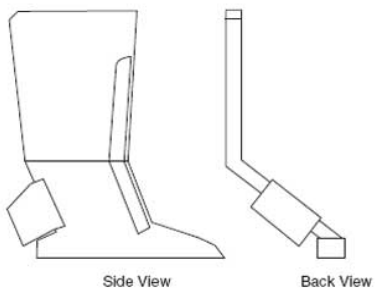


Figure 12. Bent offset shank.

Shank spacing and height should be adjustable in the field. Towed subsoilers should have gauge wheels to control the shank's depth. Conventional ripper shanks typically found on dozer equipment, work reasonably well when winged tips are added and may be suitable for many jobs and locations.

Shanks With Shear Bolts

Shanks with shear bolts (**Figure 13**) are better suited for open ground with few rocks. If the shank strikes a rock or buried wood, the shear bolt breaks, allowing the shank to swing back. The subsoiler must be lifted out of the ground, the shank swung back into place, and the shear bolt replaced. Shanks with shear bolts typically are cheaper than shanks that reset automatically, but will cost the operator time in the field replacing shear bolts.

Figure 13. Shanks need to be mounted to subsoilers so that the shank can
survive if it runs into rocks or stumps. This shank is protected by a shear bolt designed to break if too much force is put on the shank.

Figure 14. Shanks with spring loading.

Shanks that reset automatically (**Figure 14**) use a spring-loaded mechanism that allows the shank to hinge back when it hits objects in the ground. The shanks typically withstand 3,000 to 7,000 pounds of force before hinging. The shanks snap forward and reset after the subsoiler has passed the object.

This type of shank is more expensive than those that rely on shear bolts, but require less repair time in the field. Some subsoilers use hydraulic systems with accumulators (hydraulic devices that store energy) to absorb force on the shank.

The Para Plow (**Figure 15**) breaks up compaction without destroying the soil structure. Loosening the soil improves water penetration and drainage. The shanks of the Para Plow are angled 45 degrees to the side at working depth of up to 15 inches. This angle allows the shank to lift the soil gently, fracture and then set it back. This action prevents mixing of top soil with subsoil and prevents pulling large clods to the surface.

Figure 15. Para Plow

Is subsoiling the only way?
Is using subsoiling equipment always the answer to soil compaction? Well, if soil compaction is the result of repeated livestock and/or equipment traffic on soil, is the solution to use heavy equipment? There are other possible solutions to reduce soil compaction.

Alternatives to subsoiling

Hydrological ripping
Although it might be tempting to pull a deep ripping implement across the pasture, landowners should not underestimate the soil loosening power of nature. There are few things on earth with more power than water. Hydrological ripping uses the expansive nature of water turning to ice to shatter compaction layers. The timing of this process is critical and the goal is to provide an opportunity for water (precipitation) to enter the soil and once in the soil, to freeze.

The process for hydrological ripping:

1. Aeration
2. Precipitation
3. Infiltration
4. Freezing
5. Fracturing

The aeration component should be done in the late fall or early winter depending on temperature. Soil should be dry and aeration is done in anticipation of precipitation followed by freezing conditions. The concept involves breaking up the surface soil through aeration providing the path for water to infiltrate.

The goal is to promote soil saturation and subsequent soil water freezing. The freezing soil water expands and exerts enormous pressure within the compaction zones.

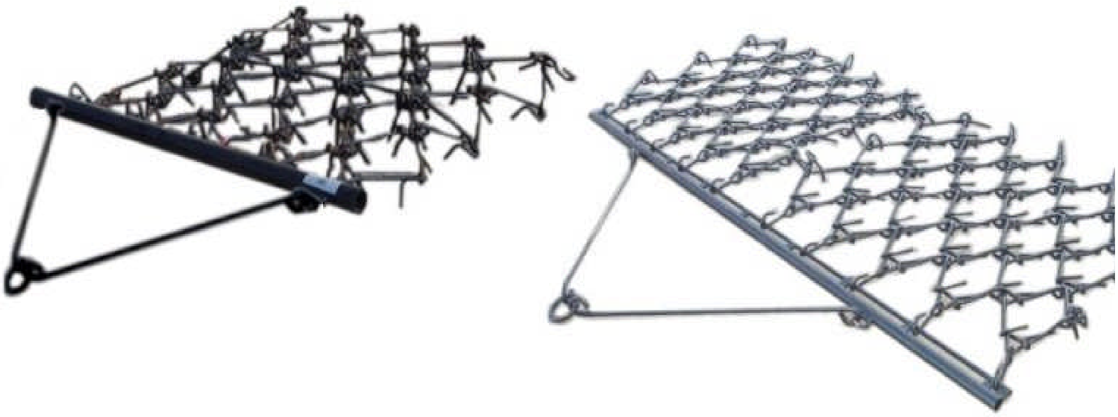
Frost tillage
Frost tillage is a way to take advantage of seasonal changes and reduce unintended tillage damage. It can break hard pans which will allow water and air to flow through the soil. It can be done after frost has first entered the soil, but before it has penetrated more than 4 inches. When frost penetrates unfrozen soil, water is rapidly moved upward, drying the soil underneath. This makes the soil tillable as long as the frost layer is 1 to 4 inches. Tillage equipment will fracture the surface soil which supports equipment without causing compaction. The resulting rough surface promotes water infiltration and reduces runoff.

Biological ripping
Crop roots create soil pores (air spaces) and plants with tap roots also promote the formation of cracks in soils. Both of which promote water infiltration. This 'biological ripping' is a risk-free form of repairing soil compaction. However, this process requires more time for the establishment of the plantings and success of establishment is not guaranteed. There are two seed application methods specifically for established irrigated pastures.
The basic methods are:

- Over-seed selected species into existing pastures by broadcasting
- Interseed selected species into existing pastures by drilling

Broadcast over-seeding in established pastures
Although broadcast seeding is considered the least expensive method of application it does not come without risk. Broadcasting requires either hand or a mechanical spreader to distribute seed. The success of any seeding method is greatly determined by the seed to soil contact. Broadcast seeds, especially the larger seeds like smooth brome and wheatgrasses are likely to become snagged in the established forage and never germinate. Smaller seeds like timothy or red clover are more likely to find the soil surface but again the limited ratio of seed to soil contact does not lend itself to success. There are methods that when used with broadcasting can promote seed to soil contact and greatly increase the chances of success. One such method would be to broadcast the seed in the late fall after livestock have left the existing vegetation stubble height approximately 3 inches and then reintroducing livestock into the field immediately after broadcasting. The livestock will brush against the existing forage knocking the broadcast seed to the ground and hoof trampling in the area will provide for the seed to soil contact. Some reports suggest that this trampling action is nearly as effective as a drill. However, if livestock remain too long in the field, it may result in doing more harm than good. A light harrow or pasture drag (**Figure 16.)** can also be used after broadcasting to produce the seed to soil contact. If broadcasting is the application method used, you should double the amount of seed recommended under drilling rates. Try to avoid mixing different sized and shaped seed in the spreader because this causes uneven distribution.

Figure 16. A pasture drag



Interseeding in established pastures

Interseeding is another method of introducing seed into an established pasture. Remember, the purpose for this process is to help break-up soil compaction through a "biological ripping". The main difference between interseeding for forage establishment verses compaction reduction is timing. When the goal is to reduce soil compaction, interseeding is best done in the late fall after the field has been aerated.

Interseeding involves placing the seed directly into the sod which improves the seed to soil contact. There are many types of interseeding equipment but the selection of the equipment should be made based on the pasture conditions. When dealing with surface soil compaction issues, the equipment must be able to make a small furrow in the sod into which the seed is dropped. Features of interseeders generally include a kind of coulter set up (which slits the soil), followed by double disk openers (which make the furrow), and then press wheels (which close and pack the furrow), once the seed has been dropped. Check the interseeder to confirm that the seed can be planted within the seed specification (typically, between ¼ and ½ inch deep).

Figure 17. The Plant-O-Vator has a slightly different set-up but is considered an interseeder.

The Plant-O-Vator has leading coulters followed by a ridge shank opener that creates a 3” wide by 5” deep furrow. This method of application basically tills the soil which reduces competition from existing grasses. One disadvantage is this machine seeds on 12” centers.

Is it efficient or effective?

The purpose of pasture and soil renovation (at least for this document) is to improve water infiltration whether that water arrives through irrigation or precipitation. There is a long held belief that irrigation efficiency equals effectiveness. However, this could not be further from the truth. Landowners can invest countless dollars in addressing irrigation efficiency and yet miss the mark on using the water effectively. Irrigating compacted soils regardless of how efficiently you move the water does not always mean a water savings. Compacted soils reduce infiltration and increase runoff. Grasses start to wither, so more water is pumped onto the field only to runoff again or evaporate. So, regardless of the irrigation method you use, make sure you are actually irrigating the crop!

Alternative cropping

Many Sprague River Valley ranchers are facing future irrigation water uncertainties. It is impossible to predict the weather; will there be enough snow, will snow come at the right time and even if there is plenty of snow (which results in stream flow), will I be able to afford the cost of pumping? Mom always told us to save for a rainy day, but maybe we need to save for those non-rainy days. Basically, your ranch is your financial portfolio and as any stock broker will tell you, it is all about diversity. Livestock and irrigated pastures are a part of the portfolio, but being the smart investor you are, having a substantial part of your portfolio in irrigated pasture may be something to reconsider. You might want to consider an investment in non-irrigated pastures. There is risk associated with converting irrigated pasture to non-irrigated (dryland) pasture, but a strategic plan including small acreage trials will limit the risk. The benefits of a successful non-irrigated pasture can certainly outweigh the risk of gambling on irrigation water deliveries. Prior to getting the plow out of the barn there are many considerations.

What is dryland pasture? Well, quite simply it is a pasture that thrives by using only precipitation. A pasture that uses only the water or snow that falls from the sky!!! Just think on this for a few minutes. In the Sprague River, irrigation water is looking pretty scarce and the cost of power to pump irrigation water is climbing beyond the market value of pastures. Dryland is nothing new in the Sprague River Valley, so maybe something old is new again.

Establishment of a new crop is always a risk and dryland species are no different. The first thing to do is to evaluate your situation. Do you have a field that is difficult to irrigate or to get irrigation water to? Do you have large areas of high ground in your pastures that are not receiving irrigation? Are there areas where no matter how much irrigation water you apply, it disappears in no time (sandy loam soils)? Do you have a field that has been nothing but a weed patch for year? Look at these areas and consider the risk involved if the first time planting of dryland fails. What have you lost? Well, you have lost time in preparation, maybe the cost of seed and fuel. Over the last couple of years in the Sprague River Valley some agency types have been promoting the idea of dryland. Consultation and equipment has been made available to landowners for the asking but these dryland programs have been far from successful. Why? Wrong equipment, poor soil conditions, wrong recommendations and no follow up trying to understand what went wrong. As discussed earlier there is a difference between efficient and effective. Many times in our efforts to be efficient we have not been effective. Many previous dryland plantings have lacked the seed to soil contact due to a fluff layer of topsoil. Or, in the opposite case, the seed was unable to penetrate the soil surface layer due to severe compaction.

The previous sections in this document discussed ad nauseum the importance of soil health and specifically the reduction of soil compaction. Here is why, seed and water that cannot get into the soil does not produce a product!

Things to **know** before you pull the tractor out of the barn.

- What is the precipitation range?
- What is the condition of the soil?
- What type of soil is predominant?
- What is the slope of the site?
- What is the aspect (facing/direction) of the site?
- What equipment is needed?
- What happens if the planting fails/ fall back plan?

What to **think** about before you pull the tractor out of the barn.

- What are my seeding objectives?
- Have I selected the appropriate species and equipment for the site and the objectives?
- Will I be able to properly prepare the site and use the correct seeding techniques?
- What is my plan for implementing grazing management of the site, once planted?

Dryland species selection

It seems almost unbelievable but, the annual precipitation in the Sprague River Valley over the last 25 years ranges between 15-17 inches. However, for much of the last 10 years (due to numerous drought years), a range between 12-16 inches seems more likely. There is of course the possibility that the next 10 years precipitation might exceed the 15-17 inch range. When considering dryland species, selecting a species with the widest precipitation range would be a wise selection. **Table 1** provides a guide comparing annual precipitation and dryland grass species.

Table 1. Dryland grasses and annual precipitation distribution

		Annual Precipitation (in inches)						
Grass Species	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Crested wheatgrass								
Intermediate wheatgrass								
Bluebunch wheatgrass								
Tall wheatgrass								
Western wheatgrass								
Smooth brome								

Meadow Brome								
Basin wildrye								
Russian wildrye								
Pauite Orchardgrass								

	Best suited for this range
	Ok in this range
	Don't bother range

Table 2 provides a list of possible dryland species and the range of soil textures best suited for each species.

Table 2. Dryland species and compatible soil textures

Soil Textures								
Grass Species	**Mostly Clay**	**Clayey Loam**		**Silty Loam**		**Sandy Loam**		**Mostly Sand**
Crest wheatgrass								
Intermediated wheatgrass								
Bluebunch wheatgrass								
Tall wheatgrass								
Western wheatgrass								
Smooth brome								
Meadow brome								
Basin wildrye								
Russian wildrye								
Pauite Orchardgrass								

	Best suited for this soil texture
	Ok for this soil texture
	Don't bother

Using the Precipitation table and selecting species that perform best within the 12-16 inch precipitation range will help to refine the species selection.
Species to definitely consider:

1. Intermediate wheatgrass
2. Tall wheatgrass
3. Western wheatgrass
4. Smooth brome

Species to possibly consider:

1. Crested wheatgrass
2. Basin wildrye
3. Russian wildrye
4. Pauite orchardgrass

Looking at the Soil Texture table and selecting the species that will most likely perform the best in the clay loam soils of the Sprague River Valley:

1. Intermediate wheatgrass
2. Tall wheatgrass
3. Western wheatgrass
4. Smooth brome
5. Meadow brome
6. Basin wildrye
7. Pauite orchardgrass

Now combining the results from the Precipitation and Soil chart, the list of dryland species that have the greatest potential to succeed would include:

1. Intermediate wheatgrass
2. Tall wheatgrass
3. Western wheatgrass
4. Smooth brome

The next and most important questions are how will the dryland crop be used? When will the pasture be used? **Table 3** provides additional information about dryland grasses which landowners should consider.

Table 3 Dryland grass information

Species	**Minimum precip**	**Ease to establish**	**Competiveness with weeds**	**Season of Use**				**Height**	**Growth type**
				spr	**Sum**	**Fal**	**winter**		
Crested wheatgrass	10	easy	good	X		X		1.6 - 2.6 ft	bunch
Intermediate wheatgrass	13	easy	excellent	X	X	X		2.6 – 4 ft	rhiz
Bluebunch wheatgrass	8	moderate	fair	X	X			1 – 2.6 ft	bunch
Tall wheatgrass	12	easy	excellent	X	X	X		3 -7 ft	bunch
Western wheatgrass	12	moderate	excellent		X	X		1- 2.6 ft	rhiz

Smooth brome	13	easy	excellent	X	X			1.6 – 3 ft	rhiz
Meadow Brome	14	easy	good	X	X	X		2 – 6 ft	Poor rhiz
Basin wildrye	10	difficult	fair	X			X	3 – 7 ft	bunch
Russian wildrye	9	difficult	excellent	X	X	X	X	2.6 – 3.6 ft	bunch
Pubescent wheatgrass	13	easy	excellent	X	X	X		3 – 4 ft	rhiz
Pauite Orchardgrass	14	easy	fair	X		X		1 – 2 ft	bunch

Rhiz=rhizomatous

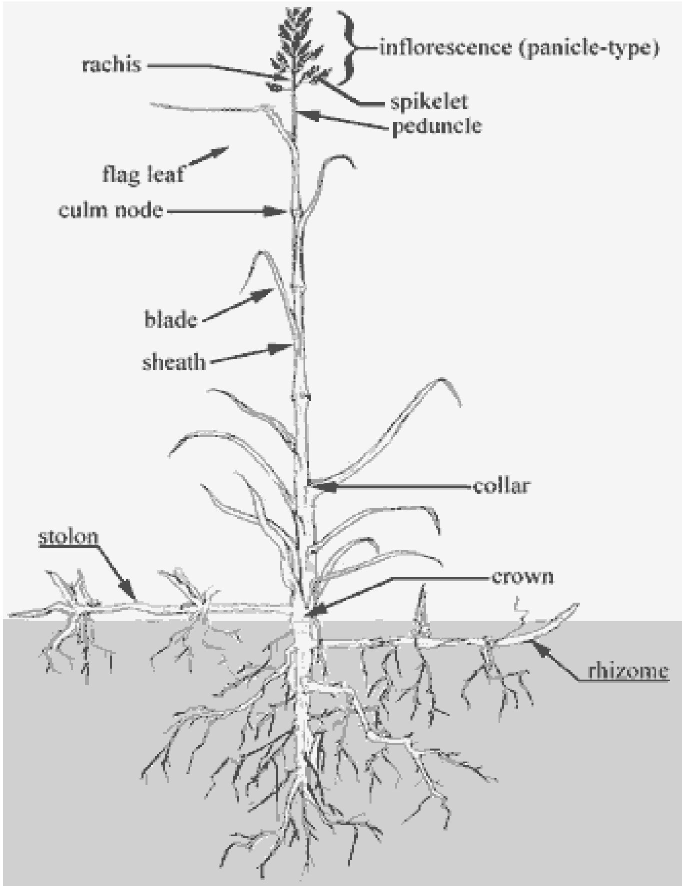
All of the above listed species are cool-season grasses. Warm-season grasses are also available. However, they are not discussed in this document for several reasons:

1. Cool season grasses will usually outcompete warm season grasses;
2. Warm season grasses are more difficult to establish;
3. Warm season grasses have a shorter growing season so they have less total annual production;
4. Cool season grasses tend to have an additional bump in production during the late summer/early fall; and
5. Warm season grasses store their winter reserves, not in their roots like the cool season grasses but in the top 8 inches of the plant, this means warm season grasses require 8 inch of top growth to survive winter kill and grazing would need to end in August.

It is possible to mix warm and cool season grasses but it is not advisable. Mixed stands are difficult to establish and, more importantly, they are difficult to manage to maintain desirable production from each grass type. If both types of grasses are desired, plant them as separate stands so they can be managed appropriately.

What is a rhizomatous species and why is it important to include in a dryland seeding? There are two major methods of reproduction in grasses. Grasses may reproduce sexually by seed, or asexually by vegetative propagation (tillers which arise from buds on culm nodes, rhizomes, and stolons) (**Figure 17)**. Stems growing along the ground's surface called stolons and stems that grow below the surface are called rhizomes. All plants have a root system; a rhizomatous species means that the plant has rhizomes or nodes associated with the root system.

Figure 17. Grass structures



It is possible that a species may have both rhizomes and stolons but, generally, a species will have one or the other.

Why is it important to include a rhizomatous species? And should the dryland mix be only grasses?

Dryland legumes

A grass-legume mixture is typically very productive and generally produces a higher quality of forage than grass alone. Many legumes and some grass species are nitrogen fixing. This is where the question of rhizomatous species comes into play. A species with rhizomes has the ability to convert the nitrogen from the air to the nitrogen that plants can use. All pasture plants require nitrogen. However, the nitrogen in the atmosphere is not the form of nitrogen that most pasture plants can use. Landowners can choose to apply (and pay for) the needed nitrogen through adding fertilizers or by choosing nitrogen fixing grasses or legumes.

Some legumes such as alfalfa have deep taproots that pull water and nutrients from the deeper soil layers enabling them to access soil water even in drought years. An added benefit to using species with vigorous taproots is their ability to act as subsoilers and fracture tillage pans and deeper hardpans (discussed under Biological ripping). However, not all legumes are created equally. Legume species such as white clover have short fibrous roots which remain close to the soil surface and therefore are less drought tolerant and less able to reduce soil compaction.

Landowners, when selecting an accompanying legume, need to consider the risk of livestock bloat specifically with alfalfa. To minimize the potential of bloat, alfalfa should not exceed 1/4 of the production of the field. In most cases, the benefits of alfalfa in a grass mixture outweigh the potential risk of bloat. There are legumes with low-bloat or no-bloat potential such as sainfoin, cicer milkvetch or birdsfoot trefoil.

Sainfoin is extremely palatable, nutritious, deep rooted and very drought resistant. It establishes well with 14 inches or greater of annual precipitation. Although, comparable to alfalfa's good qualities, sainfoin is non-bloating, resistant to the alfalfa weevil and has higher digestible nutrients. For good establishment and growth, sainfoin must be inoculated with a special rhizobium just before planting. Sainfoin does not do well in high water table areas so it should be planted on the toe slopes or slightly higher knolls.

Cicer milkvetch is not as palatable as alfalfa, birdsfoot trefoil or sainfoin. It is also less acceptable to sheep than alfalfa, birdsfoot trefoil and red clover. Cicer milkvetch will grow in soils of all textures from clays to sands, but best performance comes from plants grown on moderately coarse textured soils. It is best suited for areas receiving greater than 15 inches annual precipitation. Cicer milkvetch also does well on wet sites or on sub-irrigated sites where ground water is within 3 feet of the soil surface. The most compatible grasses to plant with cicer milkvetch are creeping foxtail, meadow brome and orchardgrass.

Birdsfoot trefoil has a well developed tap root with numerous lateral branches in the upper 15 inches of soil. Empire-type birdsfoot trefoils are better adapted for grazing. Birdsfoot trefoil yields less than alfalfa on well-drained, fertile soils but is superior to alfalfa on soils of marginal fertility and production capabilities. It should also be inoculated prior to planting.

Dryland Mixtures

All dryland grasses have pros and cons which must be weighed against the landowners goals prior to the species selection. Every landowner must decide for themselves which risk or disadvantages they can live with. Many folks choose to deal directly with seed companies which can recommend seed mixes. However, this sometimes becomes a "shotgun" approach to seed success. Sometimes the recommended mixes contain 5 to 8 different seeds in the hope that 2 or 3 might actually grow. This might seem like a good approach. But, consider if only 2 species out of the 6 species included in the mix are actually viable for the site, then only 1/3 of the seeding stands a chance at producing something. Now, let's take that a step further and realize that not every seed germinates. Let's assume that maybe 80% of the seed for the 2 successful species will germinate. This means that slightly more than ¼ of all the seed that was planted will germinate. Is there a gamble in choosing the correct seed? You bet! So, do your homework and some research.

Much of the dryland seed available has cultivars available. The term "cultivar" comes from a combination of words meaning "cultivated variety." Cultivars are seed sources for individual species (parent seed) that have been developed for specific areas and/or conditions. The term native seed or native grass is pretty ambiguous and basically refers to a species that was present in North America prior to the arrival of Europeans. Much of the grass seed used today was "introduced" from Europe and Asia. These introduced species became the parent material for the grass seed of today, expanding on the desired traits and developing more area specific varieties of each species. As an example, intermediate wheatgrass has numerous cultivars one of which is Reliant. Reliant was developed by intermating 24 different intermediate wheatgrass cultivars and experimental strains for the purpose of developing sustained hay forage. However, it is less drought tolerant than the Clarke cultivar. So, not only is the species selection important but, the cultivar selection is critical. For the purpose of this document an in-depth discussion about cultivar selection is not possible. However, most seed distributors will assist in identifying the type of cultivar that will meet the need.

So, what's the big deal about pure live seed? Having a basic understanding of seeding rates and of pure live seed (PLS) will help in deciding how much seed to purchase. Making the wrong decisions when buying seed will cost time and money and increase the chance of having a stand failure.

PLS refers to the quality of the seed within the seed bag. When dealing with seed it is mostly about the number of seeds in the bag that will produce a product. The first thing to look for is the percent germination, which is the percent of seeds within the bag that is expected to germinate based on standard testing. This is usually at least 90%. Next, what is the percent purity? This is the percent of the weight in the bag that is actually seed. This is important because contained within each bag are inert material such as dust, chaff, and seed coating; weed and other crop seed. These other ingredients can reduce the percent purity to 70%. Generally, a percent purity of 95% or higher is desired.

To determine the PLS, multiply the percent germination times the percent purity and then divide by 100.

(Percent germination X percent purity)/100=PLS

Using the numbers above as an example:
(90% X 70%)/100= 63% (PLS)   In this particular bag of seed only 63 lbs out of 100 lbs is actual live seed.

By purchasing seed with a higher percent germination and purity:
(95% X 90%)/100=85.5% (PLS)   In this particular bag of seed, 85.5 lbs out of 100 lbs is actual live seed.

Seed species are no different than the average family, there are some family members you like to hang out with and there are some that, well….

The goal is to have a simple mix with 2 or 3 species with similar growth rates, drought tolerance and palatability. Complex mixes with different species traits often lead to some grasses being overgrazed while others are underutilized. The optimal mix addresses the landowners grazing/hay needs and provides the best bang for the buck. For example, if the primary goal is to enhance grazing then, determining species tolerance and appropriate grazing times is critical. Crested wheatgrass is one of the most tolerant grazing species, followed closely by bromegrasses, rhizomatous wheatgrasses and Russian wildrye. Recommended levels of use vary by the length of grazing and rest periods and by season of year. Russian wildrye seeded with alfalfa and sainfoin can double animal gain per acre compared with Russian wildrye seeded alone.

Intermediate or pubescent wheatgrass should be included in most dryland grass seed mixtures. Either wheatgrass is easily established; seeds germinate quickly and provide considerable forage while other grasses and legumes are getting established.

Dryland species descriptions (species selected from page 17)
This section includes specific descriptions of the dryland species. Previously discussed species that are not likely to be successful in the Sprague River Valley due to precipitation or soil limitations have been eliminated. It is also important to realize that just because a species fits within the precipitation and soil limits of the Sprague River Valley does not mean that it will be successful. Many additional factors, such as inundation and duration of spring flooding or drought tolerance should be considerations in species selection. Dryland species can be very site specific and species selection should be based on the landowners' interest in field management. In other words, not every inch of the field is identical. There are soil variations, slope changes and areas of limited drainage all within the same pasture. A different seed mix could be used in these microzones, but this will require more management. So, when selecting species be realistic about field capabilities.

Also, included in the descriptions are suggested seed rates, timing and seed depth. All of these suggestions are very dependent on the cultivar used and the planting method. The suggested seed rate is based on single species seeding and not as part of a mix. When used as part of a mix, seeding rates should be decreased. The planting method is assumed to be drilled. Many dryland seed plantings can be broadcast with great success, but seeding rates should be increased 50-75%.

Crested wheatgrass—(not highly recommended, needs drier climate)
Crested wheatgrass provides good forage value for all classes of livestock. Additional, it cures well for use as winter forage. Early spring grazing provides the most value. If provided with sufficient re-growth times between grazing, it has been shown to be highly resistant to grazing damage unless grazing occurs during the stem (culm) elongation phase. For those of you that slept through plant anatomy (and who can blame you!) **Figure 18** might help. Crested wheatgrass is very competitive and can often be used to suppress cheatgrass.
Crested wheatgrass is generally not recommended for use in areas with more than 14 inches of annual precipitation. In Sprague River the historic annual precipitation has been between 15-17 inches which during a "normal" precipitation year would mean the area is just a little too wet for crested wheatgrass. Also, it might not perform well in the low land areas where standing water or extended spring time flooding may occur.

Seed count: 190,000-210,000 seeds per pound
Seeding rate: 5 pounds per acre (PSL)
Seeding times: March 15 to May 15
Seeding depth: ¼-1/2 inches deep if drilled
Germination: 12 to 18 days
Mature height: 8 to 24 inches
Minimum annual precipitation needed: 9 inches

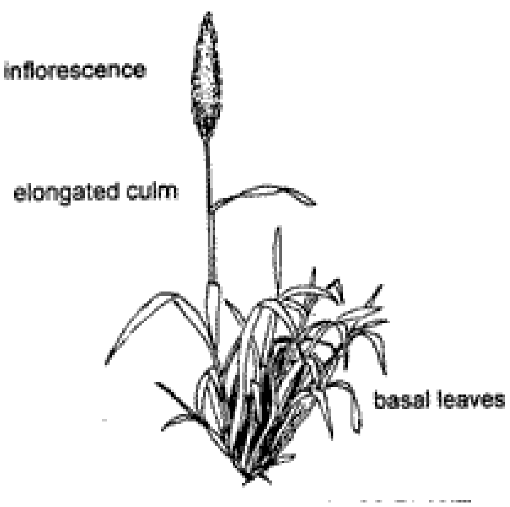


Figure 18. Typical grass plant showing elongated culm or stem

Intermediate wheatgrass—(highly recommended)
Intermediate wheatgrass grows to 3 to 4 feet tall and is a long-lived, cool season grass with short rhizomes and a deep feeding root system. It provides excellent spring, early summer, and fall pasture and is highly palatable. Intermediate wheatgrass is adapted to areas with 12 inches or greater annual precipitation. It performs best between 3500 and 9000 feet elevation. It is not as drought tolerant as crested wheatgrass or Russian wildrye, but it is far easier to establish than Russian wildrye. Intermediate wheatgrass consistently out yields crested wheatgrass and brome grasses.
Intermediate wheatgrass establishes quicker than meadow brome or smooth brome varieties. Seedling

vigor is good to excellent. Under favorable conditions intermediate wheatgrass provides good weed suppression. It has good spring growth and fair summer growth. If moisture is available, it will also provide good fall growth.
Prior to the first spring graze, stand growth should be 10-12 inches. A six-inch stubble height should be maintained following grazing, mowing and prior to winter dormancy.

Seed count: 78,000-80,000 seeds per pound
Seeding rate: 12 pounds per acre (PLS)
Seeding time: March 15 to May 15
Seeding depth: ¼-3/4 inches deep if drilled
Germination: about 14 days
Mature height: 30 to 60 inches
Effective annual precipitation needed: 12 inches

Bluebunch wheatgrass
Bluebunch wheatgrass is a perennial bunchgrass that adapts to many varieties of soil textures. It is very drought resistant. Bluebunch wheatgrass can be used for hay production and will make nutritious feed, but is more suited to pasture/rangeland use. It is palatable to all classes of livestock, but it is considered coarse in summer.

It is very compatible with slower developing native species, such as western wheatgrass. However, it does not compete well with aggressive, introduced grasses or legumes. It is very susceptible to over grazing. Spring grazing should be limited to no more than one out of three years. Bluebunch wheatgrass experiences rapid growth in early spring and therefore no more than 40 percent utilization should occur.

Seed count: 138,000-140,000 seeds per pound
Seeding rate: 6 pounds per acre (PLS)
Seeding times: March 15 to May 15
Seeding depth: ¼-1/2 inch deep (drilled)
Mature height: 24 to 48 inches
Minimum annual precipitation needed: 9 inches

Tall wheatgrass: (Recommended, but with limitations)
Although tall wheatgrass passed the test and met the requirements for use in the Sprague River Valley (at least when the criteria was precipitation and soil textures), its use should be limited. Tall wheatgrass prefers soils with a high water table. It can survive five weeks of spring flooding inundation and therein lies its particular value. Much of the low lying lands adjacent to the Sprague River are typically flooded during normal or high water years. Dependant on weather conditions, late March through the middle of May could find many pastures under water. With the increasing interest in reducing surface irrigation and converting to dryland species, tall wheatgrass could perform well in these areas.
Tall wheatgrass is slow to establish and is not particularly drought tolerant. Under dry conditions it is short lived. It is not as palatable as other wheatgrasses so it should not be planted with more palatable species. Because it matures late, it provides for a longer grazing period.

Seed count: 75,000 to 80,000 seeds per pound
Seeding rate: 12-14 pounds per acre (PLS)
Seeding depth: ½ inch deep (drilled)

Seeding times: March 15 to May 15
Germination: 12 to 18 days, slow to start.
Mature height: 30 to 60 inches
Minimum annual precipitation needed: 12 to 14 inches

Western wheatgrass: (Recommended with limitations)
Western wheatgrass is possibly one of the most adaptable and versatile dryland species. It has a well-developed root system with a mass of surface roots feeding to a depth of 8 inches and deep-feeding roots that penetrate to a depth of 60 inches. This would be a possible selection for pasture biological ripping due to its' root system and capability to survive in water inundated irrigated pastures.
Western wheatgrass thrives in soil types typically found throughout the Sprague River Valley including deep to extremely shallow soils. Not only is it winter hardy and drought resistant but, it is highly palatable early in the growing season while tolerating heavy grazing. Western wheatgrass cures well, making good winter forage.
Hold on before you call the local seed company, there are some possible concerns to consider. Western wheatgrass is difficult to establish from seed due to poor seedling vigor and seed dormancy. However, the young seedlings are small and somewhat inconspicuous. The second year will likely show better results because western wheatgrass spreads not only by seed but by rhizomes. The stand may have appeared to have failed but, importantly these plants spread not only by seed but also spread rapidly by rhizomes. It is more likely that the second year after seeding will show better results.

Seed count: 105,000 to 115,000 seeds per pound
Seeding rate: 8-10 pounds per acre (PLS)
Seeding depth: ¼ - ¾ inches deep (drilled)
Seeding times: March 15 to May 15
Minimum annual precipitation needed: 12 inches

Smooth bromegrass: (Recommended, but can be very invasive)
Smooth brome is a long-lived, sod-forming cool season perennial. It has a well developed deep rooted rhizomatous root system which enables it to survive long periods of drought, extreme temperatures and short periods of flooding.
Bromes adapt to a variety of soils including most soils in the Sprague River Valley. It is a highly productive grass best suited for hay production, but also excellent for pasture use. Because of its aggressive tendency, brome is an excellent companion with alfalfa. Growth is in the early spring followed by dormancy during the dry hot summer months. Then re-growth periods will occur during the late, cool fall if moisture is available. The young grass is very palatable, and so is very susceptible to overgrazing. For this reason, early grazing should be restricted until the plant reaches 10 inches in height. This will provide for much better later season grazing.

Seed Count: 130,000 to 140,000 per pound
Seeding Rate: 12 to 16 lbs/acre (PLS)
Seeding depth: ¼ - ½ inches deep (drilled)
Seeding Time: March 15 to May 15
Germination: 7 to 14 days
Minimum annual precipitation needed: 13 inches

Planting

Ok, great the seed is in the barn. Now what the heck do I do with it?

Planting dryland

There are two common methods for dryland planting, drill or broadcast. As a part of the dryland planting plan, consider the type of equipment necessary and the equipment available. Most seeds come with recommendations for planting, but the application method is not nearly as critical as the seedbed preparation. The previous sections discussing soil health and methods to improve soil health are just as applicable in seed bed preparation. Prior to any seed planting, evaluate the field conditions around compaction and or sod-bound areas. Remember one of the primary reasons for field failure is lack of seed to soil contact. Are the current field conditions likely to promote or inhibit seed to soil contact?

Field fallowing

Fallowing is the process of using tillage or herbicides (either singularly or together), in an effort to remove weeds, increase soil moisture and improve soil health. The field can either be rested for a season or planted with an annual grain crop a year or two prior to the dryland planting. The grain crop can be harvested and the stubble disked into the soil to increase the soils organic matter. Another option is to mow the grain crop and then plant the dryland crop into the stubble. The remaining stubble provides protection or cover for the newly planted dryland.

Seedbed preparation and Seedbed packing

Methods of seedbed preparation depend on individual situations but tillage is usually necessary. The basic idea is to break-up the top layer to remove unwanted vegetation, and then plant the desired vegetation.

If you are planning a spring planting, begin seedbed preparation during the previous fall. This can usually be accomplished using a disk harrow. Disking of the site in the fall exposes perennial weed roots to winter freezing temperatures, promotes water infiltration and reduces soil compaction. During the following spring, after the upper soil surface layers have dried, the surface should be re-worked at a shallow depth to break up clods and eliminate annual weeds. Again, a disk harrow is suited for this job. The goal of the final seedbed preparation is to provide a firm seedbed. A correct seedbed (**Figure 19**) is the first step towards the successful establishment of a grass and/or legume crop. A correctly-packed seedbed provides a shallow, precise seeding depth and promotes a greater seed to soil contact. The seedbed should be packed firm enough so that footprints made by a person walking on the field are hardly visible. A cultipacker (**Figure 20)** is used to crush dirt clods and smooth and repack the soil creating a firm seedbed.

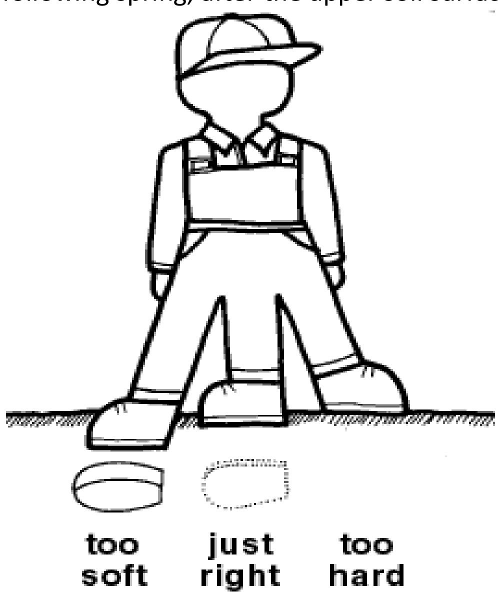


Figure 19. Correct seedbed firmness

Figure 20. Cultipacker

Figure 21. Field after cultipacking

Seed Planting
Broadcasting
Broadcasting of dryland plantings is not highly recommended by most industry experts. However, in the Sprague River Valley availability of equipment necessary to drill seed is somewhat limited. Some dryland has been successfully established in the area using a seed broadcaster. **Figure 22** shows a broadcaster with a cultipacker attached. Keep in mind, that seed planting depth is critical. Many fields will require several passes with a packer prior to seeding to establish a firm enough seed bed.

Figure 22. Broadcasting seed and pulling a cultipacker to maximize seed to soil contact

The above dryland site (**figure 22)** involved a spring planting. The site had been surface irrigated pasture. However, the site was at the tail end of the irrigation system and slightly uphill. Irrigating this site was not only inefficient but also ineffective. The field was plowed, chiseled, and harrowed during the previous fall in preparation for the spring planting. The field surface was left rough over the winter to promote infiltration (**Figure 23).**

Figure 23. Fall preparation for spring planting

When spring arrived and the upper soil layers had dried, the field was re-worked using a cultipacker to break-up the clods and pack the seedbed. The dryland seed at this site was broadcast early May of 2010 using the method shown in **Figure 22**. The results of this dryland planting are shown on the cover page.

Drilling

The planting of dryland seed using a drill is considered the best application method. There are many types of seed, grain, range and grass drills out there and selecting the proper equipment is the first step. It is best to use a grassland drill specifically designed to seed grasses **(Figure 24)**. These drills are equipped with a large seedbox (or preferably two seedboxes) that contains an agitator to prevent light and chaffy seed from bridging over the seed openings. The drill should have a positive feed mechanism to meter seed distribution uniformly which produces even stands.

Figure 24. Grass drill

Seeds should pass freely through the seed tubes into furrows. Double disk openers positioned to provide for 12-14 inch rows with attached depth bands, provide for a ¼-1/2 inch planting depth. Packer wheels should follow to firm the soil around the seed. A roller may be towed immediately behind the drill if it doesn't cover seeds too deeply.

For seed depth placement, a general rule of thumb is*: the heavier the soil and the higher the moisture content, the shallower the seed should be placed. In contrast, the lighter the soil and the lower the soil moisture, the deeper the seed should be placed.*

Desirable drill features include:

1) Double disc seed furrow openers;
2) Multiple seed boxes provided the ability to seed native fluffy seeds, cool season species, small grains, and/or legumes at the same time;
3) A seedbox agitator for keeping large and small sized seeds blended together evenly;
4) Depth bands, wheels or other methods of controlling the depth of each seeding unit; and
5) A press wheel following each seeding unit, to firm the soil around the seed.

To produce stand uniformity and avoid missed spots it is sometimes helpful to drill half of the seed in one direction and the remainder at right angles.

Summary

Dryland cropping has been and will continue to be, a viable alternative to irrigated pastures and irrigated hay production in the Sprague River Valley. Of course, dryland will not be productive everywhere and converting any existing irrigated field to dryland, does not come without risk. The question is: is that risk any more injurious than the risk of unknown surface water supplies or the continuing, rising cost of power?

But first and foremost ask yourself if your current operations are efficient or effective. What are the conditions of your soil? Are you using your soil to the best of its potential? Is soil compaction sending what little water that is received on the land into thin air?