Alfalfa's Potential in Dryland Crop Production

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Alfalfa is a nutrient rich forage crop that is productive and beneficial agronomically and environmentally in the Inland Empire. There are adapted varieties for all but the driest areas, and alfalfa performs even better under irrigation. Because most alfalfa literature and variety testing done in the West pertains to irrigated alfalfa, this article attempts to extrapolate that information in order to estimate alfalfa's potential as an alternate or longer term rotation crop in the three-year rotation, dryland grain producing area of the Inland Empire. Here, yields range from one to three tons of alfalfa per acre in areas receiving 14 to 17 inches of precipitation. One cutting is the rule except on good soils in the higher end of the precipitation range where a second cutting can occur in wet years. Multi-cutting alfalfa production in sub-irrigated meadows, or in the higher rainfall area of northeastern Washington near the Washington-Idaho border, is more akin to production under irrigation and is not the topic of this article.

History. Alfalfa is an ancient crop. Charred seed has been found in archeological sites in Iran dating back 8000 years, and charred seed from small seeded legumes and grasses collected by people 12,000 years ago in present day Syria has also been unearthed. It is speculated that alfalfa was used as a forage crop and its seed eaten by humans. By the first century, alfalfa had migrated along war and trade routes from the mid-east to the Mediterranean and to China. The Conquistadors brought alfalfa to the Americas in the 1500's, and settlers in the American colonies brought or ordered seed from Europe. Both Washington and Jefferson experimented with alfalfa, but neither had much luck growing it because of their wet, acidic soils. These alfalfa's from Europe were called Lucernes, bluepurple flowered plants (Medicago sativa) of Mediterranean origin. South American alfalfa, known as Chilean clover, was found to be well suited to the calciferous soils of the west, and spread from California to the mid-west in the mid-to late 1800's. These early alfalfas were poorly adapted to the colder parts of the US. One exception was a variety later named Grimm after its developer, a Minnesota farmer who selected winter hardy plants from seed furnished by his Swiss neighbors in the post-Civil War period. Grimm was apparently a cross of the two species, M. sativa and M. falcata. But the success of this variety was not widely known. So, USDA's first agricultural explorer, Niels Hansen, was sent to Russia and Siberia to collect cold hardy, yellow flowered alfalfa seed (Medicago falcata), which he did during three trips around the turn of the 19^{th} century. Figure 1. depicts the historic, world-wide paths of alfalfa migration.

Figure 1. World-wide alfalfa migration (from Russelle, 2001)

For the first quarter of the 20th century, winter hardiness was bred into alfalfa varieties. Then, up into the 1950's, bacterial wilt resistance was added as a selection criteria by alfalfa breeders. In the second half of the 20th century, many varieties were developed with multiple pest resistance, production traits including vigorous recovery after cutting, and multi-foliate characteristics intended to (but not proven to) improve nutrient content. Today, alfalfa varieties contain germplasm from a number of sources. The relative importance of these sources in the genetics of fall dormant alfalfa varieties is illustrated in **Figure 2.**

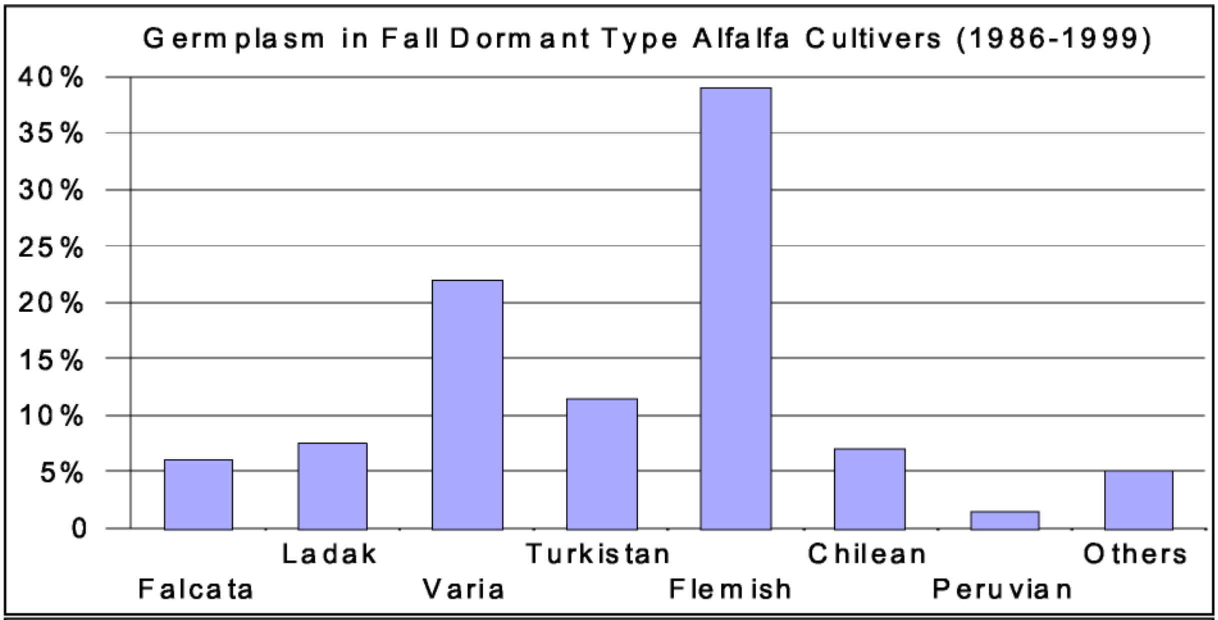

Figure 2. Germplasm sources. Adapted from Proc. N. American Alfalfa Improvement Conf., 2000.

Agronomic benefits. Alfalfa improves and protects the soil as a result of its robust and perennial root system, fast growing protective canopy, and ability to fix atmospheric nitrogen. It requires no nitrogen fertilizer. Alfalfa has a nitrogen replacement value in succeeding grain crops of about 65 pounds of nitrogen (Soil and Water Quality, 1993). Its deep and extensive root system reduces erosion by holding soil together, improves tilth and water infiltration, and contributes to a rhizosphere conducive to growth of beneficial microorganisms. Because of its perennial nature, annual tillage is reduced. Its vigorous growth combined with annual harvest during the growing period provides excellent weed control. In Canada, reduction in herbicide use in flax production following alfalfa netted an additional $22 per acre (Martens, 2001). Alfalfa's pesticide requirements are much lower than for other crops (often none). Alfalfa's residual benefit to succeeding corn crops, probably from disease suppression and fixed nitrogen, has been shown to range from 5 to 13 percent (Peel, 1998), although this benefit may not translate directly to small grain crops if adequate soil moisture recharge does not occur following alfalfa which depletes deep soil moisture reserves.

Ecological benefits. Reduced erosion and chemical use are obvious ecological benefits of alfalfa production. Carbon sequestration is a less obvious, but important one. Wildlife enhancement goes hand in hand with alfalfa production. It provides direct feed for deer, upland birds, and rodents. It also provides protective habitat for these wildlife, and as a consequence, it provides hunting opportunity for predators. Alfalfa is a productive insectary, providing feed and habitat to honey bees and other beneficial insects as well as insects that provide feed for birds, reptiles, bats and other small mammals.

Economics. For alfalfa to be a viable rotation crop, it must perform economically and agronomically. Since we in the PNW have the capacity to easily overproduce alfalfa hay, driving hay profit margins into the red as we have done with other commodities, look before you leap. All of you cannot start rotating to alfalfa. Nevertheless, the following budgets are intended for guidance and planning for those who might. Be forewarned: farmers' actual costs and returns from alfalfa will vary widely from those in these budgets depending on their individual circumstances. These include cost of land, equipment, and purchased inputs, their land's inherent production capability, and their local market opportunities. Consequently, readers are cautioned to examine the assumptions carefully in evaluating just how these budgets should be used and modified to reflect actual operations on their farms.

Budget 1 shows the cost of establishing dryland alfalfa as a rotation crop following grain, and Budget 2 shows the cost of producing dryland alfalfa as a rotation crop. Assumptions are that alfalfa is established in a spring crop or summer fallow year, there is no harvest during the establishment year, subsequently there are three harvest years followed by fallow or spring crop, establishment costs are amortized over the three harvest years, and yield averages 2.0 tons of hay per acre. This yield assumption is based on a first harvest year yield of 2.25 tons hay per acre followed by an annual yield decline of ten percent per year as the stand ages. Dryland alfalfa yield potential in our area is limited by precipitation. It takes roughly 6 inches of available soil moisture to produce one ton of alfalfa. Using Davenport as an example, there is about 7 inches of effective precipitation (available for storage in the soil) during the non-growing season, and additionally about 2.25 inches from the beginning of the growing season until hay harvest, for a total of 9.25 inches effective precipitation in an average year, enough to grow approximately 1.75 tons alfalfa. Three harvest years were used in this analysis because of the increasing need for additional inputs (fertilizer, weed control, gopher control) beyond this time with diminishing yields expected from these inputs as the alfalfa stand ages and any residual soil moisture reserves are depleted.

Profit potential for alfalfa under the budget assumptions in this article depends on whether the grower harvests alfalfa for hay or sells standing alfalfa to someone else for harvesting. Hay is projected to return $1.02 per acre, and standing alfalfa is projected to return $16.52 per acre. Although no one is going to get rich on these margins, alfalfa as a rotation crop may be competitive with spring grain which currently projects only break even or negative returns (Platt et al., 2003) Furthermore, alfalfa provides an excellent opportunity for substantial, low cost inroads in combating weeds because of its competitiveness coupled with the fact that it is mowed annually before most weeds go to seed. Alfalfa's future contribution to soil nitrogen, reduced herbicide use, and boosted crop yield have been discussed previously in the section on Agronomic Benefits.

For those not owning hay equipment, there are several alternatives. First, don't make hay. Sell standing alfalfa to someone in the hay making business. Standing alfalfa generally sells for 50 to 60 percent of the price of field stacked, baled hay. A second alternative is to hire a custom operator to make hay. Budget 2 shows costs for producing standing alfalfa and for producing big bale hay using a custom operator. Cost of producing hay with farmer owned equipment is similar when all costs of equipment ownership are considered. A third alternative is to have hay made on shares. The grower's share of the split generally ranges between 50 and 60 percent.

Budget 1. **Cost of establishin g dryland alfalfa as a rotation crop following grain, $/acre**

Operation	Materials	Equipment and Operator	Total
Harrow	$ 2.50		$ 2.50
Chisel/fertilize	$40.00	$ 7.88	$ 47.88
Cultivate	$ 4.00		$ 4.00
Harrow	$ 2.50		$ 2.50
Pack	$ 6.51		$ 6.51
Seed	$20.00	$ 7.50	$ 27.50
Weed control	$ 12.00		$ 12.00
Taxes and overhead	$		4.00
Total establishment cost per acre			$106.89

Operating Assumptions:

- Two ton per acre yield
- Alfalfa rotation will last for 4 years, establishment year plus 3 harvest years. No harvest during establishment year
- Cost of establishment plus interest amortized over 3 harvest years
- Fertilizer is applied during establishment. Fertilizer cost is amortized over 3 harvest years
- Seeding rate, 8 pounds per acre planted with a grain drill. Seed mixed with rice hulls as a carrier
- Weed control occurs only during the establishment year by mowing or herbicide application having approximately the same cost
- No gopher control is utilized
- Cost of field operations adapted from Platt et al., 2003

Budget 2. Cost of producing dryland alfalfa as a rotation crop, $/acre			
Operation	**Materials**	**Equipment & Operator**	**Total**
Establishment [a]			$41.48
Harrow		$2.50	$ 2.50
Land [b]			$21.50
Taxes and overhead			$ 4.00
Per acre production cost for standing forage			**$69.48**
Per ton production cost for standing forage [c]			**$34.74**
Swath		$17.00	$ 17.00
Rake		$ 8.00	$ 8.00
Bale		$30.00	$ 30.00
Field Stack		$ 8.00	$ 8.00
Load Out		$ 6.00	$ 6.00
Land [b]			$ 40.00
Taxes and overhead			$ 6.00
Per acre production cost for hay			**$158.98**
Per ton production cost for hay [c]			**$ 79.49**

Operating Assumptions:

- Alfalfa rotation will last for 4 years, establishment year plus 3 harvest years

[a] Cost of establishment (Budget 1) plus interest amortized over 3 harvest years

[b] Land cost is 25% of the crop sold. Assumed sale price is $43/t for standing crop (hay equivalent basis) and $80/t for field stacked, big baled hay

[c] Two ton per acre yield of hay or equivalent standing alfalfa (based on a first harvest year yield of 2.25 tons per acre and a 10% annual decline in yield

- Harvesting costs are for custom swathing, raking, big baling, field stacking, and load out
- Fertilizer and weed control occurs during the establishment year and is amortized over the 3 harvest years of crop production
- No gopher control is utilized
- **Totals in shaded cells** for standing alfalfa were not double counted in totals for alfalfa hay
- Cost of field operations adapted from Platt et al., 2003 and current custom harvest rates

Timeliness of harvest operations and adverse weather risk must be considered when deciding whether to sell standing alfalfa or baled hay, and both should be evaluated in relation to the hay's market potential. For example, a week to ten day delay in harvest because a share or custom operator was unavailable could easily result in a 10 to 15 percent loss in the hay's market value because of advanced crop maturity, and even more value loss if rain damage occurred during that period. Farmers undertaking a new haying operation themselves might experience similar delays because of inexperience, equipment problems, and unanticipated time and equipment conflicts with other late spring farm operations. Loss in alfalfa hay's value because of untimeliness depends on how important alfalfa crop maturity at harvest is to potential buyers. If hay is sold on a USDA hay quality designation basis, maturity is a very important anti-quality factor. This topic is discussed later in the section, Hay Quality. Who bears this market risk of untimeliness? If the alfalfa is sold unharvested as standing crop, the purchasing hay operator bears it. If the alfalfa grower undertakes the harvest operation or has the hay harvested on a custom basis or on shares, the grower bears the risk. However, when others are responsible for harvest, the grower has little control over its timing and consequently has little ability to manage risk of untimeliness. This can be an untenable situation.

Varieties. Alfalfa varieties are classified by their tendency to go dormant in the fall as opposed to growing throughout the winter. This classification is called *fall dormancy rating.* Fall dormancy is related to winter hardiness; the stronger alfalfa's tendency to go dormant in the fall the more winter hardy it is likely to be. Although controlled by separate genes, it is thought that the two traits of fall dormancy and winter hardiness co-evolved. Fall dormancy is triggered by decreasing daylight. It is unrelated to temperature. Strongly fall dormant varieties tend to produce lower yields in multi-cut production systems because they begin growth later in the spring and begin to slow growth earlier in late summer and fall as a result of their sensitivity to shortened day length. However, strongly fall dormant varieties also tend to be drought hardy and tend to be good, single cut producers–just what we need for a dry land rotation crop. Alfalfa breeders recognize that the traits *fall dormancy* and *winter hardiness* can be separated, and they are beginning to offer higher yielding, multi-cut winter hardy varieties that are only moderately fall dormant (Busbice, undated).

Unfortunately, winter hardiness is not one of the characteristics used by the National Alfalfa Alliance (formerly Alfalfa Council) in classifying varieties. Rather varieties are characterized by fall dormancy and pest resistance. Most alfalfa yield trials also characterize varieties by fall dormancy and pest resistance. Consequently, fall dormancy remains a useful, although imperfect tool for evaluating both drought hardiness and winter hardiness. The National Alfalfa Alliance is an alliance between segments of the alfalfa and alfalfa seed industry: growers, genetic suppliers and universities. The Alfalfa Council's Fall Dormancy and Pest Resistance Ratings for Alfalfa Varieties (the industry standard) is available on the web at http://www.alfalfa.org/falldormancy.html . Private seed companies generally offer additional information on their varieties' winter hardiness and drought hardiness, but this information needs to be evaluated carefully, because it is difficult to ascertain from promotional information whether testing was done under climatic conditions even remotely similar to those found here.

Fall dormancy is rated on a scale of 1 to 11, with 1 being the most fall dormant and 11 being non-dormant. Research in Montana (Cash et al., 1993) indicates that alfalfa varieties with fall dormancy ratings (FD) 1-4 are suitable for production there, and it is a reasonable assumption that varieties with these FD ratings are also suitable for dryland production in eastern Washington. In the absence of other information from on-the-ground testing or local experience, varieties with FD ratings of 2 or 3 should be selected. For reference, the old standard varieties commonly used in the past in eastern Washington have the following FD: *Ladak 65,* 1; *Vernal,* 2; *Ranger,* 3; and *Saranac,* 4. Although there are only a few commercial varieties with FD 1, including *Ladak* 65, there are many with FD's 2-4.

In addition to FD ratings, alfalfa varieties are rated by their resistance to disease and insect pests. Although selected for uniformity, most alfalfa varieties are cross pollinated populations of plants with a variety of genetics. Consequently, there are differences in disease and insect resistance among plants comprising a variety. A variety is considered highly resistant to a pest if greater than 50% of plants show resistance. Forty percent resistance is considered adequate for field protection (Cash et al., 1993). Forage agronomists recommend that farmers seek multiple pest resistance in selecting alfalfa varieties, with special attention to verticillium wilt, bacterial wilt, fusarium wilt, and pea aphid. Table 1 describes alfalfa variety pest resistance ratings commonly used by seed dealers and reported in variety trials.

Table 1. Alfalfa pest resistance ratings

Resistant Plants, %	Resistance Class
0-5%	Susceptible (S)
6-14%	Low Resistance (LR)
15-30%	Moderate Resistance (MR)
31-50%	Resistance (R)
>50%	High Resistance (HR)

Adapted from Alfalfa Council, 2002.

In the absence of dryland alfalfa variety tests in eastern Washington, the experience of local alfalfa producers and seed dealers serves as the best guide for variety selection. Visit with your neighbors and seed dealers for their experience with different varieties. Ask seed dealers for names of local growers you can contact. If you are tempted to plant a new variety without any local experience, don't put all your eggs in one basket. Use it sparingly. In fact, planting several varieties in different fields or portions of a field has important advanstages. One, you can readily evaluate performance of different varieties on your farm, and two, differences in maturity date can spread out workload at harvest, which has advantages in maintaining hay quality and in dealing with adverse weather.

Establishment. Spring planting alfalfa is recommended. It is easier to establish into spring grain stubble rather than into heavier, winter grain stubble. The soil must be free of residual broadleaf herbicides used in previous small grain crops. Prepare the seedbed as you would for a spring grain crop using care not to overwork and dry out the soil surface.

Fertilize according to soil test. Established alfalfa fixes its own nitrogen, although 20 pounds N is often recommended for new seedlings. Alfalfa is a heavy user of phosphorus

(P), using about 10 pounds of phosphate (P_2O_5) per ton of alfalfa produced. Phosphorus incorporated into the soil before planting is approximately two times more available for plant use than is top dressed phosphorus. Phosphorus is not mobile in the soil profile, and alfalfa's roots are not able to extract phosphorus from dry soil. So, phosphorus applied to the soil surface isn't available once the surface dries out. If one anticipates a two ton yield annually for 3 years, then 60 pounds of phosphate will be extracted by the crop over the life of the stand. WSU's fertilizer guide, *FG-30 Non-irrigated Alfalfa in Eastern Washington,* calls for incorporation of 60 pounds of phosphate if soil test is less than 4 ppm P (using the Olsen-bicarbonate laboratory phosphorus extraction method) . The rule of thumb: apply enough pre-plant P to last the life of the crop or until your wallet says ouch, and then reapply as necessary according to soil test when the stand is mid-life.

Alfalfa is also a heavy user of potassium, but eastern Washington soils generally have adequate levels. If soil test indicates otherwise, potassium can be top-dressed. Sulfur is also required by alfalfa, and about 15 pounds of S is required per year. Several years worth of sulfur can be applied at one time. Boron deficiency is common in eastern Washington. Three pounds of boron should be applied if soil test B is below .5 ppm (two pounds in sandy soils). Boron is toxic, so do not apply excess or in bands.

Seeding. Alfalfa should be planted shallower than grain, because the small seed has less stored energy to push the seedling from great depth. Most recommendations are to plant alfalfa at a depth of 1/4 to 1/2 inches. Although this shallow depth accommodates the seeds' energy reserves, under dryland conditions, it does not assure that the seed will remain in contact with soil moisture. Seeds that dry out before they germinate or seedlings that can't sink their roots fast enough to follow the moisture won't grow, so don't gamble. Plant a little deeper, up to one inch, in a firm seedbed. Using a drill with good depth control is desirable. Packing, either with the drill or prior to or after seeding, helps maintain seedsoil-moisture contact. A good spring rain prior to seeding and after seedbed preparation will also firm up the seedbed. Research from Wisconsin (Undersander et al., 2000) shows that there is very little difference in emergence between alfalfa seeded at 1/2 inch or at one inch, but there is a great difference in emergence from seeds planted at 1 inch versus 1 ½ inches. No-till drills are used successfully to seed alfalfa, but, *as with al drils,* time and care must be taken to ensure seed placement is proper and soil moisture contact is maintained. Don't assume drills are calibrated and seeding properly. Plan on taking the time necessary to calibrate and check out your drills prior to and during seeding. This could easily take a full day with drills not previously set up to seed alfalfa.

What is the proper seeding rate? Under normal conditions, 50% to 60% of planted alfalfa seeds emerge and 60% to 80% of emerged seedlings die the first year. A reasonable goal for alfalfa plant density in a year old stand after the first winter is 12 plants per square foot. If you do the above math on survival rates, this translates to a seeding rate of about 15 pounds per acre, more than is needed for dryland eastern Washington. Research in Wisconsin (Undersander, personal communication) found that under good seeding conditions there was no advantage in stand establishment to planting more than six pounds of alfalfa seed per acre. So, the general recommendation there, taking into consideration that not all seeding conditions are ideal, is to plant 12-18 pounds per acre. In dryland eastern Washington, drilling six to 12 pounds of alfalfa seed per acre is adequate. Interestingly, drills set at the same setting will seed different varieties of alfalfa at greatly different rates. Undersander (1999) found that actual, on-farm seeding rates varied from 14 to 19 pounds per acre using different varieties of alfalfa seeded with the same drill at the same setting. The point is, calibration is essential every time a new lot of seed is used, because differences in seed size and weight will affect seeding rate.

Alfalfa fixes atmospheric nitrogen through a symbiotic relationship with *Rhizobium* bacteria which create nodules on its roots. To assure adequate amount and proper species of Rhizobium, all alfalfa seed must be inoculated before planting, either by using pre-inoculated seed or by mixing inoculum with the seed before planting.

When to plant. Alfalfa seedlings are very cold tolerant at emergence, but become sensitive to freeze damage by the time the second true leaf emerges, which is generally about 2 ½ weeks (Undersander et al., 2000). Then, four hours at 26 degrees will kill seedlings. Generally, when soil conditions allow field work in the spring, alfalfa can be planted, but frost pockets remain susceptible to damage. However, waiting too long before planting can also result in a dry seedbed, so date of seeding is a trade off. *Washington Climate Summaries* for Harrington, for example, show a 70% chance of 24 degree frost on April 15, dropping to 50% on May 1, and 20% on May 15. These probabilities indicate that alfalfa seeded around the first of May would be susceptible two weeks later to injury by frost one year out of five. Unfortunately, these climate summaries do not indicate duration of the freezing temperatures, although freeze damage occurs from the combination of freezing temperature and its duration.

Nurse crops or companion crops are sometimes seeded with alfalfa to boost hay yield in the establishment year. My advice is forget both the companion crop and the first year hay crop. The companion crop will compete with the alfalfa seedlings for moisture, and on a dry year, this can result in a seeding failure. In any case, even with a companion crop, establishment year hay yield will still be low. Because of the high cost of establishing alfalfa, it is better to establish a healthy stand than to plant a companion crop and gamble on a wet spring, risk damaging your alfalfa seeding, and still harvest a small grain companion crop at yields near or below breakeven cost. The only crop you should plan on harvesting during the establishment year is weeds. Mowing once or twice is often necessary if herbicides aren't used, and mowing provides effective weed control.

Pests. Once established, a healthy stand of alfalfa is very competitive against weeds. Mowing also helps keep many weeds in alfalfa from going to seed. As the stand ages and declines, weeds increase, especially mustards, cheatgrass and bulbous bluegrass. Gophers become problems in most alfalfa stands, also as they age. A three year productive life for alfalfa used in rotation with small grain was used in the budgets discussed previously in order to reduce added costs of pest control, additional fertilizer application, and normal stand decline. Insect pests generally are not a problem in single cutting, dryland alfalfa.

Your approach to managing pests should depend on your goals for hay quality. Don't use pest control designed to produce dairy quality hay if producing hay of that quality is unlikely because of excess cost, inexperience, drought hardy varieties with high stem to leaf ratio, adverse weather, timeliness of harvest operations, equipment problems, weeds, or other factors. Know your market and your quality potential. Producing "premium" alfalfa hay in a single cut, dryland operation is unlikely. However, desirable "feeder" to "good" quality hay can be raised with minimum pesticides (see section on Hay Quality).

In dryland alfalfa production, herbicides are used in three different situations:

1. Pre-plant, soil incorporated herbicides are sometimes used where direct seeding does not provide enough mechanical weed control. Products contain benefin (Balan

DF), EPTC (Eptam); or triluralin (Treflan HFP). With a few exceptions, these herbicides are effective against annual grassy weeds and also against kochia, pigweed, and lambsquarter. For a detailed discussion of herbicide effectiveness on specific weeds, see Parker, 2003.

2. Post-plant herbicides for seedling alfalfa are available both for grassy and broadleaf weeds . The following are registered for broadleaf weeds: 2,4-DB (Butyrac and Butoxone) and bromoxynil (Buctril). These herbicides can be mixed to broaden the range of weed families on which they are individually effective. Timing is important to minimize damage to seedling alfalfa. For grassy weeds, sethoxydim (Poast or Poast Plus) and cethodim (Select) are registered. Some herbicides have effectiveness on selected grassy and broadleaf weeds. Imazethapyr (Pursuit) and imazamox (Raptor) fall into this category. For these two chemicals, long re-cropping and pre-harvest restrictions apply, so give this careful consideration. You may view labels for these herbicides on-line at *Crop Data Management Systems* (see references).

3. For established alfalfa, and in addition to several of the herbicides discussed above, the following are registered: pronamide (Kerb) for grassy weeds, applied to dormant alfalfa in fall or winter; contact herbicides paraquat (Gramoxone Extra) for annual broadleaf and grassy weeds, applied to dormant alfalfa in fall or spring, and diuron (Karmex or Direx) for annual grasses and broadleafs, applied at start of fall dormancy; metribuzin (Sencor), terbacil (Sinbar), or hexazinone (Velpar) for selected broadleaf and grassy weeds, applied to dormant alfalfa; and norflurazon (Zorial), a soil active, pre-emergence inhibitor of annual grassy and broadleaf weed seedlings. The reader is referred to Parker, 2003 for more detailed information on use of these herbicides.

Remember, alfalfa herbicides have specific time windows for application as well as post-application haying, grazing, and plant back restrictions. Study the label carefully and consult with your agri-chemical supplier.

Although small grains do not produce an environment favorable to gophers, alfalfa does. Eventually, they will find their way to their new home, your alfalfa! Gophers love alfalfa; they will eat the roots, killing some plants, and their mounds cause dirty hay when hit by the mower. Since gopher populations increase in alfalfa gradually, normal rotation back to small grains often provides adequate control. However, if control is needed during the life of the alfalfa stand, your options are limited. Trapping with body gripping traps, a time consuming but effective control, was banned in Washington State by initiative several years ago. Of the many other methods and gimmicks for controlling gophers, underground poison bait applied with a three point, tractor mounted, artificial burrow builder is the most commonly used. This device deposits about two pounds of bait per acre in artificial burrows made with a below ground opener. Gophers find the bait when the artificial burrow intersects their natural burrow.

Alfalfa growers can become obsessed with gophers, like Bill Murray in Caddyshack. However, some growers choose to live with gophers. As an alternative to control, mowing height can be increased to avoid gopher mounds. Increasing mowing height decreases yield 15 to 25 percent, but it also increases hay quality by about 30 Relative Feed Value units (Meyer, 2002). Hay quality parameters will be discussed in more detail in the section entitled Hay Quality. Badgers feed heavily on gophers. Although they make a few mounds themselves, some alfalfa growers think a few badger mounds are a good trade off for lots of gopher mounds. Badger mounds can be staked and flagged so that they can be avoided at harvest. Female domestic cats make great gopher hunters. I have a mental image of an alfalfa field with cat houses placed out every 4 acres, complete with self-waters and feeders. All the cats, of course, are sleeping on the front porch of the farm house.

Deer are attracted to alfalfa and feed on it periodically throughout the growing season, but their preference for alfalfa seems to increase as the season progresses beyond midsummer. For single cut, dryland alfalfa, this isn't much of a problem, because the alfalfa is already harvested by the time deer start feeding more heavily on it. But for irrigated alfalfa, deer damage can be substantial late summer.

Alfalfa weevil is the insect most likely to be a problem on dryland alfalfa because the larvae begin feeding in the spring, first on alfalfa's growing tips, and then shred the foliage, giving the field a grayish hue. However, alfalfa weevil populations high enough to economically warrant control are not common in our dryland production area.

Hay Quality. Standing alfalfa is a perishable commodity. When you make hay for sale, you need to get it right. Producing quality alfalfa hay is an art based on timely harvest operations; clean, healthy stand of alfalfa; well operating equipment; cooperative weather; and experience and judgment of the hay producer. Timely harvest and baling operations are critical. Delays caused by equipment malfunction, too many acres, family obligations, or weather can quickly translate into loss in hay quality and value of $15-$30 per ton. Since hay prices reflect hay quality, a basic understanding of hay quality is important for anyone raising and marketing alfalfa hay. This section provides background information to help hay growers interpret terminology used in classifying and marketing alfalfa hay in the PNW.

USDA compiles weekly hay market reports for the PNW and California from its office in Moses Lake. In addition, USDA also compiles monthly and annual hay market summaries. This information is available in several agricultural publications, and it is also available online at *USDA Agricultural Marketing Service Livestock and Grain Market News Branch* (see References).

Table 2 specifies USDA's alfalfa and grass hay quality designations for western hay market news reporting, revised in March of 2003.

Table 2. Alfalfa Hay Designation (domestic use, not more than 10% grass)

QUALITY	ADF (Acid Detergent Fiber, %)	NDF (Neutral Detergent Fiber, %)	RFV (Relative Feed Value)	TDN (Total Digestible Nutrients, %)	CP (Crude Protein, %)
Supreme	<27	<34	>185	>62	>22
Premium	27-29	34-36	170-185	60.5-62	20-22
Good	29-32	36-40	150-170	58-60	18-20
Fair	32-35	40-44	130-150	56-58	16-18
Utility	>35	>44	<130	<56	<16
Grass Hay Designation					
Premium					>13
Good					9-13
Fair					5-9
Utility					<5

Quantitative factors are approximate, and many factors can affect feeding value. Values based on 100% dry matter. End use may influence hay price or value more than testing results.

Hay quality designation's and physical description:

<u>Supreme.</u> Very early maturity, pre-bloom, soft fine stemmed, extra leafy. Factors indicative of very high nutritive content. Hay is excellent color and free of damage. <u>Premium.</u> Early maturity, pre-bloom in legumes and pre-head in grass hays, extra leafy and fine stemmed-factors indicative of a high nutritive content. Hay is green and free of damage.
Good. Early to average maturity, early to mid-bloom in legumes and early head in grass hays, leafy, fine to medium stemmed, free of damage other than slight discol-oration (reasonable target quality designation for dry land alfalfa hay). Fair. Late maturity, mid-to late-bloom in legumes, head-in grass hays, moderate or below leaf content, and generally coarse stemmed. Hay may show light damage. <u>Utility.</u> Hay in very late maturity, such as mature seed pods in legumes or mature head in grass hays, coarse stemmed. This category could include hay discounted due to excessive damage and heavy weed content or mold. Defects will be identified in market reports when using this category.

Most single cutting, dryland alfalfa hay that is properly harvested will fall into the USDA hay quality designation *Fair* or *Good,* with *Good* being a reasonable target. Over the last few years, the reported difference in average price for “Good” versus “Fair” quality designated hay is about $8.35 (Alfalfa Hay, 2002). All other things being equal, the difference between “Good” and “Fair” alfalfa hay is crop maturity at harvest. Harvest delay of one week could push what would have been “Good” hay into the “Fair” designation. If hay is sold on a quality designation basis, this delay would result in a substantial loss to the producer.

Following is a discussion of terms used to describe the nutrient content of hay as determined by laboratory analysis.

Dry matter. Moisture content of hay varies, from extremes of about 7% on the low side to about 17% on the high side. In our area, properly cured hay contains about 12% moisture. So that the nutrient content of hay having different moisture content can be easily compared, laboratories generally report nutrient content of hay on a 100% dry matter (DM) basis, although some laboratories standardize nutrient content to a 90% DM basis (10% moisture) to approximate the nutrient content in farm stored hay as it is fed.

Fiber is mostly found in the cell walls of forage plants. The fiber content of forage is related to the digestibility of the forage and also to the amount of forage livestock will eat before they become full and stop eating.

NDF. Neutral detergent fiber (the name refers to the laboratory analytical procedure) contains most of the plants’ fiber, both digestible and indigestible. NDF predicts, and is negatively related to forage intake: the higher the NDF the lower the forage intake.

ADF. Acid detergent fiber separates the more indigestible fiber components from the NDF. ADF predicts, and is negatively related to digestibility of forage: the higher the ADF, the lower the digestibility of the forage.

RVF. Relative feed value is a comparison of the overall feeding value of different forages. It is not measured in the analytical laboratory; rather, it is calculated from NDF (a prediction of feed intake) and ADF (a prediction of digestibility). Mid-bloom alfalfa hay is the standard, having a RFV of 100. RFV has no units of measure; it is just a number on a scale with a range of about 50 to 190. Alfalfa hay with high nutri-

It is also noteworthy that USDA hay market reports, despite specifying that TDN was calculated by the “western formula,” in fact have not established that the reported TDN was actually calculated by the “western formula. ”Rather, the TDN value given the reporter by the farm submitting the report is used regardless of the laboratory having done the analysis or the formula used. By the way, TDN calculated by the “western formula” is on the lower end of the range of TDN’s calculated by other formula’s commonly in use. You might ask why TDN calculations aren’t standardized. The simple answer is that there are practical pros and cons for using the different formulas as well as sound nutritional reasons, and different people weigh these factors differently. So, the bottom line is that one needs to use a grain of salt (perhaps a rock) in evaluating TDN values reported by USDA or anyone else, for that matter, if the TDN formula is not also reported. Aside: soil testing laboratories also use several different analytical procedures for determining soil phosphorus. Based on the procedure used, phosphorus fertilizer recommendations differ, even if the different procedures find the same level of phosphorus. Crazy? No, similar to the case with TDN, regional soil differences and different weighting given to various factors that complicate phosphorus analysis give rise to this anomaly.

TDN 90%. This is the standardization discussed above under Dry Matter. TDN calculated for hay containing 90% dry matter (10% moisture).

Mixed Hay vs. Alfalfa. The demand for mixed hay (grass-alfalfa) is strong, especially for those willing to bale conventional small bales and cater to the horse hay market. Production potential of alfalfa-grass mixed hay (50-50) is similar to straight alfalfa, however nitrogen fertilization for the grass component is required, and the selection of herbicides is limited. Properly put up, mixed hay in conventional small bales commands about a 20% premium over fair to good quality alfalfa in big bales. However, additional cost of producing and handling mixed hay in conventional small bales for the horse hay market will eat up at least half of this premium, perhaps all of it. And, in the horse hay market, quality is everything; there is a low tolerance for weeds, dust, mold, shatter, and inadequate weather protection. Nevertheless, the strong demand for mixed hay provides marketing opportunities at times when demand for straight alfalfa hay falters.

Conclusion. Based on limited experience in this area and research information extrapolated from other growing regions, alfalfa projects to be an agronomically and ecologically valuable rotational crop for some grain producers in the conventional three year rotation crop production area. Economic modeling suggests that leaving alfalfa in production for 3 to 4 years is optimal. Net profit margins are projected to be small, but comparable to spring grain. Profit potential is projected to be greater for those selling standing alfalfa to a hay harvester rather than undertaking the haying operation themselves. Mixed hay has greater market demand and value than straight alfalfa, but it has additional expense in production and management.

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