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Haymaking on the Westside

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Myths and misconceptions surround hay production west of the Cascade Mountains. Among them are: "Hay cannot be made on the westside," "First-cutting hay is likely not fit for man nor beast," "Good hay cannot be made in May or June," and "The only sure time to make hay is after July 4." Unfortunately, these and other myths continue to plague successful hay production in the region. However, reality indicates good quality hay can be produced on the westside with proper knowledge, skills, equipment, storage, and perhaps a bit of luck. Aside from luck, this publication provides insights on the other issues of westside hay production.

Let's begin with the hay bale since this is the product to be marketed. *The hay bale reflects many things about **you and your operation***. It demonstrates:

- Management—preparation, timing, understanding, crop growth stage
- Field—forage crop, manure, moles, weeds, other crops, and debris
- Soil—adequate fertility and pH adjustment in relation to soil test results
- Equipment—adjusted and clean mower, tedder, rake and baler, wagon
- Weather—impacts/extent of rain damage and sun bleaching before cutting and baling
- Removal of bales after baling—in-field rain damage and surface molds
- Extent of storage—barn or outdoors, exposed or trapped, molds, dust, rodents

When visually inspecting hay bales, look at the bale's composition. Estimate the percentage of legumes, grasses, and weeds in the bale. A high percentage of legumes and weeds may require a closer inspection for mold and dust compared with a grass-only bale. However, don't assume that grass-only or mixed grass-legume bales will not have mold or dust. Though highly nutritious for ruminants, pea hay is often very dirty and dusty due to the nature of the field operations. The key is to look for mold and dust in the bale.

Relationship of Plant Components with Forage Crop Selection

Successful production of hay bales begins in the field with adapted perennial forage crops. **[Slide 1]** In western Washington and Oregon, cool-season grasses dominate the landscape, providing the foundation of the forage hay

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Slide 1. Field view of grass hay ready to harvest at good maturity. Left side of field was cut recently and right side will be cut that day.

industry. Many different cool-season grasses can be grown in the region, but for the purpose of making hay, orchardgrass, tall fescue and timothy are the most important grasses. At the turn of the 20th century, timothy was the most important westside grass for hay and forage (Hunter 1906). This is logical since horses were the main source of power on the farm at that time. Hunter also suggested orchardgrass, ryegrass and meadow fescue for hay production in the region.

Since World War II, plant breeders have greatly improved both orchardgrass and tall fescue releasing many new cultivars. Important characteristics shared by orchardgrass, tall fescue, and timothy for successful hay production are rapid dry-down, good quality, high yields, and a long stand life. Ryegrasses are excellent for pasture and silage in our region, but dry too slowly for hay. Other grasses that can be baled for hay include meadow fescue, bentgrass, and cereal grains, such as oats (Kreiinger and Law 1948).

A variety of legumes are adapted to our weather and management conditions. Legumes adapted to the region include alfalfa, white, red and Alsike clovers, and Lotus spp. On occasion, crown vetch or hairy vetch can be found in hay bales from this area. Normally, legumes contribute less than 25% of the total forage mixture of westside hay. Legumes made into hay require more field-drying time than grass. In a grass-legume mixture, grasses tend to hold the legume above the soil and prevent matting on the soil surface. Forage dried above the soil surface receives greater exposure to sunlight and warm air circulation, resulting in a shorter drying period. This is one of the most important keys in westside haymaking. Pure legume fields are rare on the westside because they are more vulnerable to rain damage than a grass-legume or pure grass hay stand.

Leaves of forage plants dry more quickly than stems due to the higher water content of stems. Physical breaking or bending of stems with conditioning machinery increases air penetration and circulation to these tissues. Increasing air movement results in greater drying speed compared with limited or no mechanical action. Orchardgrass, tall fescue, and timothy dry down faster and more uniformly than legumes, clovers, and ryegrasses. Legumes possess both stems (petioles and true stems) and leaves. Legume leaf surfaces are more waxy than most grasses (ryegrasses are an exception), so the drying rate of leaves is also different between grasses and legumes. Grass tillers are made up of stems and leaves. The drying rate of grass stems and leaves is about the same on a weight basis. But, with most first-cutting grass, the hay has more weight in stems than in leaves (about equal weight of stems and leaves at boot stage of growth, but with stem weight increasing as grass maturity advances). So, breaking or bending forage stems speeds up drying rates and shortens the drying time before baling.

MOISTURE AND FORAGE CHANGES IN THE FIELD

Moisture (water) content of the hay prior to baling is critical. The custom of harvesting at mature stages of growth with lower moisture or higher dry matter (DM) content to hasten field drying makes no sense when the goal is quality hay. Higher quality forage will contain higher moisture content prior to cutting; this will increase the amount of time swathed forage must dry in the field. Generally, young, pasture-type forage for hay contains about 80 to 90% water (10–20% DM). Grass in the boot stage ranges from 70 to 80% water (20–30% DM), flowering stage of grass ranges from about 50 to 70% water (30–50% DM) and at stage of seed maturity (ripening), water content will often be less than 50% (greater than 50% DM). **[Slides 2 and 3]**

Several environmental factors can affect the moisture content of forage. High rates of nitrogen or manure application will keep moisture content higher in forages than low or no nutrient applications. Overcast skies lower sunlight intensity and increase moisture content of preharvested forages. Wind movement is essential on the westside for haymaking, otherwise the drying hay may be cooked rather than dried. Finally, when selecting replacement varieties, tetraploid cultivars tend to be higher in moisture content than diploid cultivars, especially for ryegrass.

Before taking the equipment through the gate of the hay field, stop, look, and think that for every pound of dry matter, the plants to be cut must evaporate up to 10 pounds of water before a single hay bale can be produced safely! It is understandable why some people have decided they cannot make good quality hay on the westside when so much water must evaporate in such a short time span.

After cutting the forage crop several reactions involving moisture occur within the plant. Plants will continue to evaporate, that is, lose water from within the plant to the surrounding atmosphere. Over 90% of plant water loss occurs from small pores on the leaf surface called "stomata." Stomates remain open while internal cell pressure pushes internal moisture out of the plant. These small pores ultimately permit water loss and plant dehydration. During the early phase of plant dehydration, enzymes break down or reduce simple sugars, organic acids, and carbon dioxide. Losing sugars, acids and carbon dioxide into the air results in an overall loss of forage DM and highest quality, most digestible forage components in the field (Sullivan 1973). Losses of forage DM in the field can range from less than 5% to greater than 50%, depending on weather conditions and how long it takes the plants to dry. The faster the dry-down time without rain, the higher the retention rate of DM and quality.

The longer the wet, cut forage lies in the field, the longer bacterial and fungal microorganisms have to damage the drying crop. If partial fermentation occurs, the hay becomes haylage (silage) exuding a strong vinegar or acetic acid smell. Fungi in the wet forage promote mycotoxins that will produce hay molds. Certain types of fungi and microorganisms will produce airborne products that can cause human diseases known as "Farmer's Lung" (McDonald et al. 1995).

Prolonged drying of hay will increase the loss (oxidation) of certain plant vitamins and pigments. Carotene, the precursor to vitamin A, is unstable in the presence of sunlight and losses can be high if the hay is not dried quickly. On the other hand, vitamin D is promoted by sunlight, so concentration of vitamin D can actually increase in the hay with prolonged field drying. Chlorophyll, the green pigment of plants, is more stable than carotene, but will degrade during field drying and storage. Rainfall can leach plant protein, phosphorus, potassium, carotene and digestible energy components during hay cutting and drying processes (Sullivan 1973).

Slide 2. (Far left) Orchardgrass seedhead fully expressed. Note the green seedhead on the reverse side showing darker green color indicating no seed development in the head—a less mature stage of development.

Slide 3. Orchardgrass seedhead fully expressed, but after flowering. The small anthers (male flower parts) have turned white on the surface of the head. The reverse side is a lighter yellow color and will turn white when fully mature. This process of grass seedhead maturation is characteristic of all the grasses recommended for hay in the region.

STRATEGIES FOR HAY HARVESTING

Strategy One—Weather

Become a weather watcher and closely follow local forecasts for changing weather conditions during haying time. The best method is to track building high barometric pressure systems as they move into the region. High barometric pressure means good weather with mostly clear skies and reduced chances of rainfall. Low barometric pressure indicates a probability of cloudy skies, rainfall, and wet soils. During the haying season, whether first or second cutting, harvest the crop at the beginning of a high-pressure front rather than the middle or end. A strong high-pressure system will remain in the region longer, providing more time for haymaking. It seems so often in spring, a high pressure is followed by a low when the hay is almost dry and ready to bale. These frequent spring rains are a good reason why only a small portion of the field is cut on any one day. Satellite tracking of high and low pressures and the strength of the high pressure through barometric pressure readings will improve the odds of making good quality hay in May and June.

Strategy Two—Grazing

If you have livestock, another key for success is early grazing to delay seedhead elongation. **[Slide 4]** The first-cutting hay produces the highest tonnage of the growing season. If the goal is high quality first-cutting hay, then several management options are possible. Graze the hay land in the spring, until mid-April in western Oregon and early to mid-May in western Washington. If the ground is saturated at this time and grazing livestock are pugging and rutting the soil, graze rapidly with quick livestock removal to give the grass-land time to recover. Extended grazing on wet soil can lead to soil compaction. If soils are firm and fairly dry, a normal grazing pattern will accomplish delayed seedhead development, with many grass species actually heading 2 to 3 weeks later than normal. If the hay field is dominated by timothy, we recommend no grazing due to slow regrowth after first cutting or grazing.

Properly grazing timothy to maintain healthy stands is difficult on the westside. If you must graze westside timothy hay fields, leave 8 inches of stubble height. With proper management timothy will provide some regrowth for limited fall grazing (in October). In either case, do not overgraze timothy if you wish this plant to remain in the stand. With early grazing and timely removal of animals, first-cutting grass hay will still have about as many seed heads as normal.

Strategy Three—Cutting

DO NOT cut first-cutting hay so close to the soil surface that it looks like it has been scalped. Walk across the newly cut hay field. If your feet touch the soil surface, then either the stand is thin or the cutting height is too low. Close cutting is usually 2 or 3 inches above the soil surface. If the harvested forage looks like it has been given a “fine, close” haircut then several negative conditions will occur.

For example: (1) Harvested forage must dry while lying nearly in contact with the wet soil surface. The

Slide 4. Hay mowing with flail chopper. In the process of cutting, many of the stems and leaves are broken. This facilitates rapid drying in the field. A drum mower will be just as effective in conditioning the grass hay.

Slide 5. Cutting stubble height shown. It is best to leave about 6 inches of stubble after cutting so the grass hay can lie on the stubble surface for rapid drying. Cutting as low as 2 inches places the hay closer to the soil surface and will increase the time needed for drying.

forage stubble residue is recovering from cutting so these tissues continue to lose water through the cut area. Simply put, the distance between the soil surface and the cut edge of the stubble residue is too short. Short stubble height limits the ability for the newly fresh cut grass to lose water. When water loss is limited then the drying rate is slower compared with a 6-inch stubble height, **[Slide 5]** thus slowing the drying time and increasing the odds of the hay getting rained on. (2) Crop-regrowth after drying first cutting will be slower when first cutting is mowed at 2 inches rather than 6 inches because energy reserves in stem bases were removed at harvest. Regrowth yields can be reduced because of water evaporation from prolonged soil exposure to the sun at a time when water conservation is most needed. (3) More weed seeds will germinate because of more exposed soil.

Slide 6. Cut grass hay shortly after mowing. Notice the high percentage of stems that have been broken through the mowing process. Broken stems will lose water more rapidly than intact stems.

Strategy Four—Equipment

Many hay producers only have a sicklebar mower for cutting hay. For first cutting this is not the best equipment to use, but it is acceptable for second cutting. Harvesting the first cutting requires the forage to be processed in some manner. You will have more success with a disc mower, a mower-conditioner or similar harvesting equipment that mechanically alters and conditions the forage and spreads the forage out widely for rapid dry down. Conditioning means the breaking or bending of stems which allows moisture to escape more rapidly **[Slide 6]**. First cutting often has a higher percentage of hay yield in stems (higher in water content) than leaves, hence takes longer to dry. First cutting is also the highest hay yield of the season, so there is more volume to dry **[Slide 7]**. Sicklebar mowers do not break or condition the stems, **[Slide 8]** adding more days of drying and increasing the risk of rain damage. Sicklebar mowers also leave the harvested forage covering the total mown surface like a blanket. This lack of open stubble and soil surface hinders the drying process. In second cutting, hay yields are less than the first, weather conditions are drier, plants are normally drier and we get more sunshine. However, second-cutting hay still cannot be put into windrows until the forage is dry, just before baling.

Slide 7. New-mown grass on left side for drying. On right side this grass will be mowed the following day if the high-pressure system persists. Notice the wheel tracks area is open and the stubble is drying as well as the mowed grass. During the tedding and windrowing this wheel track area will be needed to move the cut grass to a dry area for further drying.

Slide 8. A grass hay field cut using a sicklebar mower. Notice the blanket-like appearance resulting in trapped moisture from the cut stubble and the soil surface. The stems are fully intact and lying in one direction. First-cutting grass mowed with a sicklebar will take longer to dry down than grass drum-mowed or flail-chopped.

GOING TO THE FIELD

Let's assume the weather service is forecasting dry, sunny conditions for the next two weeks in May or June—don't believe this; long-range forecasts are based on computer models and can be unreliable. Estimate how much hay you can bale and remove from the field in one evening, 3 or 4 days from now, and that is how much you cut today. If the weather front remains strong cut more hay the next day and continue the process until the weather changes. **The goal is to make hay in either 3 or 4 days—not more than 4 days** on the westside for both first and second cuttings. Daily high temperatures may not exceed 70°F with first-cutting hay. Second-cutting daily high temperatures may fluctuate greatly, but will be higher than first-cutting temperatures. Divide the hay field into smaller units, and then do a good job with each cut unit. The division size of a hay field depends on whether it is in a low wet area, the total yield to harvest, and your equipment. The following method diminishes the risk of getting all your hay wet when unexpected rain fronts do occur. The more land in hay, the better line of machinery you need to cut, ted, rake, and bale the crop. For the second cutting, weather is usually better for haymaking so you can cut more than for the first cutting. But, keep looking at the weather maps and barometer, even in July or August.

- **Day One.** In order to dry the forage rapidly in both first and second cuttings, start cutting the forage about 8am and stop harvesting by noon. The ideal day starts out warm, with clear skies and a building high-pressure system. Whatever equipment is used, **DO NOT MAKE A WINDROW ON THIS DAY**. Also, don't completely cover the stubble with newly cut forage or in the tedding operations to follow, or you will have no dry cut stubble or soil surface on which to place the drying forage. This is one reason why it has often taken longer than 4 days to make hay on the westside. Leaving open wheel tracks will increase drying speed on this and the next day. After the harvested forage starts to dry on the top layer, fluff and move the forage with a tedder. The first tedding should be done within about 4–6 hours after harvesting (right after noon or so) to obtain maximum use of the sunshine, warm temperatures, and wind for drying the first day **[Slide 9]**. Tedding fluffs the drying forage, which is critical for air penetration and circulation, that results in rapid water loss.

- **Day Two.** This pivotal day dictates whether forage is baled on day three or day four. Allow surface dew to evaporate. Tedding forage after surface moisture evaporation prevents incorporating the extra dew moisture into the swath. The tedded forage should be moved from the area where it was lying, preferably onto the wheel track area that is drier than the area under the swath since it has been exposed to sunlight and warmer temperatures in the morning hours. The tedder must be set level, not like a harrow (nose down). **[Slide 10]** Don't set the teeth too close to the soil surface, because plants can be ripped out of the soil, debris can be picked up, and rocks just

Slide 9. *Tedding grass*. The tedding process fluffs and repositions the grass hay to increase air penetration and circulation into the forage. Ted after the morning dew has evaporated. ***Note: the drying process must be mostly completed through tedding before being windrowed.***

Slide 10. *Adjusting the tedder*. The tedder is adjusted from spreading the mowed grass to making a windrow.

seem to love the touch of those teeth. With good drying conditions and warm wind, check the swath condition in mid-afternoon. Two outcomes will be possible in the afternoon of day two. First, if the present swath is dry then rake into a windrow. To do this, the drying forage must be moved again and returned to the area from where it came in the morning. Second, if the swath is wet inside (where the wet forage slugs, i.e., clumps, are hiding), then ted again and do not make a windrow.

- **Day Three.** This is the payoff day. Allow the morning dew to evaporate. With the mostly dried and windrowed forage from day two, re-rake the windrow onto the drier stubble and soil surface. This hay will be ready to bale by mid-afternoon, but check moisture content as outlined in Appendix A to ensure dry hay. **[Slides 11, 12, 13, 14]** Once the baling is completed it is best to remove the bales from the field. A procedure using the microwave oven to determine DM content in hay is described in Appendix A. Electronic moisture meters are also available. When determining hay moisture content, remember a 2%–3% difference in measuring accuracy may decide the difference between success and failure of stored hay.

  If the forage was too wet to windrow in the afternoon of day two, this forage should be ready for windrowing the afternoon of day three. Again, check both the swath and windrow to see if desired moisture level is about achieved. Raking into a windrow on day three at 3pm, or mid-afternoon, will establish haymaking the next day.

Slide 12. Windrow produced by the tedder.

Slide 13. Windrow produced by a hay rake.

Slide 11. *The tedder is making a windrow.* The windrow is being moved from the damper area to the dry wheel tracks area.

Slide 14. Windrowing and baling must take place on the same day to prevent rehydrating.

- **Day Four.** This is our final target day. Too often the high-pressure system is moving out of the region, the clouds are increasing, and rain is threatening. But, hope should not be lost because we have set in motion the best chances to get the forage baled and out of the field. Allow the morning dew to evaporate from the top surface of the windrows. Re-rake the windrow onto the drier stubble and soil surface (as in day three). The baler should be in top condition because breakdowns at this time are not in your best interest. **[Slide 15]** Check the windrow moisture and bale as soon as possible, or no later than mid-afternoon.

Is Your Baler Ready to Go?

Check if the baler is properly picking up the windrow and avoiding foreign material. Are the bale ties spaced correctly on the bale? **[Slide 16]** Are you making those infamous “banana” bales because tension is not equal on both sides? Check the weights on some of the bales to see if they are the desired size and weight. **[Slide 17]** Two popular bale weights in the region are about 50 to 55 pounds for lighter bales and 75 to 80 pounds for heavier bales. Most westside hay buyers dislike bales heavier than 80 pounds. Bale density is dependent upon forage composition to be baled. **[Slide 18]** Second-cutting bales will likely be heavier than first cutting because legumes will contribute more to the bale in second cutting compared with the first. The density of the bale should be such that the ties leave a gap of about 1 inch. If the gap is greater than 2 inches, the bale chamber tension cranks need to be adjusted to increase the density.

Slide 16. The finished product.

Slide 17. Pick up bales the same day they are produced. Get them under cover to prevent rain damage.

Slide 15. Proper adjustment of knotters and plunger will increase bale production per hour.

Slide 18. If all the bales cannot be removed from the field the same day they are produced, then stack them upright to minimize the ground contact.

If the baler has no mechanical problems and the knotters are adjusted properly, but the bales are breaking, the forage is too moist. A more viable option is to let the forage dry more, re-check the windrow moisture, and resume baling when the forage is dry. **[Slide 19]** Another option is to adjust the tension cranks on the bale chamber by releasing some pressure. By watching weather patterns, use of proper harvesting, tedding and baling techniques, and minimum breakdowns, the bales should be removed from the field within 3 days of cutting. The goal is to produce hay on the westside in 3 and not more than 4 days.

WHAT TO DO IF THE HAY GETS RAINED ON BEFORE BALING

Hopefully you're wondering, "What do I do if my forage does get rained on before it is baled?" That's a great question. The answer is simple. Wet forage must be moved frequently. After the top of the swath or windrow dries, get the tedder out and quickly ted the forage to a drier area. The open stubble surface and soil will be drier than where the wet swath or windrow is setting presently. Too often these showers come in the afternoon. Many stop before dark. When the afternoon shower stops, get out and ted as soon as the top forage surface has dried. If this was a single rain shower event the next morning should be clear. Let the dew and moisture evaporate and pick up the process of either day two or three. If it rains for several days in a row all is not lost. Yes, many nutrients have been washed away, but you can still prevent blackening of the forage, mold formation, and dust in the hay. When examining hay you should always look for off-smells, dust, and mold once the hay bale is opened up. Extended rainfall will require more days to dry down again than with a passing shower. The goal now is no longer to make top quality hay, but to salvage what you can and avoid a complete crop loss. Salvaging this hay crop will likely start with the process outlined on day two and proceeding to day four, but likely will require more tedding operations than we've outlined above. Remember, the soil is wetter than before so we don't have the best open soil surface condition in which to move the drying forage.

Slide 19. In problem spots such as corners, low and shady areas, extra care will be required for sufficient drying.

POST BALING AND HAY STORAGE

Long-term hay storage on the westside will require the hay to be greater than 88% DM (less than 12% moisture). If moisture content at baling is too high, the entire bale stack can become a block of mold spores unfit for livestock consumption and a potential fire hazard. Sometimes a "slug" of wet forage is put into the bale. The area surrounding a slug heats from plant respiration and microbial activity resulting in mold, dust, and spoilage. When examining hay, carefully smell it because sometimes you will not see the mold or dust, but you can smell it. Normally if you can smell the spores, you will also see a light amount of dust unless you're inspecting on a windy day; then the dust may not be visible.

Bales should not be left to lie in the field after baling. Westside soil surfaces tend to accumulate moisture overnight. The newly baled hay can easily attract this outside moisture which promotes surface molds. Hay damage will be greater with prolonged field exposure in May and June than in late July or August. In our environment, moisture inside and outside the bale will dictate how long the bale will be a quality food product for your animals.

When inspecting hay bales, look at the composition of the bale and estimate the percent of legumes, grasses, and weeds in the bale. A high percentage legumes or weeds may require a closer inspection for mold and dust compared with a grass-only bale because of the greater difficulty in field drying legumes and weeds compared with grasses. However, don't assume that grass-only or mixed grass-legumes bales will not have mold or dust. The key is to examine the bale for mold and dust. Often you may not see the mold spores, but smelling hay with mold often causes a person to cough and choke. Mold spores and dust are never healthy for livestock that eat the hay.

All bales must go through a "sweat" after baling. The sweat is the final stage of plant and microbial respiration. The temperature of the hay increases during this time, but does not usually remain elevated for more than a couple of weeks during the sweat. If the bales are stored too tightly immediately following baling, the sweat moisture cannot escape. Thus, the first storage of bales should be loose enough to encourage air exchange and loss of surface moisture. Tight packing of bales high in moisture content will surely promote long-term storage problems.

Hay stored in a barn is completely safe at 12% moisture (88% DM). However, producers have safely stored hay on the westside as high as 18% moisture (82% DM). Check bale moisture content by collecting a single core sample from each of 20 bales and following the procedure in Appendix A. When hay is too wet for safe storage in a barn, danger of fire is very real.

Purchase a thermometer that can be pushed at least 12 inches into the bales to check the temperature. Check the temperature of at least 20 different bales and monitor each daily until the sweat period is over. Bale temperatures should not go much above 100°F in our area. If the temperature is 90°F or below, storage problems will be minor. Once bale temperature exceeds 110°F you need to break open the bales to dry them. Certain heat-resistant fungi become active at about 110°F and will drive the temperature of the bales to about 150°F. Above 150°F the danger of fire is very high (Martin 1980). Wet hay can ignite spontaneously, depending upon oxygen supply, in less than a month after storage. **[Slide 20]** Heating bales must be moved, and perhaps cooled with water, to prevent the stack or barn from burning.

Safety is important and preparation for spontaneous combustion will reduce the risk hazard. This is not a fun task, but quite necessary. When storing hay in a barn or outdoors, don't stack more than 8 tiers high before the hay has gone through the sweat. After the sweat when temperatures lower, more tiers can be added to the stack without fire danger. Every growing season it seems people must relearn the lesson associated with moist hay—it can spontaneously combust.

Proper storage facilities to preserve hay quality and value on the westside are critical. The barn roof must be in good shape to keep rain and snow off the hay. If the hay is stored outdoors then it should **ALWAYS** be kept off the ground, i.e., on ties, pallets, etc., which are covered with tarps or plastic. The idea is to stop movement of soil moisture into the stored bales. The top of the haystack should be covered with a tarp and weighted to prevent blowing off in winter winds. Bales **SHOULD** be stored on their sides, the bale ties facing outwards so they can be seen when walking by the stack. Stacking hay in this manner is not easy, but if moisture does get into the hay, this is the best opportunity for the moisture to pass through the hay and out the bottom.

There is a smooth side and a cut side on every bale. The cut side is very sharp where the forage is cut during bale formation. This cut side, not the smooth side, of the bale should be the side that is faced down. If storing hay outdoors, and with the ties out, on a concrete, gravel, or soil base, the bottom tier of bales will likely be lost due to moisture absorption and bad weather. Moisture is the most aggressive and destructive enemy once the hay is stored. Storage is the final step, but if done improperly, expect to have problems and all previous efforts and investments will have been wasted.

Slide 20. Spontaneous combustion from wet hay caused this haystack to catch fire and burn near Ephrata, Washington.

The bottom line is that it costs no more to make a bad bale of hay than a good one. Hay can be made successfully, as it has for over a century, in both western Washington and Oregon. Working with Mother Nature rather than against her, having a harvesting plan, a good line of well-maintained equipment, watching the barometer and conditions around your farm and following this three- or four-day procedure, will increase the chance of successful haymaking on the westside.

APPENDIX A

DETERMINING DRY MATTER WITH A MICROWAVE OVEN

The following procedure has been developed over several decades and is taken from a combination of several sources. This method is fast in determining forage moisture (dry matter), but care must be taken not to over-dry the forage or the cup of water. Over-heating can result in a fire in your microwave oven.

1. Obtain a representative sample of the hay, either from the field windrow or cored bales. The DM determination is only as good as the sample taken.
2. Place a glass plate or dish on a postage or gram scale and write down the weight.
3. Transfer 3.5 ounces or 100 grams of sampled forage to the glass dish. The forage can be cut into lengths about one-half inch (windrow samples). Spread the samples evenly over the dish and weigh again—this is the wet sample weight.
4. Before placing the dish and sample into the microwave oven, place a three-quarter full glass of water into the oven. It may be easiest to put this glass in one of the rear oven corners.
5. Start the microwave oven for about four minutes at 80 to 90% full power. Watch the sample through the door to avoid charring.
6. Remove the glass dish and sample and weigh on scale. Record weight.
7. Replace dish and sample in oven for one minute at same power level (Step 5).
8. Remove the glass dish and sample and weigh on scale. Record weight and determine if weight has decreased from weight in Step 6.
9. If weight decreased then repeat Step 7 until weight stabilizes. Carefully watch water glass level and add water to maintain initial three-quarter level.
10. Once dish and sample weight do not change, all the water from the sample is gone. Record this final weight—this is the dry sample weight. Avoid charring the sample to prevent fire danger and inaccurate results.
11. Subtract the dish weight from the dish plus sample weight and use the formula below to determine moisture percentage.

$$\textbf{Moisture Percentage} = \frac{(\text{wet sample weight} - \text{dishweight}) - (\text{dry sample weight} - \text{dish weight})}{(\text{wet sample weight} - \text{dish weight})} \times 100$$

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