Nº13
Oct 2019

ALFALFA INSIGHTS

VIRENXIA'S NEWSLETTER ON ALFALFA, THE QUEEN OF FORAGES

MINIMIZING LOSSES IN HAY STORAGE

Because of its many merits, hay is the most commonly used stored feed on livestock farms. Unfortunately, losses of hay during storage and feeding are often high, particularly with round bales stored outside in high rainfall areas. On some farms, such losses account for over 10% of the cost of livestock production. These are real, and not just potential, losses (time, labor, and monetary inputs are lost along with the hay). Unfortunately, many producers probably do not realize how large their losses really are, or that with relatively little effort or expense they could be reduced considerably.
The purpose of this publication is to provide information as to how and why hay losses occur, and how they can be reduced.

Types of storage losses

Losses rise sharply as moisture levels increase above 20%.

Hay storage losses vary greatly depending upon several factors, but storage technique is of utmost importance. Losses of dry hay stored inside a barn are usually of little concern. However, even for barn stored hay, losses rise sharply as moisture levels increase above 20%, and losses from round bales stored outside under adverse conditions can be much larger. During storage, hay can be subject to dry matter losses as well as losses of forage quality. Dry matter losses during storage result from plant respiration (the continuation of normal plant processes), microbial activity, and weather deterioration.

Even at low moisture levels (20% or less) there is some loss due to respiration and low numbers of microorganisms, but this is constant across hay types and essentially unavoidable. At higher moisture levels (above 20%) where mold growth is likely to be visibly detectable, dry matter losses are greater, and significant levels of heating (which can also lower forage quality) occur due to microbial activity. Although numerous bacteria are present in hay, fungi account for most of the microbial growth.

Heating of hay is related to moisture content. Peak temperature is often reached within a week after baling, but with higher moisture hay and conditions which limit heat escape, it may take as much as three weeks. At safe moisture levels (less than: 20% for rectangular bales; 18% for round bales; and 16% for large rectangular packages) inside storage losses are typically around 5% of dry matter, but losses several times higher have been reported for extremely moist hay.

At safe moisture levels inside storage losses are typically around 5% of dry matter.

"Weathering" (the term which is commonly used to refer to the effects which climatic conditions have on hay) is partially a physical process. Some of the dry matter loss which occurs during outside storage is caused by leaching, which refers to the dissolving and removal of nutrients by

the passage of rain water over the surface of, and through, the bale. The more digestible nutrients are, the more soluble they are, and thus the more likely they are to be removed by leaching. The switch from small rectangular bales to large round bales on most farms has resulted in higher storage losses. Round bales are not inherently subject to greater losses, but they are much more likely to be subjected to adverse storage conditions, often remaining outside with no protection between baling and feeding. Feeding losses are usually sharply higher with round bales as well, partly because big round bales are generally fed on sod while rectangular bales are often fed in bunks.

Examples of things you should not do

Bales should not be allowed to be in standing water, even on a temporary bunks.

The rounded sides of bales should not touch.

Hay should not be placed under trees.

Forage Quality Losses

Storage conditions can also have a dramatic effect on hay chemical composition and feeding value. Even if there were no dry matter losses or additional feeding losses with weathered hay, changes in forage quality would be of great concern. Total crude protein declines with weathering, but the percentage of crude protein may increase due to dry matter losses (a phenomenon which has been reported to also occur with rain damage of field-curing hay). This is because protein is less subject than other plant constituents to weathering loss. However, the proportion of digestible crude protein may decrease,

especially if the hay undergoes heating due to excessive moisture. Soluble carbohydrates, which are highly digestible, decline during weathering as shown by increases in ADF and decreases in IVDDM; thus carbohydrate levels differ greatly between the weathered and unweathered portions of round bales. Declines in hay quality from weathering are usually greater for legumes than for grasses. Some heating of hay is normal, but extreme heating (above 120o F) lowers forage quality along with dry matter. Microbial activity associated with heating uses soluble carbohydrates, which reduces digestibility and increases fiber levels. A reduction in voluntary intake accompanies excessive increases in NDF.

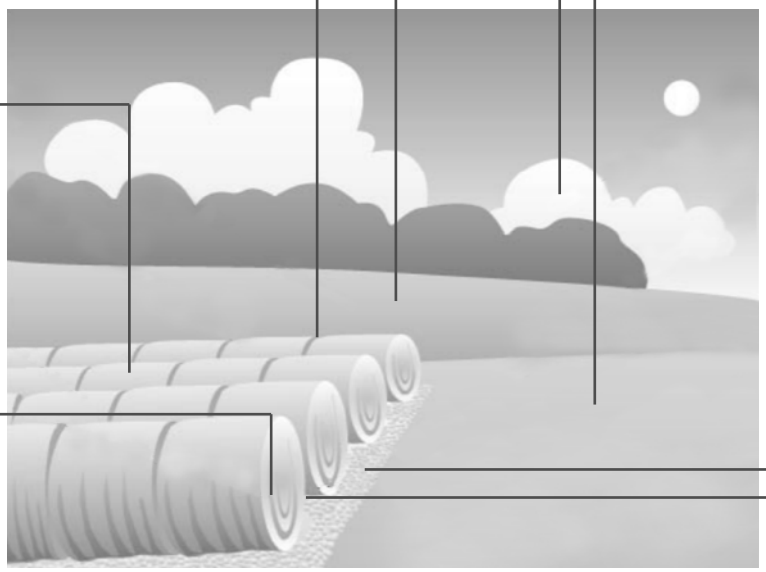
Understanding the weathering process

From the preceding discussion, it should be obvious that most of the hay storage losses which occur are associated with hay being stored outside in a situation in which it is exposed to the elements, resulting in weathering. The longer hay is exposed to unfavorable weather conditions, the greater losses will be. Bales stored outside on the ground without covers increase sharply in moisture content during storage.
This is especially true for the outer 2 to 3 inches of the bale in which moisture may increase by as much as 120%. Weathering begins slowly, but then accelerates because weathered hay is more easily penetrated by rain, and doesn't dry as rapidly thereafter. In areas of high and/or frequent rainfall, or with hay which does not shed water readily, the method of storage can make the difference between less than 5%, or more than 50%, dry matter loss from weathering. Furthermore, losses of more than 14% of the total crude protein and more than 25% of the total digestible nutrients can occur in the most highly weathered portions of a bale.

Losses of more than 14% of the total crude protein can occur in the most highly weathered portions of a bale.

An important associated factor is that the palatability of weathered portions of bales is decreased, which lowers intake and increases refusal. Thatch Formation In theory, a round bale should form a thatch that will, at least initially, shed almost all of the rain which falls on the top of the bale, but any of several factors may prevent this from occurring. Hay made from coarse-stemmed forage crops will not thatch well. This is due to large stems, hollow stems, or other physical factors which do not allow thatch formation.
Coarse-stemmed weeds within hay can also provide an avenue for water to penetrate bales. Once a wet layer forms, a bale does not shed water well and moisture levels inside the bale are likely to continue to increase during the storage period. As the wet, moldy area on the top of the bale deepens, less and less drying occurs between rains. Hence, once weathering gets underway, it usually proceeds much faster than with newly baled hay. Understanding the importance of thatch formation is made easier by considering the amount of water which must be shed during storage. A 6 foot long by 6 foot diameter bale will receive about 22 gallons of water for each inch of rain. Therefore, if there are 30 inches of rainfall during the storage period, a bale will receive 660 gallons of water.

OUTSIDE HAY STORAGE RECOMMENDATIONS



No objects near hay which are likely to attract lightning

Flat ends of bales butted tightly together

Bale rows run up and down slope with north/south orientation; a southern exposure is best

High bale density resists water penetration

Tops and sides of bales can be protected from rain with any of a number of different types of covers

Bright, sunny location; no trees or other objects near hay to slow drying after rains

Storage area located on a gently sloping, well-drained site

Hay/soil contact avoided by placing bales on rock, wooden pallets, etc.

Rounded sides of bales not touching; at least 3 feet of space between rows

Fire risk can be reduced by storing hay in more than one location and by maintaining a no-vegetation zone of at least 3 feet in width around the storage area

Key concepts regarding outside hay storage

1. Weathering of hay results in losses of dry matter, lowered forage quality, reduced hay intake and greater refusal.

2. The more valuable the hay, the easier it is to justify spending time and money to reduce storage losses.

3. Hay/soil contact is usually the most important source of spoilage of hay stored outside and should be eliminated if possible. This can be accomplished by placing bales on crushed rock, a concrete pad, or some object such as wooden pallets. If placing bales on the ground cannot be avoided, selection of a well-drained area (preferably with sandy soil) should be selected.

4. Water should quickly drain away from any bales stored on the ground. Storing bales near the top of a sloping area reduces the amount of water flowing around them. Bale rows should run up and down a sloping area to avoid trapping surface water.

5. Hay should be stored in a sunny location, preferably in an area where frequent breezes occur. Hay should never be stored under trees or other areas where drying is slow.

6. It is preferable for bale rows to run north and south rather than east and west. Also, a southern, rather than a northern, exposure is best.

7. The flat ends of bales should be butted together, but the rounded sides should not touch. Unless rows are put together to facilitate covering with sheets of plastic or similar material, at least 3 feet of space should be left between rows to allow air circulation.

8. The larger the bale, the lower the total percentage of weathering of hay stored outside. However, there are some disadvantages associated with handling larger bales.

9. As hay density is increased (particularly in the outer portion of the bale), outside storage losses decline. A minimum of 10 pounds of hay/cubic foot is recommended for round bales stored outside. Course-stemmed forages are more vulnerable to weathering than fine-stemmed forages which form a thatch.

10. The efficiency and cost of various methods of storing hay outside vary greatly. Whether a particular technique or combination of techniques can be justified depends on the cost of the technique(s) versus the value of hay which will otherwise be lost.

Source: DR. DON BALL, Auburn University, DR. DAVID BADE, Texas A&M University
DR. GARRY LACEFIELD, University of Kentucky, DR. NEAL MARTIN, University of Minnesota,
DR. BRUCE PINKERTON, Clemson University

5 TIPS FOR BETTER STORAGE

As with any livestock operation, the hay needs to be preserved to prevent losses of dry matter and nutritional quality. The single biggest factor in that preservation is, of course, storage. The following are five tips:

Storage Tip #1

Understanding Types of Loss

A good way to begin this discussion is with a review of the two basic types of losses that affect hay:

- dry matter, which refers to a decrease in the physical amount of hay present and available for consumption; and
- nutritional quality, which refers to the specific nutritional value of the hay, such as total digestible nutrients or crude protein. A number of factors can cause both categories of loss, but moisture—whether the bale is stored with too much of it, it comes from precipitation or wicks up from the ground—is one of the main causes.

VIRENXIA Alfalfa farm in Oman

Storage Tip #2

Managing Moisture

The first step to preserving quality hay, according to Dan Undersander at the University of Wisconsin, is baling it at the right moisture level—even if it means leaving bales outside to "sweat" a few days before going into tight storage.

If, he says, bales are put "at 20 or 22% moisture, then we will have microbial growth, and the microbes are using up the starches and the sugars. They're giving off heat and carbon dioxide, and we're basically losing energy from that forage."

Storage Tip #3

Understanding Types of Loss

Next, says Undersander, is keeping bales off the ground to prevent them from wicking moisture up from the soil. For instance, in the case of round bales, "one of the things a lot of people don't realize is that a couple of inches of exterior is a very high percentage of the bale," he says. "So, if you have a 5-foot-diameter bale and you lose 4 inches around the edge, that's 30% of the bale that you're losing. Anything to break the contact of the bale with the soil is truly beneficial to keep that bale from taking up moisture from the soil. That means putting bales on boards, tires, asphalt, plastic or some other barrier to limit water uptake from the ground."

Damage to large round bales stored outside occurs from rain soaking into the top and sides of the bales and moisture wicking up from the soil into the bottom of the bales. When large round bales are stored outside, storage losses are affected by a number of variables:

- Bale size — large diameter bales have less surface per ton of hay than small bales.
- Bale density — tight bales shed water better than loose bales.
- Type and number of wraps on bale — more twine or net wraps improve water shedding.
- Hay type — grass makes better thatch than legume.
- Soil drainage — well-drained hilltop or gravel soil allows less bottom spoilage than low areas or loam or clay-type soil.
- Weather — dry weather results in low storage loss; frequent rain or wet snow mean a high loss.

- Bale orientation — north-south rows are better than east-west rows for the sun drying bales between rains.
- Bale spacing — bales far enough apart to allow good air circulation and prevent deep snow from drifting up between and on bales.
- Bale location — exposed to sun and wind to dry bales between rains versus under trees.
- Length of storage — one season less loss than two seasons.

Considerable research has been conducted on round bale storage under different management scenarios. Bales stored directly on the ground and uncovered fare the worst, with 10 to 25 percent losses reported most. Storage loss ranged from 5 to 61 percent under these storage conditions.

Storage Tip #4

Get It Covered

As you would protect the bottoms of the bales, it's also best to protect them at the top, and, if possible, on the sides. There are two very distinct reasons, says Undersander, depending on where you live. In hotter, more arid climates, it's important to cover hay, mainly to protect it from solar radiation and to keep it from getting too dry and brittle. In areas where rain is a concern, producers need to cover the hay to keep the rain from going into the top layer of bales, and, again, causing the moisture content to increase and mold to grow.

The best solution is to store bales in a barn, whether they're round bales or big square bales. That's particularly true in wetter climates. The next best alternative, of course, is to cover the bales with a tarp or plastic.

Storage Tip #5

Sorting Bales by Quality

Undersander echoes the need to sort and stack bales according to forage quality, noting: "You might want to feed higher-quality forage to beef cattle in January and February, when they have a higher energy need, and as they're nearing the end of pregnancy. Likewise, you might use a lower quality for dry cows. If you store by quality, then you can … make best use of the energy and protein that you have in those bales."

If a milk cow is fed with less quality than she needs or feed her hay with a little mold in it, there would be a drop in milk production for the next 24 hours.

Source: Dan Undersander, University of Wisconsin

STACKING UP HAY STORAGE OPTIONS

Bales stored on ground can lose as much as 30 or 40% of their dry matter after just six months.

Why work hard and spend money to produce a quality product – and then throw a quarter of it away? That is what many producers do by not investing in quality storage options for their harvested hay.

Various options exist for storing hay bales, whether small squares, large squares or round bales. The lowest-cost alternative is simply leaving them on bare ground with no covering. However, some researchers have found bales stored on ground can lose as much as 30 or 40% of their dry matter after just six months (Table 1).

TABLE 1 % of dry matter lost after six months of storage

Source	On bare ground	On gravel or pallets		On bare ground, covered			Inside a building
	No cover	No cover	Covered	Tarp	Wraps	Roof	
Michigan State U. 1993	35%	30%		15%	23%		12%
Penn State U. 1992	15-40%						4%
Iowa State U. 1996	10-25%	11%					5%
U. of Georgia Journal Production Ag. 1993	50%	35%	14%	10%			4%
Anderson et al 1981	14%						3%
Belyea et al 1985	15%			6%			2%
Verma & Nelson 1983	28-40%			12%	11%		2-9%
Atwal et al 1984	40%			30%			9%
Baxter 1986	33-35%						3-7%
U. Wisconsin (Holmes)	9.5%	8%	4%				2%
Oklahoma State (Huhnke)	5-20%	3-15%	2-4%	5-10%		2-5%	2%
U. Wisconsin (Saxe, 2007)	5-61%	3-46%	2-17%		4-8%	2-10%	
West Va. U. (Rayburn)	7-61%	28-39%	5-10%				
Average	**27%**	**22%**	**8%**	**13%**	**13%**	**5%**	**5%**

Ground covers

If bales are stored on bare ground, they should at least be on a slope that is well drained. A fairly low-cost option is to spread a layer of crushed rock or gravel on the surface area where bales will be stored. This will reduce the amount of moisture that seeps into the bales over time.

An even better base can be provided by arranging used wooden pallets. These not only form a moisture barrier, they also allow air to circulate under the bales, reducing storage losses by two-thirds or more. The cost of pallets can vary widely depending on the source.

Top covers

Bales can be protected even further by covering them with a plastic tarp. This choice is more economical when bales can be stacked several layers high. Uncovered bales should not be stacked, however, as this prevents water from running away from them and keeps them from drying out.

Low-cost plastic requires a minimal investment but may not be reusable. Most costly thick plastic or canvas tarps can be used for multiple years.

Individual covers have become more economical and more popular in recent years. Bales wrapped with plastic netting or sleeves shed water better than those wrapped only with twine. Plastic bags do a very good job of preserving hay quality but require investment in bagging equipment.

They are more expensive but may be cost-effective for very high-quality forage. Bale wraps and bags generally can be used only once, however, and create a disposal problem.

Storage buildings

For higher-quality hay, investing in permanent storage facilities may be the most economical choice when reduced spoilage losses are taken into account. This can range from refurbishing an existing barn or shed to erecting a pole barn with a roof but no sides to building a completely enclosed new building.

These options involve a higher initial cost, so should be undertaken only when a consistent volume of hay is likely to be produced over a longer period of time.

Maintenance costs should be minimal, especially in the early years. Existing buildings often can be refurbished at a very low cost.

For higher-quality hay, investing in permanent storage facilities may be the most economical choice.

Other considerations

Labor requirements will vary widely by system. Simply moving bales to the edge of the field and dropping them on a surface requires minimal time. Covering them with a tarp will add some more time, especially for an individual working alone.

Moving bales to a storage building and stacking them inside will require the most labor, and the effort will be duplicated when they are removed. What value to put on the producer's own labor is arbitrary and may depend on what other activities need to be performed during forage harvesting season.

Source: William M. Edwards, Iowa State University

EFFECTS OF RAIN DAMAGE ON WILTING FORAGES

One of the most common problems faced by hay producers is how to manage production schedules around unfavorable weather. Inevitably, some wilting forage crops are damaged by rainfall each year, and producers often inquire about the effects of rain damage, and what impact this may have on forage quality and animal performance. Actually, the problem is more complex than damage to wilting forage crops via leaching, extended or reactivated plant respiration, and/or leaf shatter. Common consequences of uncooperative weather also may include:

1. spontaneous heating and/or combustion that occurs when producers try to complete baling operations of incompletely wilted hays prior to an oncoming rainfall event;
2. poor silage fermentation; and
3. excessively mature forage that results from delaying haying or silage harvesting operations until weather is more favorable. Maturity effects on forage quality can be as severe as spontaneous heating and/or rain damage.

What happens when rain falls on wilting forages?

Plant sugars are assumed to be 100% digestible. Therefore, any loss of sugar has a direct effect on the energy density of the harvested forage. During the normal wilting process, respiration of plant sugars continues to occur at moistures suitable for ensiling; numerous research studies have shown that this process slows considerably by the time forages reach 50% moisture, but may persist at a low level until the forage is nearly dry enough to bale as hay. These factors explain why rapid drying to the desired forage moisture concentration is important, regardless of whether the forage is to be preserved as silage or hay. Unfortunately, rainfall events can reactivate respiration within dry forages, and promote the growth of micro-organisms on the forage. One study has reported that respiration rates for rain-damaged forages can return to rates

similar to those of freshly mown forages (Pizarro and James, 1972) after rewetting by rainfall events. This type of secondary respiration causes additional plant sugars to be respired, greater losses of DM, and further reductions in nutritive value.

Rain falling on wilting forages also directly leaches soluble nutrients (primarily sugars) from the forage. Leaching losses are affected by forage species, the moisture concentration of the forage when the rainfall event occurs, concentrations of soluble sugars within the forage, and the number, amount, intensity, and/or duration of the rainfall event(s). Plant sugars also serve as the primary substrate for formation of lactic acid during the silage fermentation process; therefore, rain-damaged forages can be problematic to ensile. Significant losses of DM also can occur directly as a result of leaf shatter, particularly if the forage is a legume. In addition, any rainfall during the wilting process may lead to additional tedding and raking operations that result in even more leaf shatter before the forage is dry enough to bale.

Source: Wayne K. Coblentz and Richard E. Muck,
US Dairy Forage Research Center, Marshfield, WI

MOISTURE CONTENT AFFECTING STORAGE

Baling: Recommended moisture content

Timing of baling is critical to maximize the hay's value. Optimum moisture for baling is between 15 to 20% moisture (wet basis), which is low enough to prevent mold activity.

Baling at lower than 15 percent moisture will result in greater harvesting losses, especially for alfalfa, because leaf loss increases as moisture decreases.

Large hay packages, especially large rectangular bales, don't lose much moisture after baling. This is why it's important to bale at the proper moisture, instead of baling at a higher moisture and counting on some natural drying in storage.

Baling at higher moistures

If you must bale at higher moisture, here are some options:

- Bale at a slightly higher moisture (20 to 30 percent) and apply a preservative that inhibits mold growth in storage.
- Bale at a higher moisture (20 to 35 percent) and artificially dry the bales.
- Bale at a much higher moisture (50 to 65 percent) and ensile the bales by storing them sealed in plastic.

Storage: Recommended moisture content

After baling, hay should continue to be at moisture contents below 20 percent for storage. Storing hay at moisture contents above 20 percent will result in:

- Some molding and heating.
- Dry matter and nutrient loss.
- Some discoloration.

Study: Impact of storage moisture

A study of small rectangular bales stored in a barn at the U.S. Dairy Forage Research Center in Madison, Wis. showed that dry matter loss increased with storage moisture (Table 1). Quality loss was also greater in the wetter bales.

Table 1: Dry matter and quality loss

Storage moisture	Dry matter loss	Digestible dry matter loss	Crude protein loss
11 to 20%	4.50%	6.20%	6.00%
20 to 25%	7.90%	11.80%	8.80%
25 to 34%	10.90%	13.50%	7.50%

Source: Bill Wilcke, Greg Cuomo, University of Minnesota Extension

Alfalfa Hay market prices in US markets *(As of 15 October, 2019)*

Alfalfa hay prices reported to USDA from selected states.			
	Forage Quality Grade		
Location	Premium+	Good	Fair
	$ per ton		
California	175-270	165-230	180-190(d)
Colorado	180-323(d)	200	N/A
Idaho	155-170	150-153	N/A
Iowa	200-340	133-200	88-105
Kansas	170-250	160-175	90-155
Minnesota	155-230	95-200	70-160
Missouri	170-225	120-160	100-125
Montana	150-250	110-180	75-150
Nebraska	180-200	100-165	130-140
New Mexico	200(d)-260(d)	150(d)-210(d)	130(d)-150(d)
Oklahoma	225(d)	N/A	N/A
Oregon	175-250	150-170	N/A
Pennsylvania	350-390	N/A	N/A
South Dakota	200-250	225	98-175
Texas	240-330	175-190	N/A
Washington	205-210	195-205	N/A
Wisconsin	255-275	175-210	N/A
Wyoming	180-270	150-165	130-140

Source: USDA Hay market prices

July prices for Premium and Supreme hay in the top milk-producing states averaged $209 per ton, down $8 from May (Table 1).

TABLE 1	Monthly average prices received for Premium and Supreme alfalfa hay in large dairy states ($ per ton), 2019			
State	March	April	May	June
	(Dollars per ton)			
California	235	225	225	220
Idaho	170	170	190	190
Michigan	190	200	200	190
Minnesota	236	232	211	203
New York	222	222	246	246
Pennsylvania	288	294	296	256
Texas	255	247	235	229
Wisconsin	252	264	252	223
Five-state total[1]	219	222	217	209

[1]Five-state total represents a weighted (hay purchases) average price for the five largest milk-producing states (based on the pounds of milk produced during the previous month): California, Idaho, New York, Texas and Wisconsin.

Source: USDA National Ag Statistics Service

Organic hay prices

USDA's Aug. 28 Organic Hay report showed f.o.b. farm gate prices paid for both Supreme large square bales and Good small square bales averaged $260 per ton; Premium and Supreme alfalfa large square bales averaged $245 per ton. No price data was available for delivered organic hay.

China alfalfa purchases hit 13-month high

While Japan and South Korea remain oversupplied with domestic timothy, quality grades are lower than earlier estimates, according to Christy Mastin, international sales manager with Eckenberg Farms Inc., Mattawa, Washington. The market for U.S. alfalfa is holding, but higher prices are causing concerns about rations and the need to replace the high-cost alfalfa with lower-priced forage.

Japan's exchange is better for buying U.S. products, but customers are purchasing smaller volumes and making spot purchases instead of signing long-term contracts. That leads to shipping challenges as the U.S. hay export market moves into its busy season (October through February). Normally during this time, vessel space is in high demand, so early bookings are needed to secure cargo space. Shipping lines may also have issues with equipment availability and relocating containers. Adding to shipping costs, low-sulfur fuel surcharges are being announced for Oct. 1.

The political environment and never-ending threat of tariffs hangs over the hay export market in China, with concerns there may be additional tariffs placed in the middle of December. Mastin said she believes export sales to China will be strong into November, as customers move to beat those tariffs.

Elsewhere, demand for U.S. alfalfa remains strong in the Middle East, Mastin said.

Here's a look at the numbers:

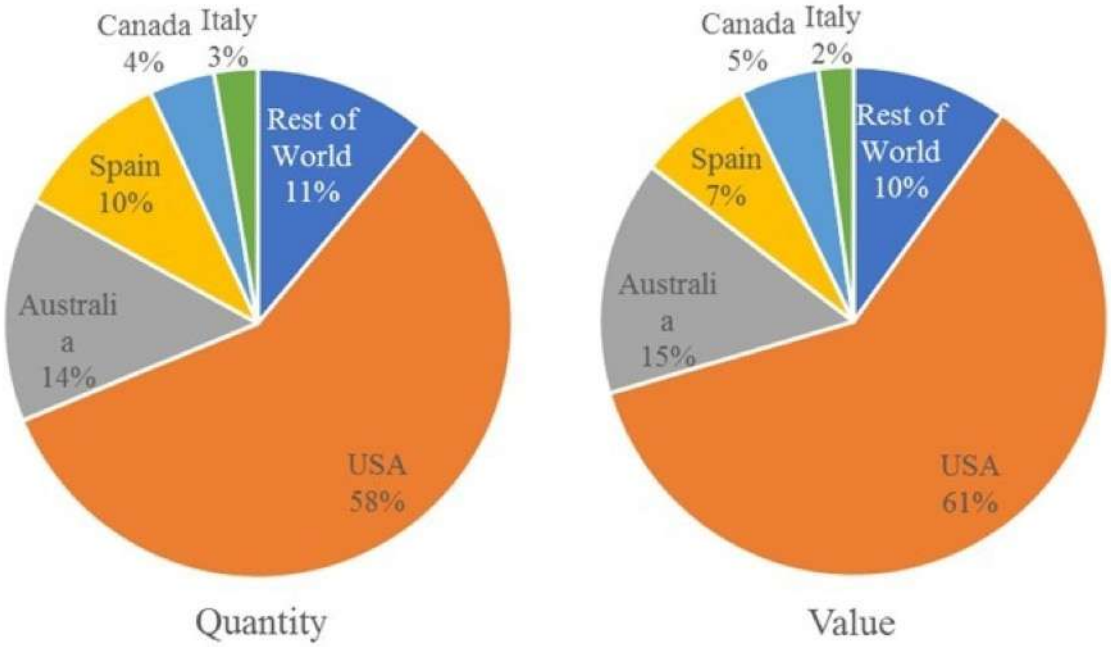
- July alfalfa hay shipments totaled 233,547 metric tons (MT), the highest volume since June 2018. The July alfalfa hay exports were valued at $73.6 million, up nearly $5 million from June. At 1.48 million MT, January-July 2019 exports of alfalfa hay are slightly ahead last year's pace and trail only 2017 in terms of sales for the first seven months of any year on record.
- Despite tariff headwinds, China climbed back atop the U.S. alfalfa hay buyers' list. At 71,799 MT, July's total was the highest since July 2018. Among other leading markets, sales to Saudi Arabia, Japan, the United Arab Emirates (UAE) and South Korea remained strong and near normal monthly volumes.
- July shipments of other hay remained average at 112,336 MT; monthly sales were valued at $38.2 million. At nearly 797,225 MT, January-July 2019 exports of other hay are slightly ahead of last year's pace, but trail seven-month sales totals for every other year dating back more than a decade.
- Japan topped 60,000 MT in shipments for the seventh consecutive month, but sales to Japan, South Korea, Taiwan and the UAE were all down slightly from the previous month.

Source: USDA Market News

Alfalfa Export trends

US Leads. The United States is the leading hay export country, followed by Australia, Spain, Canada and Italy (Figure 4). While some forage is exported from other countries (e.g. Argentina, Sudan, Morocco, France, Germany, Mongolia, Romania), these make up less than 11% of the world trade, according to the International Trade Center.

Figure 4. Global Exports of Alfalfa and Grass Hays by Country Share of Quantity and Value, 2017.

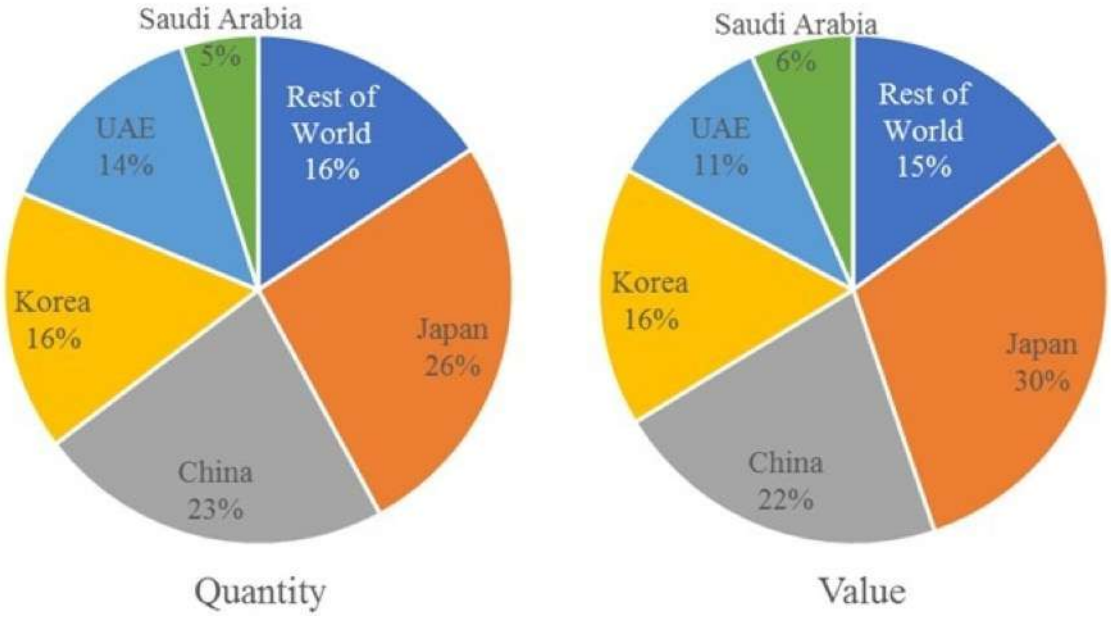


Source: ITC Trade Map

What is Exported:

While alfalfa dominates hay markets in many countries, high quality grass hays (timothy, sudan-grass, bermudagrass, oat hay, kleingrass) make up a substantial portion of exported hay, nearly 50% from the US. Australia's exports are nearly all 'oaten' grass hay.

Figure 5. Global Imports of Alfalfa and Grass Hays by Country Share of Quantity and Value, 2017.



Source: ITC Trade Map

Published by VIRENXIA (Global Innovation Investments LLC),
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