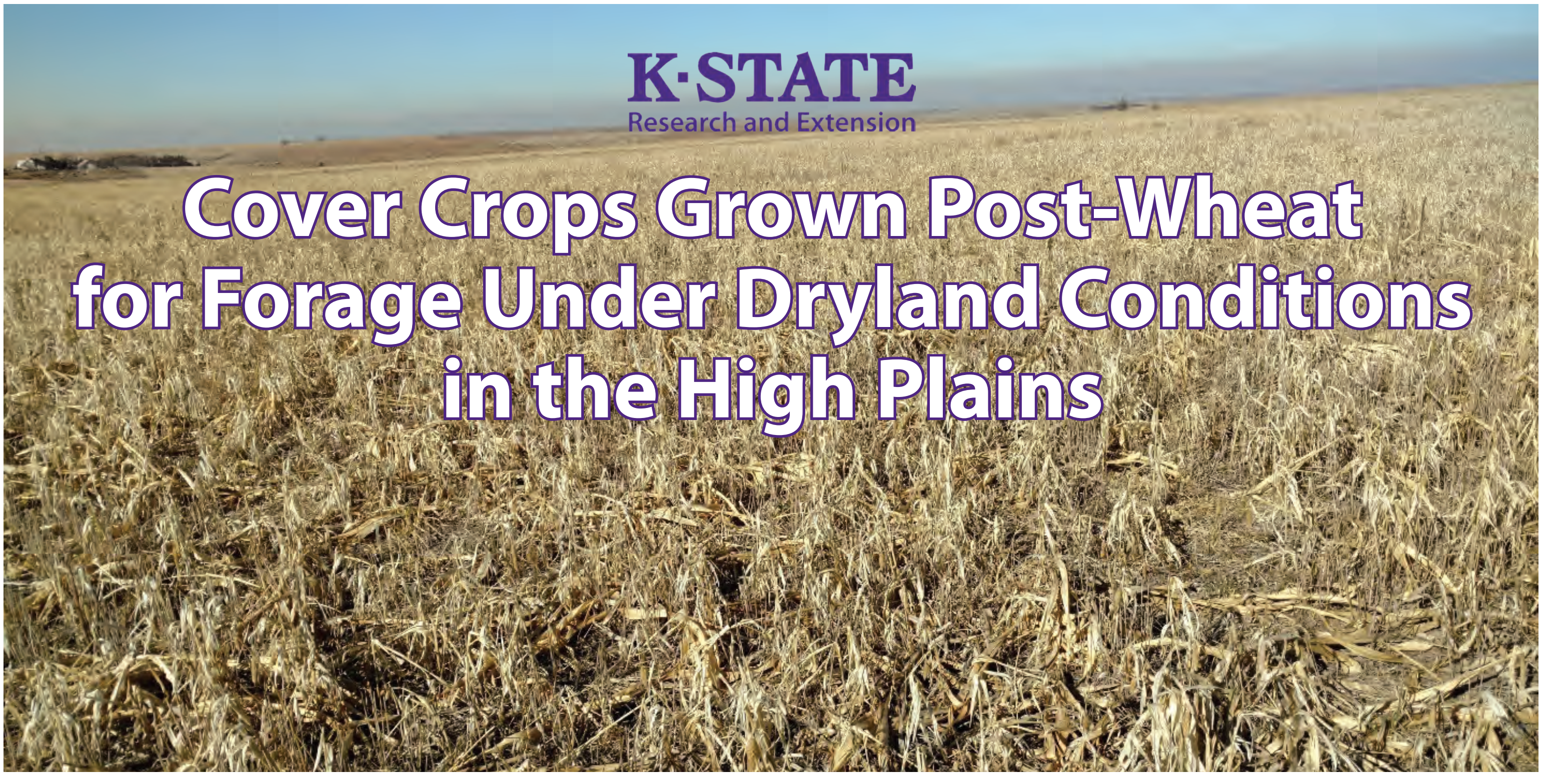

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Cover Crops Grown Post-Wheat for Forage Under Dryland Conditions in the High Plains

Post-wheat planted cover crops may offer a longer and more flexible grazing period than spring-planted cover crops within wheat-based dryland cropping systems. However, low available soil moisture and variable weather patterns this time of year can make cover crop establishment and productivity highly variable. Concerns about disrupting good wheat stubble, managing volunteer wheat to reduce disease transmission, and controlling weeds should be considered.

Species Selection

Determining what to plant can be difficult with all the varied species available for use as cover crops. Producers can use the ***Midwest Cover Crops Council Cover Crops Decision Tool*** to help select species based on specified goals. The decision tool currently includes recommendations for Kansas and Nebraska counties. When cover crops are grazed, producers should choose species that will not only benefit soil health but will also be palatable and safe as forage for livestock. Fortunately, many of the species recommended for use as cover crops are also good for forage production. Factors such as nutritive content and potential toxicities must be considered.

While some forages come with risks (i.e., nitrates, prussic acid, alkaloids), most can be managed. Planting immediately after wheat harvest comes with the risk of limited moisture in August and September, plant stress, and the accumulation of nitrates. Members of the sorghum family (sorghum-sudan, sudangrass, grain sorghum, and forage sorghum) as well as millets, oats, and brassicas are common nitrate accumulators. Environmental stress and excess nitrogen can result in increased nitrate levels in these plants. Anecdotal evidence suggests that the tolerance level of livestock may be different when grazing green growing forages than when feeding hay or silage. Animals consume green forage at a slower rate (graze) than when eating hay or silage at a bunk. In addition, animals will selectively graze heads and leaves, which are lower in nitrates, before moving on to stalks. Nitrate concentration is highest in the base of the stalk, thus careful observation and management might allow for grazing forages with elevated nitrate levels. Producers should use caution when grazing forages with high nitrate potential and test before grazing.

Although a hard freeze does not change nitrate content, prussic acid toxicity can occur when grazing sorghums, particularly young plants, and in the fall following a frost/freeze. Potential problems will be addressed in the grazing management section. For more information see ***Nitrate Toxicity, MF3029*** (K-State Research and Extension), or ***Nitrate Poisoning, 1.610*** (Colorado State University Extension). To learn more about prussic acid toxicities, see ***Prussic Acid Poisoning, MF3040*** (K-State) or ***Prussic Acid Poisoning, 1.612*** (CSU). For a more complete overview of forage crops with potential toxicities, see the K-State publication, ***Grazing Management: Toxic Plants (MF3244)***.

Goals for the timing and length of grazing are considerations in specie(s) selection. Grazing may occur in the late summer or fall, after the first hard frost or freeze, or over the winter and early spring. In some years, the best moisture conditions for planting occur immediately after wheat harvest. For earlier plantings and late summer through early winter grazing, warm-season species such as millets, sorghum-sudangrass, or sunflowers should be considered as a larger component of a mix. These species have the greatest potential for dry matter production when grazing is delayed until after a hard freeze and plant growth stops.

Rarely do growing conditions in the High Plains region allow for sufficient growth in the late summer and early fall for grazing with enough time for cover crop regrowth before a freeze. For later fall and spring grazing, cool-season grasses such as triticale, barley, and cereal rye are more suitable because they overwinter. Planting a mixture of warm-season or spring cool-season species along with winter cool-season species increases fall forage production while allowing some plants to overwinter and produce spring forage. This mixture of plants provides a wider range of grazing opportunities. If cool-season species are not included in the mixture, the crop will stop growing after the first hard freeze in the fall, eliminating the expense of crop termination in the spring.

Even when allowed to head, crude protein may remain above 7% in warm-season mixes (Table 1). The inclusion of cool-season species (brassicas, grasses, or legumes) or warm-season legumes (cowpea or sunn hemp) can increase forage quality.

A high-quality forage in the fall can meet the needs of weaned calves or fall-calving cows, whereas winter annuals available in the spring before native pastures are ready to graze can be an asset if spring-calving cows need more energy for lactation or to reach a positive energy balance before breeding. A single species will typically produce more tonnage of forage (Table 1), but it may not meet other goals such as nitrogen fixation or soil pest suppression.

Complex mixtures of six or more species, often referred to as "cocktails," are commonly recommended when planting cover crops. The benefits of cocktails relative to single species or simple mixtures of 2 to 4 species depend on specific management goals. Competitive warm-season grass species tend to be the highest biomass producers when planted post-wheat, which can optimize weed control and forage production. Mixtures that contain competitive species along with legumes and/or brassicas can provide similar or, in some cases, less biomass than a single warm-season grass. Mixtures are often used for benefits other than biomass production. For example, legumes can be included for nitrogen fixation, or brassicas to suppress soil pests. Mixtures provide an opportunity to achieve other goals. The challenge is determining how dense a population is needed to achieve the goal, the cost of the seed mixture, and weed management options.

From a grazing perspective, mixtures can produce forage with a range of palatability and offer both benefits and limitations. For example, protein can be increased by including a legume in the mixture, but protein content may already exceed animal requirements. In addition, mixtures may contain species that are grazed

Table 1. Summer cover crop forage dry matter (DM) production and nutritive value§ at the Kansas State University HB Ranch north of Brownell, Kansas, after heading and before frost.

Treatment	Forage DM			Crude protein§		ADF§		NDF§	
	2016	2017	2018	2016	2018	2016	2018	2016	2018
	---------- lbs/acre ----------			----- % -----					
Full season cover crop†	5950 a	4031 b	6730 b	8.8 a	7.5 ab	37.8 a	36.2 a	58.7 a	53.9 a
Post-wheat cover crop*	3845 b	0 c	3825 c	10.4 a	8.8 a	36.3 a	35.7 a	55.8 a	54.2 a
Forage sorghum	---	7330 a	8923 a	---	6.2 b	---	34.5 a	---	52.7 a

† Full-season cover crops were planted at grain sorghum planting. (The mixture consisted of 7.5 lbs/acre sorghum-sudan, 2.5 lbs/acre pearl millet, 20 lbs/acre cowpea, and 5 lbs/acre sunn hemp.)

*Post-wheat cover crops (same mix as full season) were planted in July after wheat harvest and after spraying herbicide on the first flush of volunteer wheat. (No biomass was harvested in 2017 because drought resulted in little growth.)

a,b,c Means in columns followed by same letter(s) are not significantly different ($P > 0.05$).

§Nutritive values were determined October 17-24, before frost but after heading had occurred in sorghum-sudan and pearl millet. Acid detergent fiber (ADF; higher values reflect lower digestibility) and neutral detergent fiber (NDF; higher values reflect lower animal intake).

selectively. This may reduce the utilization of some species while helping to achieve residue goals.

In a two-year on-farm study, complex mixtures containing 8 to 9 species were dominated by sorghum-sudangrass or millet, which contributed an average of 55-80% to total forage yield when there was enough forage to graze. If the main goal is to produce forage for livestock, monocultures or simple mixtures of grasses may produce more biomass and be more cost-effective as compared to more complex mixtures. Timing of grazing in regard to the maturity of forage consumed will have a large impact on animal performance.

Variability in Forage Production

Forage productivity varies from year to year under dryland conditions, making this one of the biggest challenges facing producers that graze cover crops in the High Plains. As an example of yield variability across years, Figure 1 presents seven years of forage sorghum yields at the Southwest Research-Extension Center (SWREC) near Garden City, Kansas, with long-term average annual precipitation of 19 inches. Forage sorghum planted after wheat produced an average of 5,600 lbs DM/acre, which was 75% of the full-season yield and ranged from 1,130 to 8,900 lbs DM/acre over a seven-year period in southwest Kansas (Figure 1).

Based on a two-year on-farm study conducted in western Kansas, eastern Colorado, and southwestern Nebraska, forage yields ranged from 500 lbs/acre up to 2,300 lbs/acre (Table 2). The earlier planting dates were associated with higher production of biomass. At some locations, regrowth was documented before spring termination but not in an amount sufficient for grazing. The effect of the east-west precipitation, elevation, and evapotranspiration gradient within the region was also evident as the two farms located in the drier part of the region (i.e., eastern Colorado) produced less biomass than the Oberlin, Kansas, location farther east. Approximately 50% of the time, grazing was not possible, either due to lack of growth or wet soil conditions.

Producers have several options to manage this variability in forage production. A flexible herd size where animals can be added or subtracted based on a given year's productivity is the ideal situation. Grazing a stocker-only herd or the inclusion of stockers with cows and calves makes it easier to add or subtract

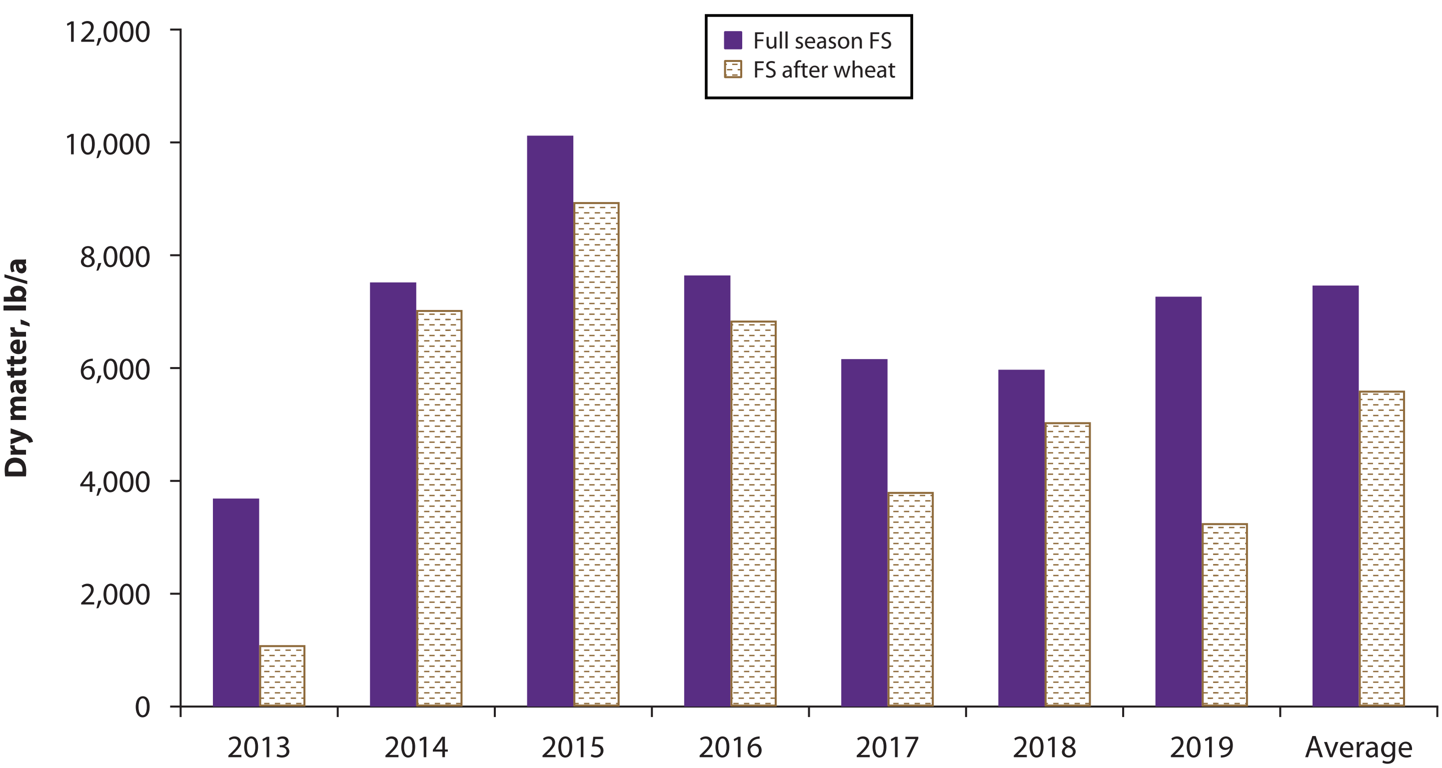

Figure 1. Variability in forage sorghum (FS) yield over seven years as a full-season crop or after wheat at the Southwest Research-Extension Center near Garden City, Kansas.

Table 2. Examples of dryland cover crop planting dates, growing degree days*, grazing start and end dates, grazing days, and forage production in 2017 and 2018 for various farm fields located in western Kansas, eastern Colorado, and southwestern Nebraska.

Location	Planting Date	Killing Frost	Growing Degree Days*	Start Grazing	End of Grazing/ Forage Sampling Date[a]	Days Grazing	DM Yield (lbs/ac)
2017[b]							
S of Oberlin, KS	7/10	10/27	2056	12/8	1/9	32	2143
NE of Idalia, CO	7/8	10/30	2000	9/15	10/30	33	1886
N of Vona, CO	7/18	10/27	1587	---	11/15	Not grazed	514
S of Seibert, CO	9/11	10/27	507	---	12/5	Not grazed	816
2018[c]							
S of Oberlin, KS	7/20	10/15	1567	Too wet to graze			2294
S of Seibert, CO	7/9	10/14	1670	12/17	2/12	57	1236
N of Bird City, KS	7/7	10/14	1757	1/14	2/15 : 4/2	32	856

*Planting to killing frost

[a]If field was planted, but not grazed, date represents when forage production data were collected.

[b]On per acre basis, mix was composed of 20 lbs triticale, 6 lbs Austrian winterpea, 4 lbs sorghum-sudangrass, 4 lbs cowpea, 3 lbs sunflower, 2 lbs millet, 1 lb radish, 0.5 lbs rapeseed, and 0.2 lbs phacelia.

[c]On per acre basis, mix was composed of 20 lbs triticale, 4 lbs Austrian winterpea, 4 lbs sorghum-sudangrass, 5 lbs cowpea, 1 lb sunflower, 2 lbs millet, 1 lb radish, 0.75 lbs sunn hemp, 0.5 lbs rapeseed, and 0.2 lbs phacelia.

animals based on differences in carrying capacity from year to year. If it is difficult to adjust herd size, then the number of days a field can be grazed will have to be shortened or lengthened to achieve residue goals.

If excess forage is produced, putting some up as hay or silage to preserve forage for dry years may be a good option. The removal of hay and silage can reduce the amount of residue left in the field, negating soil health goals compared to carefully managed grazing. A long-term study at the Southwest Research and Extension Center revealed no differences in soil physical or chemical properties when comparing a cover crop left standing or one hayed with 6-inch residue. Both improved soil physical properties compared to fallow. For information on how to calculate the number of animals or days a field can be grazed based on estimated forage productivity, see "Determining Stocking Rates" on page 6.

In years with minimal precipitation and forage productivity (i.e., ~1,000 lbs/acre or less), the best choice might be not to graze at all if soil protection is the primary goal. Ideally, a producer would want to maintain a minimum of 30% ground cover, and approximately 1,000 lbs/acre is needed to achieve that goal.

Grazing Management

When it comes to managing grazing of cover crops, producers have numerous options. The strategy chosen should be guided by the overarching goal(s) for the cover crop. Cover crops are generally grown for reasons beyond achieving high levels of harvest efficiency (i.e., percent utilization of available forage) as is typical for a dedicated forage crop. Enough residue should be left behind to maintain most of the benefits associated with planting cover crops. With that in mind, continuous grazing is not a bad option. In that case, the producer would calculate a stocking rate based on the estimated yield and place the whole herd in one large field to graze. Advantages of this grazing system are not having to move fences and needing only one water source.

Labor and inputs are minimal, but if the field is large, livestock tend to overgraze the forage closest to the water source and underutilize the forage that is farthest away unless it is possible to move the watering location. One benefit of continuous grazing is that livestock are free to choose any plant or plant part. As a result, diet quality and performance are high, especially at first, but will decline over time as animals are left with the less palatable and nutritious plants. Harvest efficiency is around 30% with continuous grazing.

Photos from study field North of Bird City, Kansas, referenced in Table 2. Top image was taken August 13 during a field day. Bottom image was taken at the end of the grazing period that started in January. The heifers are standing at the end of the grazing area. The previously grazed strip is to the right of the fenceline.

Some form of rotational grazing where a large field is divided into two or more smaller units, or paddocks, and the animals are rotated from one paddock to the next is another good option with some advantages and disadvantages. The more paddocks in a field, the higher the stocking density (i.e., number of animals per acre). As stocking density increases, harvest efficiency can reach a point where 50% or more of the available forage can be utilized by the livestock. This increase in harvest efficiency allows for longer grazing or more animals but may not meet the goal of leaving a given amount of residue in the field.

Higher stocking densities may lead to the trampling of plant material onto the soil surface, resulting in faster decomposition and nutrient cycling. Manure and urine also tend to be more uniformly distributed across the field as stocking density increases, reducing the buildup of nutrients near water, windbreaks, and other loafing areas. If multiple paddocks are used, any undesirable effects (grazed too long, compaction) may be limited to one paddock.

One drawback to concentrating animals into small paddocks is that it can compound the effects of soil compaction, especially on heavier clay soils following a significant precipitation event. If native pasture is available adjoining the crop field, cattle can be removed when the field is wet to prevent soil compaction. Alleviating soil compaction is not easy, especially for no-till producers. Freezing and thawing cycles reduce compaction in the top 6 inches of soil. Soil compaction will be greatest in traffic lanes to and from and around the watering location. Tillage may be required to correct problems in these isolated areas that usually make up only a small fraction of the entire field.

The need to move fences every day or every few days and coming up with a plan for watering the animals are two of the biggest hurdles that keep many producers from practicing rotational grazing. But with electric fencing, it is relatively easy to move fences in minimal time. Watering can still be a challenge unless the producer has a portable water tank and a moveable supply of water. If not, portable fencing can be used to construct alleys that provide animal access to watering points.

One common method used when grazing annual cover crops is known as strip grazing. It is similar to rotational grazing where a temporary fence is set up

Table 3. Example calculations to estimate length of grazing for a set number of animals or the number of animals for a set grazing period.

Variables	Inputs
Acres	120
Total yield (lbs/acre dry basis)	2200
Utilization (%)	30
Animal wt (lbs, average for period)	800
Dry matter intake (% of body wt)	2.5

Example 1 – Estimate number of animals for given grazing period.

Length of grazing (days): 50

$$\text{Stocking rate (head)} = \frac{\text{acres x yield/acre x utilization}}{\text{animal wt x dry matter intake x length of grazing}}$$

$$\text{Stocking rate (head)} = \frac{120 \times 2200 \times 0.30}{800 \times 0.025 \times 50} = 79 \text{ head}$$

Example 2 – Estimate number days a given number of animals can graze.

Number of animals: 85

$$\text{Length of grazing (days)} = \frac{\text{acres x yield/acre x utilization}}{\text{animal wt x dry matter intake x number of animals}}$$

$$\text{Length of grazing (days)} = \frac{120 \times 2200 \times 0.3}{800 \times 0.025 \times 85} = 47 \text{ days}$$

to allow animals to access one to a few days of feed, but it differs in that there is no back fence, and animals can graze both fresh, residual, and regrowth forage. This is a convenient method for watering animals because fencing can be set up to provide continuous access to a single water point. A problem with having an unmovable water source is that animals continually cross back and forth over the same ground on the way to and from the water. This increases the chance of soil compaction, especially near the water source. In addition, the area closest to the water will be grazed more heavily, and manure and urine tend to be concentrated near the water. Unlike rotational grazing, little regrowth accumulates with strip grazing as animals continually search for and graze new growth in strips grazed previously, which prevent residue goals from being met. Utilization levels are usually high in the first strip and gradually decrease as moves are made across the field to the last strip. Because residue is distributed unevenly, strip grazing may not be the best strategy for meeting certain goals.

Timing of grazing in relationship to frost is an important consideration in post-wheat planted cover crops. The biggest concern is with plants in the sorghum family and the release of prussic acid after frost damages cell walls. Grazing should be suspended for 7 to 10 days after a frost to avoid prussic acid poisoning. The days available for grazing before frost will vary based on growing conditions. A forage planted immediately after wheat harvest can provide 30 or more days of grazing before frost. In other cases, delaying grazing until after a hard frost may be easier, particularly when it may be time-consuming to move animals on and off the field and difficult to predict frost timing. A forage mix that includes species that overwinter can provide additional growth for another grazing period or serve as a ground cover. Grazing can be delayed if heavy snowfall buries plants. The earliest time to start grazing cereal grains is limited by sufficient growth and tillering to withstand grazing. In plants with prussic acid potential, delay grazing until plants achieve 18 to 24 inches of growth because prussic acid is highest in small plants or regrowth.

Determining Stocking Rates

Several key pieces of information are needed to estimate a stocking rate, the first being an estimate of the forage yield the field will produce during the period it will be grazed on a dry matter basis. (See the section on "Variability in Forage Production" on page 3 and Table 2.) The next step is to determine the amount of forage consumed in a day, which will depend on animal body weight and forage quality. For green and growing forages, intake runs from 2.5 to 3% of body weight on a dry matter basis. Another key input is the percent utilization desired. In dryland systems, 30% is a conservative starting point unless moisture is excellent for the year and results in above average yields. Use the examples shown in Table 3 to estimate days of grazing for a given number of animals (Example 1) or the number of animals for a set grazing period (Example 2). For a spreadsheet to help with calculations, use the ***Carrying Capacity Calculator*** found at DrylandAg.org.

Other Considerations

Wheat streak mosaic virus complex (WSMV) is a disease vectored by the wheat curl mite (*Aceria tosichella*) and is easily transmissible through feeding on plants. The wheat curl mite feeds on young, lush growth of wheat and certain grasses. The virus will persist in the mite for up to nine days without further disease infection. Thus, eliminating any host species, otherwise known as a 'green bridge' for a couple of weeks greatly reduces the likelihood for disease transmission. This disease is estimated to reduce wheat yields 1.3% on average annually, but in extreme cases, can result in much greater losses.

Volunteer wheat is the primary host for the mites and WSMV. It can also persist on barley, corn, millet, and susceptible perennial grasses such as buffalograss (*Buchloe dactyloides*) and several foxtails. In addition, several weed species including jointed goatgrass (*Aegilops cylindrica*), cheat (*B. secalinus*), field sandbur *(Cenchrus pauciflorus),* and smooth crabgrass *(Digitaria ischaemum)* can be a host for WSMV and the mite. The relative risk of various species as hosts for WSMV and mites can be found in the publication, ***Wheat Streak Mosaic (MF3383)***. Growing a cover crop may not allow for control of volunteer wheat and weeds that can serve as hosts for WSMV. Growing a wheat variety with resistance to WSMV helps prevent problems from occurring. To avoid conflicts that may arise from cover crop fields with potential WSMV hosts, timely and sensitive communication with wheat-producing neighbors can benefit long-term relationships.

Example Timeline

Following is an example timeline with suggested planting, start grazing, and end grazing dates for post-wheat planted cover crops. In good moisture years, grazing could occur in September and October. Depending on species planted, removal of livestock before the first hard freeze is recommended. Others may prefer to delay grazing until a week or more after the first killing frost.

Planting date
July 10 – August 10

Start grazing
October 10 – January 30

End grazing
30-60 days following start of grazing

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