Annual Forages

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Outline

• Systems
• Precautions
• Species Selection
• Concepts
• Integrating Forages into Various Crop Rotations
• Resources Available
Systems

Livestock
- Cow/Calf
- Stocker/Yearling

Forage
- Native Range
- Annual Forage
  - Baled
  - **Graze**
  - Swath/Graze
  - Bale/Graze
Every producer’s operation is a bit unique:

- Resources (land, labor, skills, capital, fence and water infrastructure, etc.)
  - Baled
  - Graze
  - Swath/Graze
U.S. Drought Monitor
August 14, 2012
Valid 7 a.m. EDT

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, August 16, 2012
Author: Michael Brewer/Liz Love-Brotak, NOAA/NESDIS/NCDC
U.S. Drought Monitor

January 16, 2018
(Released Thursday, Jan. 18, 2018)
Valid 7 a.m. EST

Drought Impact Types:
~ Delineates dominant impacts
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:
- Yellow: D0 Abnormally Dry
- Light Yellow: D1 Moderate Drought
- Orange: D2 Severe Drought
- Red: D3 Extreme Drought
- Dark Red: D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Brian Fuchs
National Drought Mitigation Center

http://droughtmonitor.unl.edu/
Wheat stocking density: effected rate of gain: 1.5 to 3 lbs/day
Increased placements due to larger herd size & dry fall conditions reducing wheat pasture grazing
Annual Forage Systems

Bale/Silage Forage

**Advantages**

• Control Feeding
• Ration Formulation
• Controlled Traffic
• Storage
• Drought Insurance

**Disadvantages**

• Machinery Costs
• Feed Delivery Costs
• Nitrates in Bale
• Nutrient Removal
Grazed Forage

**Advantages**

- Less Machinery and Feeding Costs
- Less Nutrient Removal
- Extend Grazing Season
- Manage High Nitrate Forage
- Drought Rescue Crop

**Disadvantages**

- Unpredictable Weather
- Unpredictable Yield
- Uneven Nutrient (Manure) Deposition and Volatization
- Selective Grazing
- Trampling/Cover Loss
  - 60% for Mature Forage
  - 40% for Grain Residue and Immature Forage
- Move Electric Fence every 1-3 days
  - Increase utilization
  - Reduce selective grazing
Swath-Grazed Forage

**Advantages**

- Same as grazing but includes cost of swathing
- Easier to move electric fence
- Lock in Forage Quality
- Forage regrowth

**Disadvantages**

- Same issues as grazing
- Mold/Rot/Rejection
- Best suited for cold, dry climate
## Annual Forage Systems

### Bale-Graze

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduce feeding expense</td>
<td>• Equipment expense</td>
</tr>
<tr>
<td>• Easiest to move electric fence</td>
<td>• A lot of forage not consumed/“wasted”</td>
</tr>
<tr>
<td>• Control amount of forage fed/preserved</td>
<td>• Too much concentrated residue</td>
</tr>
<tr>
<td>• Strategically place bales for residue/manure placement</td>
<td></td>
</tr>
<tr>
<td>• Can improve soil quality over time</td>
<td></td>
</tr>
</tbody>
</table>

![Image of hay bales scattered across a field](hay_bales.jpg)
Summer Annual Forages
Sorghum Types:

- **Grain Sorghum:**
  - Selected for grain production
  - Developed to be shorter to resist lodging
  - Stalks underutilized for grazing
  - Failed crop can be good rescue feed crop
Sorghum Types:

• Forage Sorghum:
  • Older ‘work horses’ were open pollinated: ‘Rox Orange’ or ‘Sumac’ vs newer Hybrid: ‘Sweet King’ or ‘Canex’
  • Older varieties drought tolerant and lower seed cost, but less disease/insect resistance, more variable, and slower emergence than hybrids
  • Plant when soil temp is 60°F or warmer, seed up to 2” deep
  • Taller, more leaf area, and mature later than grain sorghum
  • High biomass: best in a one-cut system for silage or hay
  • Grain production for silage & crop insurance
  • Less regrowth, coarser stems, but better palatability (sweeter stems) than sudan or sorg/sudan
  • Prussic acid risk higher than sorg/sudan or sudan
Sorghum Types:

- **Sudangrass:**
  - Less common in the marketplace
  - Good regrowth, fine stemmed, looks like a “grass”
  - Good quality for grazing - cut early
  - Lower quality and palatability silage
  - Low grain yield
  - Less prussic acid risk than sorghum
Sorghum Types:

- **Sorghum/Sudan (Two-way cross):**
  - Typically has ‘Grazer’ in the name
  - Forage sorghum (female) x sudangrass (male parent)
  - Good all around purpose for hay or graze
  - Better vigor, iron chlorosis tolerance, regrowth, tillering, and drought tolerance than forage sorghum
  - Grazing may be initiated when the plants are 18-24” tall
  - Less sweet and palatable than forage sorghum
  - Palatability reportedly drops more than forage sorghum at heading
Millet Types:

- **Pearl Millet:**
  - Smaller seed size (75,000-90,000 seed/lb)
  - Seeding depth shallower (0.5-1.5”)
  - Plant when soil temp is 65°F or warmer
  - Very leafy, good regrowth, can be grazed
  - Regrowth less than sorghum/sudan, leave 8” stalk
  - Yield less than sorghum but high quality (50% or more leaf)
  - Some PS varieties
  - Good tolerance to high pH soils
  - Good drought tolerance
  - Can be fed to horses
  - May not be a host to sugar-cane aphid (SCA)
  - Does not have prussic acid, **higher potential for nitrate**
Millet Types:

• German (Foxtail) Millet:
  • Fine stemmed, very leafy, good palatability for hay
  • Not suitable for grazing-roots are easily dislodged
  • Short season crop (rescue crop)-60 days
  • Yield potential less than Pearl Millet
  • Seed heads unpalatable-cut early
  • Does not have prussic acid, higher potential for nitrate
  • May not be a host to SCA
  • Can be fed as fine textured hay to weaning calves
Crabgrass:

- Annual but managed as a perennial if allowed to make seed
- Can be a weed in subsequent crops
- Seed does not meter well-fertilizer carrier
- Can be incorporated by hoof action into grazed wheat or seeded 0.5” deep
- Plant 5-6 lbs/acre
- Germinates at soil temps of 60°F
- 1st year stands can be variable
- Can interseed with other annuals-improve first year yield
- Good forage quality and regrowth
- Can be grazed after ~4 wks
Teff:

- Small seeded annual, seed 0.25” deep, soil temp 65°F
- Seed 8-10 lbs/acre
- Multiple cuttings with irrigation
- Leafy, high quality forage
- **Good for horses or weaning calves**
- Cut prior to heading for best regrowth
- First cutting after ~45 days, and every 30 days thereafter
- Use caution when grazing for dislodging roots
- Can accumulate nitrates but less risk than sorghums or millet
- May not be a host to SCA
• Determine nutrient requirement, forage needs, and opportunities
  • Weaned calves, yearlings, 1st calf heifers, thin cows,...
• Determine nutrient requirement, forage needs, and opportunities
  • Weaned calves, yearlings, 1st calf heifers, thin cows, ?
Species Selection

- **Spring:**
  - Oat, Triticale, Pea
    - Yield range: 1500-4000 lbs DM acre\(^{-1}\)

- **Summer:**
  - Annual: Forage sorghum, Sorghum-Sudan, Sudan, Pearl Millet, Cowpea, Sunhemp, Forage Brassica, Teff
    - Yield range: 4000-8000 lbs DM acre\(^{-1}\)
  - Perennial (high rainfall): Bermuda grass, Crabgrass
    - Yield range: 4000-14000 lbs DM acre\(^{-1}\)

- **Fall/Winter:**
  - Oat, Triticale, Rye, Wheat, Vetch
    - Yield range: 3000-6000 lbs DM acre\(^{-1}\)

- **Midwest Cover Crop Decision Tool:**
  - [http://mccc.msu.edu/covercroptool/covercroptool.php](http://mccc.msu.edu/covercroptool/covercroptool.php)
# Midwest Cover Crops Council - Cover Crop Decision Tool

## Kansas: All Counties Average County Seeding Dates

### Attribute Information
- Location Information: Kansas
- Cash Crop: None or Prevented Planting
- Plant Date: ______________
- Harvest Date: ______________
- Drainage Information: Moderately Well Drained
- Flooding: No

### Forage Harvest Value

<table>
<thead>
<tr>
<th>Good</th>
<th>Late Spring</th>
<th>Early Summer</th>
<th>Late Summer</th>
<th>Early Fall</th>
<th>Late Fall</th>
</tr>
</thead>
</table>

#### NONLEGUMES
- Barley, Winter
- Oats, Winter
- Millet, Forage
- Millet, Pearl
- Millet, Spring
- Oats, Block
- Oats, Spring
- Rye, Winter Cereal
- Ryegrass, Annual
- Sorghum, Forage
- Sorghum-sudangrass
- Triticale, Forage
- Triticale, Winter
- Wheat, Winter

#### BRASSICAS
- Broccoli
- Cauliflower
- Cabbage, Escapado
- Mustard
- Rapeseed, Canola
- Rapeseed, Choyse
- Radish, Ireland
- Turnip

#### LEGUMES
- Bean, Mang
- Clover, Crimson
- Clover, Red
- Cowpea
- Lentil, Spring
- Lentil, Winter
- Pea, Spring Field
- Pea, Winter
- Soybeans

#### MIXES
- 60% Oats/40% OSR
- 60% WC Rye/40% OSR
- 60% Soy/40% Cowpea
Forage Quality

Soil test for N, P, K and S

Implement weed management

Manage forage/cover crop as a “cash” crop to maximize production and profit
Volatilization 65%
Do not be misguided in thinking cattle grazing annual forages will not require fertilizer inputs
Managing Stubble Height

Corn stalks with standing strips

All taken 2/24/15

Forage sorghum cut 6” tall in 2014, no regrowth

Grain sorghum residue from 2013
2015 Forage Sorghum Harvest

Picture taken March 16, 2016:
4,700 lbs of production cut at 6” plus regrowth

Ideal situation:
1. Good forage crop
2. Left adequate residue to prevent soil erosion, capture precipitation, and reduce soil water evaporation
Residue Reduces Soil Erosion

• Must be careful to leave enough residue when haying or grazing
  – Very easy to take too much
  – Important for soil erosion and precipitation storage
• Grazing no-till wheat and grain sorghum residue reduced grain yields over time due in part to soil compaction near Bushland, TX (Baumhardt et al. 2011, AJ)

• Grazing no-till corn stalks increased crop yields over time and did not affect soil compaction in NE (Drewnoski and Blacno, 2015).

• ?
Grazed from 5/19/15 to 5/22/15

Grazed from 6/14/16 to 6/21/16

A. Obour and J. Holman, Hays, KS
Grazing increased compaction 0-2” when soil grazed wet
No compaction measured deeper than 2”
Soil Compaction

• Compaction is less on frozen, dry soils

• Wet/dry and freeze/thaw helps break-up compaction near the soil surface

• Shallow tillage can correct livestock compaction

• Avoid grazing when soils are wet
Estimating Forage Yield-ASW & GS

Spring Oat and Spring Triticale

\[ y = 207x + 197 \]
\[ R^2 = 0.1 \]
\[ \text{Avg} = 1494 \]

Winter Triticale Yield

\[ y = 640x - 1475 \]
\[ R^2 = 0.4 \]
\[ \text{Avg} = 3620 \]

Forage Sorghum Yield

\[ y = 402x + 915 \]
\[ R^2 = 0.2 \]
\[ \text{Avg} = 5216 \]
Estimate available forage?

Establish stocking rates?
Stocking Rates

- **Forage Yield:** Average yield estimate (adjust based on planting conditions and seasonal outlook)

- **Determine Utilization:** 90% baled, 40-50% with grazing

- **Animal class and intake:** 2.5-3% of body weight

- **Determine grazing days or number of animals needed:**

\[ f(x) = \frac{\text{Acres} \times \text{Forage Yield} \times \text{Utilization Rate}}{\text{Animal Wt} \times \text{Intake} \times \text{(Number of Head or Grazing Days)}} \]
Stocking Rates

Need to have a Plan B

- Too wet, too dry, too few head or too many head

- Works best to supplement native range nearby
  - Move them to range if too wet, run out of feed, make better utilization of higher quality forage

- Consider baled forage/silage as part of the plan
  - Store excess forage for those years it is not in excess
Considerations

Many Opportunities and Advantages to Grazing but consider some things to be aware of:

• Resource availability (land, capital, labor, fencing, water, etc.)
• Cattle sickness, death loss (stockers)
• Variable/unpredictable weather (feast or famine)
  • Western KS: we know precipitation will be variable
  • Need to have a mitigation plan in place
• Eastern KS/Irrigation: forage production more predictable
  • Watering cattle may be a concern
Management Concepts

- Cover crops are grown for agroecosystem benefits but not technically harvested

- Forage crops are grown for “feed” that is either hayed or grazed

- Statements like: “Hay or Graze my Cover Crop”

- We can manage forage crops for residue cover

- We can grow cover/forage crops in place of fallow to increase crop residue and improve soil health over time
Cover/Forage crops use water
- The more biomass grown the more water used

Plant Available Soil Water at Wheat Planting

- $y = -0.0004x + 6.0534$
- $R^2 = 0.66$
- Winter wheat: 4.7 bu ac\(^{-1}\) inch\(^{-1}\)

\[
y = 4.7x - 33
\]

\[
R^2 = 0.86
\]
Wheat-Fallow
(Forage, Cover Crop, Grain, or Fallow)
**Economic Net Returns: W-F**

- **Fallow costs ~$55/A**
- **Returns include variable costs and wheat yield**
- **Incentive for forages:**
  - Profit ↓, when spring triticale reduced wheat yield >14 bu/acre
  - Fallow most profitable in dry years
- **Flex-fallow to reduce losses and take advantage of wet years?**

<table>
<thead>
<tr>
<th></th>
<th>Spring Species</th>
<th>Winter Species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lentil/</td>
<td>Hairy</td>
</tr>
<tr>
<td>Fallow</td>
<td>Lentil</td>
<td>Vetch/</td>
</tr>
<tr>
<td>Lentil</td>
<td>Pea Triticale</td>
<td>Triticale</td>
</tr>
<tr>
<td>Pea</td>
<td>Pea Triticale</td>
<td>(grain) Triticale</td>
</tr>
<tr>
<td>Pea Triticale</td>
<td>Pea</td>
<td>Triticale</td>
</tr>
<tr>
<td>Pea (grain) Triticale</td>
<td></td>
<td>Triticale</td>
</tr>
<tr>
<td>Pea Triticale</td>
<td>Lentil</td>
<td>Pea Triticale</td>
</tr>
<tr>
<td>Pea</td>
<td>Triticale</td>
<td>Triticale</td>
</tr>
<tr>
<td>Cont</td>
<td>WW</td>
<td></td>
</tr>
</tbody>
</table>

| Cover Crop | -82 | -104 | -113 | -113 | -99 | -137 | -130 | -84 | -105 | -112 | -122 | -110 | - |
| Forage     | -83 | -62  | -77  | -57  | -48 | -140 | -10  | -92 | 4    | -109 | -1    | 7    | - |
| Other      | -55 | -    | -    | -    | -114 | -    | -    | -    | -    | -    | -    | -    | -71 |

LSD 0.05 21
Wheat/(Forage or Fallow)-
Sorghum(Grain or Forage)-Fallow(Forage or Flex or Fallow)
• Forage sorghum (FS) grown after wheat reduced second year grain sorghum (GS) yield
Forage sorghum (FS) grown after wheat did not affect second year FS yield.

FS double-cropped after wheat yielded about 50% of full season.

Opportunity to crop more intensively with forages.
Replacing Fallow with a cover/forage crop:

- Cover crops under all conditions were **never profitable**
- Forages can be profitable if:
  - Seed cost is minimized
  - Select crop with high forage yield
  - Wheat yields weren’t reduced by >7% (sensitivity analysis)
- Cover crop mixes (up to 6 species) did not reduce water use or improve crop performance compared to single species
- **Need to match cropping intensity to environment**
- Wheat yield <50 bu/a expect some yield and profit reduction if forage grown in place of fallow
- **It is only sustainable if it is profitable**
NRCS-CIG On-Farm Cover Crop Grazing

• Cooperative On-Farm Project with KSU, CSU, and NRCS
• Producers graze and leave standing replicated plots
• Project started in 2016
• 2016 spring covers in W-S-F
• 2017 spring and double-crop cover after wheat in W-S-F
• Measure soil moisture and crop yield from grazed and ungrazed plots

Figure 1. Map of demonstration and on-farm research sites.
Project Team

Research & extension team

**Colorado State University**
- Joe Brummer
- Kat Caswell
- Norm Dalsted
- Steven Fonte
- Courtland Kelly
- Kevin Larson
- Ron Meyer
- Angie Moore
- Steve Rosenzweig
- Meagan Schipanski
- Arathi Seshadri
- Wilma Trujillo
- Sarah Ward

**Kansas State University**
- Lucas Haag
- Keith Harmoney
- John Holman
- John Jaeger
- Sandy Johnson
- Augustine Obour
- Andrea Burns
- Alyssa Rippe

**NRCS Technical Contact**
- Candy Thomas, Salina, KS

**Collaborating producers**
- Lance Feikert, Bucklin, KS
- Doug & Larry Manhart, KS
- Mike Neff, Dresden, KS
- Michael Thompson, Almena, KS
- Steve Tucker, Venango, NE
- Todd Farnik, Snyder, CO
- Curt Sayles, Seibert, CO
- Troy Klassen, Vona, CO
- Jeff Hurlburt, Idalia, CO
Improved Cow BCS .3 to .4
Determining Profitable Annual Forage Rotations
Forage Rotation Research:

- Forage rotations with winter triticale (T), forage sorghum (S), and spring oat (O)
  1. S-S (no-till)
  2. T-S-O (no-till)
  3. T/S-S-O (no-till)
  4. T/S-S-O (min-till)
  5. T/S-S-S-O (no-till)
  6. T/S-S-S-O (min-till)
- Garden City, KS (19 in annual precipitation)
• Annual yield due to rotations are different lengths
• Tillage increased triticale yield after oat
  – No-till works best with high residue, oat stubble poor residue
• Consider forage quality and other available feed sources
• Based on current prices
• Estimated trampling loss at 60% in S & 50% in O or T
• More beneficial to graze oat or triticale than sorghum
• Too much hay production, may have difficulty selling or using
• Does not account for costs to feed forage (delivery, fence, or hay loss in feeding)
**Resources**

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### FORAGE CROPS

**Grazing Management: Toxic Plants**

**MF3244**

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**A Shortage of Good-Quality Pasture Can Be a Limiting Factor for a Cattle Operation.**

Annual forage crops grown in place of fallow can provide high-quality forage during key production periods and may help reduce soil erosion, suppress weeds, and increase soil nutrient profiles. Traditionally grown for agronomic or soil benefits but not harvested, cover crops are being considered for grazing, haying, or planting as annual forages. They are appealing because of the potential for additional revenue from improved cattle performance combined with the benefits of soil stabilization. Those contemplating this decision should know that plants that work well as cover crops may not be suitable for forage or grazing. In fact, some species can be toxic or fatal to livestock. This publication describes popular cover crops and the dangers they present for grazing livestock.

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### Metabolic Disorders

**Bloat**

Bloat is a condition that occurs when a ruminant consumes feeds that produce thick, foamy gas that the animal cannot pass by belching. Froth buildup in the rumen can cause noticeable discomfort.

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### Glucosinolates

Glucosinolates are natural compounds that plants contain a bitter, "hot" taste. Found in the leaves of certain plants, they are highly concentrated in: When consumed by livestock, glucosinolates affect thyroid function, cause liver and kidney damage, and reduce mineral uptake. For livestock, the most serious issue is inhibited iodine uptake which reduces production of the hormone thyroxine in goats.

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### Grass Tetany

Also known as grass staggers or wheat past poisoning, grass tetany is a metabolic disorder characterized by low magnesium levels in the blood. Tetany mainly affects older lactating cows grazing on tall pastures. It can result in uncoordination (staggering), convulsion, coma, and death. To prevent grass tetany, supplement magnesium by offering mineral or high-magnesium feeds when grass growth is high-risk pastures with steers, heifers, and cows that are less susceptible to this disorder.

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### Nitrate Toxicity

Ruminants are vulnerable to nitrate toxicosis which occurs when plant nitrate is converted to nitrite in the rumen. From there, nitrite is absorbed into the bloodstream, causing nitrite toxicity.

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### Summer Annual Forages: Selection and Production Characteristics

#### FORAGE FACTS

**MF2871**

**Introduction**

Summer annual forages are warm-season grasses that tolerate hot, dry weather and are adapted to most areas of Kansas. Although most species should not be planted until the soil temperature reaches 70 degrees Fahrenheit, some can be used by 4 to 6 weeks after planting. Summer annual forages include forage sorghums, sudangrass, sorghum-sudangrass, and bermudagrass hybrids, pearl millet, and foxtail millet (a.k.a. Italian, German, Hungarian, or Japanese Millet).

Selecting a type of summer annual should be based on the needs and location of the individual livestock program because they have different growth characteristics that influence how they are used. The following table summarizes characteristics of the most commonly used summer annual forages used in Kansas.

<table>
<thead>
<tr>
<th>Forage Sorghum</th>
<th>Sudangrass</th>
<th>Sorghum-sudangrass</th>
<th>Hybrid Pearl Millet</th>
<th>Foxtail Millet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yield, better quality with brown midrib (BMR) hybrids, may have better yield with photo-period sensitive (PS) hybrids</td>
<td>rapid regrowth (leave 6 to 8-inch stubble), small stems, extensive tillering</td>
<td>yield, regrowth, better quality with brown midrib (BMR) hybrids</td>
<td>rapid regrowth, quality, greenbug resistant, extremely low potential for prussic acid toxicity, drought resistant, high leaf to stem ratio</td>
<td>short growing season/late planting, no prussic acid toxicity, drought resistant, can plant in August for emergency forage</td>
</tr>
<tr>
<td><strong>Weaknesses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>limited regrowth, no grain yield with PS hybrids, BMR trait may result in more lodging with delayed harvest, potential for nitrate and prussic acid toxicity, susceptibility to chinch bugs</td>
<td>yield, potential for nitrate and prussic acid toxicity, potential for nitrate and prussic acid toxicity, susceptibility to chinch bugs, poor leaf retention after heading</td>
<td>potential for nitrate and prussic acid toxicity, susceptibility to chinch bugs, poor leaf retention after heading</td>
<td>sensitive to overgrazing, maintain 8-inch stubble, potential for nitrate toxicity, susceptibility to chinch bugs</td>
<td>quality, palatability, yield, shallow rooted, uproots easily when grazed, awns can injure livestock (sore mouth)</td>
</tr>
<tr>
<td><strong>Uses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silage, hay – harvest at mid to late dough, increase seeding rate for hay</td>
<td>grazing, hay – harvest before heading to maximize quality</td>
<td>grazing, hay – harvest before heading to maximize quality</td>
<td>grazing, hay – harvest before heading to maximize quality, cut whenever growth</td>
<td>grazing, hay – always harvest before heading to maximize quality and to avoid</td>
</tr>
</tbody>
</table>
DUAL-PURPOSE WHEAT AS A FORAGE SYSTEM

The unique climate characteristics of the southern Great Plains allow producers to use wheat as a forage and grain crop (dual-purpose), potentially increasing overall profitability compared to grain-only or forage-only systems. Dual-purpose wheat is currently working well on about 8 million acres in southern Kansas, Oklahoma, and Texas.

The fall and winter temperatures in this region generally allow for significant wheat growth before winter and for relatively few snow-covered days that limit grazing. As a result, winter wheat in this region has the potential to be grazed for 120 to 150 days.

Wheat pasture is a valuable source of high-quality forage when most other forage sources are low in quantity and quality (late fall, winter, and early spring). To minimize grazing effects on grain yield, certain adjustments in management practices must be considered.

CULTURAL PRACTICES

Compared to grain-only management practices, when implementing a dual-purpose wheat system, adjustments are required in planting date, seeding rate, variety selection, and soil fertility. These adjustments help maximize fall forage production while minimizing grain yield losses.

PLANTING DATE

Earlier planting dates increase wheat fall forage yield potential. Research in north-central Oklahoma has shown that planting 2 weeks earlier, in early September rather than late September, can increase fall forage dry-matter production as much as 1,000 pounds per acre when wheat was sown at 120 pounds per acre (Figure 1a).

Earlier planting dates may result in suboptimal conditions for grain yield (Figure 1b). Therefore, producers should consider the tradeoff between maximizing forage yield while minimizing grain yield losses when selecting the best planting date. Generally, a good compromise for producing both good forage and grain yields would be to plant 2 to 4 weeks earlier than the optimal planting date for grain yield. This increases the chances of maximizing wheat enterprise profitability in a dual-purpose system.

It is best not to plant any earlier than that unless the wheat is to be produced only for grazing, or "grazerot." For grain yields, the risks from early planting include an increased potential for wheat curl leaf, aphid, and Helminthosporium leaf blight, leading to an increased risk of fall infections by wheat streak mosaic virus (WSMV) and barley yellow dwarf virus (BYDV). These pathogens can not only lead to a significant decrease in grain yield, but also reduce forage production.

Another disadvantage of early planting is that dry and hot soil conditions frequently prevail in late August and early September, and rain usually "dries out" the soil cloud if

SEEDING RATE

Nontraditional Forages as Emergency or Supplemental Feedstuffs

**FORAGE FACTS MF2872**

**Introduction**

Despite the best plans, shortages of forage commonly occur some time during the year in Kansas. Drought, hail, early freeze, crop failure, harvest delays, and unusually cold and wet winters can cause forage shortages. In response, producers may choose to buy the extra forage needed or sell livestock. But in many cases, it may be more economical to use nontraditional forages. The following table summarizes several options for obtaining forage from nontraditional sources or in emergency situations generated by an unexpected shortage of forage. In times of drought stress and when harvesting weeds as emergency forage, always test the crop for nitrate levels. High nitrate levels are toxic, and death can occur without proper feeding of forages high in nitrate.

<table>
<thead>
<tr>
<th>Forage Source</th>
<th>Uses</th>
<th>Quality/Livestock Performance</th>
<th>Management Tips</th>
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<tbody>
<tr>
<td>Annual Legumes</td>
<td>grain, hay, or ensile</td>
<td>good quality forage with crude protein up to 21 percent and TDN up to 57 percent if harvested by early bloom</td>
<td>Usually planted as cover crops. Can be planted in mixtures with cereals to improve yield and quality of cereal forage. Recently-developed sunn hemp varieties should have no toxic alkaloids and can produce significant biomass in a short time. Cut sunn hemp for hay rather than grazed to avoid potential toxicity problems. Seed pods require longer to dry than stems and might delay curing slightly longer than plant material without seed pods.</td>
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<td>Austrian winter pea; spring; spring pea, lentil; summer: cow pea, sunn hemp</td>
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<tr>
<td>Brassicas (canola, kale, rape, turnip, radish, turnip x Chinese cabbage crosses)</td>
<td>graze or hay</td>
<td>good quality forage with high digestibility, protein and energy content; low fiber content – provide additional roughage when cut at early bloom, rape can have 24 percent crude protein and 75 percent TDN</td>
<td>Fast-growing, cool-season species with relatively high water requirement. Seed at 3 to 8 pounds per acre from mid-March through May for summer grazing, or June through August for fall and winter grazing. Begin grazing in about 45 to 60 days. When planted immediately after wheat harvested on irrigated ground, brassicas can make excellent forage for livestock during the summer.</td>
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<tr>
<td>Soybean</td>
<td>graze, hay, or ensile</td>
<td>good quality forage, comparable to alfalfa or clover hay</td>
<td>Pasture as soon as plants are 12 to 18 inches tall; remove livestock once most of the leaves have been eaten to allow regrowth for additional grazing in about a month. Cut for hay before pods are 1 inch long. Mix 1 ton of chopped soybeans with 2 to 4 tons of corn or sorghum for a more nutritious hay.</td>
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**Knowledge for Life**
**Prussic Acid Poisoning**

Prussic acid is also known as hydrocyanic acid or hydrogen cyanide (HCN). Ingesting plants that have produced excess cyanide causes prussic acid poisoning. Sorghums, sudangrass, sorghum–sudangrass crosses, and closely related species are most commonly associated with prussic acid poisoning. Most sorghums and sudangrasses contain a prussic acid precursor (dhurrin) in their epidermal cells. Dhurrin in itself is not toxic. The mesophyll cells located below the epidermis contain an enzyme that under certain conditions converts dhurrin to prussic acid (HICN). It is the prussic acid that is toxic to livestock.

Grain sorghum generally has higher concentrations of dhurrin than forage sorghums or sudangrass. Under normal growing conditions, the dhurrin concentration is low enough that animals can detoxify it before it causes toxicity. Dhurrin concentrations are highest in young plants, new regrowth, and following rapid regrowth after a period of stunted growth, such as rapid growth of drought-stressed plants following a rain, or regrowth following a frost or freeze. Under these conditions dhurrin concentrations can be high enough to poison livestock.

Appropriate management of these forages combined with sample analysis can minimize poisoning risks and allow safe use of these forages. Delaying grazing until minimum plant heights are achieved or until injured or stressed plants have had adequate time to recover or by proper ensiling or conditioning and drying hay can reduce prussic acid concentrations.

**Why Prussic Acid is Toxic**

Once the prussic acid precursors are eaten, the animal is on a short road to illness for formation of Table 1. Level of prussic acid in and potential effect on animals.

<table>
<thead>
<tr>
<th>ppm HCN</th>
<th>Effect on animals</th>
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<tbody>
<tr>
<td>0–500</td>
<td>Generally toxic.</td>
</tr>
<tr>
<td>500–1,000</td>
<td>Potential the only</td>
</tr>
<tr>
<td>1,000 and above</td>
<td>Danger will cause</td>
</tr>
</tbody>
</table>

Prussic acid acts rapidly within minutes. Symptoms increased pulse rate and respiration and foaming at the mouth, difficulty in breathing, convulsions, and collapse. Paralysis follows shortly.

The clinical signs of poisoning are similar to nitrate toxicity, but poisoning has bright red blood whereas animals poisoned with nitrate have black or chocolate-colored blood. It is often detected in animals because it occurs quickly observed too late for effective treatment. In md diagnosis, the animal can be sodium nitrate and sodium thiosulfate to form a complex. Animals still alive on the onset of visible signs usually

**Prussic Acid Concentration**

Plant species, age, and growth stage of plants eaten are the major factors that influence the amount of prussic acid ingested by livestock. The average prussic acid concentration for most sorghum species is about 200 ppm HCN. Forages with high prussic acid concentrations should be avoided or used only forage toxicosis.

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**Nitrate Toxicity**

Nitrogen is a critical nutrient for plant growth and development. However, when nitrate levels in feeds exceed certain thresholds, they can cause toxicity and health issues in animals. This is known as nitrate toxicity.

The potential for high nitrate concentrations in crops such as corn, sorghum, canola, cereal grains, and some grasses occurs after exposure to drought, hail, frost, cloudy weather, or soil fertility imbalance. Nitrate accumulates in the lower portion of these plants when stresses reduce crop yields to less than those expected, based on the supplied nitrogen fertility level. Feeding harvested forages or grazing plants that are high in nitrate can be toxic to livestock because the metabolism products from nitrates interfere with the ability of blood to carry oxygen, causing asphyxiation.

**Why Nitrate Are Toxic**

Nitrate toxicity is a misnomer because nitrite (NO₂⁻), not nitrate (NO₃⁻), is poisonous to animals. After a plant is eaten, rumen bacteria rapidly reduce nitrates in the forage to nitrites. Normally, the nitrites are converted to ammonia and used by rumen microorganisms as a nitrogen source. But, if nitrate intake is faster than its breakdown to ammonia, nitrites will begin to accumulate in the rumen. Nitrite is rapidly absorbed into the blood system where it converts hemoglobin to methemoglobin. Red blood cells containing methemoglobin cannot transport oxygen, and the animal dies from asphyxiation.

Animals under physiological stress (sick, hungry, lactating, or pregnant) are more susceptible to nitrate toxicity than healthy animals. Toxicity is related to the total amount of forage consumed and how quickly it is eaten, but, generally, if forages contain more than 6,000 ppm nitrate, they should be considered potentially toxic (Table 2).

Forage Toxicity

Table 2. Nitrate poisoning symptoms in livestock.

<table>
<thead>
<tr>
<th>Nitrate Concentration (ppm)</th>
<th>Symptoms</th>
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<tr>
<td>2,000–5,000</td>
<td>Mild symptoms, salivation, depression, anorexia</td>
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<tr>
<td>5,000–10,000</td>
<td>Moderate symptoms, drool, weakness, diarrhea</td>
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<tr>
<td>10,000–20,000</td>
<td>Severe symptoms, weakness, stupor, coma</td>
</tr>
<tr>
<td>20,000–50,000</td>
<td>Death</td>
</tr>
</tbody>
</table>

Nitrate levels above 5,000 ppm are considered toxic, and levels above 20,000 ppm are considered potentially lethal. Nitrate toxicity can be prevented by avoiding high-nitrate feeds, providing adequate water, and ensuring adequate dietary protein.
• Garden City, Hays, and Scandia
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