Dear Valued Forage Producer,

In this edition we highlight forage and hay species mixes, cover crop planting methods, interactions between herbicides and cover crops, and successes of U of M graduate students.

We would like to take this time to highlight the contributors to this edition:

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Sincerely,

University of Minnesota Forage Team

Plan your forage supply for summer grazing

Brad Heins

Pasture is the primary source of forage for organic dairies, and organic livestock production regulations require a minimum of 120 days grazing per animal. In the northern U.S., this requirement is typically met by a May to October grazing season, and profitability depends on pastures that provide a season-long supply of high quality forage.

Spring and summer are just around the corner. This is a good time to start thinking about your pasture forage supply for grazing this summer. First, we will briefly provide results from a study where we evaluated pasture forage quality on Minnesota dairy farms, and then, we will discuss selecting pasture species when renovating a pasture.

We monitored nine grazing dairy farms in Minnesota that were utilized in a study to measure monthly changes in forage quality of pastures over a two-year period. Farms were from a wide geographical area across Minnesota representing a range in herd size, pasture size, and pasture management. Across the nine farms, spring pasture dry matter (23.96%) was higher than summer (23.52%) and fall (19.76%) pasture dry matter. Seasonal average crude protein concentrations were 21.01%, 20.11% and 23.93% for spring, summer, and fall. NDF concentration in the pasture forage was different for spring, summer, and fall grazing. Seasonal NDF concentrations were 46.63%, 49.25%, and 45.97% for spring, summer, and fall, respectively.

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Plan your forage supply for summer grazing (Continued from page 1)

Compared to monocultures, diversity reduces risks associated with loss of any single pasture species, provides for variable resource use within a field, supplies potentially more uniform biomass during the growing season, and improves soil health. Pasture diversity can be increased by adding grasses and forbs and by increasing numbers of species within grasses and forbs. An example is to grow nitrogen-fixing legumes with grasses. Although legumes supply nitrogen to grasses and provide a higher energy feedstuff than grasses, legumes are generally less persistent and require higher levels of soil fertility than grasses. Increases in diversity in a farm's forage base can be achieved by planting mixtures in individual pastures, and by planting separate pastures with different species.

There are a lot of disagreements regarding the ideal number of species to include in pasture mixtures. Most agronomic guidelines recommend the use of a small number of species in grazed mixtures. Past research in the Northeast United States found that six to nine grass species were more productive than a white clover-orchardgrass mixture.

When selecting pasture grass species, producers should consider yield potential, palatability, survival of grasses. Producer should select species that are winter hardy, have good seasonal yield distribution, and are rust resistant. Quite possibly, variety is as important as or more important than specie choice.

At the West Central Research and Outreach Center, in Morris, we are measuring the performance of dairy cows grazing two unique pasture systems designed to maximize seasonal forage yield and quality and extend the grazing season. System 1 will increase within-field species diversity targeting perennial cool season, polyculture pastures to enhance multi-seasonal productivity (spring, summer and fall). System 2 will increase across-landscape diversity achieved by adding a combination of perennial polycultures and annual warm season grasses fertilized with livestock manures. Regional differences in soil fertility and rainfall may favor different pasture species in other locations.

Our current pasture species mixtures and seeding rates are as follows:

1. Perennial ryegrass (4 lb), White clover (2 lb), Red clover (3 lb), and Chicory (2 lb);
2. Orchardgrass (3 lb), Meadow Fescue (6 lb), Chicory (1 lb), Alfalfa (10 lb); and
3. Perennial ryegrass (3 lb), Meadow Fescue (8 lb), White clover (4 lb), Red clover (2 lb), and Chicory (1 lb)

Grazing systems using these different approaches to achieve diversity require biological, environmental and economic analysis. In summary, pasture management and forage species selection within a farm can influence the forage quality of pasture forage for grazing dairy animals.

Exploring new cover cropping opportunities in Minnesota

Reagan Noland, Neith Little, and M. Scott Wells

Cover cropping practices have been gaining popularity and interest across the agricultural landscape as systems evolve to optimize land and resource management for greater economic and environmental sustainability.

In other agricultural regions, cover crops are used as an effective tool to sequester nutrients, contribute organic matter, and protect soils from erosion during otherwise fallow periods. The high intensity corn-soybean systems of Minnesota could gain similar benefits from cover cropping, particularly in the spring when soil and nutrients are most vulnerable to offsite movement.

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Exploring new cover cropping opportunities in Minnesota (Continued from page 2)

In the upper Midwest, these losses occur through leaching and tile drain discharge, as well as surface runoff. Research conducted in Southwest Minnesota estimates an average 25 kg ha⁻¹ (22 lbs/ac) of nitrate nitrogen is lost through subsurface tile drainage between mid-September and May every year.

The primary challenge facing successful cover cropping in Minnesota is the short growing season. There is rarely ample time and favorable field conditions to plant and establish a cover crop after the grain harvest and before winter sets in. Current research at the University of Minnesota is working to identify and develop viable options for interseeding cover crops into standing corn. Field sites are at the UMN Southern (Waseca) and Southwestern (Lamberton) Research and Outreach Centers, and trials have been conducted for the past two years (2014 and 2015).

The study is looking at five different cover crops and three different planting methods around corn growth stage V7. Species include winter rye, red clover, pennycress, hairy vetch, and an Albert Lea cover crop mixture called NitroMax CC1 (oats, peas, and tillage radish).

The three cover crop planting methods are as follows:

1. Drilled with a 3-in-1 InterSeeder™ high clearance drill (Figure 1)
2. Directed broadcast (interrow) with light incorporation (dragging a rake and chain)
3. Directed broadcast (no incorporation).

Cover crop biomass and soil NO₃-N levels were assessed following corn harvest (late September) and again in the spring (mid-April) prior to termination. The covers were sprayed out with glyphosate and soybeans were no-till planted into the residues, as well as check plots with no cover crops.

All cover crop species germinated, although establishment and persistence varied across species and planting methods depending on climatic conditions. Rye (Figure 2), red clover, and hairy vetch (planted with the InterSeeder™) had the most successful stands across locations after the corn harvest. However, the directed broadcast + incorporation planting method resulted in competitive stands especially in the small seeded species such as red clover (Figure 2) and pennycress.

Following the 2014 planting at Waseca, all species (except for NitroMax CC1) overwintered and produced significant biomass in the spring (Figure 3). At Lamberton, only the rye and pennycress successfully overwintered and put on significant spring growth. Lack of snow cover in Lamberton during the winter of 2014-2015 likely resulted in winterkill of the legume cover crops. Cover crops did not affect corn yield at either location in 2014 or 2015 (Figure 4). Soybeans no-till into the residues (with no fertilization) all yielded competitively as well (Figure 5).

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Exploring new cover cropping opportunities in Minnesota (Continued from page 3)

Figure 3. Cover crop spring biomass by species and planting method prior to termination and soybean planting in Waseca, MN (May 8, 2015).

Figure 4. Corn yields measured from different interseeded cover crop treatments in Waseca and Lamberton, MN. Cover crops were planted into the corn interrows at growth stage V7 (June 25, 2015 and June 26, 2015 respectively). HV: Hairy Vetch, N-Max: NitroMax mix (pea, oat, and tillage radish), PC: pennycress, RC: medium red clover, WR: winter cereal rye, CHK: Check (no cover crop).

Figure 5. Soybean yields following different cover crop treatments in Waseca and Lamberton, MN. Soybeans were no-till planted into the cover crop residues. Cover crops were interseeded into corn at growth stage V7 in the previous year (2014). HV: Hairy Vetch, N-Max: NitroMax mix (pea, oat, and tillage radish), PC: pennycress, RC: medium red clover, WR: winter cereal rye, CHK: Check (no cover crop).
Exploring new cover cropping opportunities in Minnesota (Continued from page 4)

In addition to ecological benefits, cover crops are being developed and utilized as added-value crops or “cash cover crops” that can be grazed or harvested in the spring prior to (or in relay with) the following warm-season crop rotation. One example is seeding a winter annual forage crop following a corn silage harvest. Taking a silage crop removes more organic matter and leaves soils exposed for an even longer period of vulnerability than grain corn and soybean. This time can be utilized as a greater window for establishment of a supplemental winter annual forage crop. This fall (2015) was a prime opportunity for such cover cropping. Figures 6 and 7 illustrate the establishment of a rye cover crop no-tilled into corn stubble following a silage harvest near Canby, MN this year. This stand will likely provide spring forage for ~2 months grazing before it is terminated and planted with short season soybeans next year.

Grasses to grow with alfalfa in mixes

Jim Paulson

Interest in the potential for perennial forage grasses to complement alfalfa for high-quality forage production continues to grow in the North Central USA. Forage mixtures of alfalfa with perennial cool-season grasses offer whole-system (soil, crop, and livestock) advantages over alfalfa monocultures. Our increased knowledge of NDF digestibility has shown additional benefit to feeding of grasses in ruminant diets. But data on the yield and forage-quality potential of alfalfa/grass mixtures with modern grass varieties and harvest management was lacking.

A team of UMN-Extension personnel have been assessing forage yield, quality, and species compatibility of alfalfa/grass mixtures vs. alfalfa monocultures on Minnesota farms for the past eight years. We were fortunate to receive funding for research to establish stands and conduct harvests, collect yield and composition data, and analyze forage quality for multiple years.

The seeding rates are shown below in Table 1. Note that we only seeded 10 lbs of alfalfa seed in the mixtures. Our intent was to have a 50:50 alfalfa:grass stand and for the most part, this was achieved. Seeding rates reflect seed size and number of seeds per pound. The critical factor of success in establishment is good soil to seed contact.

Table 1. Seed rates for forage mixtures.

<table>
<thead>
<tr>
<th>Seeding rates for mixtures</th>
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<tbody>
<tr>
<td>Alfalfa = 10 lbs/a</td>
<td>+ meadow fescue (MF) = 12 lbs/a</td>
</tr>
<tr>
<td>Alf 10 lbs + MF 7 lbs</td>
<td>+ tall fescue (TF) = 10 lbs/a</td>
</tr>
<tr>
<td>Alf 10 lbs + MF 7 lbs</td>
<td>+ meadow brome (MB) = 15 lbs/a</td>
</tr>
<tr>
<td>Alf 10 lbs + MF 7 lbs</td>
<td>+ smooth brome (SB) = 15 lbs/a</td>
</tr>
<tr>
<td>Alf 10 lbs + MF 7 lbs</td>
<td>+ orchard grass (OG) = 4 lbs/a</td>
</tr>
</tbody>
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Forage quality of most cool season grasses can complement alfalfa in forage by moderating soluble protein concentration and adding greater amount of digestible NDF. Too much focus is often put on crude protein content of forage and not the digestibility.

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Greater digestibility allows for greater intake of forage. At the same stage of maturity, grasses exceed alfalfa in the amount of digestible NDF. Matching stage of maturity with alfalfa, especially in the first cutting, can be a challenge with certain species. It is very important to use improved varieties within species of grasses to attain the higher quality forage. This is particularly true for tall fescue and orchard grass varieties.

For lactating cow forage, the mixture of alfalfa with meadow fescue and tall fescue results in higher yields and higher quality forage compared to alfalfa alone and it appears to tolerate the cutting intensity of a four cut system. Meadow fescue and improved orchard grass varieties also perform well. From our trials, smooth brome grass, meadow brome and timothy can yield well, especially in spring, but may not tolerate a four cut system as well. They are better suited to a two or three cut system and also do well in a managed pasture system. Brome grasses can also be used in dry cow and heifer diets at a more mature stage by utilizing different cutting strategies for some fields and even pastures.

Our observations include a concern that newer and improved grass varieties within species such as tall fescue and orchard grass may not have as much cold tolerance as older varieties. However, each of the different species had greater survival rates when part of a three species mixture compared to when in a pure stand. Smooth brome and meadow brome grasses showed the typical slower establishment that we expect in brome grass and are better suited to spring seeding with a cover crop.

Meadow brome was particularly slow in establishing. This might have been due to the year of establishment; 2012 being a drought year. It did however become very prevalent in the second year. I do believe that, meadow brome in particular, is sensitive to cutting height. I would not expect to harvest much of either brome grasses in the seeding year.

Another critical aspect of managing grasses in alfalfa stands is to watch the cutting height. Grasses need to regrow from the stubble above ground left in the field. Alfalfa regrows from the crown, which is below ground. If a mixed stand of grass and alfalfa is cut at a 2” height, the grasses will not grow back as fast as the alfalfa and will be more prone to not surviving. This is particularly a concern with disc mowers. A disc mower needs to adjusted to a 3-4” cutting height. This cutting height will also help to reduce soil contamination in forage as well.

In conclusion, from the results of this project, meadow fescue is a cool season grass that offers another forage choice in our growing areas. Its yields and forage quality would meet or exceed other comparable grasses and also compare with alfalfa. It also offers an additional grass to use in mixtures with alfalfa and other grasses.

Diversifying your herbicide options doesn’t have to hurt your cover crops

Neith Little, Jeffrey Gunsolus, and M. Scott Wells

This question comes up often when talking about cover crops: Should I worry about carryover injury from herbicides used on the previous crop?

For farmers who rely on glyphosate (SOA 9) for weed management, carryover injury to the following crop is not a concern, because glyphosate does not have residual activity—it does not kill plants that emerge after it has been sprayed.

However, the spread of herbicide resistant weeds is prompting many Extension weed scientists to encourage growers to diversify the herbicides they use.

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Diversifying herbicides and cover crops (Continued from page 6)

Jeff Gunsolus, University of Minnesota Extension weed scientist, and Rich Zollinger, from North Dakota State University, have published a set of tables (z.umn.edu/prepostoptions) of PRE and POST herbicide options for diversifying the herbicide sites of action (SOA) used to control weeds in corn and soybean. These tables include rotation intervals for common crops, which can also suggest which related cover crop species are likely to be sensitive to the listed herbicides.

PRE herbicides work by using active ingredients with residual activity in the soil. This residual activity makes it important to consider how PRE herbicides might impact the following crop. Pre-mixed products that contain multiple active ingredients and tank mixes of multiple products require special attention, because the label restrictions for each product and the residual activity of each active ingredient must be considered.

The first question to consider is whether the following crop is intended for use as forage or feed, or whether it is being planted solely as a cover crop.

If the following crop is intended for use as forage or feed, strict rules apply to prevent herbicide residue from contaminating the feed. If there is any chance the crop might be used as emergency forage, label rotation restrictions must be followed. University of Wisconsin Extension has a helpful publication on this issue: z.umn.edu/UWrotationrestrictions

In contrast, most herbicide labels are silent on rotational planting of cover crops not intended for forage (Hornet and Python WDG are two exceptions). When planting a cover crop in the fall, the main concern is whether any residual herbicide activity will damage the crop enough to hurt establishment. Unless specifically prohibited by the product label, a farmer can choose to plant a cover crop after any herbicide program, if the cover crop will not be used for forage and if the farmer is willing to assume the risk that the cover crop may fail.

To assess the risk of carryover damage, consider the following questions:

1. What herbicides were applied? When? At what rate? Well-kept records are valuable!
2. How long is the herbicide active in the soil after application?
3. How sensitive to the applied herbicides are the cover crops you are considering planting?
4. Since herbicide application, have the weather conditions favored herbicide degradation (high rainfall and warm temperatures) or has the weather favored herbicide persistence (drought and cool temperatures)?
5. Do the soil characteristics contribute to longer herbicide persistence (high pH or fine-textured “heavy” soil)?

Two publications are particularly useful when considering the above questions:

- **Herbicide persistence and rotation to cover crops**, by Bill Curran and Dwight Lingenfelter, Penn State University Weed Scientists, contains a helpful table summarizing the risk of residual activity of many herbicide active ingredients. Note that this guide is written for Pennsylvania conditions, and may not account for Midwest climate and soils: z.umn.edu/PSUherbpersistence

- **Effect of residual herbicides on cover crop establishment**, by Iowa State University Extension’s Bob Hartzler and Meaghan Anderson, reports the results of an experiment studying the tolerance of five common cover crops to 11 common corn and soybean herbicides: z.umn.edu/ISUresidualherbicide

As an example, let’s walk through how one might use the information in those articles to assess the risk of cover crop damage from two common PRE herbicide premixes. **Products mentioned are used only as an example, and are not an endorsement of specific products.**

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Diversifying herbicides and cover crops (Continued from page 7)

Example 1:
Lumax EZ is used PRE in corn, and is a premix of the active ingredients **mesotrione** (SOA 27), **s-metolachlor** (SOA 15), and **atrazine** (SOA 5). Looking at Penn State’s table, atrazine poses the most risk out of the three of causing carryover damage, because it has a half-life of 60 days under normal conditions (longer in high pH soils), and because both grass and broad-leaf cover crops are sensitive to its effects. Similarly, in Iowa State’s experiment, atrazine was observed to cause some damage to all five cover crops studied. Based on this information, concern is warranted that a cover crop might sustain enough damage to hurt establishment if planted after a corn crop treated with Lumax EZ.

Table 1: Estimated half-lives, cash crop restrictions, and potential to injure fall cover crops of active ingredients contained in Lumax EZ. Table adapted from Curran and Lingenfelter (2012). Always follow the product’s current label restrictions and instructions.

<table>
<thead>
<tr>
<th>Trade names</th>
<th>Active ingredient</th>
<th>SOA #</th>
<th>Half-life (days)</th>
<th>Cash crop restrictions</th>
<th>Fall cover crops</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrazine 4L, Aatrex</td>
<td>atrazine</td>
<td>5</td>
<td>60</td>
<td>Can plant corn, sorghum, and soybean the following year (some products allow others)</td>
<td>Sorghum species</td>
<td>Cereals, ryegrass, legumes, and mustards</td>
</tr>
<tr>
<td>Callisto</td>
<td>mesotrione</td>
<td>27</td>
<td>5 to 32</td>
<td>10 to 18 months for legumes and vegetables</td>
<td>All grasses</td>
<td>Small seeded legumes, mustards</td>
</tr>
<tr>
<td>Dual II Mag 7.62E, Cinch</td>
<td>s-metolachlor</td>
<td>15</td>
<td>15 to 50</td>
<td>Labeled for use on many crops</td>
<td>Almost anything</td>
<td>Annual ryegrass or other small seeded grasses</td>
</tr>
</tbody>
</table>

Example 2:
Optill is used PRE in soybeans and is a premix of **saflufenacil** (SOA 14) and **imazethapyr** (SOA 2). Saflufenacil has a relatively short half-life under normal weather and soil conditions. Imazethapyr has a long half-life, but it is ranked in Penn State’s table as having low risk for damage to several common cover crops. This prediction was supported by Iowa State’s experiment. There is always some risk, especially under dry, cool, conditions, but based on this information, a rye cover crop planted after Optill was applied in soybeans would have a relatively low risk of sustaining enough damage to prevent successful establishment.

Table 2: Estimated half-lives, cash crop restrictions, and potential to injure fall cover crops of active ingredients contained in Optill. Table adapted from Curran and Lingenfelter (2012). Always follow the product’s current label restrictions and instructions.

<table>
<thead>
<tr>
<th>Trade names</th>
<th>Active ingredient</th>
<th>SOA #</th>
<th>Half-life (days)</th>
<th>Cash crop restrictions</th>
<th>Fall cover crops</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpen 2.85SC</td>
<td>saflufenacil</td>
<td>14</td>
<td>7 to 35</td>
<td>Any crop can be planted 4 mo. after application</td>
<td>All</td>
<td>None</td>
</tr>
<tr>
<td>Pursuit 2S</td>
<td>imazethapyr</td>
<td>2</td>
<td>60 to 90</td>
<td>Recrop restrictions range from 4 to 18 mo.</td>
<td>Wheat, triticale, rye, alfalfa, clover</td>
<td>Oats, sorghum, mustards</td>
</tr>
</tbody>
</table>

Minimizing selection for herbicide resistance and protecting soil from erosion are both important management goals. The keys to making sure those goals do not conflict are to keep good records of your weed management program and to use the best available information to assess the risk of carryover damage. If you know you want to plant a cover crop in the fall, keep that in mind as you make weed management decisions. If you have already applied an herbicide earlier in the season, consider the susceptibility of different crops when you choose which cover crop to plant.
CFANS graduate students take Minnesota research national

M. Scott Wells and Krishona Martinson

Please extend our congratulations to the following graduate students who presented their research at the National ASA/CSA/SSSA Tri-Societies Annual Meetings held in Minneapolis, MN (Nov 2015).

Reagan Noland was awarded 1st place in the Crop Ecology, Management and Quality Student Poster Competition. His presentation was titled “Supplemental and Alternative Forage Options in Winter-Killed Alfalfa.” He is advised by Drs. M. Scott Wells, Jeffery Coulter, Craig Sheaffer, John Baker and Krishona Martinson.

Kayla Altendorf was awarded 3rd place in the Agronomic Production Systems Student Poster Competition. Her presentation was titled “Characterization of Field Pennycress (Thlaspi arvense L.) Germplasm”. She is advised by Drs. James Anderson, David Marks, Kevin Betts, and Donald Wyse.

For more information: https://z.umn.edu/altendorf2015

Amanda Grev was awarded 3rd place in the Robert F Barnes Ph.D. Student Oral Competition. Her presentation was titled “Yield, Preference and Forage Nutritive Value of Fall Planted Annual Grasses Under Horse Grazing at Two Maturities”. She is advised by Drs. Krishona Martinson, Craig Sheaffer, M. Scott Wells and Marcia Hathaway.

For more information: https://z.umn.edu/grev2015

Michelle Schultz was awarded 1st place and Devan Catalano 2nd place in the Robert F Barnes MS Student Poster Competition. Michelle’s presentation was titled “Forage Nutritive Value, Yield and Preference of Warm Season Grasses Grazed by Horses.” Michelle is advised by Drs. Marcia Hathaway, Krishona Martinson and Craig Sheaffer. Devan's presentation was titled “Forage Nutritive Value, Yield and Preference of Alfalfa and Clover under Horse Grazing.” Devan is advised by Drs. Krishona Martinson, Craig Sheaffer and Marcia Hathaway.

For more information: https://z.umn.edu/schultz2015
For more information: https://z.umn.edu/catalano2015