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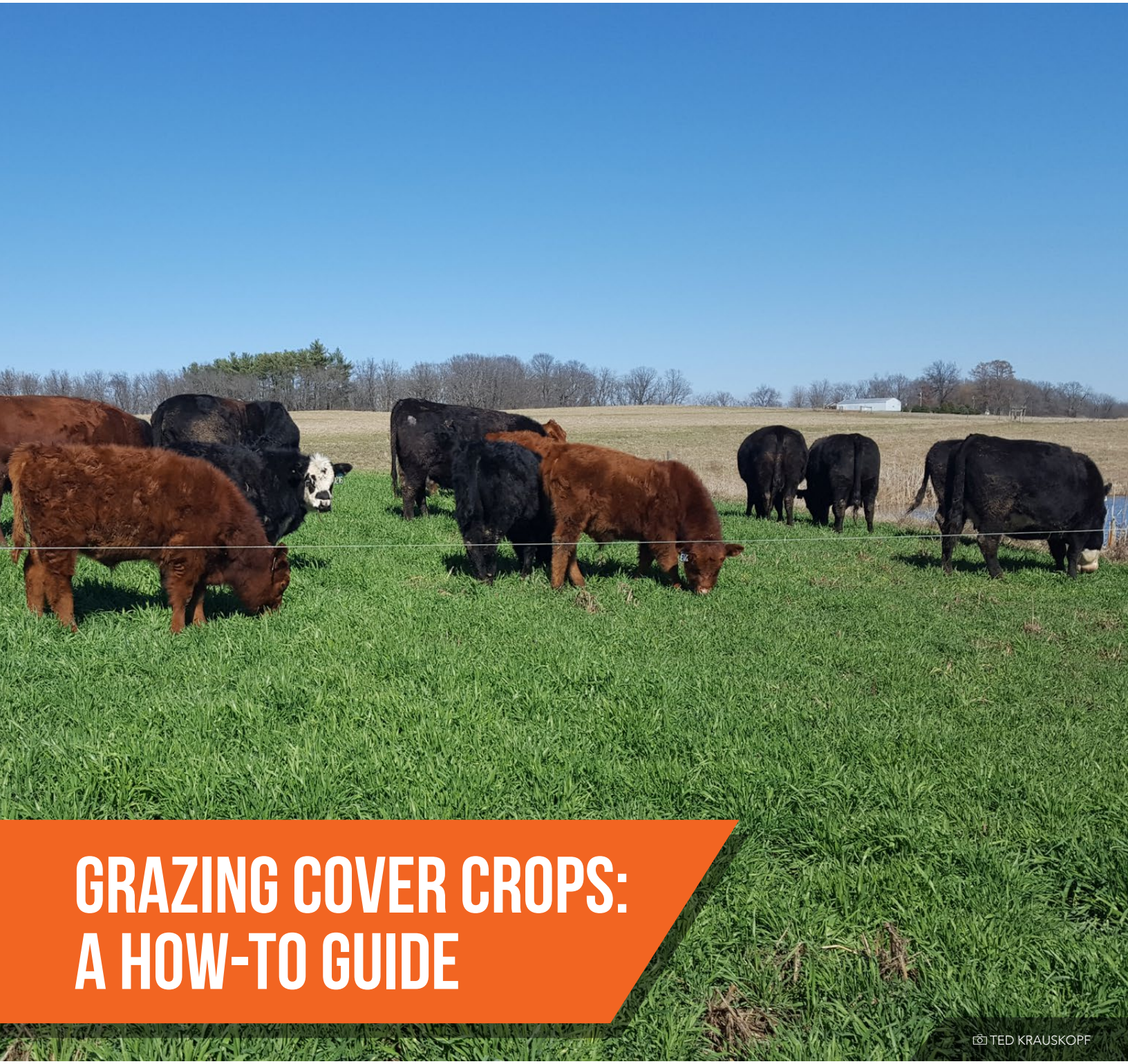

# GRAZING COVER CROPS: A HOW-TO GUIDE

TED KRAUSKOPF

DEVELOPED IN PARTNERSHIP WITH:

PRACTICAL farmers of Iowa
working together, always learning

LAND STEWARDSHIP PROJECT

sustainable farming association

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FARMER-to-FARMER NETWORK

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# INTRODUCTION

The use of cover crops in row crop farming is becoming increasingly popular. According to a February 2013 bulletin from USDA-NRCS, the four keys to improving soil health and increasing soil organic matter (SOM) are:

1. Using plant diversity to establish microbial diversity in soils
2. Managing to improve soil health by reducing disturbance (less tillage)
3. Keeping plants growing throughout the year to feed soil microbes
4. Keeping the soil covered to reduce erosion

According to many soil health experts and associations, there is also a fifth key to more rapidly improve soil health: **Integrating livestock**.

Studies and field trials have shown that combining cattle grazing with cover crops, especially multi-species cover crops, accelerate the increase in SOM, which improves the soil's water holding capacity. Each one-per-cent increase in SOM results in approximately 27,000 more gallons of water holding capacity per acre (NRCS, 2013). A USDA-ARS field study showed cow/calf pairs grazed for 48 days +/- on cover crops of pearl millet, rye, rye-ryegrass and rye-crimson clover. This trial included plantings of full season cover crops following winter wheat. Grazing also has economic benefits by providing forage for cattle and other ruminants.

In addition, grazing cover crops with livestock provides fertility for the next cash crop. Analysis performed by Grass Fed Insights, LLC shows that a 1,000 lb cow or steer produces approximately 0.25 lbs of Nitrogen (N), 0.15 lbs of Phosphorus (P), and 0.52 lbs of Potassium (K) per day in their manure and urine (unpublished data). By implementing adaptive grazing practices in cover crops, 100 cows averaging 1000 lbs grazed across one acre in one day can deposit a total of 23N-15P-52K on that acre in a single day. If three grazings of each acre of cover crops can be achieved in a single cover crop season, then a total of 69N-45P-156K will have been applied to fertilize the subsequent cash crop. This does not take into consideration the additional contribution of the cover crop itself.

In a recently completed three-year Conservation Innovation Grant (CIG) study, the Wallace Center's Pasture Project found that forage production from complex cover crops of six or more species supported between 12 to 40 days of fall and winter grazing in Minnesota and Iowa, when planted following a corn or soybean crop. Half of the participants in the 8-cooperator trial also were able to graze another 12-40 days in the spring on regrowth from the fall cover crop planting.

This How-To Guide is meant as an introduction to farmers and ranchers interested in learning more about the benefits and practices of grazing cover crops. The final report of the Grazing Cover Crops CIG project provides specifics on economic and soil health outcomes from the study, both short and long-term.

SCOTT HAASE

SCOTT HAASE

# COVER CROP ESTABLISHMENT IN PREPARATION FOR GRAZING

**IN THIS SECTION, YOU WILL LEARN ABOUT:**

- Choosing your seed mix with grazing *and* your next cash crop in mind
- Choosing a planting method that maximizes your grazing season
- How herbicide residues can affect cover crop establishment

The term "cover crop" is everywhere today. It's in the farming magazines and the ag news, and is a focus point at many agricultural conferences, workshops and field days.

Farmers and ranchers are told to plant cover crops to protect the soil, build soil organic matter, reduce input costs, reduce runoff and erosion, and even feed our next cash crop. So, more producers are trying out cover crops in efforts to improve their bottom line.

Sometimes they fail. The question then becomes: Do cover crops really deliver on the promises, or are they just an effort to sell more seed? What are the reasons for failure or success with cover crops?

Obviously, cash crops like corn, wheat and soybeans also fail. But do we stop planting them? No, we plow ahead (pun intended). We expect some failure in our cash crops, and readily accept occasional failure as a part of doing business.

But many farmers give up after their first unsuccessful attempt at planting a cover crop, even though often the failure was due to unintended mistakes and inexperience.

The success rate can be greatly improved. Let's examine the most common causes of failure of a cover crop, and what we can do to enhance our chances of success.

## DETERMINE THE RESOURCE CONCERN

Often producers do not take the time to determine what they want the cover crop to achieve, which leads to purchasing and seeding a cover crop that may not address the resource concern. Too often this leads to a poor experience.

> **Here's an example.**
>
> Gabe Brown of Brown's Ranch near Bismarck, ND received a call one March day, and the caller complained that he had an issue with cover crops. He had an irrigated field where the winter wheat was combined and the straw baled before being seeded to a monoculture of purple top turnips. The turnips grew well and he turned his cows onto them for the winter.
>
> Gabe interrupted, "Let me guess. And now your fields have no residue."
>
> "That's right," he exclaimed. "And now those fields are blowing! How did you know?"
>
> Gabe told the caller that he had seeded the wrong cover crop for his resource concern. By baling the straw, he had removed most of the carbon residue. He then planted turnips, which are nitrogen scavengers and low in carbon. The turnips took up leftover nitrogen (N) from the winter wheat crop and then released that N as they went through their life cycle, which accelerated the breakdown of the remaining residue. Add to this the fact that the cattle ate what little aboveground biomass there was, and this caller had a recipe for failure.

To prevent problems, you must determine what you are trying to accomplish. For example, are you trying to improve nutrient cycling? Increase organic matter? Leave more soil armor? Feed livestock? The list goes on. We have to know our goals before we put seed in the ground.

## COVER CROP DESIGN

The basic rule of thumb is to follow the Rule of Three and the Principle of Diversity. The Rule of Three is to include species of the three primary plant functional groups—grasses, legumes, and forbs (broadleaves)—in every mix. The Principle of Diversity is to create mixes containing a minimum of 6-8 plant species. These mixes can range up to 18 or more plant species.

One caution: be careful with the total amount of brassicas and/or broadleaves in the mix. Brassicas/broadleaves should be limited to no more than a total of about 2-3 lbs per acre in the mix. Broadleaves can germinate quickly and grow vigorously. They can easily shade out other species in the mix in early stages of growth.

Planting highly diverse mixes in your cover crop fields can play a role in attracting large numbers of pollinators, including many different species of wild bees and butterflies. These diverse mixes supply important pollinator species with vital food and shelter. In addition to attracting pollinators, diverse mixes also attract hundreds of beneficial insect species. These beneficial insects prey on many of the pest species that we often find in our row crops and can greatly reduce pest pressure and impact, thus reducing the need for chemical insecticides.

### GRAZING COVER CROPS IS PROFITABLE!

Grant and Dawn Breitkreutz, farmers near Redwood Falls, MN, have seen firsthand the value of integrating livestock on their winter cover crops. They say, "The addition of diverse cover crops to our farm rotations has resulted in rapid soil building, increased water infiltration rates, and the added revenue from grazing winter cover crops has netted us as much or more per acre as our cash crops."

In the winter grazing season between 2016 and 2017, the Breitkreutzes spent around $108/acre/year to plant, graze, and terminate their winter cover crop. But those cover crops also produced forage worth $329/acre! Plus, the added fertility to their soil from both the cover crop and livestock impact was valued around $54/acre.

**There are several good resources to help with cover crop mix design, including:**

Green Cover Seed Smart Mix calculator

Midwest Cover Crops Council cover crops decision tool

**To learn more about how to design mixes to attract pollinator and beneficial insects and the advantages, read:**

Cover Cropping for Pollinators and Beneficial Insects from Sustainable Agriculture

## MONOCULTURE OR POLYCULTURE

One of the biggest mistakes we make is in thinking that our cover crops should be monocultures, just like our cash crops. Monocultures following monocultures creates more opportunity for failure.

Trials conducted at the Menoken Demonstration Farm in North Dakota has shown that planting a more diverse mix results in plant biomass production that is anywhere from 2.0 to 3.5 times the production of the individual crops in the mix when they are planted as monocultures. Additional studies have shown that plant species richness (diversity) significantly improves subsequent plant performance. This data is presented in the *Principle of Diversity* section of this publication.

In southwestern Minnesota, Grant and Dawn Breitkreutz initially tried planting monoculture covers into their cash crops. They experienced failures in two out of three years and thought about quitting cover crops altogether. Then they started working with Minnesota's Sustainable Farming Association and the Pasture Project and decided to give cover crops another go. This time they planted more diverse mixes of at least eight seeds. That made a significant difference, and they now routinely graze covers into the winter months.

Interseeding cover crop into V4 – V6 stage corn.
GRASS FED INSIGHTS

## UNDERSTANDING THE C:N RATIO

The carbon to nitrogen ratio, or C:N, is very important in determining the specific species to include in your cover crop mixes relative to the prior crop and the next planned cash crop in the rotation. Understanding the C:N ratios of various plants and their residues is key to managing both soil cover and residue decomposition. Jon Stika's book, ***A Soil Owner's Manual***, (published 2016) notes that there are times when you want plant residue to remain on the soil, and times when you want it to disappear.

Soil microbes themselves have a C:N ratio of about 8:1, but require a C:N diet of 24:1 to meet their needs. If mature alfalfa hay is fed to your cattle, what they trample and leave behind will be quickly consumed by the soil microbes, with little to no C or N remaining. That is because mature alfalfa hay has a 25:1 C:N ratio.

In comparison, wheat straw has a C:N of 80:1. This forces soil microbes to seek out other forms of N to go with the excess C. As the microbes consume other forms of N in the soil, they tie that N up in their bodies so it is not immediately available for plant uptake. Conversely, hairy vetch has a C:N of 11:1, and soil microbes will consume the vetch and leave the excess N in the soil for plant uptake.

The C:N ratio affects soil cover and nutrient cycling, which influences subsequent cash crop performance. Planting specific cover crop mixes can help you manage N and crop residue cover.

For example, planting a low C:N ratio cover crop, such as a legume- and/or brassica-heavy mix following a high C:N cash crop (corn and wheat), helps the plant residue to decompose, thus making nutrients available to the next cash crop. Likewise, planting a higher C:N ratio cover crop, such as a small grain/grass-heavy mix (grazing corn, sorghum, sorghum-sudan, millets and sunflower) helps to provide protective soil cover after a low C:N cash crop such as soybeans or peas.

> **Good rules of thumb are:**
>
> - Mixes with a C:N ratio **greater than 24:1** will make N less available to plants and will decompose **more slowly**
> - Mixes with a C:N ratio **less than 24:1** will make N more available for plants and will decompose **more rapidly**.

## PRE-FORMULATED OR CUSTOM DESIGN MIXES

Pre-formulated mixes are often put together by companies that do not really understand cover crops, but simply want to cash in on the trend. Our discussion about proper C:N ratio is enough to tell us that you do not need to plant such mixes, or even plant the same mix every time.

Seek out highly competent cover crop seed companies with extensive experience in your area/region. They can make the correct recommendations for specific cultivars that work best for your farm, soils and climate. They can also relay valuable information from the other farmers they are working with in your area so that you can avoid common mistakes.

Don't just talk with seed company reps. Talk with other farmers in your region who are successfully using cover crops, and find out what they are doing and why. In other words, do your homework. It is your business, and you have an inherent responsibility to tend to your business and not let others make your decisions for you.

Finally, as your soil health improves, and as you further the diversity of your cash crop rotations to include crops beyond corn and soybeans, you will need to alter your cover crop mixes to further enhance and complement your goals.

## INOCULATION AND LEGUMES

Are you using the right inoculants for the legumes? There are different inoculants that are best for different legumes. Check with your seed supplier to ensure they are providing the inoculant specific to the legume species in your mix. Do not be sparing with the inoculant. In fact, it can help to double the inoculate to make certain you have good response. This is the cheapest insurance you can buy.

Legumes that we may use in a cover crops mix, such as clovers, peas, beans, vetches, and sunn hemp have the ability to "fix" atmospheric N in association with rhizobium bacteria in the soil. Atmospheric N is in a gaseous form and is not available for plant uptake. The association of Rhizobium bacteria in the soil with the roots of legume plants converts the gaseous N into a plant-usable form of N. This is a symbiotic relationship; the Rhizobium bacteria live on the roots of the legume plant, being fed carbohydrates in the form of root exudates, while feeding the plant a converted form of N that the plant can physically uptake. It is important to note that legume plants cannot fix N without the association of Rhizobium bacteria in the soil. Unfortunately, many agricultural soils today contain very low amounts of active Rhizobium bacteria, thus requiring inoculation for effective N fixation.

Various legumes can fix anywhere from 30 to 300 lbs of N per acre. Using more than one species of legume in a cover crop mix can help with promoting greater levels of N fixation. This N is then available for support of the cover crop and the subsequent cash crop. This is a very low-cost way to take advantage of the free atmospheric N that is always present.

**Some publications that can be useful to further explain legume inoculation include:**

Legume Inoculation for Organic Farming from Dr. Julie Grossman at North Carolina State University

Legume Seed Inoculants from Colorado State Extension

Inoculation of Forage and Grain Legumes from Penn State Extension

**Two useful publications to help better understand nitrogen and nitrogen fixation are:**

Nitrogen in the Nation's Rain from the National Atmospheric Deposition Program

Understanding Nitrogen in Soils from the University of Minnesota Extension

ELISABETH SPRATT

## WHAT PLANTING METHOD IS BEST

Are you aerially seeding, broadcast seeding, or drilling the seed? The method you should use is highly dependent on moisture. If you have irrigation or live where moisture is plentiful, aerial or broadcast seeding are options for many species of cover crops.

Some, such as peas, soybeans and mung beans, perform much better if they are **drilled** into the soil. Also, in drier environments it is best to drill to ensure good seed-to-soil contact.

When drilling, you must ensure the settings are correct for the seed mix. Make certain the drill is level and properly calibrated. It is recommended that you re-calibrate prior to each day of planting. Make several test passes with the drill and check furrows to make sure seeding rate and seed placement is correct. Also check to see if there is good seed to soil contact to encourage germination.

**Aerial seeding** is another way to establish cover crops, specifically when corn and soybeans are still in the field. This method can be very useful for getting covers seeded when conditions are not conducive to using a modified planter or drill.

> **The links below are to articles that discuss how to increase success with aerial seeding.**
>
> Succeeding with Aerial Seeded Cover Crops: It's Not a No-Till Oxymoron from No-Till Farmer
> 6 Tips for Flying on Cover Crops Successfully from No-Till Farmer
> Tips and Strategies for Getting More Success with Aerially Seeded Cover Crop from No-Till Farmer

**Broadcasting** covers can also be an option. Farmers have retrofitted highboy spray rigs to successfully inter-seed cover crops into standing cash crops. One of the most successful examples is David Brandt of Brandt Farms near Carroll, OH. David has been able to modify highboys to apply seed at a wind velocity of up to 60 mph, using drop down tubes.

There are many farmers who are experiencing good success with planting diverse cover crop mixes into standing corn at the V4-V6 stage. They are not experiencing any significant yield drag, and the covers are ready to grow with vigor once the corn reaches dry down and the canopy is opened, or after the corn is harvested for silage. Planting into standing cash crops gives the cover crop a head start and allows for enhanced grazing opportunities after the cash crop has been harvested.

## ALLOW TIME FOR ADEQUATE GROWTH

In northern environments, many try planting warm season cover crops after a small grain harvest, which means there will not be enough time before first frost to get much growth. In that case, consider using fall-seeded biennials such as cereal rye and hairy vetch, which can tolerate colder temperatures and provide early spring growth, allowing for more grazing days.

In the Corn Belt, many try fitting cover crops into their corn-on-corn or corn-soybean rotation. Yes, you can get a cover crop to grow and it will protect the soil. But why not diversify the crop rotation by adding a cash crop such as winter wheat? Once harvested, it will allow a much greater window of time for a diverse cover crop to take up solar energy and, through photosynthesis, pump that energy into the soil. Plus, more growth of your cover crop means more opportunity for grazing.


PRACTICAL FARMERS OF IOWA

## HERBICIDE RESIDUES IMPACT COVER CROP SUCCESS

Prior herbicide use can have profound impacts on the success of subsequent covers, and it is very important to pay attention to the herbicides used for your cash crops and their potential for carryover. Consider how long a specific herbicide persists in the soil and how sensitive the cover crop is to potential residue.

Typically, herbicides with a shorter half-life have less potential for negative impact. Products with a half-life of 30 days or less often pose no issue for subsequent cover crops. However, plant species sensitivity must be considered. The small-seeded legumes, grasses and mustards (clovers, ryegrass, canola) can be quite sensitive to some herbicides.

Other factors influencing cover crop sensitivity to prior herbicide use include soil biological activity, rainfall, soil texture, and soil pH. The half-life of many herbicides can be significantly reduced if the soil has very good to excellent soil biological activity — something that many farm soils are lacking today.

> **To learn more about cover crops and herbicide residues, review these resources:**
>
> Resources Page from Green Cover Seed
>
> Herbicides Persistence and Rotation to Cover Crops from Pennsylvania State University
>
> Grazing Restrictions Guide from Iowa State University

# MANAGING COVER CROPS AND OPTIMIZING THEIR BENEFITS

**IN THIS SECTION, YOU WILL LEARN ABOUT:**

- How to manage your cover crops to maximize your profit
- What to do if you don't own livestock? Consider a grazing lease!
- How to measure soil health benefits over time

Cover crops can be a good source of revenue generation and a good source of fertilizer inputs for the next cash crop. Livestock grazing of the cover crop has the potential to net as much or more per acre compared to the common cash crops. Not only do you have opportunity to enhance net revenue per acre, but you can also significantly advance soil health, including nutrient cycling and the ability to capture and store water. Cover crops will hold nutrients and water on your land that can be cycled via soil microbes, providing nutrients to subsequent crops.


SCOTT HAASE

Data from a number of farms shows that net profit per acre potential from grazing cover crops can be substantial.

On Farm 1 (North Dakota), 187 yearling beef steers were grazed for a total of 31 days on cool season cover crops interseeded into standing corn at the V6 stage. The grazing started 30 days after the corn was harvested. Seed cost, planting cost, land cost, and labor was a total of $104/acre for the cool season grazing period. Total gross profit from the gain on the 187 yearlings was $289.85/acre; net profit was $185.85/acre.

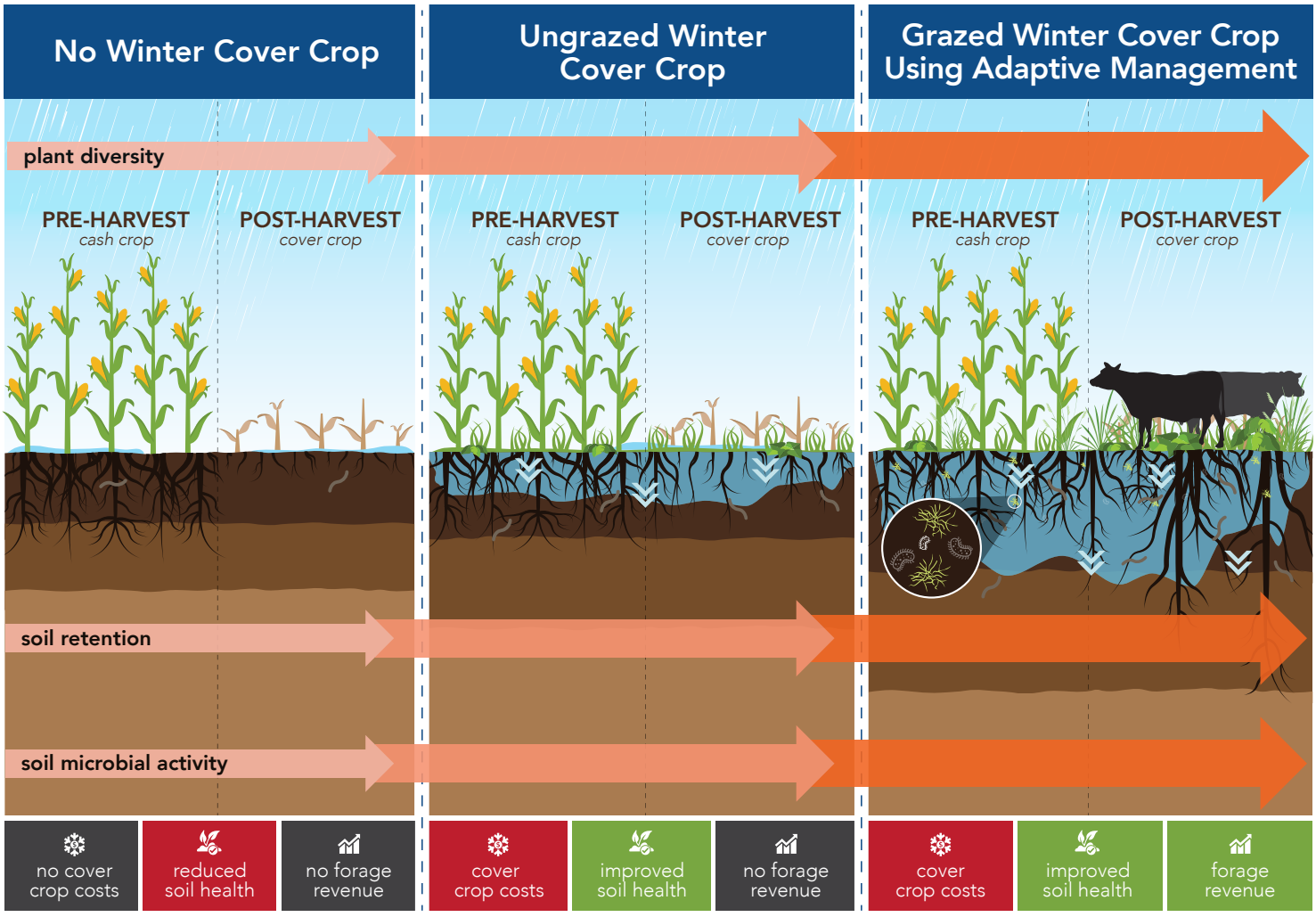
On Farm 2 (North Dakota), 107 heavy grass finishing steers were grazed on cover crops for a total of 32 days. Average daily gain (ADG) over those 32 days was 4.05 lbs/day. Total cost for seed, planting, land, and labor was $86.86/acre. Gross profit for the 32-day period was $435.83/acre; net profit was $348.97/acre.

On Farm 3 (Minnesota), stocker steers were grazed on a planted cover crop following winter wheat harvest. Cost of the cover crop seed and planting was $37.25/acre. Steers were able to graze the covers for a total of 43 days at a ADG of 2.4 lbs/day. Total net profit was $153/acre.

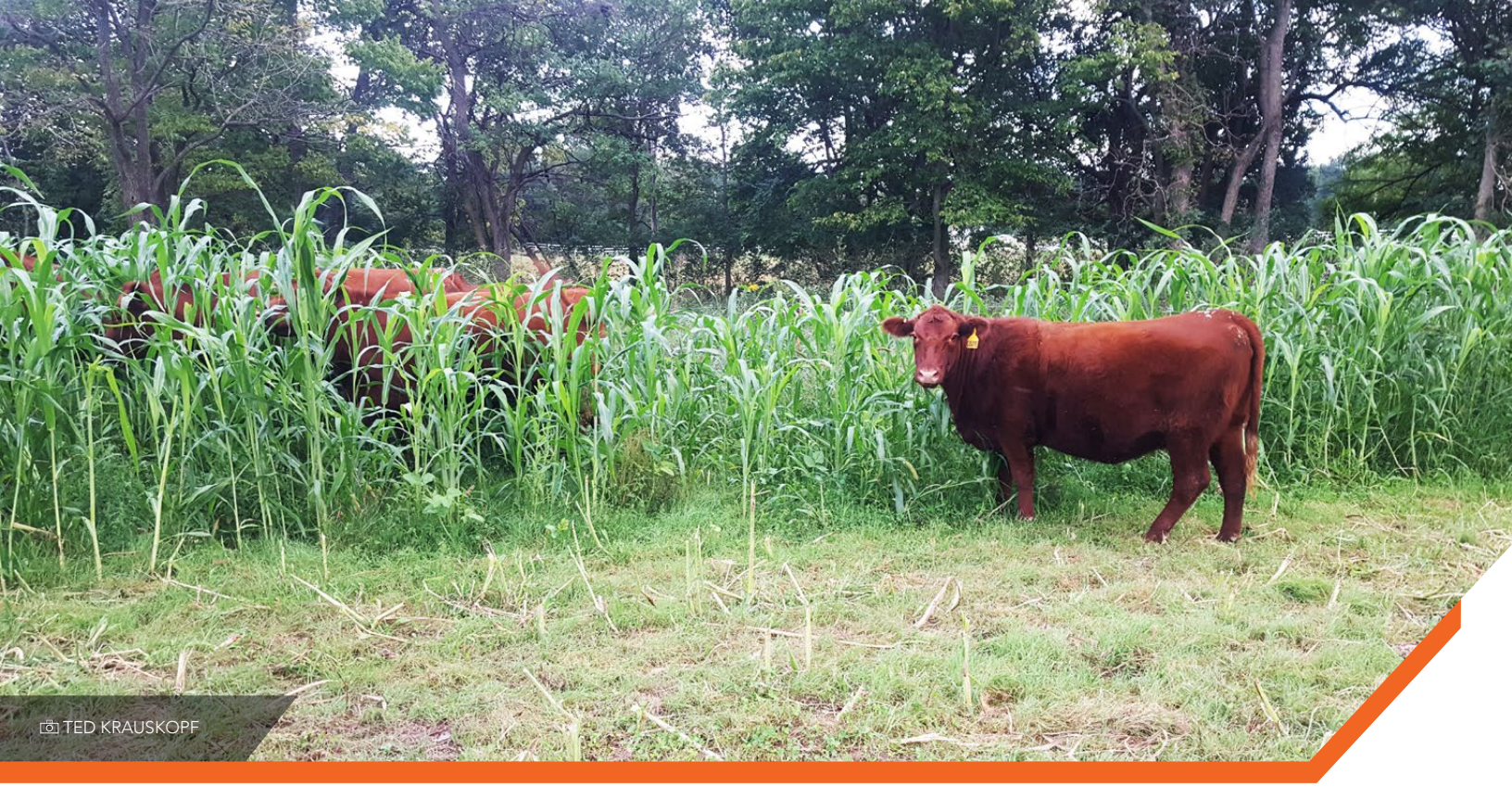
On all three farms the cash crop yields were equal to their county averages or above county average.

Many producers consider cover crops a success only if yield of the subsequent cash crop increases. It is important to state that net margins per acre for cash crops are determined more by input costs than by yield per acre. Cover crops provide a wide range of services, including feeding soil biology, keeping nutrients on your land, increasing soil organic matter, improving soil aggregation and thus water infiltration and the ability of the soil to support equipment under wet conditions, decreasing wind and water erosion, reducing fertility costs for the subsequent cash crop, relieving soil compaction, and creating enhanced stress tolerance in the subsequent cash crop. Producers who have been using covers for several years also report reduced weed pressure in cash crops, and lower pest and disease pressure on their soybean crops.

**Diagram 1. Grazing Cover Crops**




*Cover crops have related management expenses, but that is often far outweighed by the soil health improvements and winter forage revenue generated when cover crops are grazed.*



TED KRAUSKOPF

## HOW TO MANAGE COVER CROPS TO MAXIMIZE YOUR PROFIT

Knowing how to manage and utilize cover crops to economically benefit your farm is important. Even though there are long term benefits of building soil organic matter, increasing water infiltration rates, decreasing erosion and harmful runoff, and stimulating the mineral and water cycles, cover crops still must pay in the short term.

There are several key things that we need to pay attention to in determining cover crop economics. These include:

- Understanding the C:N ratio created by the prior cash crop and planting a cover crop that balances the C:N ratio for optimum soil microbial performance between cash crops and for the next cash crop. A good understanding of the C:N ratio can help build fertility for the next cash crop and can result in significant fertilizer cost reductions. A good resource for the C:N ratio between various crop types is ***A Soil Owner's Manual*** by Jon Stika.

- Selecting cover species and cultivars that work best for your region and intended season of use (e.g. fall and spring grazing). Not all plant species and cultivars work equally well in every environment, soil type, or across the full winter grazing season.

- Use a good tool for designing your cover crop mix to optimize performance, achieve goals, and minimize cost. Tools are listed on page 10-11.

- Pay attention to your Plant Hardiness Zone Map to make certain you are planting the right plant species at the right time.

- Make certain you prepare your no-till drill or planter properly for successful seed placement, germination, and seed to soil contact. The drill should be level and properly calibrated.

- Grazing of cover crops can produce net returns per acre as an additional source of revenue from the same cash crop acres. Grazing your cover crop provides winter forage that offsets the costs of seed, termination, and management time.

**There are several publications and articles that explain cover crop economics thoroughly. These include the following:**

Managing Cover Crops Profitably, 3rd Edition from Sustainable Agriculture Research & Education (SARE)

Keep Covers in Your Rotation Without Breaking the Bank from No-Till Farmer Magazine

How Seeding Cover Crops Can Slash Your Fertilizer Bills from No-Till Farmer Magazine

Understanding Budget Implications of Cover Crops from University of Illinois

Cover Crops: A Farming Revolution with Deep Roots in the Past from the New York Times

One Indiana Farmer's Response to Weather Variations by Dan DeSutte

PRACTICAL FARMERS OF IOWA

## WHAT IF I DON'T OWN LIVESTOCK? CONSIDER A GRAZING LEASE!

There is increased interest by livestock graziers in utilizing cover crop fields that farmers have planted following a cash crop. Many farmers today have little to no experience with livestock and many do not desire to have their own livestock. However, with the many benefits relative to incorporating livestock into cover crop rotations, there is opportunity for farmers and graziers to partner for mutual benefit.

There are a multitude of land use and land lease arrangements that can be made with no real "standard" contract at this time. Some farmers place so much value on the benefits derived from a complex cover crop that they have purchased cattle of their own to graze cover crops between cash crops. Other farmers, realizing the value from cover crop grazing but not wanting to own their own livestock, take the responsibility of purchasing and planting the cover crop seed, then

## YOU BRING THE LIVESTOCK, I'LL PLANT THE COVER CROPS

Bruce Carney, Maxwell, IA, raises grass-fed beef on his 200 acres of perennial pasture. Neighbor Rick Kimberley manages 4,000 acres of corn and soybeans. For the past several years, Bruce has brought his animals to Rick's winter cover crops to help extend his grazing season. Rick says he sees this relationship benefitting both parties due to the soil fertility benefit it brings to his farm: "If we're getting some benefit out of it on the agronomy side, and Bruce is getting something out of it on the cattle side, I think it's a good working relationship."

In their case, no money has exchanged hands yet. But Bruce says this may change. He says, "There's probably a split on seed costs, application costs, depending on if I get good grazing…But everyone's getting benefits out of it."

PRACTICAL FARMERS OF IOWA

allow a neighboring grazier to graze the covers during the off season. In many of these circumstances, the grazier is responsible for putting in temporary fencing, temporary water, providing the livestock and management. The grazier then removes all fencing, water, and livestock prior to the farmer beginning planting preparations. No money exchanges hands as both parties derive a perceived benefit. The grazier gets the use of the acreage for the season, and the farmer gets the benefit of the added fertility and impact on soil biology.

In other cases, there are designated lease agreements that are based on one or more factors. These may include a lease paid to the farmer based on:

- A per head or animal unit per month basis.
- A per acre grazed basis.
- A Cost of Gain (COG) basis.
- A Share of profits basis.

Factors to be considered by both parties include:

- Cover crop management responsibilities.
- Herbicide residue and resource concerns.
- Livestock management responsibilities.
- Land use management responsibilities.
- Risk management & assessment.


ALLEN DEUTZ

**To learn more about contract considerations and how to develop a contract, read:**

Rental Agreements for Cover Crop Grazing from the University of Nebraska

Contract Grazing Considerations from Successful Farming Magazine

Pasture and Grazing Arrangements for Beef Cattle from University of Iowa Extension

The Basics of Contract Grazing from the Iowa Beef Center

Pasture Rental and Lease Agreements from the Iowa Beef Center

Rates Charged for Contract Grazing Arrangements from the Iowa Beef Center

Do You Use Grazing Contracts for Cattle? From Wallaces Farmer Magazine

How To Write a Custom Grazing Contract from On Pasture

Custom Grazing Rates and Contract Structuring from On Pasture

Contract Grazing of Cover Crops from Practical Farmers of Iowa

The farmer and the grazier can develop any type of contract agreement that is best suited for their specific situation(s). Each farm, each year, and each individual is different so flexibility in contract development is key. Contracts should be kept simple and to the point so that each party has written documentation of their joint agreement. Both parties should have a signed and dated copy and it is helpful to have a third party witness to verify.

PHOTO ON VISUALHUNT

## SOIL TESTING RECOMMENDATIONS

In addition to the potential financial benefits, cover crops can provide numerous advantages to your soil which your next cash crops can benefit from. Soil testing can help you see your progress over time, which can help you determine what works for your farm. To determine chemical, biological, and physical characteristics of your soil over time, the following tests are recommended:

1. A Standard soil test with soil pH, organic matter, CEC, Base saturations, and mineral analysis
2. The Haney Test for organic mineral availability
3. Soil Biology Test using the PLFA Test

Soil testing labs will provide specific sample collection, handling, and shipping instructions. Be sure and follow all instructions for accurate results.

These tests establish baseline data for soil performance and should be repeated annually, or at least once every three years, in order to monitor progress.

In addition, soil water infiltration should be measured and monitored on a routine basis. Determining water infiltration rates using a single ring infiltrometer can be accomplished in the field by farm owners or management. Simple instructions for measuring water infiltration rates can be found at USDA NRCS. A good demonstration of performing water infiltration rate measurements is shown in this video.

# ADAPTIVE GRAZING OF COVER CROPS

**IN THIS SECTION, YOU WILL LEARN:**

- Why adaptive grazing?
- How to use adaptive grazing on cover crops
- Handling grazing toxicity concerns
- Which fencing and watering systems work best for grazing cover crops

## INTRODUCTION TO ADAPTIVE GRAZING

Grazing cover crops can both offset the cost of cover crop management *and* provide significant soil fertility benefits. In order to reap the highest rewards from grazing cover crops, grazing practices characterized by high stock densities and frequent moves, such as adaptive grazing, are advised. Adaptive grazing, also called Flex Grazing or Adaptive Multi-Paddock Grazing (AMP), is first and foremost not a rigid system or even a routine (Picture 1). It allows the practitioner to address multiple goals and objectives, and to adjust to changing conditions. It can be successfully utilized and adapted to both the grazing of perennial pastures and to the grazing of annual cover crops. The practice of adaptive grazing can be summarized in several basic points.

Picture 1. AMP Grazing Paddocks
GRASS FED INSIGHTS

**1** Adaptive grazing is **goal oriented**.
It allows us to work with multiple goals simultaneously. For example, we can target animal performance, soil building, development of plant species diversity, and soil aggregation, all at the same time. It is an excellent tool for supplying nutrients to a subsequent cash crop through the application of manure and urine by the livestock. A grazier can use higher stock densities in cover crop paddocks to more rapidly build soil aggregate, increase water infiltration rates, improve soil OM, and evenly apply fertility.

**There are several articles that explain the benefits of grazing cover crops:**

What I've Learned From No-Tilling: No-Till, Along with Longer Rotations, Makes for Great Grazing and Improving Soils from No-Till Farmer Magazine

Grazing for Soil Health and Getting Cover Crops Into the Mix from No-Till Farmer Magazine

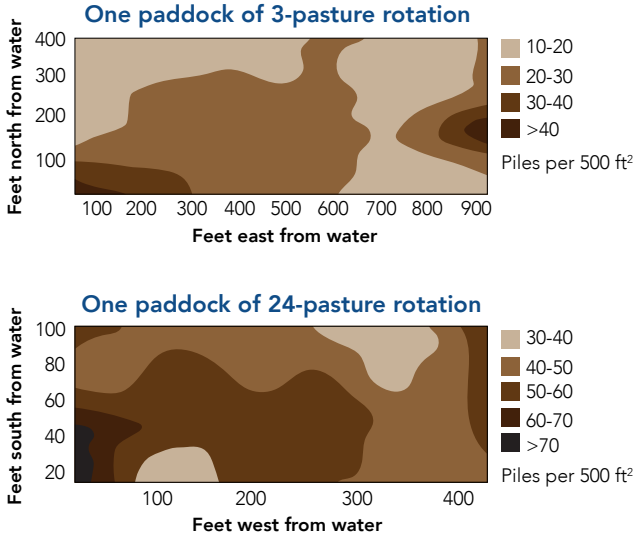
Diverse Cover Crop, No-Till System Bring High Forage Quality, Lower Cost of Gain from No-Till Farmer Magazine

## 2 It is dependent on **stock density** and not stocking rate.

Pounds of animals per acre is the focal point (Picture 2). Varying stocking densities throughout the cover crop grazing season based on plant heights, available forage and expected temperatures and moisture helps keep the ground covered and protects microbes in the soil. Research has shown that higher stocking densities work together with more frequent movement to spread animal manure and urine throughout pastures (Diagram 2).

If your goal was to have at least one manure pile per every square yard of pasture or paddock every year, then it would take 27 years to accomplish that with continuous grazing. If we moved cattle every day, just once per day, then the same objective would be reached in a single year.

**Diagram 2. Manure distribution in low- and high-rotation grazing systems.**




Adapted from Peterson & Gerrish, 1995

## 3 **Management and flexibility** are key to the success of adaptive grazing.

We must manage and adjust to changing conditions using keen observation. An example is changing directions within a paddock when strip grazing or starting the cover crop grazing season in a different paddock each year so that the forages are grazed and managed at different stage of development annually. This can be accomplished with the grazing of annuals just as with the grazing of perennials. When grazing annual cover crops planted in cash crop fields, alter where the first paddock of the grazing period is each year to alter impact. It's a good idea to keep records of your observations, rainfall, days grazed, forage biomass, forage height when cows are turned in and taken out so you can refer back to the previous season as you begin the next.

## 4 It is predicated on **frequent movement and frequent rest.**

We are to move rapidly through each paddock and allow plenty of rest for each previously grazed paddock. Being an adaptive grazier means the frequency of moves varies based on what you observe and what you expect conditions to be like within the grazing period. To get multiple grazings from an annual cover crop mix, you will need to control what the livestock are allowed to consume or "harvest" with each grazing. Generally, for adequate regrowth and extended grazing, it is best to not allow the livestock to eat more than 50% of the available forage dry matter (DM) in any one grazing event. For example, if the

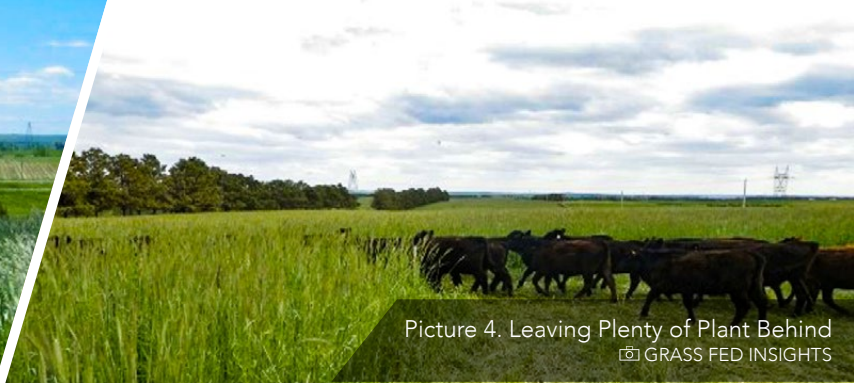
Picture 2. Stock Density of 500,000 lbs/acre.
GRASS FED INSIGHTS

**Table: Impact of Grazing Method on Manure Distribution per Square Yard of Pasture.**

| Rotation Frequency | Years to Get 1 pile manure/Sq Yard |
|---|---|
| Continuous | 27 |
| 14 Day | 8 |
| 4 Day | 4-5 |
| 2 Day | 2 |
| 1 Day | 1 |

*Source: NWDistrict.ifas.ufl.edu*

Picture 3. Grazing Annuals.
GRASS FED INSIGHTS

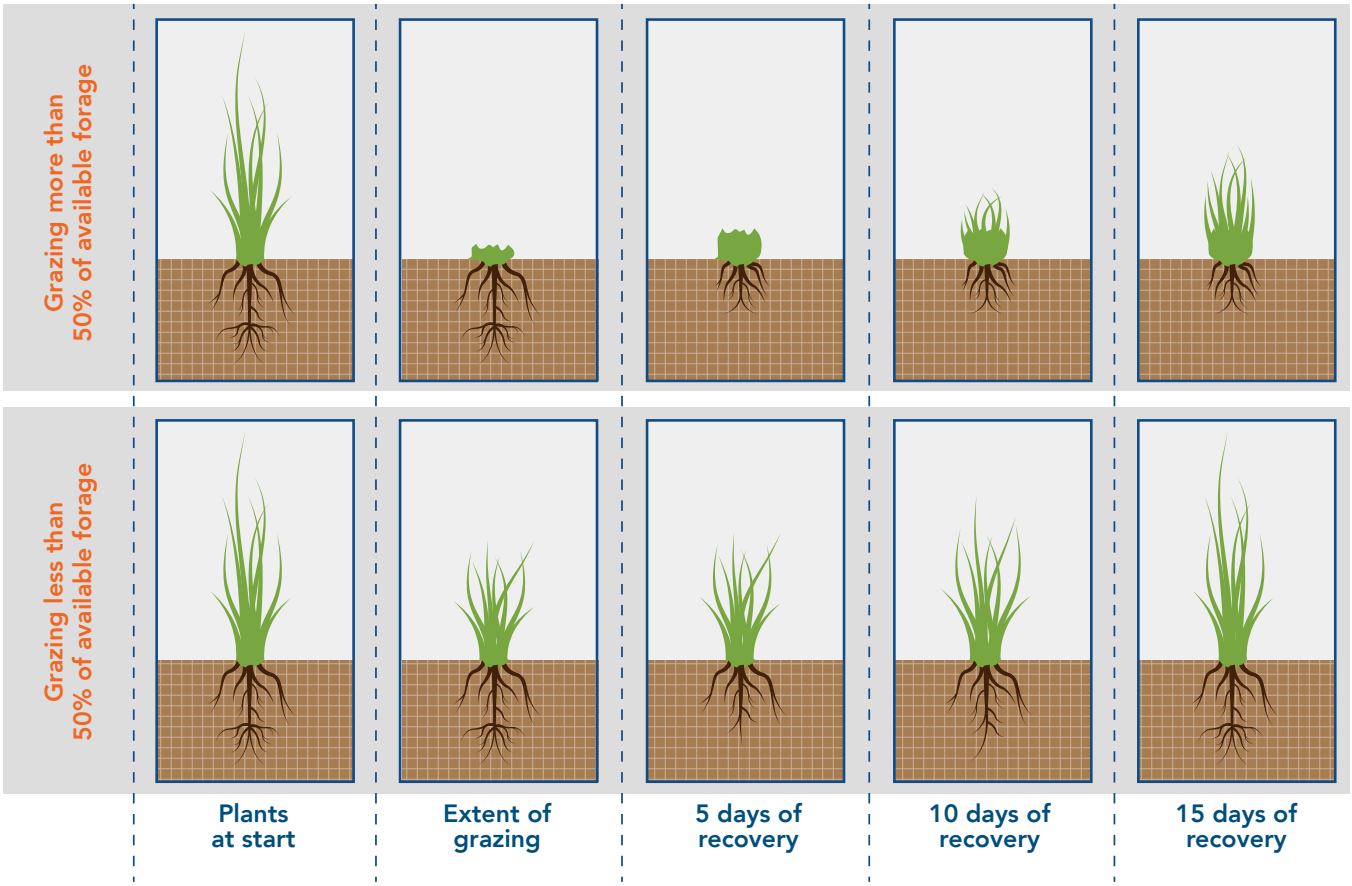


Picture 4. Leaving Plenty of Plant Behind
GRASS FED INSIGHTS

average height of the annual mix was 16 inches when the livestock were turned in to the paddock, then they should be removed from the paddock when the average height is 8 inches. For optimal regrowth and maximal grazing events within a grazing season, do not let the livestock graze below 6 inches. The exception to this is if you are wanting to use high density grazing as a possible cover crop termination method. You would then allow the livestock to graze down below two inches in height.

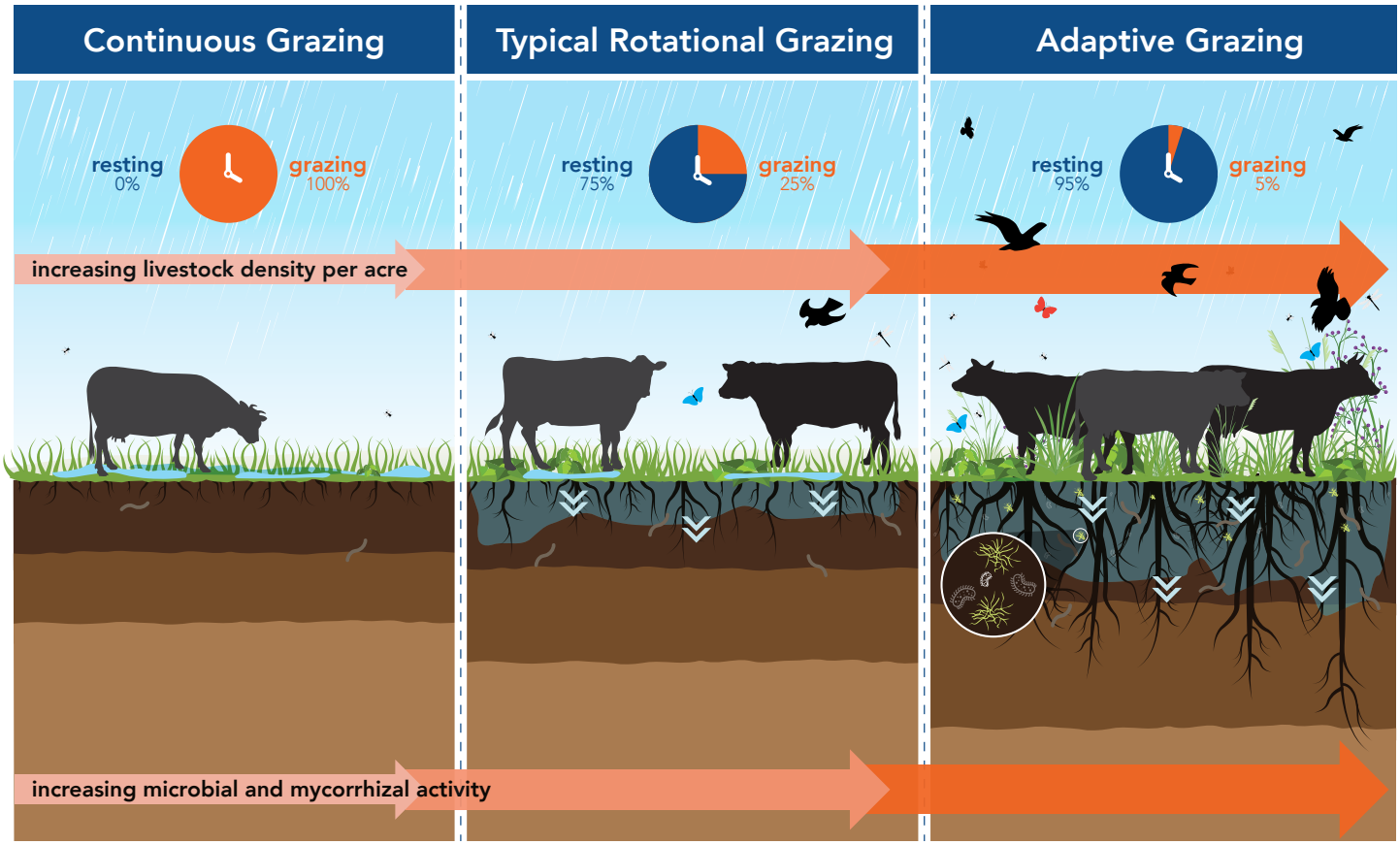
5 Adaptive grazing targets complete **plant root system recovery** between each grazing. This is very important in the soil and microbe building process (Pictures 3 & 4). Complete root recovery is very dependent on leaving enough plant standing after each graze. The adage "graze half-leave half" is meant to guide adaptive graziers and remind them that grazing too "tightly" damages root growth and leaves the plant vulnerable when the weather turns dry. Even longer recovery periods are needed for plant development and regrowth when paddocks are "overgrazed" (see diagram 3). These principles apply for both perennial pastures and annuals.

**Diagram 3. Forage Removal and Regrowth Rate**



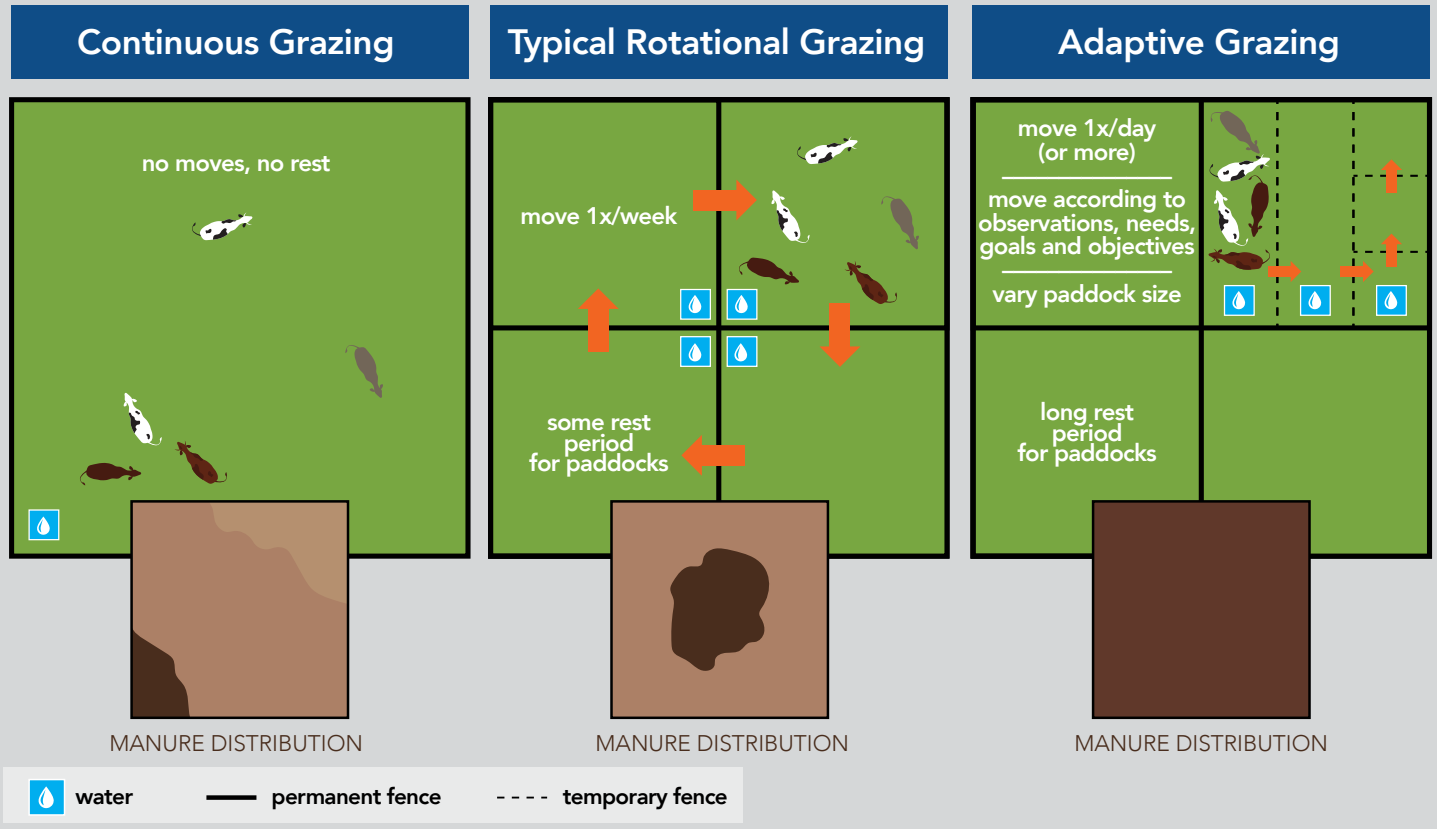

*Adapted from 400 Plus: A Guide to Improved Lamb Growth for Farmers and Advisors by Beef & Lamb New Zealand*

**Diagram 4. Benefits of Adaptive Grazing**




*Adaptive grazing differs from continuous and typical rotational grazing because of its characteristic high stock densities and long rest periods. This results in improved water infiltration, more soil biological activity, greater plant and wildlife diversity, and more.*

**Diagram 5. Characteristics of Adaptive Grazing**




*Adaptive grazing uses a mix of permanent and temporary fencing to move livestock easily through paddocks of varying size. The high stock densities and frequent moves result in more even and higher manure distribution than continuous or typical rotational grazing systems.*


## THREE PRINCIPLES OF ADAPTIVE GRAZING:

To be highly successful at adaptive grazing, there are three principles to live by: 1) The Principle of Compounding, 2) The Principle of Diversity, and 3) The Principle of Disruption. Follow these three principles and you will be a successful grazier and will maximize the benefits of grazing your cover crop.

### 1 Principle of Compounding

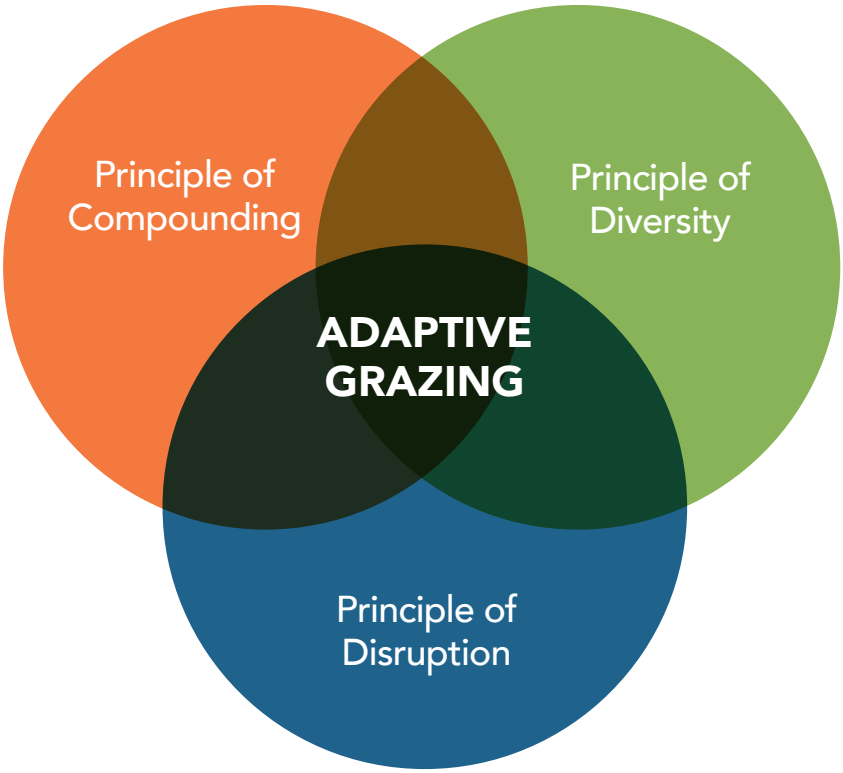
There is nothing we do in agriculture that has a singular effect. As a matter of fact, most of the things we do in agriculture have an exponential effect, but we often simply don't realize it.

Unfortunately, we have been trained to think "singularly". One example of that is we have been taught that if we see a weed in our pastures, we are to take an herbicide, spray the weed, and kill the weed. In our thought process, we think, "see weed, spray weed, kill weed". Job done. Right? Not exactly.

What really happened when we sprayed for weeds? First, we never get rid of "weeds" by using an herbicide. We simply set them back for a while. Otherwise, we would only have to spray for weeds once and never again. They are always present in the latent seed bank. Second, the herbicide may have "set back" the undesirable weed, but it also set back numerous other plant species that have highly nutritive properties for our livestock. Third, we have damaged some of our soil microbiology. There are certain microbial species that are associated with certain plants, and when we set those plants back, we also set back those specific microbial species. In addition, many herbicides have a direct impact on soil microbial species. Fourth, we have decreased our plant species diversity and complexity because we have set back certain plant species in the mix. With most herbicides, we set back our forbs and legumes. Forbs (or what most people call weeds) are packed with secondary and tertiary nutritive compounds that provide additional nutritional benefits, have significant medicinal qualities, and even contain plant compounds that have natural deworming properties.

These first four compounding effects cause a cascade of other negative effects that we often do not associate with our "singular" practice. The other cascading effects include loss of plant root mass and depth, loss of soil carbon, loss of soil aggregate and water infiltration, a decrease in soil microbial species and biomass, decrease in soil macro-organism populations, etc. So, we just went from a "singular" act of spraying weeds to triggering a whole series of compounding and cascading effects that create negative consequences that last for years or even generations.

Likewise, poor grazing practices cause a series of negative compounding and cascading effects that last for years and increase our reliance on external inputs, reduce our carrying capacity potential, and rob us of profits. These include practices such as set stock grazing, continuous grazing, slow rotations, and even high stock density grazing practices where the same methods are employed each day, without any significant alterations. Negative consequences that we routinely observe include seriously compacted soil, poor soil aggregation, significantly reduced soil water infiltration rates, reduced plant species diversity and complexity (trend towards a monoculture or near monoculture), poor soil microbial population diversity and biomass, increased reliance on fertilizers, herbicides, and other chemicals, increased reliance on supplementation, increased costs of production, and decreased net profits.




## 2 Principle of Diversity

Plant species complexity and diversity are critical to building positive compounding and cascading benefits. In that regard, when designing an annual cover crop mix we need to have the three primary plant functional groups represented. These include grasses, legumes, and forbs (broadleaves). It is desirable to have a number of species of each of the three primary plant classes, not just one grass , or one legume, or one forb. Rather, strive to have at least three or more of each plant class represented (for a total of at least 9 species) in significant quantities in each cover crop mix.

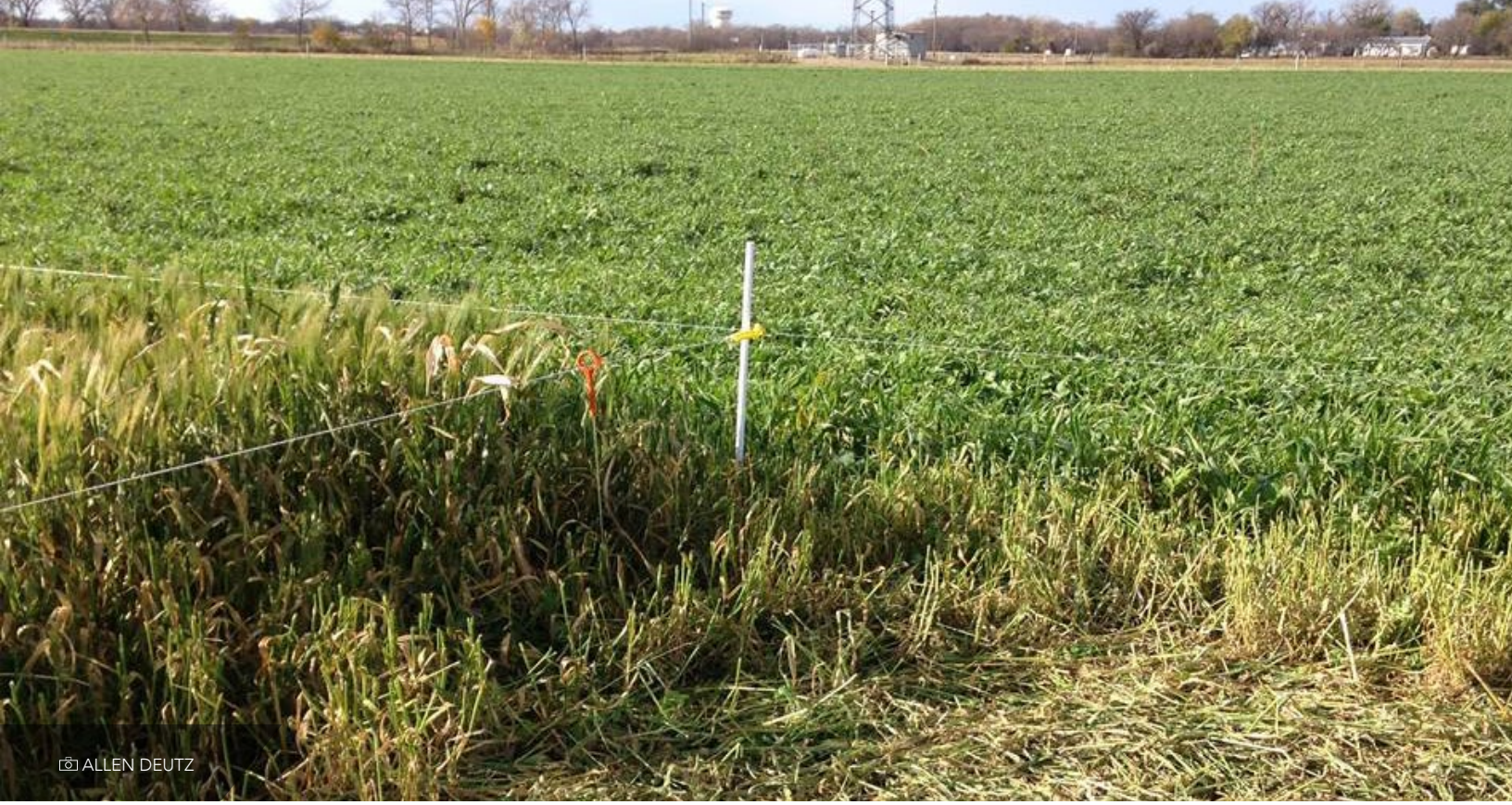
There have been a number of recent studies that show the importance of plant species diversity or "richness" in our perennial and annual fields. One study found that an eight-species mix increased soil C and soil N by 18% compared to the monoculture plots. In another study, researchers discovered that plant species diversity significantly increases plant shoot biomass, root biomass and production of root exudates, which in turn stimulate an increase in soil bacterial biomass and fungal biomass.

These studies show that plant diversity can actively promote our soil health! We have to remember that most soil microbes live and thrive in the root zone. Greater complexity and diversity in plant species results in greater root diversity --- root depth, root mass, root exudates. This fuels the underground livestock – soil microbes.

## 3 Principle of Disruption

The final principle in our series is the Principle of Disruption. We may have a negative connotation of the word "disruptive" because we have heard that "nobody wants a disruptive kid" or we "have to be nice and not disrupt the meeting."

Adaptive grazing is a form of grazing that allows the practitioner to be ultimately flexible and to address multiple goals and objectives all at once. To be truly adaptive, we must be able to adjust to changing conditions. So, how can we best be adaptive? By being disruptive!




Producers all over North America (and many other parts of the world) have had tremendous success with employing adaptive grazing practices and principles. But, there are many who want to turn adaptive grazing into a "system" or a routine. It is basic human nature to want to settle into a nice, neat routine and do things the same way every time. That is not the way biology works though. Biology is never routine. In fact, biology and nature are quite adaptive; which leads to resilience and the ability to respond very well to direct challenges.

How can we be disruptive in a way that elicits positive compounding and cascading effects (the Principle of Compounding), taps the latent seed bank to create diversity and complexity in our plant species (the Principle of Diversity), and builds resiliency into our soils and farms? By being incredibly flexible. In other words, don't do things the same way every time.

**Planned, purposeful disruptions include things as simple as:**

1. Altering stock densities through the grazing season and through the years. Do not settle on a specific stock density thinking that 100,000 lbs per acre or 250,000 lbs per acre is the magic bullet. Rather, consistently change stock densities to flux between lower densities of 20,000 lbs per acre to more than 500,000 lbs per acre. Each stock density has a specific purpose and a specific impact on the soil and the surrounding biology.

2. Alter the movement patterns of your livestock through your farm's fields. If you normally start your grazing in paddock A, then move to paddock B, and C, instead start in paddock C, then move to paddock D, or, even skip over several paddocks and move to paddock G, then eventually back to paddock A. Starting grazing in the same area each year of your annual cover crop fields inherently creates a stagnant response from the soil biology.

3. Alter rest periods of each paddock. Alternatively resting specific paddocks for 60 days if we are on a 30 day rotation can have profound positive impacts on soil biology. It will be impossible to provide every paddock within each field an extra rest period each year, but providing extra rest periods for each paddock once every 3-4 years is adequate to produce reasonable results.

4. Alter Grazing Heights on and off your paddocks. If you normally target a forage height of 12-16 inches before you graze a paddock, periodically wait until a paddock reaches 20 inches in height before grazing. In general, practice a "take 50 and leave 50" approach where you leave 50% of forage dry matter in a paddock with each grazing. However, there are times when it is advantageous to take less or more. So, if you turned into a paddock at 16 inches average forage height, take it only own to 10 inches before moving to the next paddock, or take it down to 6 inches before moving to the next paddock. Note: It is recommended that you never take a paddock down below 5 inches in forage height unless purposely transitioning from warm to cool season annuals or terminating an annual or cover crop mix.

5. Alter species order through your paddocks. If you are a multi-species grazier, you may think you always have to move the cattle through a paddock first, followed by sheep/goats, chickens, or hogs. Certainly, there are reasons to move certain species through in a specific order, but sometimes it helps to shake this up and move smaller species through first, then the cattle. You don't have to do this too often to realize big results. Remember that each livestock species releases certain classes of microbes onto the soil and plants when they are foraging through a paddock. Microbes released from the livestock communicate with microbes in and on the soil. This is called "quorum sensing" or microbe-to-microbe communication. This communication stimulates significant activity and induces microbial reproduction. This is precisely what we want to happen.

There are many more ways to be disruptive, so experiment. The great thing about adaptive grazing is that you are moving the livestock daily or quite frequently. If you do make a mistake, then it is immediately recognized and immediately correctable. It is far better to make small, immediately correctable mistakes than make mistakes that cost a season or years.



ALLEN DEUTZ

SCOTT HAASE

## TOXICITY AND GRAZING COVER CROPS

There are potential toxicity concerns that graziers must be aware of with specific plant species. These primarily involve warm season annuals such as sorghum-sudangrass, sorghums and millets, but can also impact cool season plants such as barley, oats, wheat, and rye. All plants contain at least small levels of nitrates, but these can become concentrated and toxic under certain conditions. The conditions most likely to create toxic nitrate levels in plants include drought conditions and cool, cloudy conditions. Most of the nitrates are concentrated in the lower part of the plant. The stalk or stem will have the highest concentrations and the bottom six inches can contain toxic levels under the right conditions. In addition, immature or highly vegetative plants can have greater nitrate levels than more mature plants.

The best way to prevent and avoid nitrate toxicity issues are to not graze annuals when they are too immature. It is best to delay grazing until annuals have reached mid-stage maturity. Avoid grazing immediately after an excessively dry period or a cool, cloudy period. Do not turn hungry cattle into fields where nitrate issues are possible. Fill them up on hay first. Daily move frequency where cattle are allowed to consume adequate forage dry matter each 24-hour period also aids in prevention of nitrate poisoning. Planting highly diverse mixes that contain not only grasses, but legumes and broadleaves reduce the chance of nitrate poisoning in livestock.

Another potential toxicity concern is prussic acid poisoning. Prussic acid issues are most prevalent in sorghum and sorghum-sudangrass hybrids, as well as certain grain hybrids, and Johnsongrass. Just as with nitrate poisoning, stress conditions can create circumstances where the prussic acid in the plants concentrates to toxic levels. Avoid grazing annuals immediately after a hard frost or freeze, after drought periods, or when plants are too immature. Unlike nitrate poisoning, prussic acid tends to concentrate in the leaves more than the stalks.

Keys to avoid issues include: 1) Not turning hungry cattle onto fields where prussic acid may be an issue. Fill them up on hay first and turn in during the afternoon hours, 2) Avoid grazing immediately after a hard frost or freeze, 3) Avoid grazing immediately after a drought period, 4) plant diverse cover crop mixes to minimize potential for toxic levels of prussic acid, 5) avoid grazing lush regrowth by controlled rotational grazing using adaptive principles.

**For detailed information on recognizing conditions that lead to toxicity problems when grazing cover crops, read:**

Nitrate Toxicity in Livestock from Oklahoma State University Extension

Prussic Acid Poisoning from Oklahoma State University Extension

Managing Cattle Health Issues When Grazing Cover Crops from Iowa State University Extension

## FENCING FOR GRAZING COVER CROPS

Adaptive grazing is highly reliant on temporary fencing technology. Today, we have modern electric fencing technology that allows effective grazing practices. Perimeter or boundary fencing can be permanent or temporary and constructed from a number of materials. These include barbed wire, woven wire, and high tensile wire. Permanent perimeter fencing can last 20-30 years with quality posts and wire.

For perimeter or boundary fencing around row crop fields where cover crops will be grazed, temporary or semi-permanent options are available. Five or 6" diameter posts can be driven into the ground at least 48" and pulled at the end of the grazing period, if necessary. A single gate or corner post is adequate for 1-2 strands of high tensile wire. Additional bracing may be necessary with 3 or more strands. Some producers opt to leave corner posts in that do not interfere with other field work. Line posts can be 7/8" fiberglass posts that are easy to drive and to remove (Pictures 5 & 6). Fourteen gauge high tensile wire is a good option for semi-permanent perimeter fencing (Picture 5) and can be reeled back up after the grazing season using a spinning jenny (Picture 7) or commercial PTO powered wire winder.

Interior fencing can be as simple a single strand electrified polywire with tread-in posts. The same polywire and tread-in posts are used over and over during the active grazing season, so costs per foot are negligible (see Estimated Costs link). Picture 8 shows multiple polywire paddocks constructed for multiple moves in a day. Construction is simple and can be accomplished in 30 minutes or less, depending on size of paddock. If the grazier desires to make multiple moves a day with his/her livestock, then the use of an automated gate release device can be employed. One such device is the Batt Latch. Batt latches have a solar panel that charges an internal battery. They are programmable so that bungee or spring gates can be set and released based on time interval of desired moves (Picture 9).

Picture 5. Fiberglass Line Post (7/8")
GRASS FED INSIGHTS

Picture 6. Installed Temporary Perimeter Fence for Cover Crop Grazing.
GRASS FED INSIGHTS

Picture 7. High Tensile Wire Spinning Jenny
GRASS FED INSIGHTS

Picture 8. Polywire Paddocks for Multiple Moves.
GRASS FED INSIGHTS

Picture 9. Batt Latches Set for Multiple Moves.
GRASS FED INSIGHTS

**Detailed information on fencing system options, fencing costs, and temporary electric fencing design are contained in the links below:**

Managed Grazing Systems and Fencing for Distribution of Beef from University of Missouri Extension

Electric Fencing for Serious Grazers from NRCS

Planned Fencing Systems for Intensive Grazing Management from University of Kentucky Extension

Estimated Costs for Livestock Fencing from Iowa State University Extension

Fencing Systems – Electric Fence Design from University of Maine Extension

# WATER SYSTEMS FOR GRAZING COVER CROPS

Water is a critical nutrient and livestock must have ready access at all times. Water is an investment and not a cost. Proper water system design and installation is crucial to livestock health and performance. There are numerous options for water system development. These include using existing ponds as a water source. One proven approach is to build watering ramps on each pond by using an excavator to dig a 12-foot wide ramp into a gently sloped area of each pond. Keep ramps less than 12-foot wide so that you can control animal access and not have too many animals trying to water at the same time. The ramps are secured with geotextile fabric with 2-3" diameter rock laid on top of the fabric. Ponds are fenced off with a single strand of polywire and access to the pond is only at the ramp. Livestock can walk down the ramp to drink but have no further access to the pond (Picture 10).

Picture 10. Pond Ramp to Control Cattle Access.
GRASS FED INSIGHTS

Another option is putting in subsurface water line and installing risers with quick couplers every 400-800 feet (Pictures 11 & 12). Subsurface water lines with risers work well in row crop systems where the risers are well marked.

Picture 11. Water Line.
GRASS FED INSIGHTS

Picture 12. Riser with Quick Coupler.
GRASS FED INSIGHTS

## GRAZING AND WATERING LIVESTOCK, EVEN IN HARSH WINTERS

Dan Jenniges, near Glenwood, MN, stockpiles winter cover crops for his cattle to graze even in the coldest months of winter. He says he got even more feed value out of the cover crops than he was expecting: "It should be a law, if you have livestock then you should have to do cover crops, there are zero reasons not to do it."

There are some challenges with having livestock out grazing in frigid weather. Dan says, "I have a traditional tire tank, where the bead on top is cut off, and a piece of steel is bolted on the bottom to hold the water in it. We use a submersible pump that's laying in the pond, and pump the water up to [the water trough]." The key to keeping the water from freezing? Keeping it circulating between the trough and the pond. "It's just as cheap to pump water as it is to heat water," says Jenniges.

PASTURE PROJECT

For grazing row crop fields that are planted in cover crops, there is the option of temporary water systems. These can include water troughs mounted in a trailer with water line on a reel (Picture 13), a water trough on a sled that can be pulled from paddock to paddock (Picture 14), and prefabricated waterers that can be easily moved from paddock to paddock (Picture 15). In northern climates, producers have used continuous flow systems with a simple float and tank overflow system to direct water away from the trough in freezing weather. The float is held partially open with a wooden wedge and electrical tape.


Picture 13.
GRASS FED INSIGHTS


Picture 14.
GRASS FED INSIGHTS


Picture 15.
GRASS FED INSIGHTS

There are excellent resources available that describe how to design water systems for various operations. In addition, the USDA NRCS EQIP program has cost-share available for installing water systems for livestock. Perks of that program include NRCS assistance in designing appropriate water systems for your specific farm.

**Several resources that provide guidance in designing and developing water systems for your farm are presented below:**

How to Build a Mobile Cattle Water System from Grass Fed Solutions

Livestock Watering Systems from Iowa State University Extension

Solar-Powered Livestock Watering Systems from University of Tennessee Extension

Waterers and Watering Systems for Livestock from Kansas State University Extension

Designing the Watering System for Your Grazing Method from Progressive Cattle Magazine

Watering Systems for Livestock from University of Maine Extension

Water for Beef Cattle from University of Arkansas Extension


BRUCE CARNEY

TED KRAUSKOPF

## COVER CROP TERMINATION

When you use cover crops, you will have to terminate that crop before planting the next cash crop. Method and timing of termination are crucial to the success of the subsequent crop. There are several options depending on the specific mix you plant. These include:

- **Herbicide burn down**
  Although this is common, herbicides are generally detrimental to soil biology. This is especially true of glyphosate, which is increasingly coming under scrutiny for potentially creating several adverse environmental impacts. These include the fact that glyphosate is a water-soluble herbicide that can concentrate in our streams and rivers and create issues downstream. Glyphosate is patented as an antibiotic (one of many patents) and can harm soil bacteria. Research results have also indicated that glyphosate can harm the mycorrhizal fungi in our soils.

- **Winter kill**
  Planting cover crops that winter kill is highly effective in many northern areas, especially if a cash crop is going to be seeded early the following spring.

- **Livestock grazing/animal impact**
  The cover crops mix planted and timing of the grazing are critical. For the cover crop to be terminated, it has to be at the correct stage of its life cycle. Usually this means it has finished pollinating. High stock densities are required to trample the cover crop. While high stock density grazing can significantly reduce opportunity for the cover crop to interfere with the subsequent cash crop, it will not create or cause complete termination of the cover. Therefore, cover

### TIMING IS EVERYTHING WHEN TERMINATING COVERS

Wade Dooley, an integrated crop and livestock producer near Albion, IA, knows how important timing is for ensuring proper termination of cover crops. "Some years we'll graze it to the ground, and then come in and do tillage immediately. When the plant is most stressed out, we tear it up. As long as we don't get a rain right after, that'll be the end of it."

But, he says, you need to time things in a different way if you are using herbicide burn down: "If we were going to terminate with herbicide, we'd graze it off, and then we'd let everything grow back so that there's plenty of leaf area, because without the leaves, they're not going to take up the herbicide."

crop mix design and adequate graze down of the cover are crucial to successful cash crop planting behind a grazed down cover crop. This takes a combination of science and art and is best developed by initially using smaller areas to learn how to effectively reduce pressure on a cash crop through grazing termination of a cover crop.

- **Using a Roller-Crimper**
  The chevron-type blades of cover crop rollers crimp and kill the stems if they are in the correct stage. Plants must be at least pollinating to be terminated by this process. Some species, such as rye, peas, hairy vetch and other annual legumes, are more conducive to this procedure. Depending on when you establish cover crops, and where you are located, you may or may not be able to effectively combine roller-crimper termination with prior grazing of a cover crop. If the timing of grazing and cover crop recovery is not adequate to allow full recovery of the cover crop to pollination stage, then grazing will interfere with successful termination through use of a roller-crimper. It will be more difficult to combine roller-crimper termination with prior grazing in the more northern climates, whereas the longer growing season in the southern climates make this more feasible. However, be aware that proper grazing height and recovery periods are key to combining grazing impact with successfully rolling down cover crops.

- **Using Spring Tillage**
  Tillage is another effective method for cover crop termination. However, as with the use of herbicides as a burn down, there are several potential negative impacts with tillage that must be considered. These include damage to the soil microbial population, especially mycorrhizal fungi. When mycorrhizal fungi are damaged or destroyed through tillage, then the soil quickly loses its aggregate and is susceptible to erosion, lowered water infiltration, nutrient leaching, and topsoil loss. Tillage also creates loss of soil carbon and organic matter, increases soil compaction, can stimulate weeds in the latent seed bank to germinate and proliferate, increases the need for synthetic and/or organic fertilizers, and contributes to anaerobic soil conditions. Tillage also increases cost of production since additional passes must be made in each field and the cost of labor, fuel, maintenance and repair must be accounted for.

The question is often asked, what is the lesser of two evils: herbicide termination (chemical burndown) of cover crops or tillage termination of cover crops? The truth is both have their advantages and their significant disadvantages. It is unlikely that we will be able to effectively eliminate one or both of these options, but we can develop management practices that allow us to effectively **reduce** their usage and subsequent impact. These options include greater use of complex and diverse cover crop mixes between cash crops, use of livestock grazing impact (through proper application of adaptive grazing principles) when appropriate and feasible, longer rest periods between cash crops, and greater diversity of cash crop rotations. There are a growing number of farmers who are rotating year-long or two-year-long annual cover crops in between cash crops. They are monetizing the cover crops through intensive livestock grazing while out of cash crop rotation. Longer rest periods with complex cover crop and livestock impact increase fertility needed for the next cash crop, thus lowering required input costs, allowing for greater soil biological functioning, increasing soil aggregate and water infiltration rates, and creating greater diversity of cash flow generation.

**Several resources that provide guidance in designing and developing water systems for your farm are presented below:**

How to Build a Mobile Cattle Water System from Grass Fed Solutions

Livestock Watering Systems from Iowa State University Extension

Solar-Powered Livestock Watering Systems from University of Tennessee Extension

Waterers and Watering Systems for Livestock from Kansas State University Extension

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Watering Systems for Livestock from University of Maine Extension

Water for Beef Cattle from University of Arkansas Extension

KENT SOLBERG

# SUMMARY AND CONCLUSION

To be truly successful with cover crops and livestock integration, one must understand the principle of compounding & cascading effects. Everything you do creates compounding and cascading effects, not singular or linear effects. To expect singular effects will lead to frustration and erroneous conclusions. Successful cover cropping and grazing involves building all aspects of soil health (soil aggregation, water infiltration, microbial population and array, SOM, and carbon, among others) plant species diversity & complexity (can never be highly successful with monocultures or near monocultures), water quality and abundance, and improved mineral cycles. This requires the pulsing of plant species and livestock across the landscape. Mimicking nature in our operations allows us to more successfully capture the myriad benefits of a highly productive ecosystem.

So, to experience success with cover crops and livestock, simply get started. Take advantage of all resource materials available, attend workshops and conferences, visit other farmers who are implementing these practices and ask questions. Then, start small and have comparison strips. Don't "bet" the farm all in one year. Make sure you understand the basic principles of soil health and adaptive management.

Many cover crop and adaptive grazing resources are now available for perusal. This How-To Guide provides a number of pertinent links and references. So, get started and enjoy experimenting with grazing cover crops!

Pasture Project
AN INITIATIVE OF THE WALLACE CENTER

Wallace Center
AT WINROCK INTERNATIONAL