The second edition of the agronomist handbook is updated with the most current resources intended for you and your customers to gain awareness of products and services that can reduce phosphorus, agrichemical and soil movement from fields. Resources in this handbook were developed by the IPM Institute of North America, the National Center for Water Quality Research and the Natural Resource Conservation Service, with financial support from the Great Lakes Protection Fund and the National Fish and Wildlife Foundation.

Within this handbook you will find reference and marketing factsheets for products and services, the updated P-Loss Reduction Wallet Card and order form. We have also included updated results from an annual survey of ag retailers in the Sandusky River Watershed, which tracks adoption of products and services that reduce phosphorus losses over time.

The Key Facts for Farmers are intended for you to share with your customers and include a fillable footer area for your contact information. These marketing sheets contain information on variable rate technology, strip tillage and cover crops, which are opportunities for you to increase sales and revenue, and reduce P losses and improve water quality. Providing these products and services will help you build your one-stop-shop to retain customers and get the most out of your current equipment and technology. Identifying P-Loss Hotspots is designed to help you and your customers identify and correct issues that can cause P losses, and also lead to expensive equipment repairs and downtime.

We hope these tools are useful to you in your efforts to keep P on farmland where it is needed. If you have any questions about this handbook or would like copies of resources found within, please visit the website: www.partnershipfarm.org or contact julia@partnershipfarm.org. 

Cover Photos: NRCS and MERIS/NASA
Dissolved Phosphorus from Cropland Runoff: Why is it a Big Problem?
By: David Baker, Director Emeritus, National Center for Water Quality Research
Revised November, 2017 to reflect recent year algal bloom severity

In the 1970’s, Lake Erie was in big trouble, frequently making national news for pollution from industrial waste, sewage and agricultural runoff. Since then, improvements in farming practices and industrial and municipal wastewater treatment have contributed to cleaner water, better fishing, less algae and fewer beach closings.

Farmers voluntarily reduced tillage, cutting soil losses from Sandusky farmland into streams, rivers and Lake Erie by nearly half since 1975. Reducing tillage also has other benefits including cutting fuel costs, retaining soil moisture and reducing nutrient losses, especially “particulate” phosphorus which is attached to soil particles.

A new challenge
Since the mid-nineties, algal population explosions, or “blooms” in Sandusky Bay Lake Erie have been on the rise, and fish catches have declined. Over the same time period, water monitoring by scientists at the National Center for Water Quality Research at Heidelberg University has shown an increase in phosphorus, providing a food source for algae. The greatest increase has been in “dissolved” phosphorus, which is not attached to soil and is readily available as algae food.

What happened? Evidence points to losses of commercial fertilizer from cropland. Fertilizer applied to the soil surface is vulnerable to wash off. Often fertilizer is applied in the fall when time and equipment are available, increasing the number of months the surface-applied fertilizer is vulnerable to losses.

In the Sandusky, water monitoring has shown that the highest levels of phosphorus are detected during snow melt and rainstorm events, and in areas with high concentrations of cropland acres. Livestock, industrial, municipal and residential sources do not appear to be important factors in the watershed at this time.

Sandusky ag retailers and farmers take action
What changes in practice are expected to reduce phosphorus losses? Planting cover crops in the fall, applying fertilizer in spring versus fall, precision soil sampling and fertilizer application, using liquid fertilizer formulations and “banding” fertilizer applications are among the practices being implemented. No till helps reduce erosion, and therefore total phosphorus losses, and increases water infiltration, soil organic matter and the microorganisms in the soil that help recycle nutrients. Proper nutrient management includes applying the right amount of fertilizer in a way that it will create contact with the soil and a chance to bond to the minerals in the soil. Cover crops increase infiltration, reduce erosion, recycle nutrients and radically increase the amount and diversity of microorganisms in the soil. All of these practices are tools we have readily available to improve the health of the soil. If we improve the health of our soil, we will improve the health of our streams and lakes as well.

The Fertilizer Institute is supporting the effort with information from its 4R Nutrient Stewardship Program, promoting “right fertilizer source at the right rate, at the right time and the right place.” These four principals are key to maximizing economic returns as well as preventing unintended consequences from fertilizer use.
Recent Lake Erie Harmful Algal Bloom Severity

The graph to the left shows NOAA annual data on the algal bloom severity index since 2002, and includes a prediction for the 2017 season. The severity index is based on the bloom’s biomass of harmful cyanobacteria over a sustained period. The high phosphorus loadings that cause the blooms declined sharply in the mid ‘80s with the advent of reduced tillage, but since the mid 90’s, the blooms have increased in frequency and intensity, regularly surpassing the significant threshold. The practice of reduced tillage decreased the particulate phosphorus causing the blooms in the 80’s, but recent studies have attributed the dissolved phosphorus as the main culprit now. Loads of dissolved reactive phosphorus in the Maumee River are closely tied to the size of the harmful algal blooms. The graph below illustrates this relationship, showing higher total bioavailable phosphorus loads occurring before the record breaking blooms in 2011 and 2015.

The timing of the phosphorus loads - during snow melt and rain events in winter and early spring, following fall fertilizer applications - indicates that phosphorus is coming primarily from cropland. This trend would not be observed from point sources such as septic systems, which would emit a steady stream of phosphorus loading throughout the year.

Both 2011 and 2015 had harmful algal bloom severity index values of 10 and 10.5, respectively. The 2017 algal bloom is expected to have a mean severity index of 7.5, which would make it the fourth largest bloom to date. These severity index values are not necessarily an indication of bloom toxicity; for example, the 2014 bloom did not exceed the severity index values for 2011 or 2015, however, the higher level of toxicity caused Toledo, OH to shut down its drinking water supply.
Our 2017 ag retailer products and services survey results show continued increases in sales of major products and services which can reduce P losses. Of all acres serviced by responding retailers, weather consideration before applying fertilizer and rotational sampling (acres reported sampled at least every four years) increased the most from 2016 to 2017, with increases of 8.8% and 5.7%, respectively.

Many Sandusky ag retailers also offer specialized application methods as reported below. Foliar P feeding and subsurface preplant P were the most common, with 28.7% and 9.1% usage across all reported acres, respectively.
These charts show that ag retailers have tremendous potential to help reduce P losses from cropland and improve water quality in the Western Lake Erie Basin. They include adoption rates from 2011-2016 survey results in the Sandusky River Watershed projected over all Western Basin cropland acres into the year 2022. Red asterisks indicate International Joint Commission 2022 targets for the WLEB, showing that by increasing acres of these products and services, we can make a huge difference. PARM’s 2017 products and services survey indicated that the Sandusky River Watershed has higher adoption rates than state averages in Ohio, so if the entire Western Lake Erie Basin employed similar adoption rates, projected phosphorus loads would be closer to the International Joint Commission Targets. We estimated total P and DRP load reductions using a P Loss Reduction Calculator developed by IPM Institute and Heidelberg University. The effectiveness of each product and service towards reducing P losses is an estimate and will continue to be revised as new information becomes available.
Farmer Benefit Fact Sheets

These factsheets are designed for you to provide to your customers to help them understand the benefits of products and services that reduce P losses. See also the fillable versions of these forms in this PDF package, designed for you to enter your own contact information in the footer. Additional forms may be downloaded at http://partnershipfarm.org/agronomist-handbook/
What are “hot spots” for resource loss?
Areas that can have much higher rate of fertilizer and soil loss include:

- Drainage tile breaks
- Streambank sloughing and erosion
- Concentrated water flows
- Path to streams, rivers, lakes
- High phosphorus (P) soil test levels

Special attention to these areas can preserve your investment in fertilizer and the long-term value of your land. Addressing these areas may prevent costly damage to machinery and costlier repairs in the future.

What should I look for on my farm?

- Applying P on ground with soil tests above 40 ppm or 80 lbs./acre has low potential for improving yield, use your fertilizer dollars elsewhere.
- Gullies and other concentrated water flow and/or closeness to water increases the likelihood you will lose soil and nutrients. Slowing down water flows with filter strips and grassed waterways allow sediment and nutrients to settle out and stay on your fields where they benefit you.
- Tile breaks provide direct connection to ditches, streams, rivers and lakes for soil, nutrients and other agrichemicals that you want to keep for your crops. Fix tile breaks as soon as possible to preserve your investment and clean water.
- Soils with low infiltration rates will have a higher probability of runoff. Cover crops and high residue crops can protect soil from runoff.

What can I do?

- Repair tile blowouts
- Repair and maintain streambanks
- Install grassed waterways on eroded slopes
- Draw down high P-test levels
- Install Water and Sediment Control Basins
- Install buffer strips & filter strips

Additional Resources:

Resource management practice collection
http://mda.state.mn.us/environment-sustainability/additional-clean-water-resources

Tile Drain Installation and Repair
http://www.in.gov/dnr/water/files/Sec5-2.pdf

Best Management Practices to Minimize Agricultural Phosphorus Impacts on Water Quality

Check with your county NRCS office and Soil and Water Conservation District for financial assistance programs.
Foliar feeding of field crops has been around for years but may be under-utilized and may be worth offering this service to growers as an option.

In most cases, foliar feeding should only be done if soil tests are at maintenance levels or below, and nutrition is limiting the crop’s full potential. Conditions such as high or low pH, temperature stress, high or low soil moisture, insects, nutrient imbalance, etc., can create the case for the use of foliar feeding by limiting the uptake of nutrients by roots.

Planning should be completed well ahead of planting, beginning with soil sampling. Estimate crop needs as usual, and take any foliar applications into account to meet those needs.

Nutrient deficiency symptoms. Foliar feeding can provide rapid plant uptake and response to the nutrient application, and help resolve deficiencies.

In general, the efficiency of nutrient uptake is considered to be 8-9 fold higher when nutrients are applied to the leaves compared to soil application. Foliar applications of deficient nutrients can provide a quick, but often temporary fix.

Meeting growth stage needs. Plants require different amounts of nutrients during specific growth stages. Managing the nutrient balance in soil to meet stage-specific needs can be a challenge. Foliar applications of needed nutrients, including micronutrients if they are limiting, during key stages can improve plant health and yields.

Recommendations should be based on visual assessment of crop conditions, and/or soil or tissue testing, and considering current and near-term needs. For example, in soybeans an application of 3-18-18 between the V3 and V5 stages might be applied with an herbicide and micronutrients all in one pass.

Nutrients may be foliar-applied once or multiple times up to the time of tassel. Some research suggests that macronutrients, such as P and K, cannot get into the plant in sufficient volume in a single foliar application. Multiple applications may be needed. Micronutrients on the other hand are needed in much smaller quantities and have better potential to be absorbed in one application.

Dry or liquid? Effective foliar feeding with a liquid sprayer requires adequate coverage of plant surfaces, and can provide for immediate uptake. Broadcasting dry fertilizer is faster and easier but can take much longer for a response, and adequate soil moisture is needed for uptake through plant roots, especially for micronutrients.

Where can I go for more information?

Penn State Extension
http://extension.psu.edu/plants
SMART Fertilizer Management
http://www.smart-fertilizer.com/articles/foliar-feeding
NovusAg
Soil basics
Soil is made up of many simple components including air, water, decaying plants, organic matter from living or dead organisms and minerals like sand, silt or clay. When soils are healthy, air and water can move freely through the soil profile creating an environment that supports plant growth.

Why is soil health so important?
• Increased production. Healthy soils with higher organic matter and live organisms create a soil structure that is most conducive to plant growth. Increased structure, aeration, moisture retention and excess water drainage all contribute to plant growth.
• Increased profits. Healthy soils typically require fewer equipment passes, resulting in less time and fuel costs, and reduced compaction. No-till, minimum till or strip till are often good choices to help maintain good soil health.
• Natural resource protection. A healthy soil has significantly more moisture-holding capacity. This means less soil and fertilizer is lost during heavy rain, and more moisture is available to your crops during drought.

Where do I start?
• Keep it covered. Keep a live plant growing year around to feed the soil by adding cover crops after your cash crop comes off.
• Do not disturb. No till, strip tillage or mulching are good choices.

Did you know? From USDA NRCS
• Each one percent of organic matter in the top 6” of soil can hold approximately 27,000 gallons of water, or 18-20 times its weight in water.
• Organic matter builds as tillage declines.
• Cover crops and reduced tillage lead to increased organic matter.

Check with your county NRCS office and Soil and Water Conservation District for financial assistance programs.

Additional Resources
NRCS Soil Health Fact Sheets
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/health/?cid=stelprdb1049236
Ray Archuleta’s Soil Health Page
http://vimeo.com/channels/raythesoilguy
Partnership for Ag Resource Management Cover Crop Fact Sheet
Strip Till Fact Sheet
Why the desire for more accuracy?
The days of zig-zagging across an 80-acre field for a soil sample are far in the rear view mirror. Smaller sample areas for more precise fertilizer application has become the norm to improve yields and reduce the potential for off-site environmental impacts.

Benefits
- Increased productivity by identifying soil nutrients or soil chemical factors that limit plant growth within a field.
- Increased fertilizer use efficiency by applying the most appropriate rates for the variable soils and yield potentials across a field.
- Protects the environment by reducing potential for over fertilization and excessive losses through runoff or leaching.
- Identifies underperforming sites including polluted, contaminated soils.

Taking a representative sample
- Identify within-field yield variability from historical yield maps if available.
- Consider field topography, yield variability and soil types, sampling in contrasting zones separately.
- No sample should represent more than 25 acres.
- Cores should be taken to a depth of eight inches.
- Use a zig-zag pattern when pulling samples to keep those points at a uniform distance from each other.

Precision Soil Sampling: Zone or Grid?
Each approach can be effective, allowing application equipment to vary nutrient delivery rates as it passes through the field.

Zone management uses multiple pieces of data to determine sampling locations. These may include: yield history by area, soil types, grower experience as well as many other layers. These are all considered when dividing fields into sampling zones. Each zone should be no larger than 25 acres. Take a minimum of 10 to 15 cores within each zone.

Systematic grid sampling is just as it sounds. A uniform grid is laid over the field using geographic information software (GIS), dividing the field into 2.5-acre quadrants. Sampling equipment is driven through the field to each quadrant and cores are typically pulled from four separate areas, each approximately 8 to 10 feet in diameter. Two samples are taken from each area, for a total of eight from each 2.5-acre quadrant. This is repeated across the entire field and can be time prohibitive for some. Flat fields with very little variance in topography or soil types may be best suited for systematic grid sampling, and where variability is expected due to fertilizer or manure application practices in the past.

Where can I go for more information? OSU Extension
http://agcrops.osu.edu/sites/agcropsations
University of Nebraska - Lincoln
http://cropwatch.unl.edu/ssm/soilsampling Purdue University
https://www.extension.purdue.edu/extmedia/AY/AY-281.html
A & L Laboratories
http://algreatlakes.com/pages/faqs
What is Variable Rate Technology?
Variable Rate Technology (VRT) lets you apply inputs in varying amounts across your fields so they can be used more efficiently. Precision samples make for better decisions on where to place nutrients in the field to maximize yields.

What can VRT soil sampling and applications do for my yields, soil health and water quality?
• Soil samples are the foundation of effective nutrient management planning.
• Precise soil samples allow precision applications.
• Apply fertilizer where needed, reduce where not. VRT places more of the fertilizer on more productive soils where the additional fertilizer will be used by the crop.
• Application prescription can shut off sections to follow setbacks in the field.
• Reduce overlap and duplicate application of chemicals and fertilizer.
• GPS Autosteer can run on controlled traffic lanes, reducing compaction throughout the field.
• More efficient use of chemicals and fertilizer, less waste.
• Improve your labor efficiency and effectiveness. Automation leads to improved productivity and reduced fatigue for operators.

What issues should I be aware of?
• Technology is continuously getting more accurate and efficient. New equipment can become outdated quickly. Capital investment for equipment can be prohibitive. Consider leasing or custom VRT sampling and application rather than purchase options.

Calibrate per manufacturer recommendations to ensure accurate, efficient operation.
Many ag retailers currently offer variable rate programs. Custom work allows farmers to spend more time in tractors or combines as needed.

Additional Resources:
Precision Farming Tools: Variable-Rate Application
http://pubs.ext.vt.edu/442/442-505/442-505_PDF.pdf

Soil Sampling for Variable Rate Fertilizer and Lime Application
http://www.agronext.iastate.edu/soilfertility/info/NCMR348.pdf

Precision Agriculture Series: Timely Information
https://sites.aces.edu/group/crops/precisionag/Publications/Timely%20Information/Overview%20of%20Variable-Rate%20Technology.pdf

Check with your county NRCS office and Soil and Water Conservation District for financial assistance programs.
How does strip tillage benefit me?

- Leaves macropores undisturbed between strips, improving infiltration, oxygen levels and yields.
- Reduces tillage time and allows for earlier planting.
- Retains carbon and organic matter, conserves soil moisture and improves aggregation, infiltration and bulk density, all indicators of a healthy, productive soil.
- Reduces soil erosion and loss of nutrients and agrochemicals.
- Incorporates nutrients directly in the row, protecting nutrients until they are used by the crop.
- Combined with variable rate application, puts fertilizer where it is needed and most efficiently used by the crop.
- Keeps soil and nutrients on the field and out of our waterways, keeping our water clean, clear and free of harmful algal blooms.
- Demonstrates commitment to the environment.

What can you expect from strip tillage?

- Tilled strips warm up and dry out sooner. Soils can be planted before no-till fields are ready.
- Relieves compacted soils in the planting row, improving plant health and yield.
- Efficiently cover 120+ acres a day depending on size of equipment.

What issues should you consider?

- Fall strip tillage is preferred but can be done in the spring.
- Makes additional use of high horsepower equipment.
- Can be run at up to 8 mph with 15-30 horsepower per row unit depending on implement configuration.
- Larger toolbars (up to 60’) are now available with three variable rate dry fertilizer tanks. Liquid and dry fertilizer options are also available.
- May be eligible for EQIP No-till/Strip-till payment.

Additional Resources

- Why Strip Till?
  - http://cropwatch.unl.edu/tillage/stripman
- Fall Strip Tillage Systems: An Introduction
  - https://ohioline.osu.edu/factsheet/aex-507
- Consider the Strip-Tillage Alternative
  - http://www.extension.iastate.edu/publications/pm1901c.pdf
- Strip-Till Considerations in Oklahoma

Check with your county NRCS office and Soil and Water Conservation District for financial assistance program.
Why should I plant cover crops?
Cover crops can increase yields and profits by:

• Keeping nutrients and soil on cropland by reducing water runoff and wind erosion.
• Returning nutrients to the soil as the cover crop decomposes.
• Preserving moisture by capturing and holding snow, reducing rain and snowmelt runoff, and improving water infiltration into the soil.
• Adding organic matter and increasing moisture-holding capacity.
• Improving soil biological activity and natural nutrient cycling.
• Increasing rooting depth by breaking up compaction.
• Preventing weeds and disrupting disease cycles.
• Earlier drying in spring, get on fields early.
• Providing opportunity to harvest forage crops.

What issues do I need to consider?
Manage cover crops to maximize benefits:

• Select appropriate varieties. Small grains and legumes have a long, successful track record.
• Legumes can add nitrogen before a corn crop. Clover reliably increases nitrogen and yields.
• Grasses and grains perform well before soybeans.
• Plant as soon as possible after harvest, or prior to harvest, to get an early start on growth. In soybeans, plant after sufficient senescence for good light penetration, but not so late that leaf drop will prevent good seed-to-soil contact.
• Terminate cover crops that don’t winter kill before they compete with the crop. Experiment on a small scale with new varieties and techniques. Use test plots and check strips. Keep good records.
• Scout to assess stand and identify occasional problems, such as increases in slug populations.
• Be sure to monitor and comply with pre-harvest intervals for pesticide applications if the cover crop will be harvested for forage.
• Check crop insurance requirements. You may need permission before harvesting an alfalfa cover crop prior to planting a cash crop.
• Spread risk by using a variety of cover crop strategies each year rather than relying on a single strategy.
Economic Returns
2017 National Cover Crop Survey participants reported average yield increases of 2.3 bushels per acre for corn, 2.1 bushels per acre for soybean and 1.9 bushels per acre for wheat after using cover crops.

Changing weather patterns
Over the last several years we have seen spring and early summer rainfall events increase in frequency and intensity. Scientists project the tendency for intense rain events to continue in the future. The timing of precipitation makes bare fields targets for loss of the decades of soil health improvements that growers have invested in. Cover crops and field residue have the potential to minimize these losses and protect years of beneficial advancement.

Where can I go for more information?
Midwest Cover Crops Council
http://www.mccc.msu.edu
Midwest Cover Crops Field Guide
https://ag.purdue.edu/agry/dtc/Pages/CCFG.aspx
Cover Crop Fundamentals – OSU Extension
https://ohioline.osu.edu/factsheet/agf-142
Cornell University Cover Crop Decision Tool
http://covercrops.cals.cornell.edu/index.php

2017 National Cover Crop Survey
https://www.northcentralsare.org/Educational-Resources/From-the-Field/2017-Cover-Crop-Survey-Analysis
This quick start guide provides the most up to date resources for growers interested in planting cover crops. It compiles guidance on the initial cover crop selection, available financial tools and assistance programs and the best management practices to follow after planting. For other cover crop related resources, please see PARM’s most recent webinars at http://partnershipfarm.org/webinars/.
Pick the Right Cover Crops
There are no universal cover crop solutions, but there are geographically-sensitive tools to help. Select the tool that supports your region.

Midwest Cover Crop Council’s Cover Crop Decision Tools
http://mccc.msu.edu/covercroptool/covercroptool.php
✓ Supports: Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, Ontario, Wisconsin

Cornell’s Cover Crop Decision Tool
covercrops.cals.cornell.edu/decision-tool.php
✓ Supports: New York and adjacent states

Innovations in Cover Crops Decision Tool
decision-tool.incovercrops.ca/
✓ Supports: Ontario, New Brunswick, Nova Scotia, Prince Edward Island, Québec

Read About Selected Cover Crops
Use these resources to learn more about each variety.

USDA Agricultural Research Service's Cover Crop Chart
ars.usda.gov/Services/docs.htm?docid=20323
Designed after the periodic table, this interactive PDF provides quick information on 58 crop species that may be planted individually or in cocktail mixtures. Great for comparing varieties and their different uses. Primary sources of information included the Midwest Cover Crops Council, USDA-SARE, USDA-NRCS PLANTS database, and relevant peer-reviewed journal articles.

Sustainable Ag Research & Education Program’s (SAREP) Cover Crop Variety Reference
http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/cover-crops
SAREP created a browsable online reference based on peer-reviewed articles for cover crop varieties
Financial Tools for Cover Crops

Do cover crops pay off? Use one of the tools and programs below to see what the financials look like.

Natural Resource Conservation Service (NRCS) Cover Crops Economics Tool

nrsc.usda.gov/wps/portal/nrcs/detailfull/il/soils/health

Two economists at NRCS built an incredibly thorough and research-based Microsoft Excel tool to help with cost-benefit modeling for cover crops. Use this if you are interested to see how cover crops pay off in the short-term and long-term. Find it and a video demo on how to use it on the website.

Iowa Learning Farms Cover Crop Cost Calculator

extension.iastate.edu/ilf/content/cover-crop-resources

Iowa State Iowa Learning Farms created a tool to help calculate and compare the cost of drilling vs. aerial seeding cover crops. This downloadable Excel file calculates the total cost of implementing cover crops, including cost of seeds, application and chemical termination.

Financial Assistance Programs

Contact Your Local NRCS Office

offices.sc.egov.usda.gov/locator/app?agency=nrcs

Use the link above to find contact information for your local NRCS office. Contact them to see what financial assistance options are available in your area. You can also read about these NRCS conservation programs:

- **Conservation Stewardship Program (CSP)** helps landowners and farmers maintain and improve existing conservation systems, and adopt additional resource management practices. Participants earn payments for conservation performance - the higher the performance, the higher the payment.

- **Environmental Quality Incentives Program (EQIP)** is a voluntary program that provides financial and technical assistance to farmers through contracts up to ten years in length. Support is available for nutrient management, grassed waterways, buffer and filter strips, streambank restoration and more.
Best Management Practices (BMPs)
Check out these great resources on best management practices for different topics within cover crops.

Managing Cover Crops Profitably
sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition
Sustainable Agriculture Research and Education’s excellent book, available for free download, “explores how and why cover crops work, and provides all the information needed to build cover crops into any farming operation. Along with detailed management information on the most commonly used species—including grasses, grains, brassicas and mustards, and legumes—Managing Cover Crops Profitably offers chapters on the role of cover crops in broader topics such as crop rotations, pests and conservation tillage.”

NRCS Cover Crop Termination Guidelines
nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263099.pdf
Guide to terminating cover crops based on geographic region in the U.S.

Using Winter Cover Crops to Improve Soil and Water Quality
ars.usda.gov/SP2UserFiles/Place/60100500/csr/ResearchPubs/reeves/reeves_01b.pdf
Dabney, Delgado and Reeves (2001) provide an immense, in-depth literature review, research and special considerations on BMPs for cover crops.

Managing Spring Cover Crops for Feed
ocj.com/2015/04/managing-spring-cover-crops-for-feed/
Guide to using cover crops for feed. Double check crop insurance restrictions for your state before using cover crops for feed.
What is a Nutrient Management Conservation Activity Plan (CAP 104)?
A CAP 104 is an opportunity for farmers to work with their crop advisors to develop a written plan to improve yields and reduce costs by keeping nutrient and soil on the farm, and out of our waterways.

CAP 104 is part of the Environmental Quality Incentive Program (EQIP) through the Natural Resource Conservation Service (NRCS). NRCS provides financial assistance to complete the plan.

Once the plan is completed, producers can apply for additional financial assistance to implement improvements on the farm.

What is included in the Plan?
The plan shows how and where nutrients will be managed using the 4R’s (Right Source, Right Rate, Right Time, Right Place) to keep nutrients for the crop. The plan will include:
• Soil tests results.
• Soil maps.
• Fertilizer recommendations: rates and timing
• Other practices to reduce nutrient losses and protect natural resources.

Why should I get a CAP 104?
The Plan is an excellent tool to assess current practices and plan improvements.
• Improve yields by putting nutrients where they are needed, reduce nutrients where they will not generate a return.
• Best management practices to reduce off-site movement of nutrients, keeping your fertilizer investment on the farm.
• Improve the value of your farmland by reducing soil losses.
• Position yourself for future NRCS financial assistance to implement practices like stream bank stabilization, grass waterways.
• Demonstrate to landowners your value in improving their land.
• Get ahead of potential regulation.
• Contribute to cleaner rivers and lakes.

How much does a CAP 104 cost?
Financial assistance from NRCS can help reduce if not cover the entire cost of the Plan. Payment rates are based on acres.

<table>
<thead>
<tr>
<th>Acres</th>
<th>2016 Payment Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 100 acres</td>
<td>$1,706</td>
</tr>
<tr>
<td>101-300 acres</td>
<td>$2,275</td>
</tr>
<tr>
<td>&gt;300 acres</td>
<td>$2,844</td>
</tr>
</tbody>
</table>

*Historically underserved producers may qualify for additional financial assistance.
Nitrogen (N) is an essential nutrient for plant health. N losses from cropland can reduce yields and contaminate ground and surface water, and make well water unsafe to drink.

How is Nitrogen Lost?
N is lost from through three principal pathways: denitrification, leaching and volatilization.

- **Denitrification** occurs when N in the form of nitrate is converted back to a gaseous form. N diffuses out of the soil and is lost into the atmosphere. Denitrification occurs in soils that are poorly drained or waterlogged.
- **Leaching** happens when negatively charged nitrates are moved below the plant’s root zone by percolating water. Leaching occurs most commonly in sandy soils.
- **Volatileization** occurs when the soil’s urease enzymes break urea molecules into ammonia gas. Up to 40% of surface-applied urea-based N not incorporated into the soil via rainfall, irrigation or deep mechanical incorporation can be lost through volatilization. This type of loss can occur with every soil type.

Understanding and Managing Nitrogen Losses

Preventing N Loss
Options depend upon the form(s) of nitrogen being applied, when it is applied and the environment in which it is applied.

Choose an N source and application timing that will minimize losses for your site. For example, when applying ammonium in the fall, make sure to wait until soil temperatures fall below 50°F so that nitrification does not occur.

Cost of N, labor, equipment and power availability are other considerations when choosing a fertilizer source and application timing.

Using a nitrification inhibitor can reduce N loss by holding N in the immobile ammonium form. There are many nitrification-inhibiting products available that can be used with fall and spring applications to delay nitrification closer to crop need.

Spring-applied, urea-containing fertilizers can reduce volatilization if incorporated into the soil. Urea will convert to nitrate much faster than ammonium fertilizer. Split applications of N can also reduce losses and boost yield.

N Recommendation Tools
http://www.adapt-n.com/
N-Rate Calculator
http://cnrc.agron.iastate.edu/

Where can I go for more information?
Agricultural Retailers Association
http://www.aradc.org/home
Iowa State University
https://crops.extension.iastate.edu/nitrogen-loss-how-does-it-happen
International Plant Nutrition Institute
Koch Agronomic Services
http://kochagronomicsservices.com/can/knowledge-center/
Enhanced Efficiency Fertilizer (EEF) refers to products that optimize nutrient uptake and prevent nutrient loss by controlling the speed of release or altering soil-fertilizer interactions.

Improving plant nutrient intake efficiency can improve yields, protect your fertilizer investment, and improve water quality which is important to growers, the public, environmentalists, regulators and legislators.

Types of EEF
Controlled Release Technology such as polymer-coated fertilizers (PCFs) release nutrients by osmosis and diffusion through the coating. Water passes through the outer layer of the polymer and dissolves the nutrients inside. Nutrients then move through the coating in response to a concentration gradient (high concentration inside the coating, low concentration outside the coating). Release rate and longevity are controlled by coating thickness and soil temperature. The release follows a consistent temperature response which allows the PCFs to provide a predictable, controlled release of nutrients over a desired timeframe (typically two to 12 months). Release is minimal when soil is cool and increases as soil temperatures rise, coinciding with plant growth and nutrient need.

Slow Release Technology
- Sulfur-coated urea (SCU) fertilizers are granules of urea coated with sulfur and wax. Imperfections (cracks, fissures, fractures) in the coating allow water to move in and dissolve the coating, which releases the urea. For fertilizer particles with coatings that are intact after application, water movement through the coating results in internal osmotic pressure that cracks the coating, releasing the nutrients.
- Polymer-coated sulfur-coated urea (PCSCU) is an evolution of SCU technology. A polymer layer around the sulfur provides more protection than the wax, resulting in longer and more predictable nutrient release.

Stabilized Nitrogen Technology
- Urease inhibitors work on the soil surface to slow conversion of urea to ammonium through hydrolysis, which retains more N as plant-available ammonium. This reduces the amount of N converted to ammonia gas and lost to the atmosphere through volatilization.
- Nitrification inhibitors work in the soil by slowing microbial conversion of ammonium to nitrate. Ammonium can be held on soil particle exchange sites and remain available for plant use. Nitrification inhibitors can reduce ammonium losses for up to eight weeks under typical conditions.

Where can I go for more information?
Cornell University Extension
http://nmsp.cals.cornell.edu/publications/factsheets/factsheet45.pdf
University of Florida IFAS Extension
http://edis.ifas.ufl.edu/hs1247
Grain News
https://www.grainews.ca/2013/03/20/enhanced-efficiency-fertilizer/
Koch Turf & Ornamental
http://kochturf.com/whyeefs/environmentaladvantages/
Order Form: P Loss Reduction Wallet Card

Want to receive P Loss Reduction Wallet Cards? The IPM Institute will mail them to you for free!

Or order online: http://partnershipfarm.org/p-loss-reduction-wallet-card/

Name/Organization: ___________________________________________________________

Shipping Street Address: _______________________________________________________

Street Address 2: ___________________________________________________________________

City: ____________________ State: ____________ Zip: ______________

Quantity: __________ (multiples of 25, min. 25)

Please provide a phone number and/or email in case we have questions about your order:

Email: __________________________________________________________

Phone: ____________________________

☐ Yes! I would like to receive email updates from Partnership for Ag Resource Management (PARM)

Return order form to: Julia Freuck, Project Coordinator, IPM Institute
email: julia@partnershipfarm.org, fax: 608-232-1440
Questions? Call Julia, or Caitlin Leahy, Project Coordinator: 608-232-1425

Phosphorus (P) loss from any field is possible. Fields with any of the following conditions may be at higher risk.
Your special attention can help prevent P losses.

- Soil test levels are above maintenance.
- Areas with high surface runoff potential:
  - Poorly or imperfectly drained soils.
  - Sloping fields.
  - Fields with less than 30% crop residue cover on soil surface.

4R Nutrient Stewardship for Green Crops and Blue Lakes

Do
- Inject or band phosphorus (P).
- Lightly incorporate (2-3") P applications; ag retailers can notify customer when applications are made.
- Follow recommendations for setbacks.
- Broadcast P for one crop year at a time only.
- Soil test at least every three years.
- Apply at University recommendations.
- Plant cover crops.
- Consider variable rate application.
- Consider reduced tillage: no till, strip till.

Don’t
- Broadcast without light incorporation.
- Broadcast application before heavy rain.

Ag retailers driving stewardship and sustainability

We’re always developing new resources! See http://partnershipfarm.org/ for the latest from the Partnership for Ag Resource Management.

IPM Institute of North America
211 S. Paterson Street, Suite 380
Madison, WI 53703
608-232-1425