Illinois Agriculture

Our Focus on Water Quality

Prepared by:

The Illinois Council on Best Management Practices,

with assistance from

Illinois Association of Drainage Districts

First Publication: April 2013

Updated: February 2014

CONTENTS

Chapter 1: Executive Summary

Illinois agriculture has long promoted the utilization of voluntary best management practices to reduce environmental impact of agricultural practices in the grain and livestock industry. Illinois has a strong history of agronomic research, educational efforts and government and private sector programs aimed at this objective.

Illinois' extensive tile drainage system allows for incredible agricultural productivity, but also presents challenges with regard to water management particularly when focusing on the movement of nutrients with the water.

The livestock industry supports provision in the Livestock Facilities Management Act (LMFA) that govern the application of livestock manure and the industry supports on-going research and the utilization of new technologies to minimize environmental impact of manure management practices.

Given the increasing concern over nutrient losses attributed to the agricultural sector and budget cuts to both federal and state water quality research and outreach programs, in 2010 the Illinois agricultural organizations came together to design and enact a new structure to define, implement and sustain an overall strategy to minimize environmental impact, optimize harvest yield and maximize input utilization. This structure is made up of the following entities:

The Illinois Council on Best Management Practices (CBMP)
The Illinois Nutrient Research & Education Council (NREC)

NREC is a public/private partnership defined in the Illinois Fertilizer Act that assesses a fee on fertilizer sold in Illinois to identify and fund research to minimize the environmental impact of nutrient use and fund research to optimize nutrient utilization. CBMP is a consortium of Illinois agricultural organizations whose mission is to identify and support practices that will improve water quality in the agricultural sector. NREC and CBMP, working in concert with other agricultural organizations and Illinois research universities, have defined the following programs to address the need to minimize nutrient losses:

Keep it for the Crop by 2025, which utilizes these education/on-farm tools to support the 4Rs of nutrient stewardship (right source, right rate, right time, right place):

- N-Watch ®
- On Farm Nitrogen Rate Trials
- Nitrogen Management Systems
- Split Your N Rate and Calculate (MRTN Tool)

Illinois Discovery Farms; there are currently two locations in Illinois where CBMP is combining research with outreach to implement various nutrient management strategies and cover crops to determine the impact on water quality.

Cover Crops: Both CBMP and NREC are engaged in research and educational programs to increase the awareness of the value of cover crops in Illinois.

Lake Springfield Project: This three year program is targeted specifically in this watershed to measure stream quality and work with ag retailers and farmers to adopt nitrogen management systems that will assure that the nitrate levels in Lake Springfield remain consistently and comfortably below the 10 ppm standard.

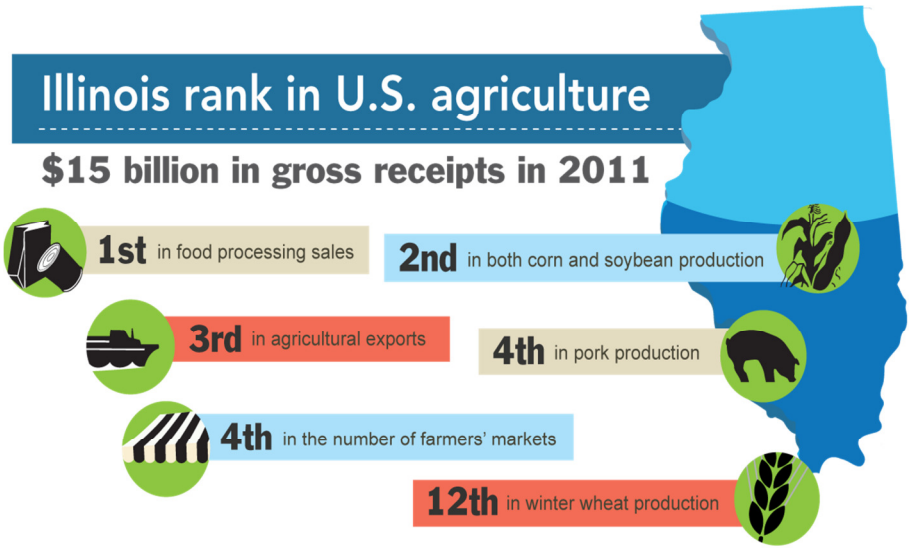
Through these programs and efforts, Illinois agriculture has helped to lay the groundwork for a new era of research and educational efforts to make substantial progress in our efforts to minimize environmental impact, optimize harvest yield and maximize nutrient utilization. These efforts are not dependent upon state or federal funding, but rather on the support of the ag industry to assess and remit a fertilizer tonnage fee to NREC to sustain these programs.

Agriculture is working to develop new accountability methods to measure the adoption of 4R nutrient practices, as well as develop new 4R methods and practices as we learn, utilizing new technology and innovation to help accomplish the mission of MOM:

For more information please visit www.illinoiscbmp.org or contact the Illinois Council on Best Management Practices at 309.827.2774.

CHAPTER 2: Illinois Agriculture: A Diverse and Productive Industry

Illinois agriculture has roots as deep and as diverse as the crops growing in the state's fertile soil. Illinois stands out as a top producer of corn, soybeans and pork. It also features a vibrant specialty crop industry and is a leader in the production of ethanol. Some statistics on where Illinois ranks in the US economy:



More than 74,000 farms cover nearly 26.6 million acres—75% of Illinois' total land area. Our fertile soil, favorable climate and availability of transportation via water, rail and air allow the state to be a world supplier of food, feed and fiber.

Approximately 19 million of the state's 26.7 million acres of farmland are used for growing crops—primarily corn, soybeans and wheat. This abundant supply of grain also makes Illinois a top producer of swine, since pork production is one of the largest consumers of the state's top two crops, corn and soybeans.

In addition to Illinois' top commodities of corn, soybeans and wheat, the state's 1500 different soil types allow for an abundance of specialty crops. Pumpkins, wine grapes, peaches, popcorn and horseradish are also grown in the state's rich soil. In fact, Illinois ranks as the top producer in the world of pumpkins and horseradish.

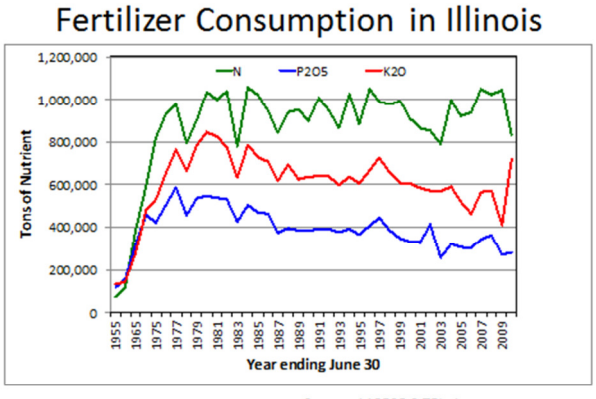
Illinois is a leading state in agriculture-related industries, including soybean processing, meat packing, diary manufacturing, feed milling, vegetable processing, machinery manufacturing and foreign exports. In 2011, the value of exports from Illinois topped $6 billion and included corn, soy, wheat and livestock. The top export markets for Illinois agricultural products are Canada, China, Japan, Mexico and Taiwan.

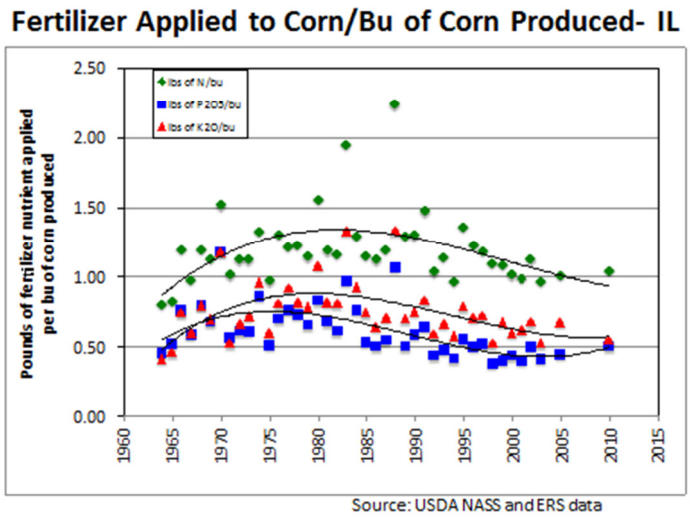
Illinois agriculture provides jobs for many of its citizens:

- approximately 1.5 million Illinois workers are employed in its food and fiber system
- 94% of Illinois farms are family owned by family partnerships, families or individuals.
- The average size of a farm in Illinois is 357 acres.

Illinois farmers are early adopters of technology, finding new and better ways to grow more on the same amount of land (or less):

- Corn yields improved 600% from 1931 – 2011 (24.7 to 147 bushels/acre during that timeframe)
- The amount of crop nutrients used per bushel of grain produced was nearly halved between 1980 and 2010, at the same time grain production has nearly doubled (see diagrams below).
- The utilization of biotechnology has also facilitated a reduction in the use of pesticides, particularly the use of insecticides
- On the livestock side, since 1959 swine producers have almost doubled the amount of pork per animal produced while decreasing their carbon footprint by 35% for each pound of pork produced.





Precision Agriculture

Technology has changed nearly every aspect of agriculture, from soil sampling, planting, fertilizer and pesticide application, monitoring of yields and pinpointing areas where productivity can be improved with better attention to details of seeding, drainage, and crop input management.

Farmers and commercial applicators use GPS to pinpoint field locations, soil sampling sites and harvest data, and they retain the data from each field and each crop year after year, building upon the knowledge to improve production and pinpoint the application of fertilizer and crop protection chemicals both from ground and aerial application.

Mobile technologies are also hitting the field and many ag retailers and crop advisors use smartphones and tablets to transmit information on application needs, logistics, prescription/recommendations, scouting reports and pest identification.

A recent survey highlighted in CropLife Magazine revealed:

- 53% of farmers use variable-rate seeding
- 66% use variable rate fertilizer application
- 81% use autosteer in their operations

Where nutrient applications are concerned, technology has completely changed soil sampling. New "on-the-go" automatic sampling machines pull a soil core every 17 feet, generating 20 cores for every 2.5 acre grid. This allows the industry to cover more acres with higher quality sampling and thus make more accurate and reliable nutrient recommendations. Variable rate irrigation systems are also new to the market and will enable technology to address water management and water conservation.

Chapter 3: The Agricultural Landscape in Illinois – Role of Tile Drainage

Illinois' extensive tile drainage system allows for incredible agricultural productivity, but also presents challenges with regard to water management particularly when focusing on the movement of nutrients with the water. This merits an explanation of this aspect of Illinois agriculture to fully understand the importance of drainage in Illinois and how this system functions.

History of Illinois Drainage

Agriculture drainage is the use of surface ditches and subsurface permeable pipes, or both to remove standing or excess water from poorly drained lands. Drainage of land has been a part of U.S. agriculture since colonial times but was extended broadly throughout the upper Midwest in the late 1800s when European settlers arrived. These settlers turned swampland or prairies into productive farmland. One-fifth of US agricultural land in the upper Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin) is artificially drained.

Farmers have improved farmland drainage by installing subsurface pipes or tiles. Prior to the 1970s, tiles were mostly constructed of clay. Today the material of tile is perforated polyethylene tubing. Since modern mapping technology was not available in 1800s, the amount of tile installed in Illinois is unknown. In fact, it is very common for landowners to discover the original clay tile during the process of improving drainage on his or her land.

In Illinois, 6-10 million acres of land has been tiled.[1] 1,700 Illinois drainage districts handle agriculture runoff with some type of drainage system for over 1.18 million acres of farmland in the state.

Why Do We Need Agriculture Drainage?

Illinois receives an average of 42 to 48 inches of rain annually. A typical rainstorm in Illinois can last 2 to 3 hours. The average soil type in Illinois can soak up ¼ inch of rainfall in one hour. However, Illinois contains some soil types that are slow water permeability or contain dense soil layers and areas of flat topography causing the land to become waterlogged. Therefore artificial drainage is installed to address the inadequacies in the land's natural ability to drain. Excess water can inhibit the growth and yield of row crops. The roots of row crops cannot tolerate excessively wet conditions (in most cases 24 to 48 hours).

Agriculture drainage systems increase crop yields by providing a better growing environment for the plants. The benefits of good drainage for row crops include better soil aeration, improved field conditions for timely fieldwork, higher soil temperatures especially during germination, less surface runoff and improved root development, and better absorption of herbicides. The

[1] P.K. Kalita, R.A.C. Cooke, et. al. Subsurface Drainage and Water Quality: The Illinois Experience. Transactions of the ASABE. Vo. 50(5): 1651-1656.

installation of tile drainage or subsurface drainage can decrease surface runoff, thus reducing sediment losses.

Types of Drainage[2]

Surface drainage is the removal of water that collects on the land surface. A surface drainage system consists of shallow ditches and should include land smoothing or land grading. This type of system is suitable for all slowly permeable soils and for soils with fragipans or clay subsoils.

The rate at which water is removed by surface drainage depends on several interrelated factors, including rainfall, soil properties, and cropping patterns. For most row crops, a surface drainage system should remove excess water within 24 to 48 hours. More rapid removal may be necessary for certain crops.

A surface drainage system consists of an outlet channel, lateral ditches, and field ditches. Water is carried to the outlet channel by lateral ditches, which receive water from field ditches or sometimes from the surface of the field.

Two common types of field ditches are the single ditch and the W ditch (also called the twin or double ditch). The single ditch is used where spoil can be moved and spread in low areas of the field without obstructing flow into the ditch. The double or W ditch is used where the land drains towards the ditch from directions, where the land is very flat and row drainage will enter from each side, and where the excavated material is not needed to fill depressions.

Subsurface drainage is used where the soil is permeable enough to allow economical spacing of the drains and productive enough to justify the investment. A subsurface drain will provide trouble-free service for many years as long as it is carefully planned, properly installed, and constructed of high-quality materials.

A subsurface drainage system consists of a surface or subsurface outlet and subsurface main drains (and laterals (tiles). Water is carried into the outlet by main drains, which receive water from the laterals. Submains are sometimes used off the main drain to collect water. The system will function only as well as its outlet.

[2] Illinois Drainage Guide, Dr. Richard Cooke, University of Illinois, www.wq.illinois.edu

Illinois Drainage Districts

Our ancestors understood that drainage is an essential utility. In 1879, two laws were passed to give landowners a means of securing proper drainage. These laws established the landowners' right to drain and formation of drainage districts based on a system of assessments that permitted the districts to include only lands benefited. This principle remained untouched in 1956 when the Illinois Drainage Code was passed by legislatures. The Illinois Drainage Code still governs the drainage districts today.

Over 2,000 drainage districts were originally formed in Illinois. Today, 1,700 drainage districts and subdistricts remain active. Since the terrain and drainage needs differ throughout the state of Illinois, the drainage structures of the districts can consist of open ditches, tile, levees, or a combination of these structures. Illinois drainage and levee districts provide agriculture drainage for 1.18 million of acres of farmland in the state.

Conservation Drainage Opportunities

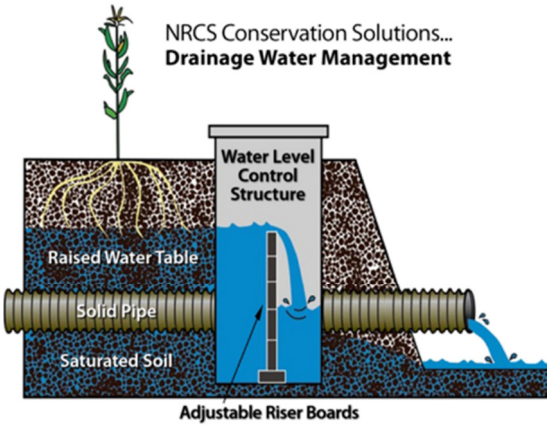
Drainage is a fundamental component of Illinois Agriculture. It is important to optimize the drainage system for crop protection but also protect natural resources. There is no one-size-fit all approach for each landowner in Illinois. Conservation Drainage is about strategic placement to optimize the benefit. It is essential that Conservation Drainage opportunity focus on protecting water quality or reducing soil erosion without decreasing drainage efficiencies, adversely affecting our neighbors, removing prime acreage of farmland out of production, and cost-effective.

Buffer Strips are small areas of land in permanent vegetation. Buffer strips strategically placed can effectively mitigate the movement of sediment and nutrients from farm fields. According to the USDA Natural Resource Conservation Service (NRCS), buffers can remove up to 50 percent of nutrients, remove up to 60 percent of certain pathogens, and remove up to 75 percent of sediment.[3] However, many factors including type of Conservation Buffer and placement can greatly affect the actual percentage reduction rate for each field.

Conservation Buffers have been widely adopted by Drainage Districts and landowners. Buffers offer a win-win scenario for landowners by stabilizing streams, controlling sediment, reducing nutrient load, and easier access to ditches.

[3] http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=nrcs143_023568

Drainage Water Management (DWM) is the process of mechanically managing the timing and amount of water discharged from agricultural drainage system. DWM system works the best with flat topography, fields with slope of 1 percent or less. It is more cost-effective to utilize the system on fields 20 or more acres. Controlling the water table of agriculture drainage system could benefit crop protection by properly controlling the water availability for the plant during key points of the growing season. Creators of DWM believe a large benefit of the system is reducing nitrate loads in the agriculture runoff. However recent studies show no significant difference in nitrate concentrations have been measured in fields with conventional drainage system and fields with DWM systems.[4] The general consensus is less water leaves the field through the tile and therefore less nitrates flow out in given time.



The NRCS currently offers technical and financial assistance for DWM. The assistance is only offered to individual landowners.

Bioreactors[5] – Denitrifying bioreactors, made of woodchips, capture nitrogen- loaded water from underground tile drainage. A water control structure is installed at the upper end of the trench intercepts and diverts tile water into bioreactor. Since the water is bypassed it does not cause water to back up into agriculture fields especially in time of high flows.

Bioreactors are less expense to install and do not require the loss of cropland. The lifespan of a woodchip bioreactor is estimated 10 to 15 years. However since this option is fairly new the actual technical specifications for installation have not been provided for agriculture producers.

Two Stage Drainage Ditches is an alternative method to ditchbank maintenance by incorporating benches that function as floodplains. In order to assure proper drainage, ditches are maintained to improve agriculture runoff by removing weeds, woody vegetation and sediment. Traditional ditch maintenance restores the ditch to a trapezoidal shape.

Two stage ditch design is commonly is used in rural landscape. However, urban areas are now adopting this design to handle stormwater runoff. A two stage drainage ditch that is properly designed can benefit the landowner and drainage district by reducing maintenance and stabilizing ditchbanks. Recently, this channel design has grown popularity for its potential to improve water quality and wildlife habitat.

In general drainage research has been limited. Many theories have surfaced in adopting conservation drainage opportunities to improve water quality. However, many research projects

[4] http://water.epa.gov/type/watersheds/named/msbasin/upload/2006_8_24_msbasin_symposia_ia_session2.pdf
[5] http://web.extension.illinois.edu/bioreactors/bioreactors.cfm

have taken large amount of farmland out of production, decrease drainage, lack real-farming application, and fail to identify cost-benefit ratios.

Voluntarily Conservation Drainage Opportunities are quicker to be adopted among landowners, agriculture producers, and drainage districts if:

- The method is proven in real-world farming application
- Drainage is not inhibited
- No or minimal amount of farmland is taken out of production
- There is low cost to installation or maintenance
- It is a practical application for the landscape

Chapter 4: Productivity Rooted in Research

For over a century, the University of Illinois, our state's Land Grant Institution, has conducted research designed to find science-based solutions to problems and opportunities associated with production agriculture. When put into practice, results of that research have allowed Illinois farmers to be among the most productive in the world and to do that with minimal risk to the environment.

Corn and soybean production has steadily increased over time. This increase can be attributed to the combined effort of University researchers, industry that has developed new products to improve the efficiency of crop production, and ingenuity of farmers that have found ways to use the newest technology profitably for their own operation.

As new products or practices were introduced into production agriculture, new problems or opportunities often developed requiring new research to find solutions, often solutions that required new products or practices. In virtually every one of these situations, it has been the cooperative work of public scientists (University based researchers and educators), industry scientists, and farmers and their advisors that developed solutions for problems. Examples of these situations follow:

Nitrogen

From its introduction into the marketplace to today, the public and private sector has independently and cooperatively worked together to ascertain the most reliable scientific information on the impact of nitrogen fertilizer on crop production and the environment.

Mid 50's to the late 60's: Rate of N application increased steadily as did crop yield.

Late 60's: Scientists identified a relationship between water quality and fertilizer N.

Mid 70's: Scientists evaluated the impact of management factors, including rate, time, and method of application on efficiency of N use.

Late 70's: Corporate scientists began to work earnestly to find chemical additives that when combined with N fertilizer would improve the efficiency of use or conversely, reduce the potential for N loss.

80's through today: Research continues on rate, time, and method of application and on additives to improve N efficiency.

The private sector has worked closely with the public sector to make sure that research based educational programs are reaching out to most people. This has been enhanced by the establishment of the Certified Crop Advisor Program, which requires that those certified must pass an exam and obtain 20 hours per year of continuing education. The industry has also supported development of a fertilizer assessment (first established in 1989 as the Fertilizer

Research & Education Council (FREC) and updated in 2012 as the Nutrient Research and Education Council (NREC) that supports research programs designed to enhance crop production while at the same time minimizing environmental degradation.

Research information generated through public sector programs has been summarized and incorporated into Crop Sciences Extension programs. Such programs include face to face meetings; Illinois Agronomy Handbook; newsletters; print and electronic media releases; and email or personal contact.

Phosphorus

Many producers adopted reduced or no-till practices based on data that has shown the benefit these practices have on soil conservation and on reduction of energy input for producing the crop. While these benefits are real, reduced tillage operations result in stratification of relatively insoluble nutrients at or near the soil surface and resulting in increased potential for off-site movement of these materials. University research—some of it based on farmer's ideas, developed new options for P application that will allow them to continue to use reduced tillage techniques and not be concerned about P runoff. Machinery companies also developed new technology that has been effective in minimizing P runoff from reduced tillage fields.

Hybrid corn: Hybrid corn, one of the top 2-3 factors responsible for high yields, cost farmers millions of dollars in one year because of a single gene that slipped through in a process attempting to improve efficiency of production of hybrid seed. The gene associated with male sterility was associated with susceptibility to a strain of southern corn leaf blight that is very toxic. Working together, industry and university scientists were able to find a way to produce non-susceptible seed prior to the next growing season.

In more recent years, plant breeding has progressed to include pest resistance genes in the seed, thus reducing the need for as much or in some cases for any pesticide for that particular problem. Resistance to specific chemistry of herbicides has also been incorporated into the genetics allowing producers to use one herbicide to control all weeds. Unfortunately, as predicted, continuous use of a specific herbicide has resulted in development of a natural resistance in some weed species, making weed control difficult.

While genetically engineered crops almost without exception are developed by industry, this would not have been as likely to happen had it not been for preliminary work done by public sector scientists. As indicated earlier, problems that develop in production agriculture are most often solved by combinations of work done by public, corporate, and farmers/field workers.

Chapter 5: Livestock Production & Nutrient Management

Emphasis on Education

As early as 1995, Illinois livestock producers were working with University of Illinois Extension, Illinois EPA, and other stakeholders to develop educational programs on nutrient management practices, stressing the importance of environmental stewardship. Starting in 1997, regular training became part of a livestock manager certificate program, called Certified Livestock Manager Training. Illinois Department of Agriculture administers that program, which draws on University research and educational resources to inform producers of the latest environmental practices and provide tools to implement those practices. *On any given three-year certification cycle there are about 1,000 Illinois farmers, most of whom are swine producers, taking the training.* Extension uses the nationally-recognized Livestock and Poultry Environmental Stewardship curriculum as the fundamental training resource. To help producers stay current on environmental regulations and technology, Illinois commodity groups and Illinois EPA provided funds to build web-based tools and other educational products.

Nutrient Planning

Illinois livestock producers are at the forefront of writing and adopting nutrient management plans for their operations. Nutrient management planning has helped producers target their needs for more manure storage and better application equipment, thus allowing better timing for manure application with an eye on reducing runoff and leaching. NRCS uses the Comprehensive Nutrient Management Plan (CNMP) process to coordinate manure nutrient storage, clean water management, and land application with water quality protection. Besides being an excellent tool for enhancing water quality on the farm and the surrounding surface waters, nutrient management plans help producers make better use of livestock manure as crop fertilizer. Unlike the situation in some states, Illinois livestock facilities produce enough nitrogen and phosphorus to fertilize only a small fraction of the total crops raised in the state; row crop farming neighbors take advantage of manure applications when the resource is available in excess of what the livestock producers need, thus helping balance nutrients across the landscape.

Technology

Livestock producers applying liquid manure to cropland have access to excellent manure injection equipment that puts nutrients in the crop root zone while maintaining soil surface residue for erosion control. GPS linked application equipment makes it easier for applicators to see and stay

out of setbacks from surface water, tile inlets, and water wells. Good sampling protocols of manure and soils, and careful records, assure the best possible balancing of nutrients from the livestock operation to crop requirements, while minimizing undesirable losses of nutrients to the environment.

Operation and implementation

Adoption of nutrient management planning techniques is increasing among swine farmers every year, as evidenced by the responses to surveys in the Certified Livestock Manager Training workshops. Producers are getting used to the recordkeeping requirements and are finding ways to make the regular plan maintenance tasks easier. Illinois-based custom manure hauling operations, several of which are applying many millions of gallons of liquid manure every year for swine facilities, are also increasing their client base as producers realize the benefits of hiring well-trained custom haulers who have up-to-date and properly sized equipment to get the manure application job done quickly and correctly.

Chapter 6: Structure of Illinois Ag Water Quality Efforts

Illinois agriculture has an integrated approach to address critical needs in research, education and outreach to increase agricultural productivity and reduce environmental impact. This approach includes these intertwined programs:

The Illinois Council on Best Management Practices (CBMP). Formed in 1998, this non-profit entity is made up of dues paying members including the Illinois Corn Growers Association, Illinois Farm Bureau, Illinois Soybean Association, Illinois Fertilizer & Chemical Association, Illinois Pork Producers , Syngenta Crop Protection, Monsanto and GROWMARK.

CBMP's mission is to identify and promote sound agronomic practices in the agricultural sector to address water quality concerns. CBMP has supported programs that have successfully addressed water quality concerns related to the use of crop protection products, education on fall nitrogen stewardship, the Illinois Buffer Partnership and most recently the "Keep it for the Crop by 2025" nutrient stewardship program.

Keep it for the Crop (KIC): CBMP launched the KIC program in September 2011. KIC is dedicated to working with the ag industry and nutrient stakeholders in six priority watersheds (identified by IEPA as impaired due to nitrogen, phosphorus, or both) to reduce nutrient losses and promote 4R nutrient stewardship principles (right source, right rate, right time right place). Dan Schaefer, KIC's Director of Nutrient Stewardship, coordinates with university researchers to encourage retailers and their farmer customers to implement nutrient application practices that minimize environmental impact, optimize harvest yields and maximize nutrient efficiency. CBMP provided startup funding for KIC through donations from CBMP organizations while working on legislation to restore Illinois' ability to sustain nutrient research and education efforts through the creation of the Nutrient Research & Education Council (NREC).

Nutrient Research & Education Council (NREC). With broad based support from all sectors of agriculture as well as environmental organizations, the industry sought significant changes to the Illinois Fertilizer Act to establish a sustainable funding mechanism for nutrient research and education programs. Signed into law in August 2012, NREC is governed by nine voting members representing ag industry organizations and four non-voting members representing environmental organizations and academia. The NREC Council established an assessment of 75 cents per ton on fertilizer sales to support projects and programs that address the role of nutrients in enhancing Illinois crop production while minimizing environmental impact. 20% of NREC funds must be dedicated to on-farm research and demonstration projects that address water quality issues. NREC funds are held outside of state government to assure a dependable and sustainable support system for nutrient research and education. Annual funding to NREC is between $2 – 2.5 million per year.

In 2013, NREC funded 7 projects, including:

1. Agronomic & Environmental Assessment of Cover Crops in Illinois (UI & SIU)
2. Updating P & K recommendations in Illinois (UI)
3. Phosphorus Runoff Potential in Fields with Minimal Slope (UI)
4. *Keep it for the Crop* Outreach & Education Program (CBMP)
5. *Discovery Farms* Program (CBMP)
6. Salt Fork Watershed Partnership (CBMP & Champaign Urbana Sanitary District)
7. On Line Anhydrous Ammonia Training for Farmers (IFCA)

In 2014, NREC was able to expand its efforts, funding 15 projects for a total of $2,558,750. These projects are a mix of efforts that fulfill NREC's goal to fund projects that minimize environmental impact, optimize harvest yield and maximize input utilization. A list is below; please go to www.illinoisnrec.org for more detailed information on these projects.

1. Agronomic & Environmental Assessment of Cover Crops (UI/SIU, 2nd year)
2. Updating P & K recommendations in Illinois (UI, 2nd year)
3. Phosphorus Runoff Potential in Fields with Minimal Slope (UI, 2nd year)
4. Keep it for the Crop Program (CBMP, 2nd year)
5. Discovery Farms Program (CBMP, 2nd year)
6. Nitrogen Responses in Continuous Corn (UI)
7. Soil Quality Changes in Corn/Soy/Wheat Rotations (UI)
8. Late Nitrogen Application in Southern Illinois to Minimize Losses (SIU-C)
9. Field Scale Comparison of Nitrogen Efficiency Practices to Reduce Losses (ISU)
10. Nitrogen Management Over Tile Trained Fields to Optimize Yields & Minimize Loss (UI)
11. A Comprehensive Corn Research Program for Illinois (UI)
12. An Analysis of Farmer's Nitrogen Management Practices (ISU)
13. Paired Cover Crop Study; Impact on Water Quality (ISU)
14. Updating Crop Removal Numbers for P & K (UI)
15. Use of Multifunctional Buffers on Marginal Farmland to Improve Environmental Profile and Diversification (UI)

Chapter 7: Agricultural Nutrient Reduction Programs/Strategies

The overall goal of the agricultural strategy in terms of funding and implementation of projects is centered on the MOM approach, which focuses on both environmental and economic factors.

Keep it for the Crop by 2025

KIC is Illinois agriculture's directed approach to encourage voluntary efforts by the industry and farmers to reduce nutrient losses. NREC has committed to fund the KIC Program long-term.

In 2011, the Illinois Council on Best Management Practices which includes Illinois Corn Growers, Illinois Farm Bureau, Illinois Fertilizer & Chemical Association, Illinois Soybean Association, Illinois Pork Producers and Syngenta Crop began implementation of an enhanced nutrient stewardship program entitled "Keep It for the Crop (KIC) by 2025." KIC establishes goals for reducing nutrient losses from agriculture through adoption of the 4R's of Nutrient Use: *Right Source, Right Rate, Right Time, Right Place.*

KIC seeks to educate the agricultural sector, dedicate significant resources toward research to reduce nutrient losses and enhance nutrient efficiency, educate suppliers and farmers, and measure the adoption of in-field practices to enhance nutrient stewardship beginning in priority watersheds and expanding over years to a state-wide nutrient stewardship program.

In launching the KIC program, IEPA established six priority watersheds for KIC, to enable the program to focus on nutrient stewardship efforts to improve water quality in these water bodies which also serve as public drinking water supplies. In 2013, we added Lake Springfield and Lake Evergreen for a total of eight priority watersheds.

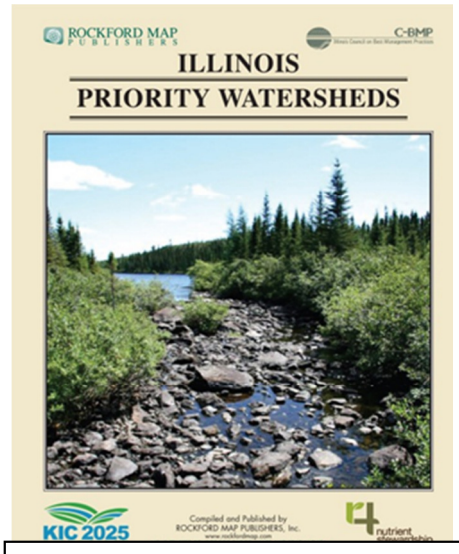
The KIC strategy sets yearly goals for the program, working up to 2025 when the final goal is ensure and document that the majority of acres in the watershed are consistently utilizing the 4R

framework. A copy of the KIC strategy document is available at www.illinoiscbmp.org

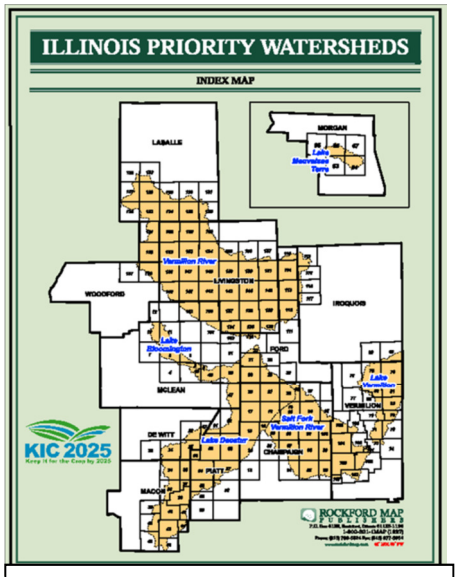
Fertilizer dealers and farmers have consistently approached nutrient recommendations and nutrient application with an eye toward maximizing nutrient efficiency. Most fertilizer dealers have their own branded agronomy programs that include soil testing, variable rate fertilizer application, harvest yield analysis and micro-nutrient programs that seek to optimize nutrient efficiency both from a yield standpoint and an optimum rate of economic return for the farmer. The challenge for KIC is to establish a baseline of these practices in order to document and track additional acres incorporated into the 4R approach.

Dan Schaefer, Director of Nutrient Stewardship for the KIC program, is a Certified Professional Agronomist and Certified Crop Advisor. Dan works full time on the KIC program, focusing his efforts on coordinating with ag retailers in the watersheds to learn of their current nutrient practices to both assess the level of current adoption of 4R practices in the watersheds and identify growers who may not be using all aspects of the 4Rs to encourage them to try new application methods.

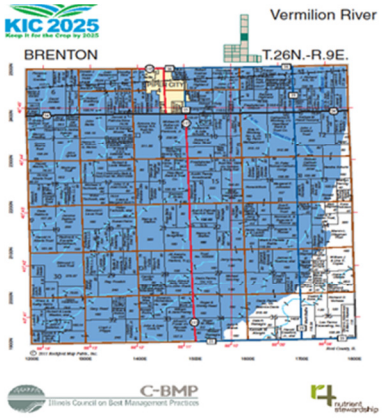
KIC Plat Books: In spring 2012, to assist ag retailers and crop advisors in identifying growers who farm within the watersheds, the KIC program commissioned Rockford Maps and with the help of IEPA and NRCS, provided detail to Rockford on the watersheds in order to develop plat books of the watersheds for distribution to the ag retailers. This enabled the retailers to better identify their customers in the watershed and to evaluate the number of acres in the watershed.



Cover of KIC Plat Book



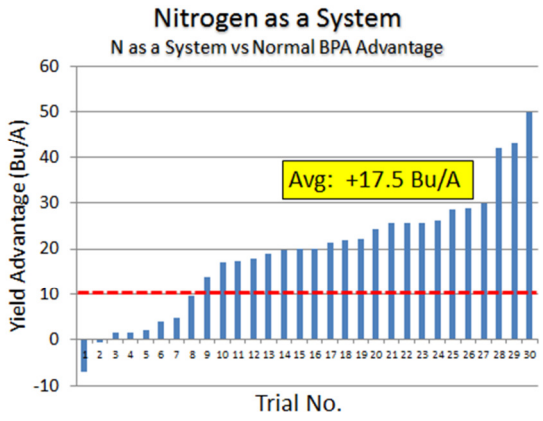
Example of Index Map



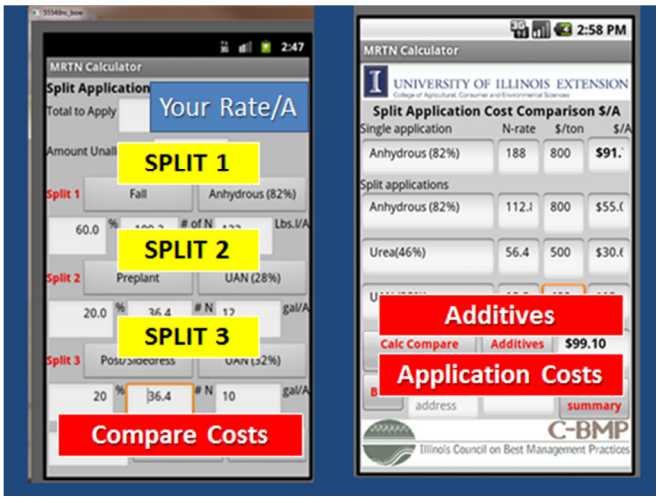
Township Detail

The KIC program promotes a fairly straight-forward approach to nutrient stewardship. In Illinois, nearly 70% of all nitrogen fertilizer is applied in the form of anhydrous ammonia, approximately 750,000 tons per year as indicated by Illinois Department of Agriculture fertilizer sales records. Historically, nearly 50% of nitrogen applied in the ammonia form in central and northern Illinois for corn is applied in the fall, following the recommendations of the Illinois Agronomy Handbook.

The KIC approach is to work with ag retailers and farmers to adopt a ***Nitrogen Management System***. KIC encourages splitting nitrogen applications (instead of a single application) of nitrogen throughout the growing season. This nitrogen management strategy enables the farmer and his crop advisor to monitor the soil, crop and weather conditions and make adjustments to the nitrogen source, rate, timing and placement throughout the growing season. Data exists in multiple years which indicates that producers who adopt this 4R approach realize an increase in yield that more than offsets the increased application or fertilizer product costs—an average of 12-17 bushels per acre for corn (see diagram above). A brochure outlining the Nitrogen Management System is available at www.illinoiscbmp.org.



MRTN Smartphone Application: Embracing new technology has enabled KIC to encourage more rapid adoption of split nitrogen applications. Dennis Bowman at UI-Extension helped KIC develop a smart phone application for the MRTN (Maximum Return to Nitrogen) calculator. This app gives a crop advisor or farmer the ability to access nitrogen recommendations from the seat of the tractor or combine. The calculator is available on the Iowa State website, and Dennis took it a step further adding in the nitrogen source, rate, time and place along with additives and application costs. A crop advisor can complete the app from a Droid or Apple device and walk the grower through the concept of maximizing corn production with a systems approach to nitrogen, also emailing a copy of the plan to the farmer for his records.



Software for Tracking 4R Implementation: By working with ag retailers, KIC will begin to track the acres in the watershed that are under a 4R nutrient stewardship program (i.e. split

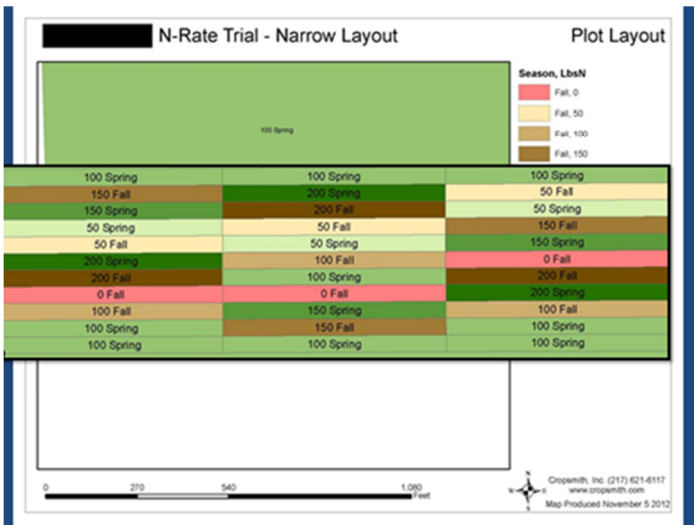
applications, use of stabilizer products, utilization of rate calculator, soil testing, etc.) Software Solutions Integrated (SSI) in Shelbyville, IL is working with KIC to develop a component within their product billing/inventory system that retailers can utilize to track progress on the 4Rs in the watershed. We will utilize these KIC dealer reports to develop web-based dashboards and other illustrative tools to demonstrate 4R progress on the acres in each watershed. The first reports from ag retailers using the KIC software will be exported to CBMP in February 2014; once evaluated for accuracy, CBMP will ask all retailers in the priority watersheds (and eventually statewide) to export this information twice a year to CBMP. PAQ Interactive (a CBMP technology partner) will use the information to create visual "dashboards" that we can utilize in presentations and share with IEPA and other stakeholders to show progress on the adoption of the 4Rs in Illinois. The information will not contain the retailers name or the farmer's name, but rather will illustrate 4R practices on the acres within each watershed.

Nitrogen Rate Trials: One of the goals of KIC is to help farmers establish a reliable, defensible nitrogen rate for their farm. Currently, university recommendations are regional. In the priority watersheds, we want to help farmers fine-tune their rates and methods of application to Minimize environmental impact, Optimize harvest yield and Maximize input utilization (MOM). Dr. Fabian Fernandez and Dr. Emerson Nafziger at UI helped with the trial protocols with the goal being to better define what the nitrogen rate should be in the watershed. The program incorporates soil associations and GIS tools to help makes these trials easy for the retailers to implement.

In 2012 KIC had 6 on-farm N rate trials; in 2013, 37 farmers participated and in 2014 we hope to enroll 50 farmers in these on-farm trials. Here's how it works:

Rate of Application: Ag retailers help us identify farmers in the priority watersheds who will work with KIC to place at least one rate study. The study consists of three replications of six nitrogen application rates applied in a randomized complete block experimental design. The N application rates range from 0 to 250 lbs of N/acre at 50 lb increments. The minimum treatment length is 500 feet. KIC will use the data collected to refine the calculations in the N-Rate calculator and the split-rate calculator.

Time & Rate: A farmer can determine the optimum rate of application relative to the time of application as well as determine the best time of application between two selected application dates, based upon harvest yields. This consists of three replications of six nitrogen rates. The rates range as described in the study above, but the applications are made in both the fall and the spring, using equipment that has a variable rate controller which "stamps" the



trial within the field, making it possible to return to the exact location in the field where some the rates were put out in the fall, and other later in the spring.

Fit A	Fit B	A	B
R^2:		94%	94%
MERN (lb/A):		201	176
Yield @ MERN (bu/A)		234	240
Partial Factor Productivity (PFP), bu/lb		1.16	1.36
Agronomic Efficiency (AE), bu/lb		0.80	0.98
Estimated Partial N Balance (PNB), %		75%	88%
Estimated Recovery Efficiency (RE), %		78%	96%
Delta Yield (bu/A)		160	173
Relative Yield (%)		31%	28%

KIC partners with the University of Illinois and with local ag retailers to collect data from these trails and provides a small incentive payment to the farmer to cover the yield loss in zones where 0 or very little nitrogen is applied. Interest in these on-farm trials is very high, as farmers see the value to determining the best 4R practice (source, rate, time, place) for their individual farm, resulting in an economic and environmental benefit.

One thing we are learning is that variability among fields is the norm, not the exception. The N rate trial above was placed in a two central Illinois fields, only one mile apart. Both were farmed by the same farmer, with the same practices (hybrid, planting rate, crop protection, etc.) and the same soil type. In this N rate study conducted in 2013, you can see that while corn yields were very similar, the optimum N rate for field A was 201 lbs of nitrogen, while field B was 176 lbs of nitrogen. We continue to work to determine the factors that affect nitrogen uptake; it could related to other nutrient factors in the soil, micronutrients, tillage, compaction issues, etc. This demonstrates that each individual field could have its own unique N rate. Dan Schaefer shares the information gathered from the N rate trials with the farmer, the farmer's ag retailer, and the University of Illinois. UI uses the information to feed and update the MRTN calculator.

Phosphorus Strip Trials: John Deere donated equipment for KIC to conduct deep placement and strip-till in both corn and soybeans. Unfortunately, this equipment is so large it was difficult to work with small plots and we have transitioned to work with farmers and retailers to utilize their toolbars in the effort. Again with the help of UI, KIC has developed written the protocols and are looking for growers who want to do a comparison between strip-till and their normal application practices. The trials will help UI researchers compare their small plots to the larger field trials KIC cooperators set out. This will help validate what are seeing for phosphorus and potassium removal rates, nutrient stratification and help refine how we soil test in strip-till fields. Dan Schaefer is also assisting the University of Illinois in an NREC funded project where various P application methods on soils with less than 2% slope are being tested to determine the

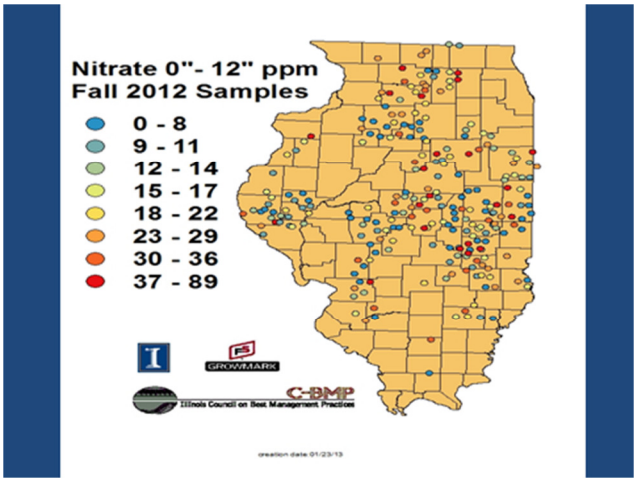
P runoff potential of each method.

N-Watch® Soil Nitrate Testing: As we witnessed the extent of the drought of 2012, it was apparent there would be an impact on nitrogen utilization. KIC teamed with Dr. Howard Brown at GROWMARK along with Dr. Emerson Nafziger at the University of Illinois to launch the N-Watch effort. We assessed the residual nitrogen that might remain after harvest, particularly for corn acres going back to corn. This would enable us to work with growers to adjust their nitrogen management plans for the 2013 crop by making them aware of the possible available residual nitrogen in the soil from the previous crop. *NRCS was willing to help with this emergency effort and provided a special grant to CBMP to cost-share the costs of the N WATCH program.* The N-Watch program evolved as follows:

Webinar: Targeted at certified crop advisors, the Webinar was held on October 23, 2012. Dr. Emerson Nafziger explained the importance of tracking residual N into the spring of 2013 with the possibility of adjusting the total amount of N applied for the 2013 crop depending upon the amount of residual N remaining in a producer's field. The Webinar explained the sampling procedures, how to ship the samples to the lab for analysis and utilization of GIS coordinates to enable repeating the samples in the spring. Dr. Nafziger reminded the participants about the proper timing of fall nitrogen applications. Nearly 200 crop advisors participated in the webinar.

Soil Analysis Kits: The KIC program provided special "back saver" soil probes to the volunteers, along with shipping labels, boxes and submittal forms for laboratory analysis. This ensured all samples were handled uniformly and the process as seamless as possible. We were thrilled to receive samples from 300 different locations in the state and we analyzed over 800 soil samples.

Assessment of Results: Dr. Nafziger reviewed the sample results and generated a map of the sampling locations using GIS coordinates provided by the samplers. The data reveals that in some areas, enough residual N in nitrate form exists (an average of 136 pounds per acre) to provide an ample amount of N to next year's corn crop if it is not lost through water movement or denitrification before the 2013 crop can take it up. The study was published in



the December 2012 UI *Bulletin* and we continue to present the data at agribusiness and farmer meetings. N-Watch continues as a valuable tool in educating the industry about soil nitrogen levels in the soil as how these levels change based on environmental conditions.

The tracking of soil N in the spring including pre-sidedress nitrate tests will allow us to continue to monitor the fate of the nitrate in the soil and the possibility of adjusting nitrogen recommendations to growers. It is normal to lose some of this nitrate during the late winter and spring due to rain and movement through the soil profile. Testing for soil nitrate is not a common practice in Illinois, but given the value of this data we hope it will continue as an on-going practice.

Discovery Farms

CBMP is working on two locations for the Illinois Discovery Farms project.

McLean County: This is a partnership with Illinois State University on a site near the Lake Bloomington/Evergreen watershed. CBMP provided funds via an NREC grant to establish tile drainage on an 80 acre field, where we will study the effectiveness of various management practices to improve water quality and ensure farmer profitability. NREC is funding on-going research at this site. This research/outreach project will provide the opportunity to measure water quality at 15 different field locations. CBMP will be a partner with Illinois State University researchers to help look at fertilizer source, rate, time and place (4Rs) and their impact on reducing nutrient losses. Demonstration days are planned in 2014.

Champaign County: Dr. Richard Cooke (UI) had previously installed subsurface water quality structures at the Kleiss farm in Champaign County, until his funding lapsed. CBMP, through an agreement with Dr. Mark David and Lowell Gentry (UI) have re-started this site and it is again functional for 2014. Dan Schaefer will work with the farmers (Kleiss) to enact nitrogen and phosphorus management practices, and UI will conduct the water quality sampling and analysis. During 2014 we will compare the fields so that when a cover crop is seeded in the fall of 2014, we will be able to assess tile nitrate concentrations compared to field with no cover crop. The pictures below show the December 2013 installation of the subsurface control structures.

Lake Springfield Project

CBMP has partnered with Springfield City Water, Light and Power (CWLP) to help ensure they can deliver drinking water (finished product) 5 of ppm below the USEPA drinking water standard of 10 ppm for nitrate-N, without the need for nitrate removal technology. We will work to accomplish this goal within three years. Other partners include the Sangamon County Soil & Water Conservation District

How it will be accomplished: The Illinois Council on Best Management Practices (CBMP) in conjunction with Illinois Corn Growers Association (ICGA) has secured funding from the National Fish & Wildlife Federation to coordinate and implement a program with local ag retailers to achieve a sustained reduction in nitrate-N loading from agricultural non-point sources through promotion and adoption of nitrogen management systems on farm fields within the Lake Springfield. We will also coordinate in-stream monitoring of Nitrate-N in lake tributaries utilizing students from Lincoln Land Community College (LLCC). CWLP is also making a substantial monetary contribution and CBMP is helping to provide staff for the project and the Sangamon County Soil & Water Conservation District is also providing critical support with staff and newsletter mailings to farmers and ag retailers in the watershed.

Program Period: November 1, 2013 through December 31, 2016.

Nitrogen Management System: A Nitrogen Management System describes how to allocate nitrogen needed to optimize harvest yield utilizing the 4R Approach to Nitrogen Management: Right source, Right rate, Right time, Right place, and current science surrounding soil nitrogen. This approach should minimize environmental impact of applied nitrogen through improved plant utilization and optimization of harvest yield through improved nitrogen nutrition.

How the program works:

1. Ag retailers will work with farmers in the watershed to manage their nitrogen inputs as a Nitrogen Management System beginning with the 2014 corn crop.

2. Enrolled farmers can participate with their ag retailer to inventory residual soil plant-available nitrogen prior to or immediately after corn harvest. Samples will be collected according to the N-Watch inventory sampling protocol. CBMP suggests that each farmer have no more than two sampling sites unless special circumstances exist.

3. Composite soil samples will continue to be collected periodically until the soil freezes and will continue once the soil thaws in the spring. Samples will be collected according to the attached N-Watch Tracking sample protocol.

4. CBMP will provide participants an N-Watch Inventory Report and updated N-Watch Tracking Reports following each periodic sampling date. Reports will be accompanied

by an interpretation of the results and will be delivered within 48 hours following receipt of lab results.

5. Fields with detectable plant-available N in excess of 15 ppm nitrate-N following harvest will be eligible for the N-Watch Cover Crop Program (farmer discretion).

6. CBMP will communicate progress and efforts to CWLP and gauge impact on water quality through CWLP, CBMP and LLCC monitoring of tributaries to Lake Springfield and finished water in the lab. CBMP and CWLP will provide 50/50 funding for the N-Watch soil sampling program and where applicable, cost-share funding for cover crops where soil residual N exceeds 15 ppm nitrate-N following harvest.

An official kick-off meeting was held on February 6, 2014 at the Northfield Suites in Springfield. 130 people attended including 60 farmers, agribusinesses, landowners, farm managers, state agency officials and local watershed leaders.

Cover Crops

Under the leadership of Mike Plumer, retired UI Extension Advisor and project coordinator for CBMP, Illinois agriculture is taking a fresh look at cover crops and they role they can play in our corn/soybean/wheat rotations to help sequester nutrients and improve soil quality.

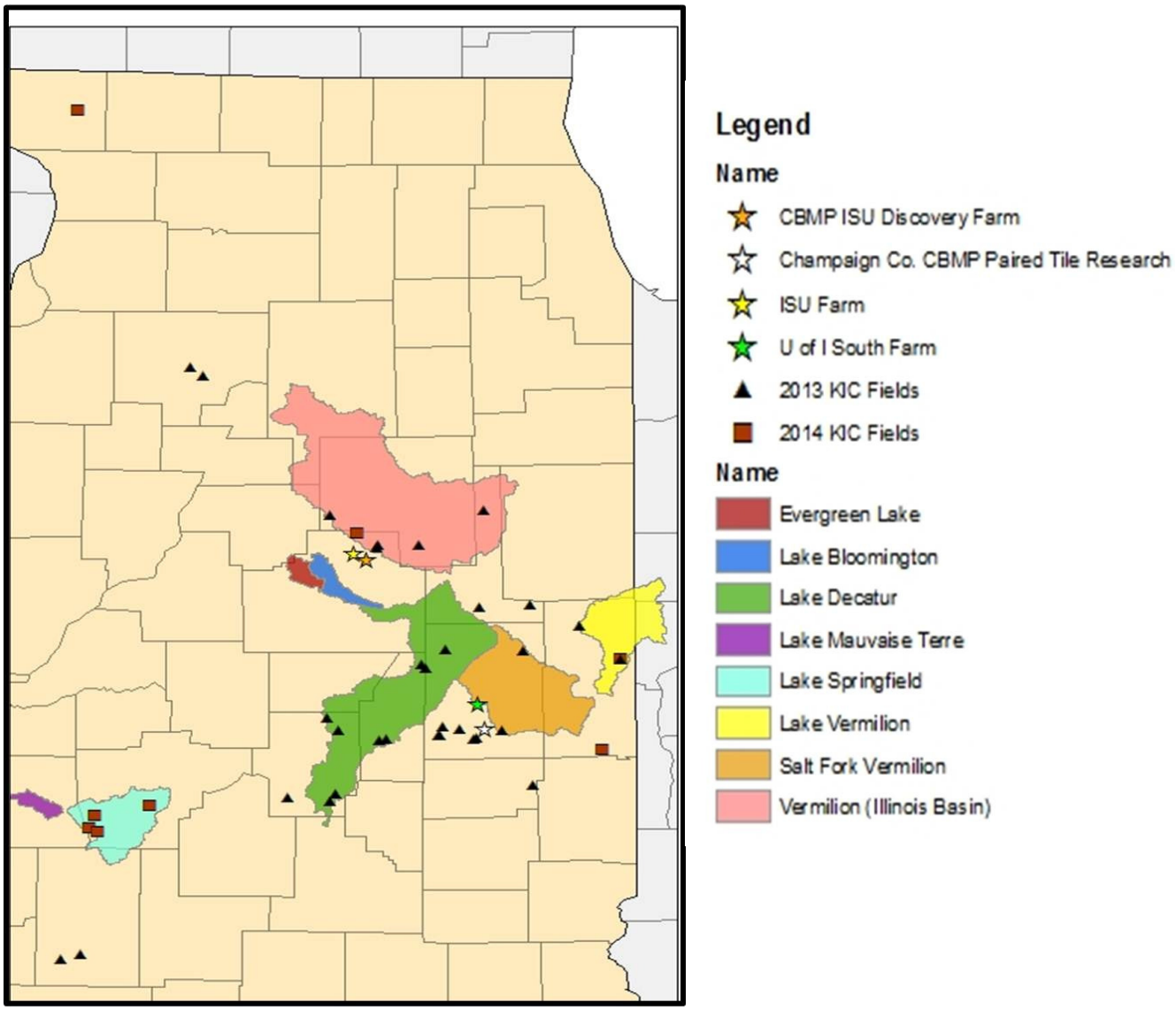
Mike has conducted over 100 workshops in the past two years on the benefits and management of cover crops. These are well attended by agribusiness and by farmers.

CBMP received funding from NREC on a project in the Salt Fork Watershed in Champaign County, IL and will work in partnership with the Champaign Urbana Sanitary District, Dr. Mark David from UI, NRCS and the Soil & Water Conservation District to look at various point and non-point practices and environmental stressors and how this collectively impacts nutrient contributions to the watershed. This partnership between the point and non-point source community is an important first step in identifying technologies and practices that will improve water quality in a cost-effective manner from the perspective of the agricultural and point source community.

NREC is also funding research projects with the University of Illinois, Southern Illinois University and Illinois State University to study cover crops on producer-owned field throughout the state and at University Research Farms. The study seeks to gather data to determine if cover covers can be utilized effectively in Illinois to improve soil nutrient values and crop yields. It will also measure the extent to which cover crops scavenge nutrients in their biomass and the availability of N and P for the following crop, looking at various tillage practices.

NRCS has also provided cost-share funding to CBMP to promote workshops on cover crops throughout the state; Mike Plumer is the lead instructor on these workshops and is extensively involved in training new professionals in Illinois to serve as cover crops experts.

The diagram below illustrates the current CBMP projects in the priority watersheds:



Illinois Buffer Partnership

Since 2001, the CBMP has partnered with an organization called Trees Forever, based in Marion, Iowa to promote the use of buffer strips and plantings along crop fields and livestock facilities to reduce nutrient runoff, enhance filter strips and improve, reduce odor from livestock facilities and enhance aesthetics.

The purpose of the Illinois Buffer Partnership™ is to improve water quality by establishing buffers of trees, shrubs and grasses along streams and in wetlands in Illinois. Combined with other best management practices, results include:

- slowed runoff from fields
- reduced soil erosion
- increased wildlife habitat
- visual screens
- education on water quality practices

The number of sites and plantings statewide from 2001 include:

- 15 sites planted
- 51.85 acres of buffers planted
- 8,395 feet of streams protected
- 6,696 trees and shrubs planted
- 50 landowners and volunteers involved
- 511 volunteer hours recorded.

#