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Dear Reader,

A club is nothing without its mission. Our collective dream is, although cliché, a simple mantra of purpose: "to leave the world a better place than when we came into it." We are dedicated to serving you and the global issues of soil and water conservation. This publication is intended to educate readers on topics of soil and water at both macro and micro scales. This is our seventh year publishing this magazine, complementing the clubs educational activities. We teach students about ground water flow with ground water flow models that we also sell to pay for some of our costs. We focus our meetings on educating ourselves, bringing speakers in to talk about a wide variety of topics in soil and water. None of this could be done without the dedication of our club members.

The members of this club come from diverse backgrounds and opposite sides of the equator. We have passions that range in location from our own backyard to international, and focus from soil chemistry to social justice. Through reading this publication you will no doubt feel this reality. I am proud that this group of remarkable people would allow me to be their leader. They have requested that I now write a little of my own experience in soil and water conservation as president of this club and professionally. It is an honor for me to do so.

I spent the summer conducting assessment research in India on garbage in streams. I received the Iowa Soil and Water Conservation Society scholarship which no doubt was helped by these activities. Throughout this self-conducted research, the most important things I learned will never appear in the results of an academic paper. Assumptions govern all research and identifying them is the only way to come close to an objective understanding. The more mistakes you make the more depth your research gains. A misnomer within science education that is not challenged enough is that you have to be right or that there are correct conclusions. Reports become a document of proof instead of learning, and ideas turn into dogmatic worldviews.

For example, we began our quantification of garbage within the streams on the assumption that most of the litter was in piles and that litter not in piles could be excluded from our assessment. I felt the weight of uncertainty hovering over me every time we went into the field. I was responsible for a group of volunteers who trusted me to find the "correct conclusions." When the assumption of discounting un-piled litter was questioned, I froze. Could it be that I was wrong? Would I soon be the next has-been scientist that made the wrong assumptions and came to

the wrong conclusions? Then I realized, assumptions are a part of our mental state, are difficult to identify, and even when identified sometimes impossible to avoid. To be a scientist is not to be right, it is to recognize when you are wrong. All scientific research is based on identifying what is not true and avoiding the question of what is true for the sake of finding a better answer in the future. We decided to change our approach so that it accounted for and even tested the assumption, which turned out to be false. The study benefitted tremendously from that transition and future studies will no longer make that assumption. Just so that I am consistent I must say that everything I have just stated is open for interpretation and falsification, except the fact that the members of this club are amazing because that is my dogmatic worldview.

We at the Soil and Water Conservation Club thank you readers for being active members in the paradigm shift of soil and water conservation. We welcome you as a part of this club and hope through reading this publication you will find new ways to continue to spread our mission of leaving the world together in better shape than when we came into it.

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A Letter from the Editors



Ligia Serrano (left), MS student, Ag & Biosystems Engineering Department and **Deborah Aller**, PhD student, Department of Agronomy

Special thanks to all the organizations that believed in our work and made this publication possible:

- Iowa Learning Farms
- Water Rocks!
- Leopold Center for Sustainable Agriculture
- ISU Department of Agronomy
- ISU Department of Agricultural and Biosystems Engineering
- ISU Department of Ecology, Evolution, and Organismal Biology
- Environmental Working Group
- Soil and Water Conservation Society (lowa and National Chapters)



e are both graduate students at Iowa State University who come from different backgrounds, have had different experiences, and have taken different paths to be here today. Yet we are similar in that we share the same passion for issues of soil and water conservation. One of us studies in the Agriculture and Biosystems Engineering Department looking at the impact of drainage from small depressions such as potholes on the environment, and the other in the Agronomy Department investigating the impact of biochar, a soil amendment, on soil quality and crop yields. Being editors of the 2015 publication has been an experience that both of us have learned from, been challenged by, and have become inspired to further educate and promote change.

Among our different schedules and responsibilities, we both found the time to dedicate to the Soil and Water Conservation Club, in part to put this publication together. Life is busy and we must choose our battles, but matters of soil and water conservation are something that we both stand for. It is the visible negative impacts of our current management practices - harmful algal blooms, soil erosion, greater weather unpredictabilitythat motivate us to engage in activities that encourage more sustainable practices and make others aware of these issues. One of us recently experienced extreme weather situations, by spending the 2014 winter in Iowa, and the 2015 summer in Rio de Janeiro, Brazil- the coldest and the hottest in decades

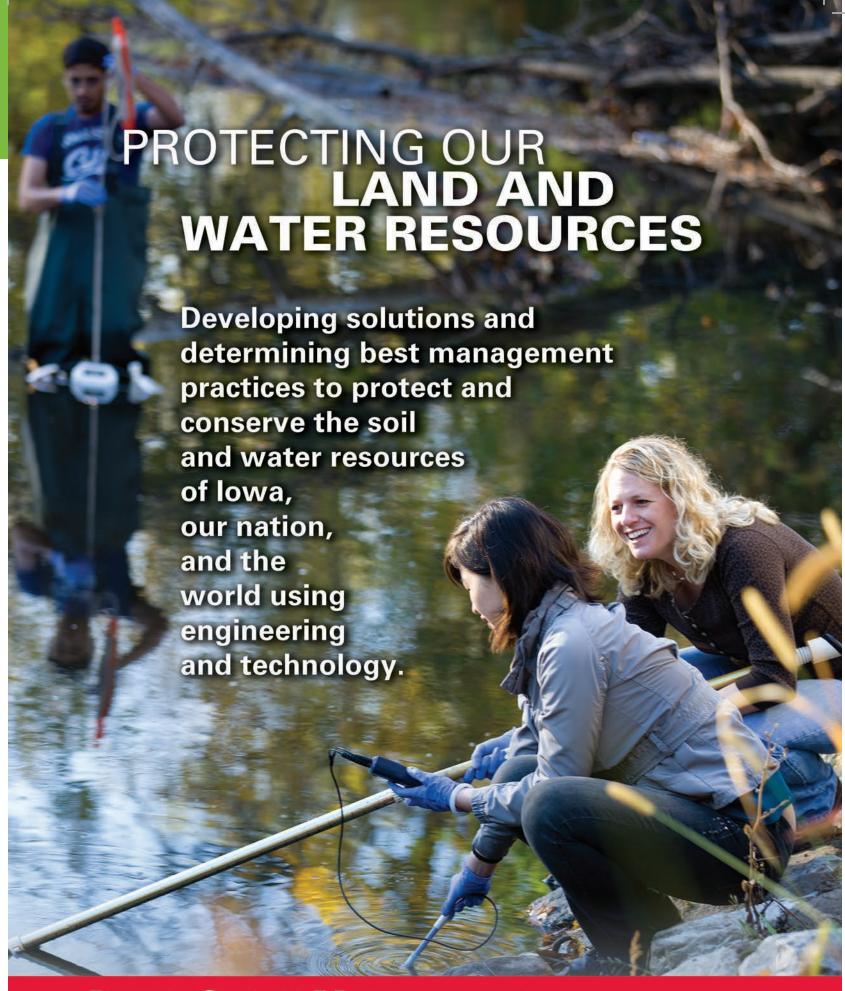
We were lucky to be able to work with a group of interested, hardworking, and committed people. It would have been impossible to put this publication together without the time and dedication of the publication committee members and our advisor. But it was all those involved that made our job as editors easy and rewarding. So although it is our similar interests that have brought

us to become involved in this publication, it is our differences and the diversity among the members of the publication committee and the entire Soil and Water Conservation Club that has shaped the topics chosen for this year's publication.

The 2015 issue covers a diverse set of topics, ranging from the use of drones to the environmental impacts of the homeowner adding fertilizer to their lawn. We talk at big and small scales and about issues here in Iowa, as well as other parts of the country and the world. We find these topics interesting and hope you will too. The publication is written in a way that is easy to understand by anyone interested in knowing a bit more about soil and water conservation issues, problems, and solutions. We hope that it will entice you to want to learn more and possibly become involved in relevant matters in your local area and beyond.

With that, we leave you to dive into the 2015 issue of "Getting into Soil and Water"!

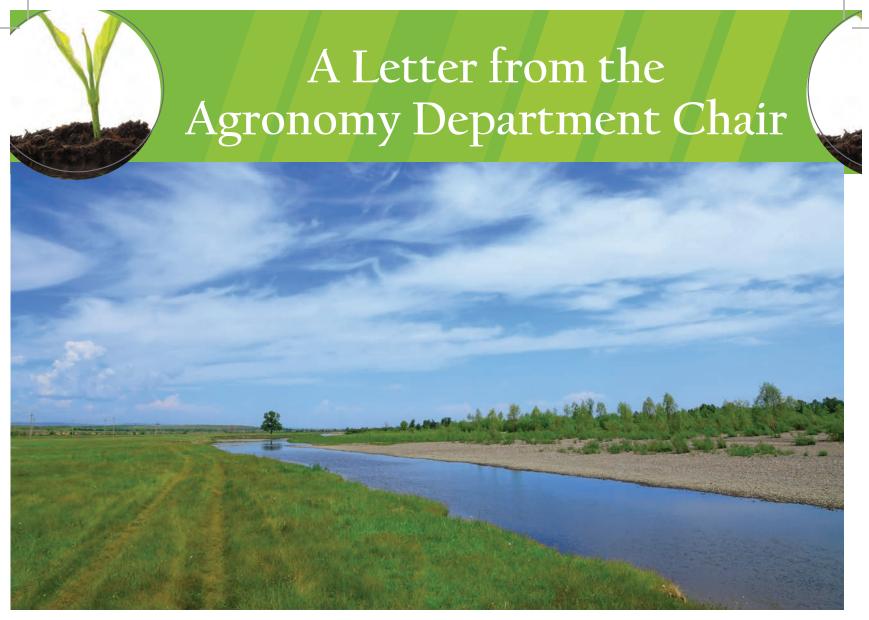
Ligia Serrano and Deborah Aller



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Kendall R. Lamkey
Chair and Professor
Department of Agronomy
Iowa State University

ne of the great things about working at Iowa State University is the students. Everyone has a different perspective on students, but all parents want their children to attend a great institution like Iowa State University, and be successful. Students bring a life and vibrancy to a city like Ames that it would not otherwise have. From my perspective, I see students as future leaders of agriculture. Students at Iowa State University in the College of Agriculture and Life Sciences are going to be our future farmers, agronomists, industry leaders, technology developers, and thought leaders. Students are what bring me to work each day with a passion to keep moving forward. They bring

me the hope and peace of mind that the future of agriculture is going to be left in great hands.

Here at Iowa State
University, we have many
future agricultural leaders
as is evidenced in the annual
production of Getting into
Soil & Water by our Soil and
Water Conservation Club.
Getting into Soil & Water
has become a very popular
publication in the State of
Iowa for its clear, insightful,
and timely articles on factors
related to two of our most
important natural resources,
soil and water.

In rainfed production environments, it is easy to take soil and water for granted, especially when both are in adequate supply. However, when one of the two becomes short in supply, the importance of the other increases dramatically. For example, the drought of 2012 illustrated just how important soil water holding capacity was for crop production. One of my favorite quotes is from the former president of the University of Illinois, Andrew S. Draper and it is inscribed on the outside of Davenport Hall at the University of Illinois (full disclosure, I am an Illinois native and University of Illinois alum, but a Cyclone forever): "The wealth of Illinois is in her soil and her strength lies in its intelligent development." This is as true of Iowa as it is for Illinois and this quote describes what our students are doing with the production of Getting into Soil & Water.

Enjoy.



Letter from Agriculture & Biosystems Engineering: What an Opportune Time!



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Reduction Strategy in 2013 there is increased focus on what can be done to protect our soil and water resources in the state of Iowa and if we are to reach the goals set by the Iowa Nutrient Reduction Strategy there is a need for an extremely high level of conservation practice implementation. While this looks like a monumental task, as a native Iowan I am confident that the people of Iowa can make great strides in protecting our soil and water resources. My confidence in Iowans being leaders in bringing together agricultural productivity and environmental protection is justified by what farmers have done in the past to make Iowa a leader in agricultural productivity. Historically, farmers have been asked to increase production and they have done that, but now they are being asked to take on this new challenge of maintaining productivity while enhancing water quality. Fortunately, there are a range of conservation practice options that farmers can consider implementing which would have positive water quality impacts. These include in-field practices (e.g. nutrient management, residue management, extended cropping rotations, and cover crops), land use, edge-of-field practices (e.g. subsurface drainage bioreactors, saturated buffers, drainage water management, and wetlands),

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release of the Iowa

Nutrient

My confidence in lowans being a leader in bringing together agricultural productivity and environmental protection is justified by what farmers have done in the past to make lowa a leader in agricultural productivity. Historically, farmers have been asked to increase production and they have done that, but now they are being asked to take on this new challenge of maintaining productivity while enhancing water quality.

and practices that may be in-field and edge-of-field (e.g. contour buffers strips or prairie strips). All of these can provide water quality benefits but many also provide many other benefits including soil quality, waterfowl, wildlife habitat, and aesthetic value. Since certain practices may perform better in certain locations and some practices provide multiple benefits there is need for stakeholders to work together to implement a system of practices that result in the desired outcome. While there is uncertainty how we move forward and how fast we can move forward it certainly makes it an exciting time to work at the interface of agriculture and the environment.

At Iowa State University we are fulfilling the land grant ideals of putting science, technology, and human creativity to work on this critical issue. We have researchers in many departments developing new technologies and documenting performance of practices that can help us meet water quality goals. We have educational programs across campus that are preparing our students to be leaders in addressing these challenging issues. And, we have Extension professionals throughout the state working with farmers and other stakeholders to increase the understanding and implementation of conservation practices.

This is an exciting time to be working on these issues and we as Iowans have the opportunity to make a real difference in protecting our soil and water resources in the state of Iowa. Working together I believe we can achieve an agricultural system that maintains its economic vitality while increasing environmental benefits.



What is Soil Erosion?



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Figure 1 (right). Soil erodes all along the slope from left to right in this figure. However, some of the sediment from the upper slope has been deposited along the lower parts of the slope (the fence is almost buried from these deposits) while other detached and transported soil is lost from the field.

e recognize it when we see it. We talk about it. We normally know it is not good for soil or water. But what is soil erosion and what does it mean when we have a soil erosion rate of five or ten tons per acre? What happens to that eroded soil? Does it leave the field or farm? Does it end up in a river, lake or pond?

Soil erosion is the process of soil particle detachment from the soil surface by some force, transport of those soil particles some distance typically by flowing water or wind, and then deposition of those detached particles at some distance from their original location. Normally we think



of water or wind as supplying that force, but forces of tillage also causes substantial soil detachment, transport and deposition (that is another topic for another day). When we quantify soil erosion, we are identifying the mass of soil that has been detached and transported within a given area. It may be deposited within that same area or outside of that area. For example, if a field has five tons of soil erosion per acre, it means that five tons of soil have been detached from the soil surface, transported from its original location and deposited either in the field or perhaps outside the field or even the farm where the field is found.

This brings us to two other questions: Are soil erosion and soil loss the same? If

they are not the same, how do they differ? Soil loss is the amount of soil that leaves a defined area – normally a hill slope in a field. Remember that soil erosion involves detachment, transport and deposition, and deposition might occur within the area we have defined for our erosion and/or soil loss estimate. All soil that is lost has been eroded. However, all soil that has been eroded may not be lost. We give an example below to help clarify this concept.

We want to know the soil erosion and soil loss from a hill that has variable slope along it (see Figure 1); this is called a complex hill slope. Soil is detached and transported during a heavy rainstorm all along the slope. All of this soil will eventu-



ally be deposited somewhere so it is officially eroded soil. As the slope becomes gentler in some positions, however, the runoff water that is transporting the soil slows and some of the soil detached from higher and steeper parts of the hill is deposited on the hill slope before it leaves the bottom of the hill. All soil on the hill that

was detached, transported and deposited either on the hill slope or somewhere off the slope is eroded soil, but only the soil that leaves the bottom of the hill, which is our defined area for this estimate, is lost soil. This 'lost' soil has been removed from a defined hill slope area. It does not necessarily mean it leaves the field

or farm, however, the higher the erosion rate, the greater the risk of losing substantial amounts of soil from both field and farm.

A somewhat special situation occurs when the hill slope is uniform top to bottom, or we call these simple slopes. In this situation velocity of runoff water flowing down the slope does not slow as in the example above. All soil that is detached and transported leaves the bottom of the hill slope (the defined area) where it is deposited. This is a situation where soil erosion is equal to soil that is lost. Convex slopes also generally result in erosion rates that equal soil loss.

The most commonly recognized estimate of soil erosion in the US is found in the National Resources Inventory (NRI) (http://www.nrcs.usda. gov/wps/portal/nrcs/main/ national/technical/nra/nri/). The Natural Resources Conservation Service periodically estimates state wide average sheet and rill soil erosion rates (tons/acre/year) based on field management practices used by farmers and historic rainfall averages. These estimates assume that the randomly selected hill slopes used for soil erosion calculations are simple, which means soil erosion rate estimates are equal to soil loss in the NRI reports.

Another erosion estimator, the Iowa Daily Erosion Project, gives daily sheet and rill soil erosion estimates across Iowa using current field management, five minute precipitation estimates for all hill slopes from NEXRAD radar, and LiDAR to determine slope steepness and shape. Average daily hill slope soil erosion and soil loss estimates are given for each HUC 12 watershed in Iowa (http://idep.agron.iastate. edu/) (there are about 1,650 HUC 12 watersheds in Iowa; they average about 35 square miles in size). Because this project uses complex slopes (slopes that approximate real field topography) soil erosion and soil loss estimates are frequently not equal. Both are given in this project.

Understanding soil erosion terminology is important when estimating soil damage and off site impacts. A simple, but important thing to remember in the soil erosion world – lost soil is eroded soil, but eroded soil is not necessarily lost soil.

Learn. Network. Grow.

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ILF held 23 field days and workshops across the state in 2014, offering opportunities to learn from other farmers and experts in your area.

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Change your farming practices.

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Building a Culture of Conservation: Farmer to Farmer Iowan to Iowan

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Cover Crops: Game-changer for Water Quality in the Mississippi Basin

Sarah CarlsonMidwest Cover Crops Research Coordinator, Practical Farmers of Iowa

owa's landscape has gone through a major conversion over the past 70 years. Prior to the 1960s farmers grew crops in long rotations of corn, small grains, hay, etc., and also had livestock on the farm. Farmers also relied on a greater diversity of plants to have more resilience against both weather and market fluctuations. But over the past 70 years farms have become more specialized. Corn and soybeans dominate Iowa farms today, and although the total amount of livestock in the state is similar to 70 years ago it has been taken off the farm. With these landscape changes Iowa's water bodies have experienced increased levels of nutrient pollution. In response to this, Iowa became one of the first states in the Mississippi River Basin (MRB) to publish a strategy to decrease its agricultural impacts on water quality. In the Iowa Nutrient Reduction Strategy (NRS) Science Assessment practices like cover cropping, adding small grains or hay to bare cropground, or setting aside prairie, have a disproportionately high impact on reducing both nitrogen and phosphorus losses. Their high impact is a result of an increased amount of living roots in the soil throughout the year. Cover crops, hay, and small grains are predominately cool season plants with their living roots scavenging and cycling nutrients during the colder winter months. Twenty three million acres of Iowa cropground grow two warm season plants that have living plant roots present for only five months of the year. This leads to our greatest loss of nutrients occurring outside of the summer growing season. Increasing the amount of living roots year round dramatically decreases the amount of nitrogen and phosphorus lost.

For some corn and soybean farmers cover crops seem like a good practice to consider because they also improve soil health.



Due to this, cover crop acreage has surged in Iowa over the past six years. A recent Census of Agriculture report revealed nearly 400,000 acres are under cover crops in Iowa, and more can easily be created. Up to 19 million acres of corn and soybean ground in the upper MRB can easily incorporate cover crops. This landscape change would result in a reduction of 400 million pounds of nitrate-nitrogen (NO3-N) loading to the Gulf of Mexico, according to a study conducted by a team of agronomists. At today's current prices that nitrogen is valued at \$160 million.

The research, published in the 2014 July-August issue of the Journal of Soil and Water Conservation, quantified both potential cover crop adoption and reduction in NO3-N losses for 10 counties in five states (Ohio, Indiana, Illinois, Iowa and Minnesota) and the region. These counties are located in watersheds which flow into the MRB and contribute to hypoxia in the Gulf of Mexico. The research simulated the feasibility of planting cover crops based on the available land, crop rotation, and tillage systems. "The potential for adoption of cover crops in these critical

MRB watersheds is substantial and cover crops should be considered as one of the primary conservation practices to improve water quality" stated Eileen J. Kladivko. Winter cereal rye was the cover crop species used largely in the modeling scenarios as it is most commonly used among Midwestern farmers even if adoption is currently below 2%.

Several reasons explain why the adoption rate of cover crops is low, including the timing for successful seeding, establishment of the cover crop in the fall, and tillage system used. Lead researcher Eileen J. Kladivko explained how different tillage methods affect cover crop adoption. "Cover crops are easier to integrate into no-till and strip-till systems in general,

compared with a full-width tilled system because they allow earlier planting in the fall and more time for cover crop growth in the spring before terminating them with herbicides."

"We realize that farmers have a lot on their "plate" and that our estimates for potential cover crop use don't consider other factors like costs, labor, and logistics. But, we all know that we need to do a better job of reducing nitrogen losses and cover crops are one of the few practices that will do that plus protect soil from erosion and improve soil health at the same time," said Tom Kaspar co-author for this study and research scientist with the USDA Agricultural Research Service National Laboratory for Agriculture and the Environment.

Practical Farmers of lowa works closely with cover crop researchers and farmers to improve cover crop recommendations for lowa. To increase adoption PFI farmers share their knowledge with others at field days, in newsletter articles, and through our online webinars called Farminars. To learn more about what cover crop recommendations farmers are using for lowa visit www.practicalfarmers.org.





Irrigation with Marginal Quality Water in Israel: Boon or Bane?

Alon Ben-Gal

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Figure 1 (right).
Drip irrigated potato field utilizing brackish water in Israel's Southern Arava Valley Region.
Photo: Alon Ben-Gal

srael, a small country with a relatively solid economic base, but isolated due to geopolitical reality, is unique as a water-scarce country with successful agricultural development. The country's agricultural success can be credited to three central driving principles: 1) intensification and modernization of agricultural systems 2) development and adoption of efficient water application technologies, and 3) establishment of reliable sources for irrigation. Water consumption from all sources and for all sectors in Israel increased from 230 mcm (million cubic meters) in 1948 to 1997 mcm in 2002; only 82% of the present amount is annually renewable. The remaining water supplied has been obtained by groundwater mining, through the use of reclaimed wastewater, or by desalination. While per capita consumption in the domestic and industrial sectors has remained essentially the same, per capita water available for agricultural uses is less than half today compared to what it was in the 1960s. Despite the reduction, agricultural production per capita today is more than 150% of that produced 40 years ago (Ben-Gal, 2011).

Intensification and modernization of agriculture were accomplished in Israel by strong research and development programs, knowledge transfer to farmers,



and government support of national strategies. Drip irrigation was developed in Israel and is an inherently efficient technology used at rates higher than anywhere else in the world. Technologies and practices promoting water efficiency have further been encouraged by national water pricing and allocation strategies.

The third principle stimulating success, a reliable source of water for irrigation, has been trickier to accomplish. The national water carrier (NWC) conveys water from the Sea of Galilee in the north of Israel to points south, mixing it along the way with various ground and flood water sources. Average EC (electrical conductivity, a measure of salinity of a solution) of the NWC water has historically ranged from 0.8 to 1.1 dS/m. Freshwater use in agriculture has dropped from 950 mcm in 1998 to around 550 mcm today. Total water to agriculture has been maintained via the utilization of brackish and recycled water. Israel's agriculture directly uses some 80 mcm of brackish groundwater with an EC of more than 2 dS/m for irrigation. Wastewater recycling has

become a central component of Israel's water management strategy. A master plan presented in 1956 envisioned the ultimate recycling of 150 mcm of sewage, all of which would go to agriculture. Today three times that level is recycled, representing more than 60% of all domestic wastewater produced. Effluents (treated wastewater) today contribute to roughly 20% of Israel's total water supply and, depending on annual rainfall, up to 60% of the irrigation supply for agriculture. Salinity levels of recycled wastewater can range dramatically depending on type and origin, but no matter what, it increases as the wastewater stream advances. In Israel, municipal recycled wastewater typically ranges from an EC of ~1 to over 3 dS/m (Tarchitzky et al., 2006).

Unfortunately, due to the high concentrations of salts in irrigation water, Israel's strategy for agricultural success seems to be unsustainable. Long-term application of salts to agricultural soils in a region where seasonal rainfall is low, unpredictable, and often insufficient to rid the system of the salts, must



Figure 2. Citrus and date palm orchards in Israel's southern desert irrigated with brackish groundwater. Photo: Effi Tripler



Figure 3.
A traditionally extensively grown, rain fed crop (olive) grown super-intensively in Israel's Negev highland desert. Photo: Arnon Dag



Figure 4.

Desert vegetable production based on irrigation with brackish water in green- and net-houses surrounding an agricultural community in Israel's Northern Arava Valley.

include application of water designated to leach accumulating salts out of the root zone. The water applied for leaching and leaving the root zone contains not only the salts that must be leached, but also various other contaminants added in agricultural processes (e.g. fertilizers and pesticides), or mobilized from soil and subsoil (Ben-Gal, 2011; Ben-Gal et al., 2008, 2013). Additional indications of problems with irrigation from effluents and other salt-rich water sources are found in: long-term increases in the soil sodium adsorption ratio (Segal et al., 2011); as a trend of increasing sodium and chloride found in irrigated plant tissues (Raveh 2013); in the tendency for Israeli fresh produce to have higher than international standards of sodium levels (Eran Raveh. personal communication; Raveh and Ben-Gal, in review); and in concerns regarding detrimental long term repercussions due to trace level contaminants in agricultural systems and the food chain (Goldstein et al., 2014).

In spite of all this, the latest responses of Israel to insure a reliable municipal water supply to its growing population, may coincidentally

provide an opportunity for a sustainable solution for agriculture. Starting in 2006. Israel has added desalinated seawater to its water distribution stream. Desalination currently provides around 30% of Israel's total water supply, often incidentally bringing very good quality water to agricultural areas and consistently reducing the salinity of recycled waste water (Yermiyahu et al., 2007). The turn to desalination as a strategy for water security is a positive opportunity to reverse the dangerous and apparently unsustainable trends consequential to irrigation with water containing high salt concentrations. Sustainable, healthy, economical, irrigated agriculture in Israel and other semi-arid and arid regions is feasible if the salts are removed before application, and not allowed to negatively affect soils, crops, produce, and the environment.

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Declining Soil Organic Matter Levels in Iowa Crop Systems

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oil organic matter is the largest direct source of nitrogen to crops. Iowa soils managed in corn and soybeans often contain more than 100x the average annual nitrogen fertilizer input – in other words, soil organic matter contains more than 10,000 pounds of nitrogen per acre! Naturally high soil organic matter and favorable climate make Iowa a national leader in crop production. Thus, good stewardship of the soil resource is essential to the future of Iowa's agricultural economy.

Although proper nutrient input is an essential component of soil organic matter maintenance, nitrogen fertilizer alone is not capable of maintaining soil organic matter or the nitrogen within it. To increase and maintain soil organic matter, carbon and nitrogen inputs must occur in tandem. Nitrogen can come from fertilizer, but the carbon must come from an external source of organic matter, typically manure or crop residue. In fact, the amount of soil organic matter is positively related to organic matter input (Fig 1).

In the absence of manure, crop residue (the un-harvested portion of crops) is the sole source of soil organic matter. An increase in crop yield provides an increase in crop residue because crop residue is a constant proportion of total crop production (roughly 50%). Soil fertility management that provides proper nutrient inputs benefits soil organic matter because it maximizes crop production.

Based on the importance of soil organic matter to crop production, the 2011 Iowa Legislature requested a formal study of the long-term sustainability of soil organic matter nitrogen in Iowa's major crop systems. This study was conducted by post-doctoral researcher Laura



Christianson, Professor of Agriculture and Biosystems **Engineering Matt** Helmers, and Assistant Professor of Agronomy Mike Castellano. The study examined the status of soil organic matter nitrogen levels in Iowa continuous corn and cornsoybean rotation crop systems. Two methods were used: The first was a mass balance approach. This

method estimates all nitrogen inputs and outputs from the system. It is based on the conservation of mass: nitrogen inputs to the soil (e.g., fertilizer, atmospheric deposition) minus nitrogen outputs from the soil (e.g., grain harvest, leaching) must equal nitrogen storage in the soil. The

Although continuous corn has a neutral or positive organic matter balance and corn-soybean rotation has a negative soil organic matter balance, continuous corn has lower nitrogen use efficiency and greater environmental nitrogen losses.

second method measured the long-term change in soil organic matter nitrogen levels in continuous corn and corn-soybean crop systems at three locations in the state.

Results from the two methods were clear and consistent. Iowa corn-soybean systems managed with optimum nutrient inputs but no organic matter inputs beyond crop

¹Soil mass balance study

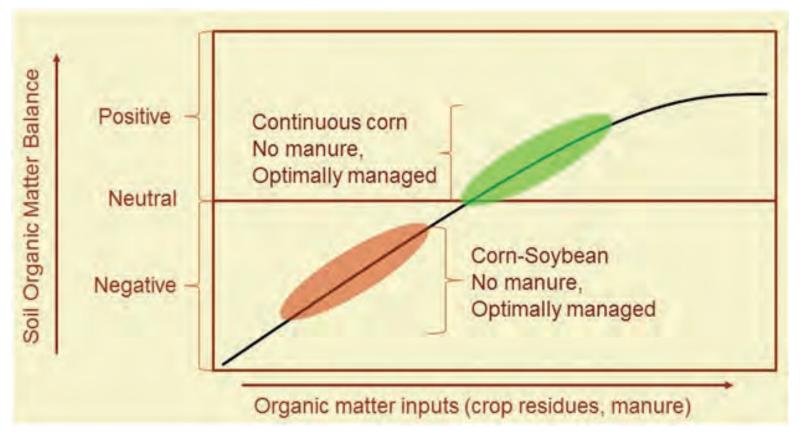


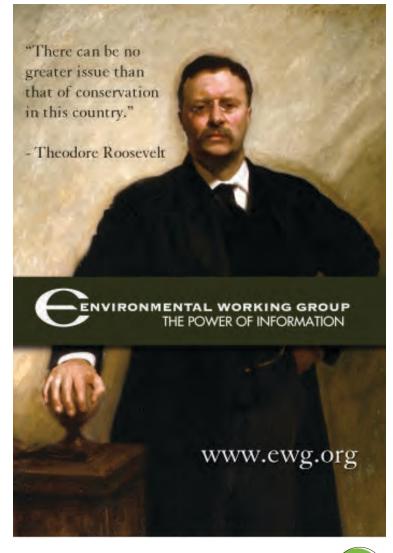
Figure 1 (above).
The response of soil organic matter (both carbon and nitrogen) to increasing rate of organic matter inputs.
Evidence suggests corn-soybean systems are losing soil organic matter carbon and nitrogen while continuous corn systems are neutral or gaining soil organic matter.

residues are losing soil organic matter at an approximate rate of 500 pounds of carbon and 50 pounds of nitrogen per year. In contrast, continuous corn systems, when managed with optimum nutrient inputs but no organic matter inputs beyond crop residues are gaining or not losing soil organic matter.

The contrasting results between the two systems are due to different crop residue inputs. Average annual crop residue inputs in continuous corn are approximately 20% greater than average annual crop residue inputs in corn-soybean rotation (despite the fact that corn yields are approximately 15% lower in continuous corn than corn-soybean rotation due to the rotation effect). The primary challenge is that soybean produces very little residue - less than half that of corn. Additional

organic matter inputs are likely required to sustain soil organic matter in Iowa corn-soybean rotations. Manure and cover crops are two potential sources of additional organic matter inputs.

Although soil organic matter nitrogen balances are neutral or positive in continuous corn and negative in corn-soybean rotations, there are trade-offs when determining the long-term sustainability of these two crop systems. Nitrogen use efficiency is greater in a corn-soybean rotation. Continuous corn requires greater nitrogen inputs and loses more nitrogen to the environment than a corn-soybean rotation. Results from this study should encourage the proper use of manure because it provides a nutrient source to crops while building soil organic matter.





Precision Soil Conservation Curriculum Piloted in the South Fork Watershed

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ere at Iowa State University in the Agricultural Education Department, we have been working in partnership with the National Institute for Food and Agriculture (NIFA), United States Department of Agriculture (USDA), Ball State University, Agren, and the South Fork Watershed Alliance to develop a Precision Conservation Planning Curriculum for Iowa Agricultural Educators. This curriculum highlights goals and expectations provided by NIFA and the USDA grant project. The Precision Conservation Planning Curriculum was pilot tested in the Fall of 2014 at three North Central Iowa high school agricultural departments and will be tested again in the Spring of 2015 at another North Central Iowa high school. As of mid-December, we began reviewing teacher feedback and assessing student scores to determine what modifications should be made in order to release this curriculum statewide this Summer.

High School agricultural educators, Doug Dodd at Iowa Falls-Alden and Kurt Veldhuizen at Webster City, are two of the four pilot study teachers who implemented the curriculum this Fall. Dodd and Veldhuizen found the curriculum to be challenging for their high school students, but plan to continue utilizing the curriculum as it introduces their students to concepts that are not often taught at the high school level. Veldhuizen expressed his appreciation for the partnership with Agren and the ability to use their tools (Soil Loss Calculator, Basin Builder, and



Pond Builder). Veldhuizen said that the students gained a lot from being able to utilize online resources, but found there to be several resources packed into what was supposed to be a two-week curriculum. Our focus is to keep the curriculum at two weeks, but it was suggested to offer a two-week or four-week curriculum based on the needs of the teacher. As we work to modify the curriculum, we plan to leave the resources as an optional appendix so that each teacher can use them at their own discretion.

Greg Pfantz, high school agricultural educator at South Hardin, also implemented the curriculum with a block schedule. Pfantz's feedback allowed us to determine how each lesson can be modified

to fit the time structure of period and block schedules. Sarah DeBour at Hampton-Dumont and CAL will be implementing the curriculum in the Spring which will provide us with more feedback as we move forward in developing a curriculum that can be adapted statewide.

In order to develop a curriculum that focused on the needs of the teachers, community, students, and school in the South Fork Watershed, we developed a needs assessment to determine the need for soil conservation or water quality curriculum and the time frame appropriate for implementation at the high school level. At the time of the needs assessment, the four pilot study teachers did not currently teach any lessons on soil conservation and

The curriculum is focused around the Agricultural, Food and Natural Resources Standards, Iowa Core Mathematics and Iowa Core Science Standards, and the Next Generation Science Standards.

thought that a one to two week unit would be effective within their Soils, Plant Science, or Natural Resource courses they were teaching this Fall. We also determined that students receiving the instruction had already had a basic understanding of soil properties and functions.

The current curriculum is comprised of six lessons, each with its own focus pertaining to precision conservation planning. Each lesson is complete with lesson plans, student activities, rubrics, and projects or assessments that build towards the final unit assessment. The curriculum is focused around the Agricultural, Food and Natural Resources Standards, Iowa Core Mathematics and Iowa Core Science Standards, and the Next Generation Science Standards

The first lesson details the different types of erosion and more specifically, the major forms of water erosion. It begins as a basic introduction for the students to grasp the main concept of soil erosion and how it impacts their lives. The second lesson focuses on the Universal Soil Loss Equation and the factors that are used to calculate soil loss and is cross-walked with national math standards. The third lesson introduces erosion control practices through a student inquiry based approach. Within the first three lessons, students are asked to use social media

in order to identify soil erosion in their home communities, determine the amount of soil loss in a local field, and construct a sales pitch to determine which erosion control practice would best fit a given situation.

The fourth lesson asks the students to test local water sources and determine the health of these sources. The importance of this lesson is in providing students with the opportunity to connect the water cycle, nitrogen cycle, phosphorous cycle, and the relationship between water quality and soil erosion. An outcome of this lesson would be that the students design a one to two minute Public Service Announcement

Lessons five and six focus heavily on the integration of technology and precision soil conservation tools. Agren has agreed to open a few of their soil loss calculation tools for the students to use within the pilot study classes. Through this application, students can determine where certain erosion

discussing what

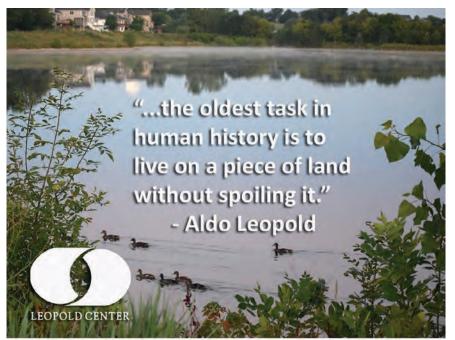
to this point in the unit.

they have learned

control practices would best benefit on their own farm, or rural farms in their area. As a goal of these lessons, the students are asked to design their own precision conservation technology and showcase it among their classmates. The final unit assessment of the Precision Soil Conservation Curriculum is focused heavily on reaching the community. Students are asked to compile each of their projects for display at a field day.

As the Precision Soil Conservation Curriculum is revised and edited according to the suggestions of the teachers and students, it is our hopes to implement this

curriculum to agricultural educators around the state. The four teachers who worked in part of this initial pilot study, will help to train Iowa's agricultural educators at their annual summer conference in June. We are very appreciative of these teachers' help as well as all the students involved. We are looking to any local and state entities to offer their time as resources for students and teachers in order to spread understanding and knowledge about precision soil conservation and the concerns of soil erosion across the world.



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Is Cellulosic Biofuel a Threat or Driver for Soil Conservation?

Douglas L. Karlen

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Figure 1 (right). The POET-DSM cellulosic conversion facility near Emmetsburg, IA.

√hree commercial corn (Zea mays L.) stover bioenergy conversion facilities, such as the POET-DSM operation near Emmetsburg, Iowa (Figure 1), will be operational in the United States in 2015. This a strong market signal that the quantity of cellulosic feedstock harvested from our agricultural landscapes will increase dramatically during the next few years as the U.S. strives to produce 60.5 billion liters (16 billion gallons) of cellulosic biofuels each year in response to the Renewable Fuels Standard (RFS2). Based on current conversion technology, achieving that level of production will require 242 million Mg (266 million tons) of biomass each year for each plant that produces biofuel at a rate of 252 L Mg-1 (60 gal ton-1). What impact will this have on our soil and water resources? My career as a Research Soil Scientist with the USDA Agricultural Research Service (ARS) began with studying the impacts of harvesting crop residues for bioenergy production following the first U.S. gas crisis in the 1970s. My goal is to challenge "Getting into Soil and Water" (GISW) readers to pursue careers that will help ensure this feedstock is harvested in a sustainable

Some may argue that other forms of renewable energy (e.g., solar, wind, hydro, tidal, or geothermal) should be pursued, but it is not actually "energy" we want; rather it's the services that energy provides. These services include work, heat, cooling, illumination and mobility. The first three services can be provided by renewable



It is not actually "energy" we want; rather it's the services that energy provides.

electricity derived from many sources, but we are much more constrained regarding renewable mobility, defined as the ability to transport our goods and ourselves. At best, renewable electricity can provide about half of current mobility services, mostly for personal vehicles and light duty transport. However, the current U.S. infrastructure simply cannot support 100% conversion of passenger vehicles to electric power. In 2008, the total U.S. light duty vehicle power consumption was equal to approximately

0.56 TeraWatt (TW). In contrast, total U.S. electricity generation across all sectors was equal to only approximately 0.47 TW. Furthermore, this comparison does not take into consideration energy inefficiencies (losses) during electricity transmission and conversion to mobility. These losses can amount to about 25% of the electricity generated.

A majority of human wealth and most opportunities for human development depend on liquid fuels derived from



Figure 2. Based on the amount of bare soil, this may be a "non-sustainable" corn stover harvest operation in Iowa.

petroleum. Liquid fuels are essential for aviation, ocean shipping, and most land freight (heavy truck and rail transport). Within (or even without) the context of peak oil, obtaining renewable liquid fuels must be our most pressing renewable energy priority. The only renewable source of high-density energy liquid fuels is biomass or plant matter. By far the most abundant, and potentially the most sustainable source of renewable liquid fuels (biofuels) is cellulosic or nonfood plant biomass.

In the U.S., the primary biomass source in the near future will undoubtedly be corn stover because of the vast area upon which the crop is grown. Harvesting a portion of the stover is also gaining popularity among farmers because of increasing crop residue management challenges. Current "Cost of Production" estimates by Iowa State University Extension suggest that farmers are currently paying from \$45

to \$65 ha-1 (\$20 to \$30 ac-1) to manage crop residues, primarily by increasing their tillage intensity. Therefore, a key challenge for those interested in soil and water conservation is to determine how to sustainably harvest corn stover without degrading natural resources. Additionally, consider the necessary increase in productivity to maintain the food, feed, fiber and fuel demands of nine billion people.

Sustainable stover harvest strategies are essential because crop residues are also needed to support many ecosystem and soil health services. Crop residues protect the soil surface, help mitigate wind and water erosion, and are needed to sustain soil organic carbon (SOC.) SOC influences chemical properties such as nutrient retention and release to plants; physical properties such as aggregate stability, surface crusting, and water infiltration and retention; and biological properties such as the fungi:bacteria ratio

Obtaining renewable liquid fuels must be our most pressing renewable energy priority

within the soil's microbial community. Excessive stover harvest (Figure 2) as well as more intensive tillage to bury crop residues are poor management decisions that can easily increase surface runoff and erosion during the winter and early spring.

So, given the fact that: (1) the only renewable source of high-density energy liquid fuel is biomass or plant matter and (2) crop residues are also needed to support many ecosystem and soil health services. How can this "wicked" problem be solved? My recommendation is that all future generations of conservationists, farmers, environmentalists, and others striving to move the fledgling bioenergy and bio-product

industries forward is to adopt and promote a landscape vision for optimizing land use. This vision can be implemented by reintroducing biomass crops into vulnerable areas that in many years are not profitable for row crop production. This land use change could also provide several critical ecosystem services and help mitigate runoff and/or drainage water losses associated with continuous row crop production for the past several decades. Utilizing this strategy also means that cellulosic biofuel production is not a threat but rather an avenue for greater adoption of soil and water conservation practices.



When Are Soils Marginal?

Lois Wright Morton

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here is a wide variation among US soils both geographically and at different depths. The distinct traits of these soils have been divided into 12 different soil orders using a classification system similar to how animals or plants are classified, separating them into genus and species. A county soil map provides a visual image of the diversity of soils. If you take a closer look at the soil when you walk across a field, you will likely see noticeable differences in color, texture, and plant growth. If you dig a pit in these soils, there would be more differences below the soil surface.

The concept of soil marginality has its origins in how humans value the functions of soils and the different characteristics they provide. Although soil has many uses, some functions are valued above others. Historically, particular soils have been highly valued for how well they effectively and efficiently produce food and a living from agriculture. Soils that were permanently wet, subject to periodic overflow by steams, or too wet for growing profitable crops were not considered to have valued qualities. They were labeled marginal. The National Swamp Land Acts of 1849, 1850, and 1860 transferred more than 65 million acres of public wetlands thought to be of no value, to states and private interest groups to encourage land drainage and development. It is only in recent years that scientists have learned that these wetland soils are valuable and have functions essential to the carbon, nitrogen, and water cycles of the earth's ecosystems.

The characteristics of each soil series affect the functional uses and ecosystem

services they have the capacity to provide. One primary function of soil is to grow crops to meet needs for food, fiber, and fuels. Another function is the regulation of the ecosystem by filtering, retaining, and cycling nutrients. Nutrients, such as phosphorus, nitrogen, carbon, hydrogen, magnesium,

potassium, are elements and compounds that plants, humans, and animals use to survive and grow. Other soil functions are regulating the water cycle; supporting biological activity and diversity (such as worms, other microorganisms, and vegetation for wildlife) and; filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic materials, such as industrial and municipal by-products. In the past many of these ecosystem functions have not been well understood or valued.

The characteristics of soil can be altered and their functional value lost by natural causes and human activities. For example, soil that loses organic matter has a reduced capacity to hold moisture, in turn making it less valuable to agriculture. Soil erosion, soil contamination, and soil loss from water runoff (becoming sediments in water bodies) degrade soil capacities to function effectively. The suite of crops and management practices farmers select to achieve crop productivity and profitability affect whether their soils' value is increased or reduced. For example, fall tillage leaves the soil bare all winter exposing it to wind and water erosion that degrades its value and leads to marginality over time. Alternatively, cover crops used after a cash crop is harvested, can increase soil organic

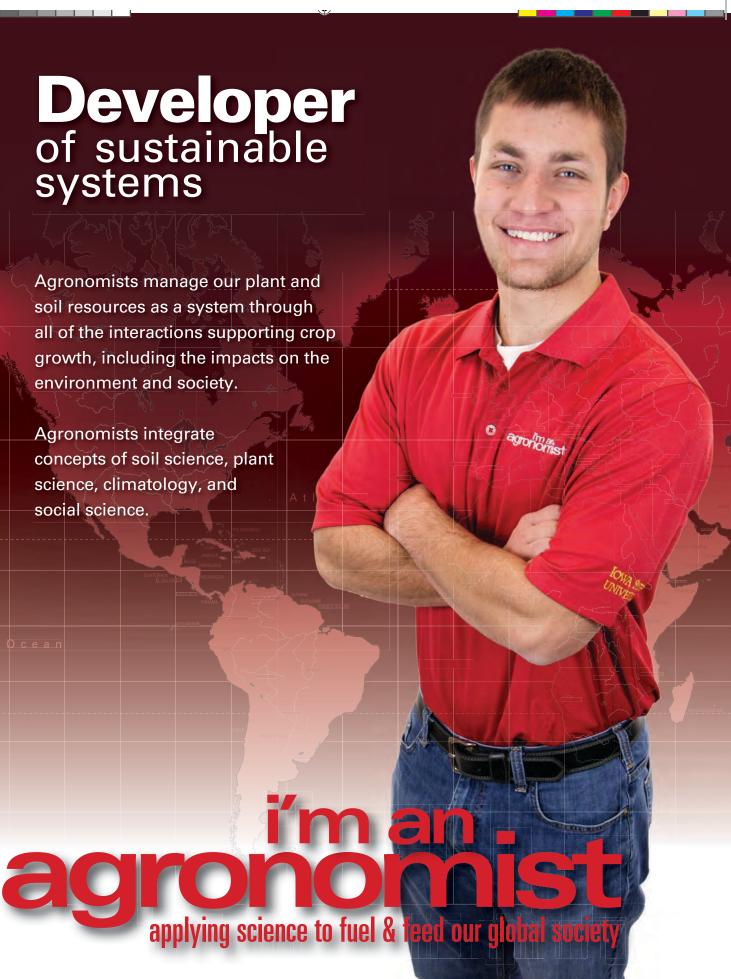
The concept of soil marginality has its origins in how humans value the functions of soils and the different characteristics they provide. Although soil has many uses, some functions are valued above others.

matter, scavenge excess nitrogen so it is not lost to nearby streams, and protect against wind and water erosion. Thus, it increases the value of the soil by improving its capacity to carry out its functions.

Landowners and managers who value their soil seek to understand its characteristics and identify the functions it is best suited for. They manage their soil to protect its unique characteristics with goals to eliminate erosion and sediment losses into nearby creeks and streams; and enhance biological functions that increase soil quality and reduce the chances that it will become marginal and not useful. Swampland, once thought to have marginal soils of no value unless drained, are now understood to be valuable wetlands with multifunctional uses providing habitats for diverse animal and plant species and essential ecosystem services to agriculture and human society.

Adapted from Hatfield, J. and L.W. Morton, (2013). Chapter 2 Marginality Principle. Pp19-55.In R. Lal and B.A. Stewart (Eds), Principles of Sustainable Soil Management in Agroecosystems. Advances in Soil Science. NY,NY: Taylor & Francis, CRC Press.

Download soil app for where you are: http://casoilresource.lawr.ucdavis.edu/drupal/book/export/html/902



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A Planning Approach for Agricultural Watersheds Using Precision Conservation

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USDA-ARS, National Laboratory for Agriculture
and the Environment, Ames
Iowa State University

idwest farmers need
to reduce nutrient

to reduce nutrient losses impacting the Gulf of Mexico and Great Lakes. This challenge is continental in scale, but involves the management of thousands of small watersheds comprising millions of farm fields. Any successful strategy must be adaptable to many landscape and farm management settings. This article describes a flexible approach that can help farming communities to develop and compare conservation planning scenarios suited to the watershed they live in.

Foremost, this approach emphasizes practices that promote healthy functioning of soils. Practices that control erosion, enhance infiltration and water retention, and improve nutrient-use efficiency can be thought of as the foundation of a "conservation pyramid" (see Figure 1). Because of the broad importance of sustainable soil management, these 'soil-building' practices (e.g., minimum tillage, nutrient management, cover crops) are emphasized without geographic "targeting".

Additional conservation practices that can reduce nutrient loads are effective when placed to intercept water where it accumulates and flows in a watershed. Geographic analyses can identify locations suited for a variety of practices, by applying criteria to mapped information including soil survey, land use by field, detailed elevation data from LiDAR (light detection and ranging) surveys, and stream-courses. We have developed GIS-based tools to suggest suitable locations for a variety of practices in fields, below fields, and in riparian zones, in places where surface runoff and/or subsurface (tile) flows can be intercepted. Because tile drainage carries

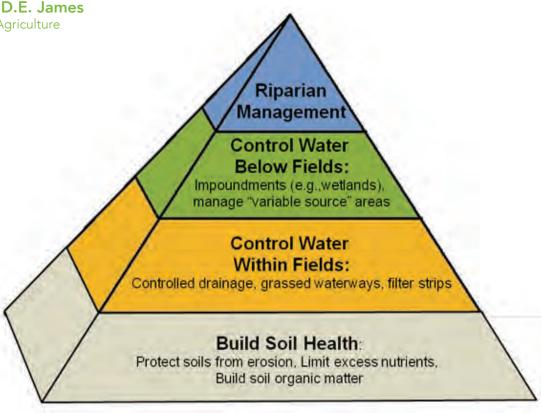


Figure 1 (above).

A conservation pyramid that provides the conceptual basis for this watershed planning approach (Tomer et al., 2013).

substantial loads of nutrients, especially nitrate-nitrogen, to Midwestern streams, tools are used to identify options to intercept and treat tile drainage.

Results produced by the practice placement tools are not recommendations, but provide a planning resource that enables local conservationists and landowners to identify preferred practices and locations suited to their own landscape. To explore these options, planning scenarios comprised of different combinations of practices can be developed to achieve a certain goal.

Lime Creek in Northern Illinois provides an example watershed for illustration. Lime Creek (16,000 acres) is covered by glacial till and has hilly terrain that grades to a flat landscape with poorly drained soils in the southern part of the watershed. Our focus here is on reducing nitrate- nitrogen loads.

Based on slope and soil-type criteria, the extent of tile drainage in the watershed was estimated to be 201 of 243 cropped fields. We identified and compared a range of conservation planning scenarios for Lime Creek, including cover crops distributed at random to emphasize the importance of soil-building practices, drainage water management and nutrient removal wetlands to address tile drainage.

We found 51 flat fields in Lime Creek that were likely suited for installation of drainage management systems. This practice, comprising control-gate structures at field edges to control water table depths, can reduce drainage volumes, thereby limiting nitrate losses as well.

We found about 15 locations potentially suited for nutrient removal wetlands, which can substantially reduce (denitrify) nitrate loads from tile drainage. Seven of Rather than asking which individual practices are most efficient for nutrient removal, this approach addresses the question of how to best distribute several practices to intercept and treat water flows throughout the watershed with minimal loss of working lands.

these wetland sites were included in our planning scenarios; i.e., those located furthest downstream along each tributary. These seven wetlands could reduce nitrate in tile drainage from 29% of the watershed, while taking little cropland from production.

The results were compared to estimate the best management for the watershed, based in the proposed goal. Figure 2 depicts a planning scenario for Lime Creek that could meet a 40% nitrogen reduction, while removing only about 3% of the watershed from crop production. Scenarios retaining the most land in crop production will usually be preferred by local landowners for voluntary implementation. The approach could be altered to include past-installed practices, effects of crop rotations, and/ or differing nutrient removal efficiencies expected among practices. This planning method could help local communities identify realistic planning scenarios for their watersheds and compare them for likely impacts on nutrient loads and crop production.

FURTHER READING

Tomer, M.D., S.A. Porter, D.E. James, K.M.B. Boomer, J.A. Kostel, and E. McLellan. 2013b. Combining precision conservation technologies into a flexible framework to facilitate agricultural watershed planning. J. Soil Water Conserv. 68(5):113A-120A.

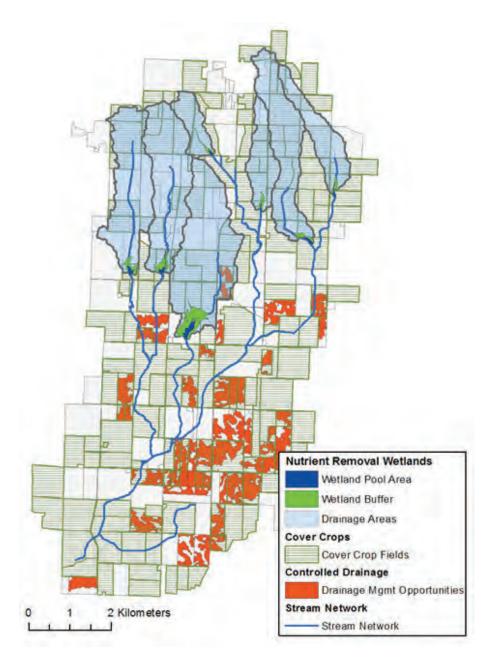


Figure 2 (above).

An example conservation planning scenario for Lime Creek watershed that could provide a 40% nitrogen reduction. The scenario includes a soil improvement practice (cover crops), a practice for water control within fields (drainage water management), and a practice installed below fields (nutrient removal wetlands).





IOWATER: Engaging Iowa's Citizens to Understand and Protect Iowa's Water Quality

Mary Skopec

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Figure 1 (right).
Students collecting aquatic benthic macroinvertebrates to test the health of a local stream. Photo by IOWATER program.

ver the past decade, water quality in Iowa has become an area of intense scrutiny as lawmakers, water quality enforcement officials, and citizens struggle with how to reduce nutrients, bacteria and sediment that frequently contaminate Iowa's waterways. IOWATER, Iowa's volunteer water quality monitoring program, empowers citizens to become engaged in these discussions and to take a proactive approach to improving water quality. By monitoring the water resources in our backyards, we can ensure the protection and productivity of high quality water resources as well as evaluate, assess, and improve those of lower quality. IOWATER brings people closer to the landscapes that surround them and encourages them to develop a sense of stewardship for their local waterways.

Becoming an IOWATER volunteer is an easy process. Volunteers attend an 8-hour workshop and learn the basics of conducting chemical, physical, and habitat tests. All tests are "field" tests - conducted at the edge of the water and using a simple test kit. Tests include nitrate, nitrite, phosphate, chloride, water transparency (a measure of how clear the water is), dissolved oxygen, and pH. At the end of a workshop, volunteers are given all the equipment they will need to monitor a local stream, creek, lake, pond, or wetland. Interested volunteers can continue their education and involvement by taking additional classes in observing and monitoring aquatic life, such as dragonflies, stoneflies, mayflies, etc., and sampling and



culturing bacteria (Figure 1). The program is intended to be flexible, allowing volunteers to dedicate as much time and energy as they can fit in their schedule.

Volunteers can select a site to monitor and collect data on a set schedule of their choosing, or volunteers can become involved in "snapshot sampling" events that combine the power of individuals into a greater whole. During a snapshot, multiple sites throughout a geographic area are sampled within a short period of time. The results provide a picture in time of water quality. Snapshots have not only increased public awareness of local water quality issues, but have also provided baseline data, and identified sites in need of further monitoring. For example, snapshots conducted in both the spring and fall provide data that can be used to compare high-versus low-flow conditions. Spring sampling has shown more nonpoint source inputs including higher nutrient concentrations, elevated fecal bacteria levels, and decreased water clarity (Figure

2). Fall sampling has identified more point source inputs, including elevated chloride levels, which suggest human and/or animal inputs or road salt applications (Figure 3). Since August 2000, volunteers across Iowa have participated in 223 snapshot samplings held at county, watershed, and statewide levels. More than 6,670 Iowans contributed nearly 26,700 hours towards the success of these events.

IOWATER WORKS IN THE CLASSROOM...

Educators throughout Iowa have incorporated IOWATER into the classroom – allowing students to investigate questions about the quality of their local water resources and involving them in local decision-making. In one southern Iowa community, students are helping to collect data to document the effectiveness of erosion control practices that have been implemented on farm fields. Students in central Iowa are collecting data

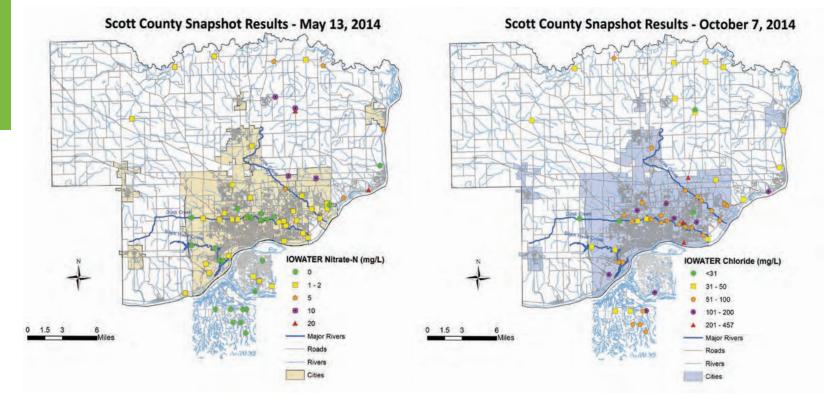


Figure 2.
Map of nitrate measurements taken during the May 2014 Scott County snapshot. Note the higher levels of nitrate in the rural areas compared to the urban locations.

Figure 3.
Map of chloride measurements taken during the October 2014 Scott County snapshot. Note the higher levels of chloride in the urban areas compared to the rural locations.

for a municipality as part of the town's federally required storm water permit program. While in Eastern Iowa, students are comparing water quality from rural, industrial, and urban sites and testing hypotheses about how water quality at each site will change through time.

IOWATER WORKS IN THE FIELD...

Aside from the obvious educational value of the program, IOWATER data have proven to be beneficial in many other circumstances. For example, IOWATER volunteers/trout fishermen in the cold water streams of Northeast Iowa collected data that state officials used to support reclassification of a warm water stream to cold water. These volunteers discovered a previously unknown resource and their

data indicated the high quality of the resource, while continued monitoring ensures its future protection. In Central Iowa, an IOWATER volunteer was approached by concerned citizens who could no longer ignore the foul-smelling creek that flowed through their small town. Simple observations revealed the abundance of sewage algae and bloodworms, and data revealed elevated nutrient concentrations, leading state and county officials to believe that illegal septic hookups may be the problem (Figure 4). The problem has since been addressed and the creek is now free from sewage.

IOWATER WORKS FOR DECISION MAKING...

One of the typical stumbling blocks for groups working to protect and improve water quality is a lack of data to

document the baseline water quality in their local waterbody and show the magnitude of the issues that exist. IOWATER data can fill these data gaps at a significantly lower cost while building a coalition of motivated and dedicated citizens. For example, data gathered by IOWATER volunteers were used to develop a watershed management plan for Squaw Creek located in Ames, Iowa. "As a Soil and Water Conservation District Commissioner, I am interested in water quality in local streams so that I can better inform the public. Data collected by IOWATER volunteers is used by the city of Ames to enhance the city's own monitoring program and is used as a 'first alert' for major problems such as sewer breaks. IOWATER data are also important for recommending

conservation practices to agriculture producers, storm water managers and residents. More recently, IOWATER data collected in the Squaw Creek Watershed over the last 14 years has provided baseline water quality information for the newly formed Squaw Creek Watershed Management Authority to develop a 20-year plan to improve water quality in this major tributary to the South Skunk River." - Erv Klaas, IOWATER volunteer.

Volunteerism is the epitome of selfless service. Volunteers dedicate their time and service, quietly and without applause. The success of the IOWATER program is undoubtedly a direct reflection of our state's most precious resource – Iowans. Their hard work, dedication, pride, and passion for the state is unmatched by any others.



Implications of Algae Blooms on Water Quality- Lake Erie

Michelle Soupir

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f you enjoy swimming, fishing, or boating in Iowa lakes and rivers, you might notice the water turning a greenish color during the summer months. What many often mistake as small green plants is actually an algae bloom.

Algae are broadly defined as a diverse group of eukaryotic organisms that can range in size from single celled to large multicellular forms. Algae are differentiated from plants in that they do not contain roots, stems, and leaves. Algae become a problem in both fresh and marine waters when it grows excessively. Some algal blooms can produce toxins that can be dangerous to animals and humans. Algae blooms also create dead zones in waters and can raise the cost for treating drinking water.

Algae are naturally occurring organisms, but excessive growth occurs when nitrogen and phosphorous levels in the water are too high, causing the algae population to increase too rapidly. Nitrogen and phosphorous in water can come from many different sources, both point and nonpoint sources of pollution. Point sources come from specific, identifiable locations such as a pipe entering a water body, while nonpoint sources are more difficult to identify. Nonpoint sources of pollution are diffuse, meaning they are generated in a watershed and typically move into waters during storms. Examples of nonpoint source pollution include runoff from agricultural lands and small urban communities, runoff from small construction sites, and atmospheric deposition over surface water bodies. Rising nutrient levels in waters promote the excessive growth of algae. Following



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this explosive growth, the organisms die and sink to the bottom of the water body. At this point the algae are decomposed and consumed by bacteria, converting the organic matter into inorganic forms of nutrients. During decomposition, the bacteria utilize oxygen in the water making it unavailable for fish and shellfish. Areas with now low levels of dissolved oxygen can result in fish kills and "dead zones".

According to the U.S. Environmental

Protection Agency, algae blooms in waters are a major environmental problem in all 50 states. In the past decade, the presence of harmful algal blooms (HAB) has increased, most frequently due to what are commonly called blue-green algae, but which are actually cyanobacteria (a prokaryotic organism). Cyanobacteria produce microcystin, which can lead to respiratory conditions, headaches, earaches, abdominal pain, vomiting and diarrhea, agitation, eye irrigation, and dermatitis in exposed





humans (KDHE - http://www.kdheks.gov/algae-illness/). A cyanobacteria bloom often looks like foam, scum or mats on the water surface and can be blue, bright green, brown or red in color; often described as looking like paint floating on the water surface (CDC - http://www.cdc.gov/nceh/hsb/hab/).

WHAT IS GOING ON IN LAKE ERIE?

The Great Lakes hold 21% of the worlds, and 84% of North America's, fresh surface water (EPA - http://www.epa.gov/ greatlakes/basicinfo.html). This abundant water supply has been in the news lately due to harmful algae blooms, particularly in Lake Erie. Lake Erie is particularly vulnerable to excessive algae growth since it is the shallowest of the Great Lakes and the depth of the western basin (20% of the lake) averages only 24 feet. While these blooms have been an ongoing problem in Lake Erie for the past decade, a particularly alarming event occurred in August 2014, when more than 500,000 people were left without access to safe drinking water in Ohio and Michigan. Water treatment plants detected unsafe levels of microcystin in the Toledo water system

at more than double the threshold of 1.0 ppb set by the World Health Organization. More than 100 people who had consumed the water came to emergency rooms in the Toledo area with symptoms including upset stomachs, dizziness, and vomiting (http://www.post-gazette. com/news/nation/2014/08/02/ Algae-blooms-in-Lake-Erie-contaminate-waterin-Ohio-and-Michigan/ stories/201408030173). Along with the risk to public health, these blooms lead to poor aesthetics, beach closures, and a loss in tourism revenue.

The situation last summer was thought to be highly unusual as wind patterns led to the blue green algae bloom being pushed near the water treatment plant intake area; however, unless changes occur in the surrounding watershed, these blooms will continue to occur. The situation in Lake Erie is thought to be a combination of increased phosphorous contributions to the lake, the presence of invasive mussels, and climate change. The concentration of dissolved reactive phosphorous in the near-shore areas of the lake has been increasing since the mid-1990s and is attributed to runoff from farmland amended Point sources come from specific, identifiable locations such as a pipe entering a water body, while nonpoint sources are more difficult to identify. Nonpoint sources of pollution are diffuse, meaning they are generated in a watershed and typically move into waters during storms.

with chemical fertilizers and manures, wastewater treatment plants, leaking septic systems, and urban storm water discharges. Invasive mussels, specifically the zebra and quagga mussels, consume algae but not the microcystis algae blooms.

Controlling algae blooms will require coordinated efforts from many different stakeholders. Through the Great Lakes Water Quality Agreement (1972), the governments of Canada and the U.S. are working together to reach the goal "to restore and maintain the chemical, physical, and biological

integrity of the water of the Great Lakes Basin Ecosystem". This is being accomplished through the implementation and development of The Lake Erie Lakewide Action and Management Plan, and in 2013 a Lake Erie Binational Nutrient Management strategy was published (http://www. epa.gov/greatlakes/lakeerie/ lake-erie-lamp-2013-eng. pdf). Progress is being made, and public dollars are being invested to reduce drinking water treatment costs. improve fish and wildlife habitat and populations, and increase recreational opportunities in and around the lake. 🚇



Iowa Drainage Districts

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ery simply; drainage districts have been created for the purpose of moving excess moisture from the surface of the land to create better conditions for growing crops. Drainage is recognized as a way to increase the productivity of land used in row crop production. Iowa would not be the productive agricultural state it is today without drainage. Food and forage crop plants need water to grow and prosper but too much water creates problems. Drainage tiles can be compared to a flowerpot with holes in the bottom. The "holes" allow excess water to flow from the soil creating a more desirable environment for plant growth.

Most of the Iowa state law which allowed for the creation of drainage districts was written in the early 1900's. Iowa law on drainage districts declares: "The drainage of surface waters of the state...shall be presumed to be a public benefit and conducive to the public health, convenience and welfare" and "shall be liberally construed to promote leveeing, ditching, draining and reclamation of wet, swampy and overflow lands" (Code of Iowa, 2014). Chapter 468 of the Iowa Code which deals with drainage laws, specifically the drainage of excess rainfall, also covers levee districts. Levee districts are created to protect land from flooding and have a similar legal structure to drainage districts.

Districts are not only subject to state law but they are constitutionally protected. The Constitution of the State of Iowa was amended in 1908 to permit eminent domain in order to establish drainage ditches and levees. "The general assembly, however, may pass laws permitting the owners of lands to construct drains, ditches, and levees for agricultural, sanitary or mining



purposes across the lands of others, and provide for the organization of drainage districts, vest the proper authorities with power to construct and maintain levees, drains and ditches and to keep in repair all drains, ditches, and levees heretofore constructed under the laws of the state, by special assessments upon the property benefited thereby. The general assembly may provide by law for the condemnation of such real estate as shall be necessary for the construction and maintenance of such drains, ditches and levees, and prescribe the method of making such condemnation" (Constitution of the State of Iowa, 1998).

The process of starting a district is spelled out in Chapter 468. Two or more landowners are needed to create a district, and must petition their county auditor to create the district. The petitioners must also file a bond to cover expenses and present the petition to their local county board of supervisors. If the supervisors find the petition to be sufficient, a civil engineer

is employed who reports back to the board of supervisors. If everything is in order, the board of supervisors can create the drainage district.

When a district is created, the county board of supervisors automatically becomes the trustees for that district. Districts can opt out of management by the supervisors and elect their own trustees, but county supervisors manage the vast majority of districts in Iowa. Landowners in a district pay all of the expenses associated with the district. When a district is established. a classification system is adopted which determines the benefit that each landowner receives from the district. For example, if it is determined one landowner is receiving 20% of the benefit from having his or her land drained, the landowner would pay 20% of all present and future costs. If the classification system becomes outdated, the district can be re-classified.

The exact number of drainage districts is unknown but data suggest that there are

The exact number of drainage districts is unknown but data suggest that there are approximately 3,500 districts across the state and more are being created today.

approximately 3,500 districts across the state and more are being created today. Roughly 9 million acres of land are drained in Iowa, representing about 25% of the state's land mass. Most of the districts are in the northwest quadrant of the state. Some districts use an elaborate system of pumping stations to move water. The exact amount of money invested in the Iowa drainage system is impossible to determine.

There are many agronomic and environmental effects as a result of drainage. Some of the effects are described here but further information can be found at: www.iowadrainage. org.

SOME BENEFITS OF THE REMOVAL OF EXTRA SOIL WATER INCLUDE:

- 1) Increases the amount of soil exposed to air creating conditions for greater aerobic microbial activity. With increased activity, plant residues and other organic matter are broken down faster than in very wet soils, allowing nutrients to become available due to oxidation. Those nutrients are utilized by aerobic microorganisms to continue additional oxidation and release more nutrients.
- 2) Improves soil porosity and tilth leading to greater soil structure. Un-drained fields contain water which

fills soil pores completely. With tile drainage, soils have higher plant available water storage capacity because excess soil water, which is not available for plant use, is removed from the soil profile. The result is a more porous environment which allows for greater water infiltration into the soil profile. During heavy rain events, increased water infiltration reduces overland flow resulting in decreased soil and nutrient losses from the land.

- 3) Decreases the risk of damage to soil structure because wet soils that are farmed have a greater risk of compaction. Wet and compacted soils are known to produce plants with stunted growth and lower productivity. Machinery tilling drier soils can work more efficiently, creating better seedbeds for improved crop vegetative and root development.
- 4) Contributes to higher spring soil temperatures which allows for tillage and planting earlier in the season. With earlier germination, plant growth occurs sooner in the year resulting in a soil-protecting canopy and higher crop yields. Drier and warmer soils permit a wider variety of crops, such as fruits and vegetables, to be grown on land where they could not have previously been raised.



Drainage districts serve many purposes but most importantly they provide favorable soil conditions for agricultural crop production where too much moisture would make production difficult. Learning more about drainage and its interaction with the environment can enable us to continue making improvements to benefit everyone.

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Prescription for Soil Health

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oil health can be a challenging subject for a researcher, especially for a soil science researcher. Regardless of institution or discipline, 20th century science was primarily about specialization. As students, most of us were trained to investigate ever narrowing aspects of our field at ever increasing depth and detail. The concept of soil health runs counter to this philosophy of science. Early attempts to characterize soil productivity and soil quality often took data from a host of parameters and synthesized those into some unifying assessment meant to portray overall soil quality. The current emphasis on soil health is the latest effort seeking to provide a more holistic evaluation of soil condition and function. This current perspective on soil quality has a greater focus on biological aspects of soils, functions that are perhaps least understood and very often under

My research perspective on soil health is balanced by a much more practical one based on life experiences. I was raised on a farm where we had little data or expertise that would be recognized as such by modern science. Still, if my father would instruct me to haul a load of manure to that "light spot north of the slough", I would know the exact location and the reason. We used crop rotations, legumes, animal manure, and strategic tillage to raise corn, soybean, oats, and alfalfa, most of which was fed to cattle, pigs, and chickens. My first relationship with soil was entirely holistic. In an era with most tractors lacking the comfort of cabs, any field operation was a highly personal sensoryfilled appraisal of soil properties. The pull on the tractor engine as I passed through a compacted wheel track, the look of soil as it rolled off tillage implements and the smell of freshly turned earth were sensory inputs that were duly recorded with each pass across a field. For our farm, the great integrator of soil health was crop yield. Harvest time would exhibit the benefits of manure application or the costs of compaction from a poorly timed tillage event. Areas with successive seasons of performance below expectations

were identified for special remedial care or perhaps a change in management. All of these decisions were made with little or no data on soil properties.

So how can we reconcile these two perspectives on soil health? As a scientist and researcher it is a reflex reaction to state that we need good data to understand relevant processes and make informed management decisions. Nonetheless, I would qualify this statement with a great admiration for the intricate complexity of soils and their ability to resist our attempts to objectively quantify their function and value. Equally unsatisfying is the "I know it when I see it" sensory perception of soil health. While I fully support the focus on and efforts to assess soil health, part of me can't help but feel that any effort to catalogue soil quality will ultimately fall short of expectations. Nonetheless, any activity that promotes improved land care, a greater sense of the role of soils in ecosystems, and extends the appreciation of soil resources gets my unqualified

One of Aldo Leopold's

arguments for establishing

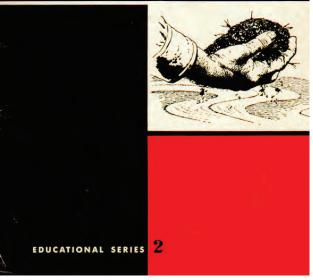
wilderness areas was that he felt

we needed to know the qualities of healthy land and ecosystems in order to assess and develop treatments to heal the "sick" lands that had been degraded by human activities. What is our reference, our "wilderness" for soil health in Iowa? After decades of continuous cultivation and erosion, are we also, as Leopold lamented, surrounded by "sick land"? Although most Iowa soils remain productive, global soil assessments list our soils as highly degraded due to changes from their native condition. Incredible advances in plant breeding and crop protection and readily available nutrient inputs continue to increase yields but what about soil quality? Is the inherent productivity of our soil also increasing or is soil health declining, a hidden illness that is

I look at the soil health initiative as a great opportunity to write the prescription that

obscured by agronomic improvements?

MAKE THE SOIL PRODUCTIVE



Tom Sauer's book "Make the Soil Productive"

will reverse decades of soil degradation and begin an era of soil improvement. Significant advances in agronomic practices in the last half century have resulted in dramatic increases in crop yields. Still, climate change, expanding global populations and competing demands for feed, fiber, and fuel will require even greater productivity in the future. The ability of our soils to support ever increasing production demands has, up to now, largely been taken for granted. One of my hopes for the soil health initiative and the 2015 International Year of Soils is that more growers, landowners, consumers, policymakers, and yes, even soil scientists, will commit themselves to addressing the pressing need to improve soil health.



Sedimentation, Flooding, and Dredging in the Mississippi

Rebecca Briesmoore

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he Mississippi has always been an important navigation route for the Midwest, but navigation was not always easy. Before the numerous alterations to the river, the waters of the Upper Mississippi could be difficult and dangerous. Boats traveling up and down the river often faced obstacles such as rapids, shifting sandbars, and fluctuating water levels, which could sink or ground a boat with little warning.

As early as the 1830s, the federal government began modifying the river to improve navigation by constructing wing dams. These submerged rock pile structures extend perpendicularly from the river bank into the river, usually constructed in groups a few hundred feet apart. Water flowing past the wing dams is forced into the channel, eroding away low spots caused by shoaling (the natural build-up of sediments in a river bed). Closing dams, which block water from flowing down side channels, were also built to keep the water directed to the main channel. These structures have been largely untouched since they were put in place over a hundred years ago, but they remain important to keeping the channel open for navigation during periods of low

With increased river traffic came an additional need for navigation improvement. In 1878 Congress authorized construction of a 4 1/2 foot deep channel in the Mississippi, and in 1907 Congress authorized the 6-foot channel. Reliable river navigation continued to be essential to commerce, so in 1930 Congress approved the River and Harbors Act authorizing the 9-foot channel project. This act, still in effect today, charges the U.S. Army Corps of Engineers with maintaining 850 miles of the Mississippi River channel from Minneapolis, Minnesota to Cairo, Illinois. The ninefoot channel was accomplished through the construction of a series of low head

Every year, the essential process of keeping the nine foot navigation channel resumes.

navigation dams (with locks) augmented by periodic dredging. This nine foot navigation channel does not span the entire width of the river, but its 400 foot width allows two full sized barges to pass comfortably. Buoys aid navigation by marking the left and right sides of the channel

Every year, the essential process of keeping the nine foot navigation channel resumes. After the ice melts off and the Upper Mississippi River reopens in the spring, the Operations Division of the Corps of Engineers begins the annual process of maintaining the channel for traffic. In the Rock Island District, a hydro survey boat is sent to either the upstream or downstream end of the district. For the next month, the boat works its way up or downriver to determine areas where shoaling has occurred and additional surveying and dredging may be required when flows return to normal summer levels

Once the initial scan of the river is complete, the hydro survey crew returns to problem areas where sediment has built-up and may block navigation. The crew uses ArcGIS to process data and evaluate conditions, conducting a hydrographic survey of the river bottom to determine the depths of the river at various points. Once these surveys are complete, they are sent back to the district office, where analysts create maps and calculate the volume of material that must be dredged to preserve the nine foot channel depth. The maps are used to layout the dredge cuts and make a dredging schedule.

The Rock Island District has two mechanical strike removal crews on the Mississippi. Each of these crews use an excavator to dig out material from the river bed and place it into an empty barge. This material is either placed in a deeper area of the channel or on the shoreline

in approved placement locations such as levees, beaches, or industrial sites. When needed, the district works with the neighboring St. Paul and St. Louis districts to borrow hydraulic dredge boats, which use a cutter head and suction pumps to remove material from the river bed much faster than mechanical dredge boats.

After the area has been dredged, the hydro survey boat returns to the area to do a post-dredge hydrographic survey to assess the success of the dredging. Each year around 400,000 cubic yards of material is removed from the river.

Many years, the dredging process is complicated by flooding. During high water, there are higher shear stresses, resulting in more bed movement of sand that is dropped out when the floodwaters recede. This changes the landscape of the river, creating new low spots and requiring surveying to be done again. Because it is both ineffective and dangerous to operate during a flood, the hydro survey and dredge boats must delay their work, beginning the process again when the flooding ends. With the continuingly changing river flows, dredging locations and quantities vary year to year. However, there are still locations of the river which are usually hotspots for sand deposits, where the dredge crews sometimes work multiple times a summer.

Maintaining the Mississippi River is a continuous process because the river is always changing. A single flood can leave behind enough sediment to close down the channel, halting Midwestern river commerce. Even without floods, parts of the river would become too shallow or narrow for navigation. Through surveying, analyzing, and dredging, U.S. Army Corps of Engineers employees respond quickly to keep the Mississippi open and ready for business.



"Drones" to Help Conserve Soil and Water

Nathan Stein

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any farmers today pay attention to the use of soil, water, fertilizer, and chemicals. Their goal is to limit the potential impact to our natural resources. Accomplishing this often requires use of precision technologies to control every piece of equipment. Now, almost every kernel of seed and every drop of water or chemical can be applied at just the right rate and in the right place. These tools are a great value, but without information they don't work as well as they could. This is where remote sensing comes in.

Remote sensing is the scanning of an area by satellite or aerial vehicle to obtain information about it. It is hardly a new science - it dates back hundreds of years. Until recently, however, it was only affordable to large governments and companies, but today, by using autonomous flying unmanned aerial vehicles (UAVs), it is much less expensive to acquire personal aerial imagery. This sensor data (typically imagery) is scaled and geo-referenced and can be used in the duties of planting, fertilizing, irrigating,

UAV BASICS & FLIGHT

The first question concerning choice of a UAV is size. Some are as big as regular planes and some are as small as a bug. In order to capture imagery efficiently most need only to be about 1-5 lbs. The next question is the UAV's configuration. Fixed wing and multi-rotor are the leading designs, however there are many to choose from. Each has its own particular advantages.

In addition to the vehicle, there is a flight control system. This enables the operator



Figure 1. Uses in Soil and Water Conservation: There is real value in acquiring high definition imagery at near-real-time speed. Imagery not only in the visible, but also in the non-visible (such as near infra-red or thermal) can provide information for many applications.

to program a particular flight path and parameters which define the mission. Once the aircraft has a basic set of instructions loaded, the vehicle can be launched. The aircraft autonomously fly's its mission and relays live information back to the pilot. During flight, an operator can intervene to hold position or change the mission completely. After the aircraft completes the mission it lands autonomously in a place designated by the operator. While every aircraft is different, the process is as simple as described above for most professional

unmanned aerial systems (UAS).

The last step is gathering the data collected and "stitching" it together. This process - called mosaicking - resembles taking many photos of an object and arranging the single images together on the table making one larger image. The good news is, a computer does it for you and much faster. It also computes a digital surface model (DSM) for the entire mosaic. These maps can then be imported into most any farm or GIS programs for analysis.



REGULATIONS

At this point the Federal Aviation Administration (FAA) is still discerning the best way to implement UAS into a busy national airspace. While other countries have been putting in place a framework to regulate the use of UAS, the U.S. has fallen behind in defining and implementing them. The FAA is currently under Presidential mandate to safely implement UAVs into the national airspace. In December 2014 it is expected that the FAA will announce its proposed rules for the operation of UAVs 55 pounds and below; those rules will be effective beginning September 2015. The new regulations would cover most of the aircrafts being produced today for civilian use.

Therefore, until rules are set forth, much of the private sector is in a holding pattern. That said, the public sector can apply for a certificate of airworthiness (COA) that enables them to operate a UAV. Universities and government agencies that have them today use them primarily for surveying and research purposes.

POSSIBLE APPLICATIONS

- Crop health
 - Chlorophyll content
 - Leaf structure
 - $\bullet \ Evapotran spiration$
- Targeted prescriptions
 - Irrigation
 - Fertilizer

• Herbicide

• Insecticide

Watershed modeling

- Survey, design & simulation
 - Waterway
 - Terrace
 - Pond
- Erosion impact analysis
- Evaluation of tillage system

It's more than just about flying a "drone". Data gathered from UAS can quickly inform us about how we ought to, and could act, improving our stewardship
of the land. As
UAS make it simpler
and less expensive
for farm operations
to monitor their crops
it will make certain

decisions easier. Especially critical decisions such as where to apply a water allotment, adopt a new tillage strategy or whether to add a waterway. Considering these examples, it's easy to understand how "drones" could help soil and water conservation efforts in years to come.



Do Fertilizers and Pesticides Used by Homeowners Have An Impact on Soil and Water Quality?

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omeowners who would generally have no contact with fertilizers or pesticides find themselves becoming "urban farmers" when it comes to their lawns and gardens. While this is great therapy for the individual, it can be a concern for the environment. Many of these are the same products used by professionals. Professionals are highly regulated and are required to have training in the proper use of these materials. In most states, they are also required to be tested, and to achieve certification before they apply pesticides. On the other hand, any homeowner can use these products with no formal training and in many cases with little knowledge of how they work, or what they do.

There is a wide selection of products available to the general public. These include many types of fertilizers that vary greatly in their source of nitrogen (N) and in their analysis of phosphorus (P), and potassium (K). There are also herbicides, insecticides, and fungicides available on the shelf at any store that handles home and garden products. While there are some limitations on certain active ingredients and there are products that are "restricted use" materials available only to professionals, many of the materials that are available to the public can be quite toxic. A few examples are the organophosphate and carbamate insecticides that are highly toxic to humans and animals if misused.

So, what is the real impact of these materials on soil and water resources? The answer to this question is that it depends on the individual applicator. While the states do not directly place restrictions on the individual homeowner, they are very selective about what is allowed into the market. These products have to be thoroughly tested and extensive data packages are required of companies that offer these products to the general public. The products also require thorough labeling. These labels provide extensive information on proper handling, use, and disposal of



the products. When properly used, these products carry a very low risk to the environment.

The problem arises when they are not properly used. It is difficult to get the homeowner to read even the basic information on a label, to say nothing of the fine print related to proper application and disposal. A good example is fertilizer. Fertilizer properly applied to lawns provides little risk to the environment. However, if they are applied to hard surfaces such as driveways and sidewalks, and are not swept or blown back onto the surface of the turf, they can easily end up in the sewer system and then in public waterways. This is particularly a problem around lakes, where the runoff from urban areas ends up in lakes. This can result in algal blooms and other highly negative effects on water

With pesticides, the biggest problems are misapplication and off target movement. Misapplication occurs when the applicator does not read the label, or when they do not know how to properly calibrate equipment and apply the material accurately. It is easy to find examples of misapplication that results in the death of the desirable plant in the landscape, rather than the target pest. Homeowner products generally have a greater margin of safety than professional products, but by tripling or quadrupling the rate, it will damage the plants that were to be protected. This is particularly

true of herbicides that generally owe their selectivity to a greater susceptibility of the weed than to the desirable species such as lawn grasses, but they will kill the grass if enough is applied.

Off target movement of pesticides is even a bigger problem than over-application. The herbicides that kill dandelion are also deadly to tomatoes, Red Buds, grapes and many other plants. The herbicides used to kill dandelions can move by wind or even by volatilization into the air if they are misapplied. Even professionals can make those mistakes, but they are much more likely with the inexperienced.

Do these products damage soil and water resources? Generally not if used as specified on the label. However, they certainly can if they are misused. It is up to the homeowner to read the label and follow it carefully to avoid environmental damage. There is training available. The University Extension Service often holds workshops and programs to help individuals learn to use pesticides properly. They also publish bulletins that can be used for training. There are "Master Gardener" programs in most states through which the individual can obtain extensive training and experience in horticulture. For those unable or unwilling to obtain proper training, there are professional companies that will handle the proper application of these materials to the yard.



An Integrated Approach to Control of Giant Ragweed

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hen I transitioned into organic crop production in the mid 1990's my primary weed control concerns were foxtail and velvetleaf. I had always wrestled with quackgrass and Canada thistle but my earlier concerns were with annual weeds. Since those early years what has happened on our farm with regards to weed pressure is similar to what has happened in many other operations. We have observed a steady increase in the presence of giant ragweed. It is a damaging competitor in most organic crops.

In response to this growing menace, I have changed my cropping practices. I now believe that an integrated approach to suppression of giant ragweed can work, year in and year out. Our farm uses a specified crop rotation where corn, soybeans, and small grains follow each other in the grain crop years, while hay and pasture follow in the small grain years. Following excellent advice from farmer Gary Zimmer, I now target a small acreage of the farm each year as a designated non-crop soil improvement area. There, I plant a cover crop and return it to the soil for the greatest soil benefit. I like Japanese Millet and sweet clover for this soil improvement practice. It is critically important to closely observe the areas where you have ragweed. In most crops you will need special attention to their early growth. Those areas get very different treatment on our farm.

Corn has the advantage of being able to compete with ragweed better than do the other grains. I suppress this weed by cross harrowing with a spike tooth drag about five days after planting. I have to close my eyes and not look at the harrow as this is an operation that can tear out corn plants before they emerge. It seems to retard emergence of the corn for two days, but is a practice that is tough on annuals weeds. I normally follow with a rotary hoe after the corn has emerged. In areas of heavy ragweed infestation, I

I have to close my eyes and not look at the harrow as this is an operation that can tear out corn plants before they emerge.

then use the front mounted cultivator with cut away discs and set them as close to the row as I can get by with. When the corn is about a foot tall I flame weed and reduce my speed to about three MPH. Flaming is somewhat effective on the ragweed but not nearly as successful on broadleaf weeds and quackgrass. These practices have given me satisfactory control of this weed in the corn year.

Giant ragweed is brutal in soybean years. It easily outgrows the soybean plant as it branches out a lot. All of the early cultivation and harrowing treatments do reduce their presence but it is generally not sufficient. I have now completed three years of a strategic approach to this weed in organic soybeans with success. The key lies in both timing of tillage, tillage type, and planting date. As I write this in mid-August my soybeans are very clean in spite of them being planted in exceedingly heavy giant ragweed pressure. What did I do? For starters I did not do any Fall or Spring tillage and let the ragweed get very good growth. After June 15th, I disked the ragweed twice and then planted the soybeans. I used a group one maturity bean and accepted the fact that this late planting would reduce yields. I harrowed the beans after emergence and cultivated them just once. I have done this for three years in a row now and the effect has been the same each year. Our farm is in Northern Chickasaw County, Iowa and we have a cooler climate than many other areas. I have learned to plant the turn rows in my soybean fields after I have the balance of the field cultivated the first time. The late turn row planting almost eliminates the damage done by turning around when the early cultivation and hoeing is done. It is late, but I generally do this at the same time that I plant the areas with ragweed pressure.

Small grains do not compete with giant

ragweed. This weed has ruined countless organic small grain fields. If the operator has no options but to proceed with a grain harvest, little can be done and this lapse in control sets the stage for more trouble in future years. This year we chopped off the heavy ragweed areas and put the material on the compost pile. Next year I hope to have a system in place where I can directly chop the weedy areas and feed the silage to my cattle. I see few other avenues of control unless a cover crop can fit into the system. I have noticed that any land where I plant Japanese Millet during the Summer is completely free of ragweed the following year. I have had other organic farmers tell me that rye grass does the same thing.

Next year in a soybean field where the borders have this pressure, I will not work the ragweed areas when I prepare the ground for the small grain crop planting. After the 15th of June, I plan on disking the weed crop and planting millet. Depending on the forage supply, I may either harvest the millet as a hay crop or disc it at seed head time. I would follow this first cover crop with Summer planted small grains. Either way my intention is to not allow the ragweed to mature and set seed that year. Giant ragweed seed has a relatively short soil life, as even heavy stands will not exist if they cannot set new seed for five years.

In the following hay and pasture crops ragweed is not a problem. If a plant does show up when cows have access to the land they devour the plant right away. I use the same approach to ragweed control near the farm sites. If cattle exist on a farm then this plant has use. Control without livestock is certainly possible but it will come at a higher cost because that land will not have income produced during the cover crop year.

Tom Frantzen farms 385 acres with his wife Irene, and son, James, near New Hampton, IA. They raise corn, soybeans, small grains, and hay. They have a 65 -cow/calf beef enterprise and 30 sow farrow-to-finish operation. The crops & livestock are all certified organic. They were selected as the 2009 MOSES Organic Farmer of the Year and are lifetime members of Practical Farmers of Iowa (PFI). Tom served as President of PFI from 1991-92. In 2011, the family was recognized with The Sustainable Agriculture Achievement Award and have also been recognized with a Master Researcher Award through PFI.

