S. Hrg. 113–639

FARMERS AND FRESH WATER: VOLUNTARY CONSERVATION TO PROTECT OUR LAND AND WATERS

HEARING

[BEFORE THE]

COMMITTEE ON AGRICULTURE, NUTRITION AND FORESTRY UNITED STATES SENATE

ONE HUNDRED THIRTEENTH CONGRESS

SECOND SESSION

DECEMBER 3, 2014

Printed for the use of the
Committee on Agriculture, Nutrition and Forestry

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FARMERS AND FRESH WATER: VOLUNTARY CONSERVATION TO PROTECT OUR LAND AND WATERS

Wednesday, December 3, 2014

UNITED STATES SENATE,
COMMITTEE ON AGRICULTURE, NUTRITION AND FORESTRY,
Washington, DC

The Committee met, pursuant to notice, at 10:03 a.m., in room 328A, Russell Senate Office Building, Hon. Debbie Stabenow, Chairwoman of the Committee, presiding.

Present: Senators Stabenow, Brown, Klobuchar, Bennet, Donnelly, Roberts, Boozman, Hoeven, Johanns, and Thune.

STATEMENT OF HON. DEBBIE STABENOW, U.S. SENATOR FROM THE STATE OF MICHIGAN, CHAIRWOMAN, COMMITTEE ON AGRICULTURE, NUTRITION AND FORESTRY

Chairwoman STABENOW. Good morning. Our Committee will come to order. I apologize in advance that, as our witnesses know, votes have been called actually for 10 o'clock. I don't know if they have started. Have we started the votes yet? But we are going to proceed with opening statements. I know that Senator Brown wants to say a word of welcome to the mayor of Toledo, and then if the vote is ongoing, we will have to recess. There are a series of votes, and so we will then ask our witnesses to be patient. We have some coffee in the back to keep you awake, and we'll be back as soon as we can to continue the hearing. So we are very glad you are here on a very, very important topic.

Among our Earth's natural resources, water is fundamental to human survival, and we all know that. Right now we have a water crisis in our country that operates on two fronts. The one most people tend to talk about, is a crisis in water quantity, and we certainly see this right now in many places in the country, certainly in California where the drought is one of the worst in the history of the State. The second—and the focus of this hearing—is around water quality.

This has long been an issue for those of us who live around the Great Lakes. We have water, but we are deeply concerned about water quality issues. We got a stark wake-up call this summer when the Greater Toledo area—with a population nearly as large as Washington, DC—as the mayor will talk about, could not drink their water, could not use the water to cook, could not wash their hands or brush their teeth or take a shower because the water was contaminated with toxins from a serious algae bloom in Lake Erie.

We are very glad the mayor of Toledo is able to join us today to talk about what happened.

Coming from Michigan, I feel a strong connection, of course, to the Great Lakes. All of my life I have seen how our lakes sustained our economy, from manufacturing to agriculture to tourism. The lakes are where we live, where we play, where we work. They are part of our identity and, frankly, our lifestyle and way of life.

Scientists tell us that the lakes were created during an Ice Age some 15,000 years ago—a thawing that coincided with the discovery of agriculture. Today the Great Lakes provide 84 percent of North America's surface fresh water. This vital resource has passed from generation to generation, just as generations of Americans have relied on the waters of the Mississippi River, the Chesapeake Bay, and so many other important waters in our country.

Yet our generation has the most urgent responsibility to conserve those waters. If we are going to solve this, we have to take action on climate change. We have to look at the nutrients going into our lakes, rivers, and streams.

Our farmers want to be a part of the solution, and, in fact, they are, which is why we made conservation an important priority in the 2014 farm bill.

While there is no single solution, no silver bullet that will resolve this crisis, we know that working together and sharing our knowledge will help us to develop strategies capable of making a broad impact on the quality of our water.

Our panel of speakers have been assembled with that goal in mind. Considering that 1.5 million jobs are directly connected to the Great Lakes, our workers and our economy cannot afford another disaster on a scale of the one in western Lake Erie.

No group understands the importance of water and soil quality more than our Nation's farmers and ranchers, and no one has more at stake than our farmers and ranchers. Agriculture has played a critical role since the 1935 farm bill, when Congress created the Soil Conservation Service in response to the Dust Bowl.

The 2014 farm bill represents the largest investment yet in the conservation of private working lands critical to maintaining not just clean water, but clean air, wildlife habitats, forests, and other natural resources.

We expanded the role of partnerships so that farmers can team with university researchers, the private sector, conservation organizations, and all levels of government to find creative solutions to improving water quality.

We know that farming is one of the riskiest businesses in the world, and farmers cannot gamble on the future of their access to clean water and neither can we as consumers.

In 1746, in his version of Poor Richard's Almanac, Benjamin Franklin said: "When the well is dry, we know the worth of water."

We have two excellent panels today. We look forward to your testimony as we begin this important discussion.

I would now like to turn this over to Senator Boozman. Unfortunately, our distinguished Ranking Member, Senator Cochran, is not able to be with us today, but we are fortunate to have my good friend Senator Boozman to give opening remarks, and we also will have him introduce our witnesses from Arkansas and Mississippi. So, Senator Boozman.

STATEMENT OF HON. JOHN BOOZMAN, U.S. SENATOR FROM THE STATE OF ARKANSAS

Senator BOOZMAN. Well, thank you, Madam Chair, and we really do appreciate you calling this hearing to help us better understand the issues involving voluntary efforts by farmers and landowners to promote land and water conservation, with a focus on water quality and the role of conservation partnerships.

We appreciate the participation of our witnesses. I am especially pleased that we have Dr. Marty Matlock from Arkansas here to offer his insight on the important issue of conservation and water quality. In Arkansas, individuals across the spectrum with diverse views on water quality issues and policies know that Dr. Matlock is a credible voice on scientific issues relating to water quality. As a distinguished professor at the University of Arkansas, Dr. Matlock has extensive experience working in urban, agricultural, and rural systems with ecologists, engineers, architects, scientists, economists, and business leaders to solve complex conservation challenges.

I am also pleased to introduce another distinguished witness, Trudy Fisher, who has traveled from Mississippi to be with us today. Most recently, Ms. Fisher served as the executive director of the Mississippi Department of Environmental Quality for 8 years where she managed a staff of more than 400 people, a budget of over $250 million, and led the agency through multiple natural and manmade disasters. Ms. Fisher formed and led the Mississippi Delta Sustainable Water Task Force, which brings local, State, and Federal partners to the table to address water quality and water issues. Ms. Fisher recently returned to private practice.

As the recent farm bill is implemented, we need USDA to listen carefully to the feedback from producers and work to make the implementation go smoothly as we go forward. We also need regular feedback here in Congress of any issues that arise. We all know that producers are the number one advocates for common-sense conservation practices because they rely on the land and water for their livelihood. We also know that the private sector plays a critical role on this front as well.

For instance, Delta Plastics in Little Rock, Arkansas, has developed the Water Initiative, the H2O Initiative, which brings together relevant stakeholders from agriculture, universities, conservation groups, and many others in an effort to help farmers in the mid-South reduce water consumption by 20 percent by the year 2020. This is just one of the many examples of efforts around the country to address the critical issue of conservation and water quality.

Another major concern is the EPA's proposed Waters of the U.S. rule. The mandates that will flow from this rule will have a devastating impact on farm families, which is why people like the Farm Bureau and so many other organizations consider it one of the most serious and consequential policy issues under debate right now. It will not just impact farm families. It will impact all low-income families who need access to affordable food. I hope that we can have an open dialogue that will help us better understand ways to improve upon our efforts to address these important issues and ensure that we have smart policies in place to support our agricultural community.

I am encouraged by the panel we have assembled today and very much look forward to hearing your testimony.

I yield back, Madam Chair.

Chairwoman STABENOW. Thank you very much, Senator Boozman, and we are so pleased to have Dr. Matlock and Ms. Fisher here.

I would now like to turn to Senator Brown to introduce the mayor.

Senator BROWN. Thank you, Madam Chair and Senator Boozman. I will be brief because I know we have got to run, and I apologize also to the panel again for the way that things ended up being scheduled. Thank you all for coming.

I appreciate so much Chairwoman Stabenow's emphasis on the Great Lakes. Nothing matters, there is no more important resource in this country, other than human beings, than the greatest body of fresh water in the world. We know what happened, the mayor will explain what happened in Toledo, this tragedy that we should never allow to happen in a country this rich. It partly happened in Toledo because Lake Erie's depth around Toledo and the Western Basin is only about 30 feet. It is draining an area in Ohio of about 4 million acres, a lot of farmland, a lot of runoff, a lot of industry, a lot of commercial activity, a lot of population. Contrast that with Ms. Weeks' Lake Superior, which has an average depth of about 600 feet, and it mostly drains forests. So you can see particularly with climate change and the sort of torrential downpours that happened this year and are happening more and more as a result of climate change, coupled with the hot summer and all the things that happened, and the mayor will explain that more.

For my brief introduction of the mayor, his career has been all about public service: a Toledo police officer for more than almost three decades, Toledo City Council, and now the mayor of Toledo. He is already—I think that police officers are trained to both anticipate and deal with crises. Mayors are not so trained to anticipate and deal with crises perhaps, but the mayor has done marvelously in his time. Early in his term—he has not been mayor that long, but early in his term he had one of the worst snow emergencies in Toledo recently or maybe ever in history, areas that were just—incredible what happened. He also early in his term had two firefighters who were killed in the line of duty, and then he had this issue with Lake Erie and 500,000 people in the city and outside the city that lost their drinking water for 2–1/2 days. So he has already made a difference for our city and our State, and I am proud that Mayor Collins has joined us today.

Chairwoman STABENOW. Thank you very much, Senator Brown. I am sure the mayor would just as soon not have had so many opportunities to show leadership. It has been a challenging time.

Let me introduce our final two witnesses before we recess for the votes. We are so pleased to have our next witness, Ms. Kristin Weeks Duncanson, who is the owner and partner of Duncanson Growers, a diversified farm family operation located in Mapleton, Minnesota. I know that Senator Klobuchar hopes to be with us today so she can greet you as well. She is the immediate past chair of the Minnesota Agri-Growth Council, past president of the Minnesota Soybean Growers Association, former director of the American Soybean Association. She is a member of the Carbon Market Working Group, sits on the board of AGree, an organization focused on driving positive change in food and agricultural systems. So we are so pleased that you are with us.

Then last, but certainly not least, I am pleased to introduce Sean McMahon again to us—we are so pleased to have you with us—who is the executive director of the Iowa Agriculture Water Alliance, a clean water initiative supported by the Iowa Corn Growers and the Iowa Soybean Association and the Iowa Pork Producers Association. Mr. McMahon has worked on natural resources policy for over 20 years in a variety of roles. Before joining the Iowa Agriculture Water Alliance, he was a North American agriculture program director at the Nature Conservancy where he worked on strategies to make sure agriculture was more environmentally sustainable, and through advocacy in the farm bill played a very important role, and we appreciate it very much. Before that, he worked for the National Wildlife Federation, the National Audubon Society, the Department of the Interior, and is currently a member of the Farm Foundation Roundtable and serves on the Advisory Board for the U.S. Soybean Export Council. So many hats, and we are very pleased to have you with us at this point.

So we thank our distinguished panel. We appreciate your patience. Right now the vote is underway, so we will recess for the votes, and then we will come back and appreciate your testimony.

[Recess.]

Chairwoman STABENOW. The Committee will reconvene and come to order. We thank you very, very much for your patience, and we are now at a point where we can focus on this very important topic.

As I indicated in the beginning, we today are focused on water quality issues. We know there are a variety of issues that are important related to our waters, and today we want to focus on one of the two pillars, which is water quality.

We know other members are coming, but in the interest of time, we will proceed at this point. Let me start by asking Sean McMahon and Dr. Marty Matlock a question. When we are looking at the fact that we are supporting 1.5 million jobs and generating $62 billion in wages from the Great Lakes and all of the efforts that are going on, and looking at the surrounding States and the country as a whole, we know how critical clean water is. I have a very straightforward question for both of you: Can farmers and ranchers make a measurable improvement in water quality by adopting voluntary conservation practices?

Mr. MCMAHON. Yes, they certainly can——

Chairwoman STABENOW. Oh, excuse me. Do you know what? I went right into questions and did not give you a chance to do opening statements. We had done our opening statements, and so, well, hold the thought then on the question. Why don't we do that? Now you know what the question is.

We want to hear from you, so let us start with the mayor of Toledo, the Honorable Michael Collins. Mayor, we appreciate very much your coming in. I really was not trying to cut you off from not hearing your testimony. So, please.

STATEMENT OF HONORABLE D. MICHAEL COLLINS, MAYOR, TOLEDO, OHIO

Mr. COLLINS. Thank you, Chairman Stabenow and esteemed members of the Senate Agriculture, Nutrition and Forestry Committee. It is a privilege and an honor for me to be allowed to testify before you today.

On the weekend of August 2, 2014, the city of Toledo made headlines both nationally and, quite honestly, internationally when we were impacted by harmful algae blooms or algal blooms. It created a situation for us where we had to execute a "Do Not Consume" order. The order was impacted by over half a million consumers of our public water system, which includes northwestern Ohio and parts of southeast Michigan.

We weathered the 72-hour incident because our community pulled together. There was no violence, and we had no reportable illness as a result of this experience. Water was supplied to those who were in need; the stores were restocked; and on Monday at 9 o'clock in the morning, we were able to execute and rescind the consumption situation. Toledo has taken those additional steps to prevent our water supply from being impacted by the microcystin toxin that is a result of the algal blooms.

Our community was impacted financially, well over $2.5 million from grocery stores where their produce was sprinkled with water to the restaurant and the hospitality trades. We as a city experienced—because of the additional chemicals which were needed, carbons and so forth, we had not expected this through our budget, but we had experienced millions of dollars of additional costs in order to continually use the chemicals necessary to stabilize that water that we so proudly serve a half a million people with.

I am here today as the mayor of Toledo. I would love the pictures of the lines of those waiting for water or the images of that glass of water which made national news being held up, looking like pea soup. I would like to see that forgotten. However, the truth of the matter is if we forget what happened in Toledo, it is destined that we will repeat it.

Toxic algal blooms are not new. We have as a Nation—and I repeat, we have as a Nation failed in studying the reasons why they continue and to take the steps to reduce or eliminate their occurrences. In my humble opinion, the experiences we had in Toledo is characteristic to the canary in the coal mine. There are many theories as to why, but we have not identified all the causes. Phosphorus in Lake Erie has been reduced, but it remains, though. We have other issues.

The new formulations of fertilizers, Open Lake dredging, invasive species interfering with the ecology of the lake, mega cattle and hog and chicken farms, and septic tank failures all obviously must have some role in this, as well as municipal sewage treatment plants.

This is not a Toledo problem, and actually it is not an Ohio problem. It is an international problem. More than 80 percent of the water in Lake Erie comes from the Great Lakes to the west and north via the Detroit River. Standards developed by the World Health Organization in 1996 have not been evaluated nor have they been confirmed by our Federal EPA. Testing is not standardized or even required as it relates to all areas of our Nation as to the algae blooms themselves. I urge Congress to work together with the administration to recognize that Lake Erie and our Great Lakes are national treasures and to make our region's water quality issues a priority by taking the following actions:

First, provide additional research funding to develop what are the causes and what are the solutions for improving water quality.

Secondly, the EPA should set a Federal water quality standard for toxic algae blooms.

Thirdly, the Federal Government must—and I repeat, must—prioritize and target funding for infrastructure and conservation funding to those watersheds that most effectively affect Lake Erie. If we continue to delay, the harm may become irreparable.

Thank you for allowing me to share this information and to have been put into your record, and I would be happy to take any questions which you may have at any point today.

[The prepared statement of Mr. Collins can be found on page 45 in the appendix.]

Chairwoman STABENOW. Well, thank you very much.

As Ms. Kristin Weeks Duncanson is going to be giving her testimony, I would also like to recognize Senator Klobuchar for a welcome.

Senator KLOBUCHAR. Thank you. Thank you so much, Chairwoman Stabenow. Thank you so much for inviting Kristin Weeks Duncanson today from the State of Minnesota. She is going to be talking about some of the new technologies and partnerships that she is using to improve water quality. You should know that she and I actually attended high school together. She was a year older, but I will not say what years we graduated. She is an owner and partner of Duncanson Growers, a family farm located in southern Minnesota that raises soybeans, corn, vegetables, and hogs. She is also the immediate past chair of the Minnesota Agri-Growth Council and was a member of the Minnesota Soybean Association for 10 years before being named the soybean growers president in 2002.

She served as a staff member for former U.S. Senator Rudolph Boschwitz and is a graduate of the University of Minnesota Humphrey Institute Public Policy Fellowship Program. She currently serves as a member of the AGree Advisory Committee—we need more agreement here—which is a diverse coalition of ag thought leaders supporting innovation in our food system, and we are really pleased to invite you to the Committee today.

Thank you.

Ms. WEEKS DUNCANSON. Great, and thank you very much for that kind introduction.

Chairwoman STABENOW. I will just add that any information you have about Senator Klobuchar that we could use on the side would be helpful.

[Laughter.]

Ms. WEEKS DUNCANSON. Well, we took piano lessons from the same piano teacher, so we can——

Chairwoman STABENOW. Recitals.

Ms. WEEKS DUNCANSON. Yes, so we will talk later.

STATEMENT OF KRISTIN WEEKS DUNCANSON, OWNER/ PARTNER, DUNCANSON GROWERS, MAPLETON, MINNESOTA

Ms. WEEKS DUNCANSON. Thank you very much. For those of you in the room, too, I would like to introduce my husband, who is sitting behind me, who once was my intern in this fine institution back a long time ago. So thank you, and thank you, Chairman Stabenow and members, for letting us be here today and to share the opportunity with you today on a farmer's perspective on how stewardship of working lands can improve water quality.

For many years, we in the agricultural community have a deep and abiding stewardship of our own land, and it runs through our veins. It is a tradition passed through the generations, and we are very proud of it.

Farmers and landowners working together to manage our water resources also goes back many generations. In Minnesota, we use a ditch system. Our challenge with water is usually too much and not too little water. Though for many years we focused entirely on making sure we had infrastructure to move excess water off our land, we have learned in more recent years that we need to make sure that we do that in a way that does not lead to erosion of streambanks or filling up the streams with eroded soils and excess nutrients.

My farming community lies in both the Blue Earth and Le Seuer watersheds. They flow into the Minnesota River and on to the Mississippi, which is about 80 miles away. We have worked together on Blue Earth County Ditch 57. A few years ago, we designed a two-tiered ditch system with a holding pond and planted native grasses that gets the water off our fields but slows the water down and absorbs the nutrients it carries with it. This improves water quality downstream.

The process for the new Ditch 57 was neither quick nor easy. It took several years of negotiating with the owners, getting a design, funding, and approvals. But the outcomes achieved were increased productivity for the working lands and a decrease in flooded areas in both the farm fields and many of the houses in the nearby town.

We and many of our neighbors are starting to use cover crops to build the health of our soils, which are the foundation of our productivity and profitability. Cover crops also help keep both sediment and nutrients out of the water. By retaining nutrients in the soil, we use less fertilizer, which also contributes to our bottom line.

We are learning more and more that we need to do conservation differently if we are to be sure that we are doing what is needed to improve water quality while maintaining and improving our productivity and profitability over the long term. Forward-looking producers and landowners are ready to provide that leadership.

We need to focus on water quality outcomes at the watershed level, not just as individual operators. Producers, with technical support from universities, agencies, or the private sector, need to measure baselines regarding both agricultural practices and environmental outcomes at multiple scales and measure the change over time.

Producers need to work together to identify what a basic standard of stewardship should look like in their watersheds, which performance standards or practices should be expected of producers regardless of cost share being available.

We need to focus cost share and public dollars on the structural practices needed to achieve the outcomes and put them where they can achieve the most cost-effective impact.

Government needs to do things a little differently too: prioritizing resources to where the natural resource problems are found; investing in collecting baseline data and monitoring change over multiple scales; providing regulatory certainty to those producers who voluntarily demonstrate continuous improvements to achieve water quality goals; and sharing data more freely among the agencies within USDA, other agencies, universities, and the private sector so that we can better understand the relationship between conservation practices, yield resilience, and environmental outcomes in specific agronomic circumstances.

Of course, we must ensure that proprietary data remains private and that data voluntarily shared cannot be used for regulatory action. As a member of the Advisory Committee of AGree, an effort that brings together a variety of producers with companies along the food and ag supply chain, environmental organizations, and public health and international development experts, I have worked with other producers to develop an approach we believe can successfully engage farmers and ranchers in achieving improved outcomes in working landscapes.

What we are calling Working Lands Conservation Partnerships would be producer-led, watershed-scale, cooperative effort to enhance both long-term productivity and improve environmental outcomes in a manner that can be recognized both by the public and private agencies as well as the supply chain. The information is summarized in an infographic that is in my written testimony.

The Regional Conservation Partnership Program in the farm bill of 2014 is an excellent example of a Federal program that aligns with our conservation approach.

I appreciate the opportunity to be here today and welcome any questions that you would have.

[The prepared statement of Ms. Weeks Duncanson can be found on page 46 in the appendix.]

Chairwoman STABENOW. Thank you very much.

Dr. Matlock, welcome.

STATEMENT OF MARTY D. MATLOCK, PH.D., EXECUTIVE DIRECTOR, OFFICE FOR SUSTAINABILITY, UNIVERSITY OF ARKANSAS, FAYETTEVILLE, ARKANSAS

Mr. MATLOCK. Chairwoman Stabenow, Ranking Member, members of the Committee, Senator Boozman, thank you for having us here.

I am anxious to get to the questions and answers, the discussion point, too, so I just want to say that I have never been more optimistic about the ability of our landholders across the United States to make positive improvements on our water quality and the landscape, not because of a regulatory framework we are imposing but because of the awareness through shared information and through a common understanding of our common impacts on water quality and the benefits we derive from that ecosystem service at the watershed level. We are seeing incredible engagement, unprecedented engagement, voluntary engagement across the landscape.

I would like to differentiate, though, that compliance with conservation practices with NRCS really are more incentivized than voluntary. As we know, under the 2014 farm bill, we have incredible incentives for participation and, in fact, if you do not engage in conservation practices, you are disqualified from participating in many of those critical elements of the farm bill. So it is really not a voluntary program so much as an incentivized program.

I do want to celebrate one initiative that I think is particularly exemplary in how our landowners and agricultural value chains are engaging together to make things better in the landscape. That is the Field to Market Alliance for Sustainable Agriculture. You have this in my statement. You also have it in my contributions to the packet. The Field to Market Alliance for Sustainable Agriculture's key performance indicators, this is a multi-stakeholder initiative that engages folks from producers across soybean, corn, cotton, wheat, and other crops all the way to biotech companies and retailers—McDonald's, Walmart, others. It includes conservation organizations—World Wildlife Fund, Conservation International, the Nature Conservancy—that is where Sean and I met—as well as many other organizations, to try to figure out what we have to do to sustain our prosperity from the land without eroding the biodiversity and other ecosystem services upon which our prosperity depends.

This organization is developing key performance indicators that are voluntarily adopted by producers across the landscape and developing strategies for targeted implementation. As the mayor indicated, not all ecosystems are equal. Some are more sensitive than others. I was in Brazil at the Global Roundtable for Sustainable Beef 2 weeks ago, and I heard a term that I had not heard before, but I love it: "glocal." We must think globally and act locally. We all understand that. We have global problems, and they require local solutions. Local solutions means we cannot paint the problems with one brush. We have to understand the local implications, and we have to have the freedom to implement solutions, to explore solutions, and, frankly, to fail occasionally so that we can learn and get better.

Continuous improvement is the hallmark of sustainability. We need a process so that we can continuously improve sustainability across our water quality and our landscape. The landscape is changing, and it is changing fast, and it is not just agricultural producers that are changing it. We have to be able to be responsive to all of those elements.

Thank you.

[The prepared statement of Mr. Matlock can be found on page 92 in the appendix.]

Chairwoman STABENOW. Thank you very much.

Ms. Fisher, welcome.

STATEMENT OF TRUDY D. FISHER, FORMER EXECUTIVE DIRECTOR, MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY, RIDGELAND, MISSISSIPPI

Ms. FISHER. Thank you. Madam Chairwoman, if I could be so bold as to jump right in there and follow your style, I would like to say yes, not only can farmers voluntarily deal and address and improve water quality, but they actively are all across the country.

I want to share with you why this issue is so important to the State of Mississippi and our producers and our organizations that we work with. I thoroughly enjoyed my visit to the Great Lakes Region, but I am going to move our thinking down South a little bit and focus on the lower Mississippi River States.

Our State is only one of two States that borders both the Mississippi River and the Gulf of Mexico. The Mississippi River and the Yazoo River form over 7,000 acres of the very rich, fertile Yazoo-Mississippi River Delta. It is a huge economic engine, a driver for not only our State but also the country, as well as the Gulf of Mexico. We recognized many years ago that what happens on our land directly impacts what happens on the Mississippi River and in the Gulf of Mexico. So we have been very proactive in addressing how do we deal with nutrient reduction? How do we deal with nitrogen and phosphorous on our lands and in our runoff water? Also, as a reminder, everything that we are talking about in a way runs downhill right by our State.

We learned, just like Dr. Matlock said—and I share his enthusiasm—there is so much going on where? At the local level, at the grassroots level. We found early on that it takes the collaborative nature, a voluntary approach of your producers, of your Federal organizations, and your local partners to really address how do you go about reducing nutrients. What is the strategy?

You know, there are conservation practices that have been in the NRCS program for years, and so we worked with our producers, with NRCS, our State Soil and Water Conservation District. What are the practices that work the best? What is achievable? What is the cost?

But you cannot just look at the cost. You have to look at the value of the conservation practices. Then what is the value to the stakeholder, to the producers? Because you have to have that buy-in. You have to have the dialogue and the buy-in for any effort such as this to work.

We have been very pleased with our collaborative efforts and what we have actually done on the ground in Mississippi. Some of the practices that I would like to talk about are just very basic farming practices that make a difference on water quality and quantity.

Land leveling. Obviously, the Mississippi Delta, it is flat, it is level. But is it really? You know, and so there are techniques such as land leveling that improves your irrigation practices, that reduces your runoff. These are programs that are supported by NRCS.

The ubiquitous ditch that we all have all across our farming country, farming land, how do you deal with the ditches? How do you slow the water down? How do you re-use the water? How do you get better drainage, whether it is too little or too much? How do you focus on improving that channel so that it controls the runoff and lessens the impacts to the river and to the Gulf of Mexico? Again, these are practices that are supported by NRCS.

I know that Chief Weller will be talking later in another panel about all the various practices, but they truly make a difference. But you have to be able to demonstrate that you are having measurable results. You know, our State environmental agencies all across the country, we know it is working, but you have to have the outcome and the results to show what you are achieving. So we are very happy in Mississippi that we are at that point now that we are able to demonstrate the successful reduction of nutrients into the water, into the Mississippi River and the Gulf of Mexico. We are working with other States.

Just like the other panelists have said, one size does not fit all. As all of you know from your own States, each of your States are regions within regions, and it is the same way in dealing with hydrogeology. You have to look at your State. You have to look at your individual watershed and what works. So we can learn from one another, but let us take a local grassroots approach to addressing the issues of stormwater runoff.

But, yes, it is—is it working? Yes. The issue is I think that we have—and I would ask the Committee to look at—we have in our State, I know probably all across the Mississippi River Basin States, a higher demand for the NRCS conservation practices than there is actually funding. I would like at one point later to talk about what are some opportunities to make sure that those meaningful conservation practices that are working continue to have the funding so they can be accessed in a voluntary way by our producers across the country.

Thank you.

[The prepared statement of Ms. Fisher can be found on page 66 in the appendix.]

Chairwoman STABENOW. Thank you very much.

Certainly again, last but not least, we are glad to have Mr. Sean McMahon here. Welcome.

STATEMENT OF SEAN MCMAHON, EXECUTIVE DIRECTOR, IOWA AGRICULTURE WATER ALLIANCE, ANKENY, IOWA

Mr. MCMAHON. Good morning, Chairwoman Stabenow and members of the Committee. Thank you for the opportunity to provide testimony and present my views to the Committee today.

I would like to thank the Committee for its work earlier this year and dating back to the last two Congresses to pass a bipartisan farm bill that contained the strongest Conservation Title in history. This is the first farm bill to ever have more funding in the Conservation Title than the Commodities Title.

The 2014 farm bill also includes an innovative new program called the Regional Conservation Partnership Program. This program codifies the principle of targeting conservation practices to where they can have maximum impact and ushers in a new era of public-private partnerships.

The recent farm bill also recouples crop insurance with conservation compliance for the first time since 1995, which will ensure more soil conservation on highly erodible lands while helping to prevent wetlands from being drained and native prairie from being plowed.

I would like to thank the entire Committee for their excellent work on the recent farm bill, but in particular I would like to single out the Chairwoman for her tremendous persistence and tireless efforts to pass this historic legislation.

As executive director of the Iowa Agriculture Water Alliance, I am partnering with many organizations, including the Natural Resources Conservation Service, to help to implement the farm bill and deliver conservation more effectively in Iowa. The Iowa Agriculture Water Alliance was launched in August of this year, and it was created by three leading Iowa agricultural associations: the Iowa Corn Growers Association, Iowa Soybean Association, and Iowa Pork Producers.

The purpose of the Iowa Agriculture Water Alliance is to increase the pace and scale of implementation of the Iowa Nutrient Reduction Strategy. The Iowa Strategy, which was released in May 2013, is a science-based framework to assess nutrient loading and reduce the impacts of excessive nitrogen and phosphorous to Iowa waters and the Gulf of Mexico. The Iowa Strategy directs efforts to cost effectively reduce surface water nutrients from both point sources, such as wastewater treatment and industrial facilities, and nonpoint sources, such as farm fields. This coordinated approach between the point source and nonpoint source strategies allows for collaboration among agricultural, municipal, and industrial interests to meet the overall goals of the strategy in a cost-effective manner.

The strategy calls for overall reductions of nitrogen and phosphorous loads to Iowa waters and the Gulf of Mexico by at least 45 percent, a 41-percent decrease in nitrogen and a 29-percent decrease in phosphorus from nonpoint sources, primarily from reducing nutrient loss in agricultural runoff.

The strategy also calls for a 4-percent reduction of nitrogen and a 16-percent reduction in phosphorous from point sources. The strategy continues reliance on voluntary conservation activities for nonpoint runoff.

There have recently been increasing calls to regulate agriculture under the Clean Water Act. Our current voluntary approach to private lands conservation is under increasing pressure and criticism. I personally believe that regulating nonpoint agricultural runoff in Iowa would be a very expensive and ineffective experiment due to both the scale and variability of agriculture in Iowa.

The Iowa Agriculture Water Alliance is collaborating with many committed partners to pursue voluntary approaches to implementing the Iowa Strategy and reducing nutrient loss.

Advancing the goals of the Iowa Strategy is a daunting challenge. It will take many committed partners and many years to realize 45-percent reductions in nitrogen and phosphorous in our waterways. It is important to remember that we have had a century and a half of impacts of agriculture on our water quality, and there is a great deal of "legacy" nutrients and sediment in our waterways. Yet Iowa farmers are committed to helping lead an effort based on sound science that will fulfill the goals of the strategy and help to improve water quality both in Iowa and downstream to the Gulf of Mexico.

It will take new revenue streams and partnerships with the private sector and municipalities to fully fund and implement the strategy. Public sector funding from NRCS and IDALS is important, but that alone is not adequate. We are engaging with additional private sector and public-private partnerships around nutrient stewardship, soil health, and sustainability to help promote conservation practices that improve water quality.

As more producers understand that there is a strong value proposition inherent in conservation practices that improve productivity and profitability over time, adoption rates for those practices will increase dramatically. At the same time, additional funding is needed to incentivize structural practices that take land out of production. It will require a combination of in-field, edge-of-field, and in-stream practices to achieve the goals of the strategy.

Thank you for the opportunity to present my views before the Committee. I sincerely appreciate this Committee's invaluable work to promote conservation on our Nation's private lands and help America's farmers to meet the growing domestic and international demand for food, feed, fiber, and fuel in an increasingly sustainable manner.

[The prepared statement of Mr. McMahon can be found on page 96 in the appendix.]

Chairwoman STABENOW. Thank you very much to each of you, and I think actually you have answered my first question, so I am going to go on from there and ask Ms. Duncanson, in the past you said that farmers need to step up and take the lead to address nonpoint water pollution, and I am wondering, as we look at ways to do that and encourage and support farmers and ranchers, can you describe the best ways to actually increase that participation?

Ms. WEEKS DUNCANSON. It is an interesting question that you ask, and we are going to refer to something old in its practice called "peer pressure." You know, farmers and ranchers across the country, our neighbors are our neighbors, and we oftentimes work together, but our neighbors are also our competitors. So we need to instill this culture of leadership amongst ourselves, and we have seen that done across the country. We just maybe have not celebrated it as much as we should and use that as a model as we work throughout our Nation in partnership with public and private sectors to move ahead with conservation as well as using resources for data collection and management at USDA while still keeping it private.

So it can be done, and we are seeing it done, as my fellow witnesses today have talked about their areas of the country, but good old peer pressure does a lot.

Chairwoman STABENOW. When you look at long-term financial benefits to implementing conservation practices, what do you see? You are running a farm in Minnesota. What are the impacts? Do you think that other producers understand the financial benefits?

Ms. WEEKS DUNCANSON. You know, it is a story that needs to be told over and over again. Some do. Some have not gotten that far yet. But if we can build better organic matter in the soil, if our soil has better resilience against the changes in weather patterns, we are more productive, therefore more profitable. Someone mentioned earlier it is the value versus the cost of conservation, always instilling that amongst producers that there really is an opportunity there.

Chairwoman STABENOW. Thank you very much.

Mayor Collins, you are at the other end, so we are talking about practices that are important, involvement of farmers and ranchers in conservation practices and so on. You are at the other end where, in fact, there was a huge problem. I wonder if you could speak to the economic impacts of the drinking water ban on Toledo businesses, and what you saw. Hopefully this is not going to happen again and we are bringing resources to bear, but this was a huge issue for your city, your businesses, your residents. Talk about the economic impact.

Mr. COLLINS. Thank you, Senator Stabenow. The economic impact was probably somewhere in the area of $2.2 to $2.5 million over that weekend. Now, one would say, "Well, how could that possibly be?" Well, basically, all of the products that were in supermarkets, grocery stores, and so forth, that required the water being put on, they were all destroyed as a result of—because of the residual impact.

The restaurant/hospitality industry was totally compromised because they could not—in this situation, you could not boil the water, because if you boiled the water, the only thing you would do is you would enhance the microcystin, and that would just basically create another problem for you. So you could not do that.

Now, honestly, what happened is, in Toledo, our Lucas County Emergency Management Program, they came out and said that you could not bathe, you could not—I mean, the prohibitions were totally off the wall, and they were not true. You could not consume, but for bathing purposes and for other purposes—you could not use the water to cook with. So basically that was where we were at.

But in listening to the testimony—and I sincerely respect all of the testimony that was given—I am hearing just we need more time. I mean, when half a million people are subjected to the circumstances we were subjected to, when there was no consistency in terms of what test protocols were used, when we called for the Ohio EPA and we called for the U.S. EPA, and we called basically Homeland Security, we got no support from them. Homeland Security told us, "Oh, you have got to wait maybe 72 hours and call us back." I mean, that was the type of response.

Fortunately, in Toledo, we had a resilient community, and I had a great team, and we were able to get through it. But I honestly and truthfully believe that if we give this the debate and it stops there, what are we going to say to the next community that goes through this?

I am asking realistically for an Executive order, and I understand in Washington, DC, right now Executive orders are sort of—it is considered by some a placebo, and it is considered by others a poison. But I really and truly believe that it is going to take the full force of our Government and Canada to evaluate this very important set of circumstances.

We in Toledo, we process 26 billion gallons of water a year from this body of water that I am talking about that was compromised.

So imagine the impact it has on this Nation. I am not suggesting that it is an agricultural issue singularly. I would not suggest that. But I really think that the full force of our Government should be looked upon to participate with Canada and participate with the States that are there and the communities.

Really and truly, do not give this lip service. When I made the statement it is the canary in the coal mine, I am very sincere with that statement. If you have not lived through it—and I would pray that no one ever does—you will not have a true appreciation of what it is like when you are in a position of leadership and you have half a million people asking you for explanations.

Most of the explanations you have to offer them are not available because there is no availability to even scientific research to advance. So you are just asking them to have faith and to hope that they will indeed—and why it turned out the way it did I cannot explain. Our crimes of violence went down. Our crimes against property went down. The community came out, and I saw high school kids and college kids standing the way we designed our distribution centers.

I will end by saying this: When I walked into that command center that morning at 1 o'clock on that Saturday, there was not one document—not one document from anywhere—that would give us a recipe as to how to handle this. We did this strictly off the seat of our pants, quite honestly. That should never happen again either. With all the money that is spent on Homeland Security, to have a complete water system compromised and not have any investment in that, in my opinion, is—it just does not make good sense.

Chairwoman STABENOW. Thank you very much. I know this was a horrendous situation to be in, and so we appreciate your being here and really in stark terms talking about the reality of what happens if we do not get this right in terms of water quality initiatives and so on. So thank you very much.

My time is past. I am going to turn now to Senator Boozman.

Senator BOOZMAN. Thank you, Madam Chair. I ask unanimous consent to include a letter and materials from the Fertilizer Institute in the hearing record today.

Chairwoman STABENOW. Without objection.

Senator BOOZMAN. Thank you.

[The following information can be found on page 144 in the appendix.]

Senator BOOZMAN. I would second what the Chairman said, Mr. Collins, in regard to what you all went through. The good news is I am excited that, despite that, we really are hearing a lot of positive things that people in agriculture, people in development across the board really are starting to get this, and we really are seeing significant improvement.

Dr. Matlock, can you explain the value of technology and innovation in making conservation efforts more effective? Maybe you could give us some examples of technology and some of the innovative things that you have seen.

Mr. MATLOCK. Absolutely, Senator, and I absolutely agree with the mayor's assertion that we need to understand our ecosystems that we depend on more effectively, and I absolutely agree with the assertion that we are too fragmented in our ability to understand and then manage those ecosystems.

The technologies that we are seeing emerge at this very moment allow us to know better what is happening around us. These are sentinel technologies associated with remote sensing, either from aerial platforms or even low-altitude microsatellite platforms. Our ability to actually track what is happening on the landscape has improved over the last year. It is happening that fast, and it was transformed the way we understand the landscape because we will be able to see the landscape real time in very short order. That means anywhere on the landscape, not just in very targeted areas. That means our ability to understand sources and causality will improve. The technology for tracking impacts in water quality, our sensors technology, are improving, so we can measure—we do not have to—we are getting to the point where we do not have to go into the river and collect a sample, take it back to the lab, and analyze it and wait for 3 to 5 days before we understand what is happening. We can track that and record those processes real-time, which means we can intervene when there is an emerging problem earlier.

Algal blooms are ripe for detection with remotely sensed technologies, and then the problem is we do not know how to interdict them. We do not know what to do to prevent them. As the mayor said, we have much to learn, but our ability to understand is really limited by our ability to know what is happening. Our ability to know what is happening has expanded because it is so much cheaper now to deploy technologies, sentinel technologies. It is happening on the landscape. Farmers have soil moisture sensors that were unimaginable in their sensitivity 10 years ago that they are using every day, and they are almost throwaway. They almost plow them over because they are that cheap. So that is sort of—and the telemetry of those technologies is increasing, too, so they are BlueTooth connected to a data logger. So that is the sort of opportunity we have for continued improvement.

Senator BOOZMAN. I know I was really amazed this past summer, when we were on lots of farms, at the use of drones that could—low flying, that could gauge whether or not one area was not getting irrigation versus another or too much irrigating just making all that very, very effective, pesticide use, the whole bit. So that is great.

Ms. Fisher, how does uncertainty impact the participation of producers in long-term programs like EQIP?

Ms. FISHER. Certainty is needed because what we want to make sure that we always have in place is, as best we can, what is a known playing field on the conservation practices and programs that are available, because these take—just like you heard us all say, these take time to implement and to get into place and then to demonstrate the success.

What we have been explaining to you today, and as a former farmer herself, I would share with you we are talking about saving fuel costs, we are talking about saving fertilizer costs, we are talking about saving labor costs, just the improved technology of the irrigation system itself, which is another one of the NRCS practices.

So you have this wonderful paradigm where you have conservation and saving money and efficiency on the farm, and in Mississippi, we have been able to demonstrate those cost savings multiple times over, and then now taking that and replicating that across our State and showing and demonstrating how it does make a difference on the bottom line, which was recognized it is such a risky industry that when you can have any cost savings, and in the name of conservation, it is a wonderful opportunity.

But certainty is—anything that we can do through our programs to add that certainty and have those programs stay in place is of great value.

Senator BOOZMAN. Can I ask one more thing?

Chairwoman STABENOW. Absolutely.

Senator BOOZMAN. Dr. Matlock, and then anybody else that would like to jump in on this after he gets through, tell me about your views on nutrient trading and why it has not become more widely used.

Mr. MATLOCK. I am absolutely happy to share my views on nutrient trading. I am on record with this in many cases.

I think nutrient trading offers the best opportunity—nutrient trading gives the ability for regulated point sources who are permitted under MPDS programs, under the Clean Water Act, to engage in a collaboration with other members in the watershed who have effects on water quality to collaboratively improve water quality through shared costs and other practices that could reduce overall loads of nitrogen, phosphorous, organic matter, sediment to a system and do it in a more cost-effective and, frankly, more sustained manner.

Right now, the challenge is that the uncertainty about who actually is regulated under those frameworks prohibits engagement. Landowners are reluctant to engaged in a process where they do not understand the regulatory risks they are engaging in. If it is a simple contractual relationship, landowners are engaging in contracts every day. Contracts are enforceable and have remedies if there is a violation. Regulations are a new world for most farmers in that Clean Water Act framework, and I can tell you they do not want any part of it, and that is the biggest limitation, that fear that they become a regulated body under the Clean Water Act through EPA, an organization which they have no historic relationship with.

Senator BOOZMAN. Anybody else?

Mr. MCMAHON. Yes, if I may attempt to answer that as well, in Iowa we are seeing a number of cities, such as Dubuque, Storm Lake, Charles City, and Cedar Rapids, express interest in having a framework that EPA and the Iowa Department of Natural Resources would approve, which would allow those cities to get credit for paying for conservation practices that farmers and other private landowners could implement.

It would not necessarily have to be a trading framework, but it is essentially that same thing. You have cities where, if they are going to have additional permit requirements to reduce their nitrogen and phosphorous, those cities are realizing that they can do so more cost effectively by partnering with private landowners on green infrastructure than if they were entirely to pay for gray infrastructure, very expensive capital investments.

However, there is uncertainty right now, as Marty just said, regarding the regulatory framework, and it is not clear that those cities would actually get credit for making those investments. So we do need to provide more clarity to enable, in particular, those wastewater utilities and municipal ratepayers to be able to get credit for making investments for upstream or downstream conservation practices throughout those same watersheds.

Senator BOOZMAN. Thank you, Madam Chair.

Chairwoman STABENOW. Well, thank you very much.

I just have one final question. Then we need to move on to our second panel. Mr. McMahon, when you were talking about the programs and what you are doing through the alliance, which is really terrific, I am wondering how you plan to measure results in terms of successful strategies so that they can be replicated and used in other areas.

Mr. MCMAHON. Well, thank you for the question. So there are a number of indicators we will be looking at right up front, and one of the most important ones is adoption of conservation practices. We need to measure increased adoption of conservation practices in terms of acres.

For the in-field practices where we believe there is a strong value proposition for producers, for practices like improved nutrient management, no-till, strip-till, and cover crops, we are looking to really increase those practices throughout the entire State, essentially taking a blanket approach for those practices.

For the practices that are more expensive and take agricultural land out of production, we are going to need to be more targeted about that, so we will not have the same amount of acreage increases for those practices. Some of those practices are the most effective at improving water quality, in particular, edge-of-field practices like nutrient treatment wetlands, bioreactors, saturated buffers, and stabilizing stream banks. For those practices, it will take additional incentives for farmers to want to adopt those, but those are some of the best practices for removing nitrogen and phosphorous.

Another measure is going to be the investment for the Iowa Nutrient Reduction Strategy. We can already measure what is going on through the NRCS and the Iowa Department of Agriculture and Land Stewardship cost-share programs. We don't have a good handle on the private sector investment—how many acres are producers putting practices in place with no cost share whatsoever. We are seeing increasing amounts of that in terms of cover crops and nutrient management and conservation tillage, for instance.

Then ultimately the biggest and most important indicator is going to be water quality. We want to see more than just the modeled load reductions. We want to actually see the needle move in terms of improved water quality and not just at the edge of field scale, but at the watershed scale.

Now, it is going to take years to do that, so we have to be patient, but ultimately, improving water quality is what this strategy and the Iowa Agriculture Water Alliance are all about.

Chairwoman STABENOW. Thank you very much, and thanks to all of you very much for the work that you are doing. Again, we see strategies happening. We have increased those tools and strategies in the farm bill. We know that there is a sense of urgency, as the mayor can say, as we look at what needs to be done in a number of ways to address this. But we do know that long term, as well as short term, that our farmers and ranchers have a very important role to play in this and that each of you are involved in helping to make that happen.

So thank you very much, and thank you for your patience today, and we look forward to working more with you.

We will ask Mr. Jason Weller to come forward. Good morning. Well, it is actually not morning anymore. Good afternoon.

Mr. WELLER. Good afternoon.

[Pause.]

Chairwoman STABENOW. Well, good afternoon. We appreciate your patience as well today, and we want very much to hear from you, in your position as Chief of the Natural Resources Conservation Service. You have been there since July 2013. We very much appreciate the work that you are doing.

Chief Weller oversees a staff of more than 10,000 employees across the country who work to protect the environment, preserve our natural resources, and improve agricultural sustainability through voluntary private lands conservation. Chief Weller has also done an outstanding job over the last several months implementing the Conservation Title of the farm bill, and we appreciate our great working relationship.

He is a native Californian who worked for the California Legislature prior to moving to Washington, DC, where he worked on conservation policy in a number of roles at the White House Office of Management and Budget, the House Budget Committee, the House Appropriations Subcommittee on Agriculture. Prior to being appointed Chief of NRCS, he served as chief of staff to the former Chief, Dave White.

So thank you very much for being here, and we would like very much to hear from you and have a couple questions.

STATEMENT OF JASON WELLER, CHIEF, NATURAL RESOURCES CONSERVATION SERVICE, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D.C.

Mr. WELLER. Well, good afternoon, Chairwoman Stabenow and members of the Committee. Thank you very much for the invitation to be here today.

If I may—and hopefully you have a little presentation packet in front of you—instead of just talking to you, I would rather actually talk with you and talk a little bit about who we are, the type of practices, and use some visuals to actually hopefully articulate what it is that we do with farmers and ranchers. But first let me just say how proud I am to serve NRCS and represent the 10,500 men and women who work across the landscape to work collaboratively with farmers and ranchers. Let me also say how appreciative we are at NRCS for the authorities, the tools, and the resources, Chairwoman Stabenow, you and the Committee have provided us. We are doing a lot of great work, and we are very excited about what we are also going to be able to deliver for farmers and ranchers with the additional resources you have given us through this new farm bill.

Also, let me just state right up front, kind of a definition of what is sustainable agriculture. The bottom-line definition for me is NRCS is only successful if the farmer is successful. That means we are helping them be economically successful. That for me is the ultimate litmus test. We want these family operations, these family businesses, to be in business not just this year or next year. We want them to be in business generations from now.

So the conservation practices we offer to them have to work economically, have to help their bottom line, and, of course, also address the sustainable use of their resources, their soil and their water resources, so they can grow the feed and fiber that is part of their business, that we as society rely upon.

So we are very focused on sustainable agriculture, sustaining those families, sustaining those businesses, because the best use of those lands are actually working lands. You talk to our colleagues in the Environmental Protection Agency, and they will say for the Chesapeake Bay the best land use for the bay, if you care about the bay health, is actually agriculture. They want those lands in working agriculture, because when those lands are lost, converted to other uses, per acre the urban use of those lands is way more polluting per acre than a pasture or crop field or a forest ever will be.

So with that, let me just kind of quickly go through, and I will try and keep it under 38 minutes or so. I will be really quick here.

First, the second slide here is really an overview. EPA produced a report last year that talked about the economic—actually the biologic condition of the rivers and streams in the United States. It turns out, according to EPA, 55 percent of rivers and streams in the U.S. are actually in poor condition, really highlighting the real challenge we face addressing not just the quality but also the quantity of the waters upon which we all rely, whether for recreation, for municipal water supply, for ag production, for industrial use.

Turning the page, the central focus, though, for us at NRCS is, across the Lower 48, 70 percent of the land is privately owned; 88 percent of the waters of the U.S. come off of private lands. So if you care about the condition of the environment, the availability of water, for whatever purpose, you really have to then think about working with those millions of landowners and the decisions they make on a daily basis which will affect the ultimate quality of our waters and the availability of our waters. We at NRCS believe that ultimately a collaborative, voluntary, incentive-based approach is the most effective.

So turning the slide, in terms of planning, if we rewind the tape a little bit about 80 years, when our agency was created by President Roosevelt in 1935, at the height of the Dust Bowl, one of the worst ecological disasters in the Nation we ever faced, what we were created to do was to provide technical assistance, to provide planning advice to a farmer or rancher.

So we worked through a nine-step planning process where we helped convey our expertise in agronomy, in nutrient management, in engineering expertise, and provided options to a landowner to then make changes in the management of their land to ultimately benefit their economic bottom line, but also to protect their soil and water resources. So it is a three-phase approach where we first assess the operation. We work collaboratively with that farmer or rancher. What are their business objectives? What do they really want to achieve in their operation? We create options, and then with the producer we arrive at the solution we want to pursue, and then we implement and evaluate.

Turning the page, Slide 5, in terms of conservation practices, we have over 160 practice standards at NRCS. We believe they are some of the best standards for conservation anywhere in the world. They are peer reviewed. They are constantly updated. These are examples—you see some visuals from the top left there of no-till operations, to grassed waterways, to prescribed grazing practices, to the injection of manure, to strip-cropping, to even helping producers manage their manure for economic benefit, in this case putting roofing structures and the heavy use pads for manure management purposes.

Slide 6, what we have also learned is that there is no one silver bullet. There is no one practice that will deliver the results for a farmer. It is really a suite of practices, a system working together, and that system for water quality purposes we called "ACT," A–C-T, avoid, control, trap. So you really want to avoid risk, the loss of those valuable nutrients and sediments from the farm field. To the extent then where you are applying the fertilizers, you are managing your soils, you also want to control the movement of water so you are hopefully not transporting the sediments and those inputs off the farm. Then you also have the last line of defense, you have practices that trap the waters, the sediments, and the nutrients before they leave the farm field, whether that is surface flow or subsurface flow.

Slide 7 are a couple of shots, examples of these ACT practices. For example, it is the precision application of fertilizer when the crops need it, so you are optimizing your use of fertilizer. It is also then farming on the contour using tillage practices, the strip-cropping like you see on the bottom left, and ultimately the trapping practices like buffers you see there protecting waterways.

Slide 8, in terms of the overall investment that this Committee has provided us from the last farm bill through 2014, over 6 years, in just water quality alone we helped put in place 727,000 practices across the United States, total investment from the Federal side of $3.4 billion that then leveraged—because these are cost-share practices, that leveraged upwards of an additional $3.4 billion from landowners themselves, total investment close to $7 billion in conservation action across the United States just in 6 years focused on water quality.

What do those practices look like? Slide 9, these are the top practices that we have put in place in terms of acreage, so the top practices being, for example, prescribed grazing, nutrient management, integrated pest management, and cover crops.

Slide 10, in terms of the overall investment in terms of dollar, really focusing very heavily on irrigation water management to help producers be hyper-efficient with their use of water. That is really good for them optimizing their yield, but also reducing the risk of loss of that water off the farm field, as well as brush management and cover crops.

Slide 11, so what do all these practices mean? So we have a really sophisticated, among the world's most sophisticated model to actually estimate what happens when you put all these practices in place. It is great to talk dollars and acres. What does that translate into?

So, for example, in the Chesapeake Bay, what we learned over a period of 5 years, through a voluntary, collaborative approach, through the investments of NRCS and our partners at the State level, through the NGO and philanthropic communities, and farmers themselves made, they helped produce tremendous reductions in losses of sediment and nutrients off their farm fields just in the Chesapeake Bay.

So, for example, between 2006 and 2011, because of conservation systems farmers put in place, they reduced losses of sediment by an additional 62 percent. That translates into 15.1 million metric tons of sediment that are now no longer flowing into the Chesapeake Bay. If you were to put that on a train, you would fill a train 150,000 rail cars long that would stretch from Washington, DC, to Albuquerque, New Mexico, that are now no longer flowing into the Chesapeake Bay. That is the power of voluntary, collaborative, incentive-based conservation.

Slide 12, we think, what the science is telling us, the targeted approach works really well, particularly on a regional approach. These are some examples of these landscape initiatives we have launched in the last 5 to 6 years. They are focusing on large watersheds. We will never have enough money, for example, to treat every acre in the Mississippi River Basin. But through a collaborative approach, we work with farmers, commodity associations, State Departments of Environmental Quality, State Departments of Agriculture, Soil and Water Conservation Districts. We identify key priority areas where we can focus, leverage together resources, and co-invest together to deliver results for farmers.

In the Mississippi River Basin, we identified around 50 high-priority watersheds across the whole basin, and NRCS, we invested about $327 million over 5 years. That leveraged an additional $20 million from non-Federal sources. It brought in 600 partners, and they then contributed upwards of 500 additional staff years to help get voluntary conservation implemented and on the ground just in the Mississippi River Basin.

Slide 13, sometimes the best conservation is actually the most beautiful conservation, so I want to just show some examples of before and after——

Chairwoman STABENOW. I am going to ask, just in the interest of time, so we can get questions in—because these are great pictures, but if we could move through the pictures quickly, and then I will ask you to wrap up.

Mr. WELLER. Absolutely. So I will let them speak for themselves. You see examples from Iowa, from Michigan, from Mississippi, and from Vermont as well. We also have success stories. Just for the sake of time here, I will end with this one success story here from Arkansas. This is the St. Francis River, so beyond modeling results, we actually can monitor and actually demonstrate actual in-stream results. So a lot of States are investing very mightily in the in-stream water quality monitoring that the previous panel talked about. In this case, streams like the St. Francis River were listed under the Clean Water Act as being impaired, so it was a collaborative, voluntary approach where producers co-invested their resources with our resources and partners, and because of the investments we made, we were able to de-list streams like the St. Francis River, reaches of this river, in Arkansas. We have examples of this across the country, from South Dakota to Oklahoma to Washington State and Arkansas itself.

So, with that, Madam Chair, I will cease and desist, and I am happy to answer any questions.

[The prepared statement of Mr. Weller can be found on page 106 in the appendix.]

Chairwoman STABENOW. Thank you very much. That was excellent. You covered a lot of ground in a few minutes, and it was very, very important. I do think the very last slide, let me just underscore that the new Regional Conservation Partnership that we have put into place, are very excited about, the sign-up resulted in 600 different proposals around the country, requests for $2.8 billion in funding, and we have about $400 million that will be available. So, clearly, this is something people want, local approaches, strategies, and so we look forward to working with you.

I want to ask you something that follows the first panel because the mayor of Toledo, who is at the other end of this where they actually had to ban the use of the water, and the algae blooms, and it was just really a horrendous situation that occurred this summer. We know that dissolved phosphorous is the primary culprit in creating toxic algae blooms in Lake Erie and in water bodies around the Nation. We know that conservation practices, some work better than others as it relates to this. I wondered if you could talk about the farm bill conservation programs, how they could tackle this specific issue, and talk about the combination of practices that NRCS has to specifically target phosphorous reduction and how it is different from nitrogen and other issues. But when we look at this particular thing, what do you think are the best available tools that we have to help in this situation?

Mr. WELLER. So it starts with sort of where I began a little bit and with what the previous panel talked about as well. There is no one single silver bullet that will solve this. Also you have to take into account there is no one approach that works. You really have to start locally. Each river basin, each watershed has its own unique characteristics—its own climate, its own cropping systems, its own soils, its own topography.

So what we are learning about the Western Lake Erie Basin is it is obviously very unique from some other basins in the country, the types of soils, the types of practices, the topography. Ultimately, yes, phosphorous is one of the main contributors to the algal problems in Lake Erie itself.

So in terms of what are the best practices, it comes back to that suite of practices working together. Producers, what we have learned from our studies and what other studies have shown, they have done a really admirable job of reducing risk of loss from surface flows. So they have done a great job. There is an expanse of no-till and conservation tilled systems. Increasingly we are promoting cover crops and other practices. They have done a great job of buffering their fields and protecting stream surface flows.

But what we as an agency—this is not just in Western Lake Erie Basin. Nationally, what we have also learned is that as an agency we very much have been focused on surface loss. Increasingly we realized we really also have to account for subsurface loss.

So what really then is going to be a suite of practices working together, starting with nutrient management, and this is something the industry is very much focused on and working collaboratively with us, with land grant universities, and with ag retailers in the basin itself, is really promoting the four R's of good nutrient management, helping producers optimize their use of fertilizers and applying fertilizers at the right rate, the right source, the right time, the right method. That is one.

There is the surface soil loss practices I have talked about—cover crops, good tillage practices, good residue management practices, buffering practices.

But also then looking at the subsurface drainage, and so 87 percent of the cropland acres in Western Lake Erie Basin are tile drained. So it is looking at the management and helping producers become really effective at managing their surface flow, subsurface flows, for example, putting in drainage water management practices like control structures, bioreactors, and saturated buffers, other different tools that they can then utilize, for the subsurface flow, the water they have in their tile lines, for hopefully retaining the valuable nutrients that are in those waters, holding those waters in place when crops need them, getting the water out of the fields when they need to get in their fields for planting or for harvest purposes, but really trying to ensure that the crops gets access to those valuable nutrients when the crops need it to grow grain, ultimately then reducing the risk of loss from both surface and subsurface flow into surface waters.

Senator STABENOW. Thank you very much.

Senator Boozman?

Senator BOOZMAN. Thank you, Madam Chair.

Chief Weller, as I said earlier, I am really excited about the testimony of the first panel and then your testimony also. I was on the Water Resources panel in the House and now Ranking on Water here in the Senate on EPW, and it is exciting. You know, it seems like all aspects of industry farming, mining, the whole bit, really are understanding the impact and understanding that they are going to have to get serious, and so that is a great thing.

I guess my concern is, you have all of these positive voluntary things. My concern is when you do something like Waters of the United States, which is so controversial, and there is going to be significant costs involved, what is that going to do to the voluntary programs? What is that going to do to the progress that we have made so far?

Mr. WELLER. So we have heard at USDA absolutely concerns from many stakeholders about the proposed rule.

Senator BOOZMAN. I guess over a million.

Mr. WELLER. A million comments it is my understanding that EPA has received and the Army Corps have received on the proposed rule, yes. I know that the comment period may have closed——

Senator BOOZMAN. Most of them negative.

Mr. WELLER. Yes, I will defer to EPA and the Corps to characterize——

Senator BOOZMAN. You have been around for a while.

Mr. WELLER. Yes, I know from farming, particularly also they are concerned about the potential impacts of the proposed rule, and we are as well concerned about the potential disincentives for folks to want to participate in programs. We really feel, though, from our agency standpoint that the voluntary, collaborative approach is very much effective, and our intent is to be there working with producers since actually one of the purposes of EQIP itself is to help producers either address or obviate the need for regulation, whether that is the Endangered Species Act, the Clean Water Act, or the Clean Air Act.

So we really view ourselves as the shield arm if not the sword arm in many cases for producers to help them address the regulatory pressures they either are experiencing or may experience.

Senator BOOZMAN. No, I would agree, we need to really concentrate on the voluntary programs, which, again, it seems like from the testimony today and what we are seeing out in the field with increased technology that was testified also, that we really are making tremendous headway. You mentioned the analogy, which I will use, with the boxcars is great. You know, we really ought to get some things done.

Again—and I will my close with this—my concern is—and I am very much opposed to the Waters of the U.S. because—for a number of different reasons, but also, after hearing today's testimony, I think that is something that really would be very detrimental to these types of programs also.

Thank you, Madam Chair.

Chairwoman STABENOW. Thank you very much.

Now the Chair of our Conservation Subcommittee, Senator Bennet.

Senator BENNET. Thank you. Thank you very much for holding this hearing, Madam Chair, and the opportunity to ask questions.

Chief Weller, thank you for your service and your testimony. You talked about voluntary, collaborative incentive-based conservation in your testimony, and I wholeheartedly agree that is where we ought to head. It was the reason I was so excited to work with members of this Committee in a bipartisan fashion to craft the farm bill's Conservation Title. Notwithstanding the spirit in which that piece of legislation was drafted, we have heard very severe concerns from Colorado about NRCS' implementation of the new Agricultural Land Easement Program. Farmers and ranchers in Colorado, rightly believe that they had a huge hand in writing these provisions to begin with, because they did. They literally helped write many of the provisions in the title. Now they have the sense that their will and the will of this Committee is being diluted by legal interpretations and bureaucracy at USDA.

One quick example. I visited the Yust Ranch outside Kremlin, Colorado, this summer, a beautiful property, the confluence of the Blue River and the Colorado River, that the Colorado Cattlemen's

Agricultural Land Trust worked hard to cover with an easement. At the 11th hour, before the deal was finalized, NRCS came in and told the Land Trust they needed to secure a right-of-way over adjacent BLM land, despite the fact that a new right-of-way could not be established because BLM is the owner. The ranch felt that this NRCS requirement was a solution in search of a problem. I would say that is polite.

In the end, NRCS did grant a waiver at the very end, which I appreciate, the requirement for the Yust deal, but what I want to convey to you is that the legal interpretation made no sense to anybody that had anything to do with drafting the legislation, including the Cattlemen's Land Trust. Beyond these right-of-way concerns, we are also concerned about the new rules to govern the easement program and the decreases in funding that Congress allotted for this program, a concern that a lot of that is being spent on overhead and on NRCS' own programs and not to help farmers and ranchers, producers, stay on their land and put their land into voluntary easements.

So with all that in mind, could you talk to us a little bit about what NRCS is doing to ensure that the Conservation Title actually works as intended and efficiently for our farmers and ranchers on the ground? Will you please pledge to work with me and other members of the Committee to rectify some of the deficiencies that we are hearing about? This is happening in real time in our States, and I would really appreciate a response.

Mr. WELLER. So let me start with the affirmative. Absolutely I would be willing to work with you and your staff and stakeholders in Colorado, but also in any State that has concerns about our delivery of the program. It is very concerning to me that there is a perception or a real experience about additional bureaucracy. If there is anything, we need to reduce that and get out of the way. In the example you provided, having a provider secure access over public lands, we are taking a hard look at that and trying to apply a little bit of country common sense, and so we are going to be updating that and fixing that.

Senator BENNET. I would say just on that point that, at least to my mind, the interpretation in that case or the requirement—which was not a requirement that any Federal agency, any other Federal agency has ever required of any landowner that I am aware of in our State, because it would be impossible to do it—is exactly a piece with the legal interpretation that your general counsel office is promoting with respect to these provisions. So I just want to make sure you are not left with the impression that this was a one-time problem.

Mr. WELLER. Absolutely. I am aware of this not just in this one example. Particularly with the checkerboard pattern of landownership throughout the West, this is a problem that we need to fix, and we are going to fix it.

Senator BENNET. I would say thank you for appreciating that. A lot of what we were trying to do with this legislation, at least in my mind, was have a Western perspective actually inform the farm bill when it came to conservation. You mentioned in your opening testimony the importance not just of water quality but of water quantity. That is a huge issue for us as well.

So I just want to volunteer to be at your disposal as you look at this to make sure that we are getting to the outcome that our farmers and ranchers really expected us to achieve.

Mr. WELLER. So we also have been—we have not been idle over the last several months. With the farm bill passing in February, we had to get the Agricultural Land Easement Program up and running in a matter of months. But in the interim, we have been working with land trusts, different conservancy groups, State agencies to try and understand—in part what we know was a little bit of a shotgun marriage coming out this summer, the new Agricultural Land Easement Program. Right now we are finalizing our regulations, and I would be happy to visit with you or your staff as we are finalizing those regulations just to update you as to kind of where we are.

Senator BENNET. That would be great, and I would also volunteer to give you the names of some people in Colorado that I think you ought to talk to.

Mr. WELLER. I would welcome that.

Senator BENNET. Good. Thank you.

Thank you, Madam Chair.

Chairwoman STABENOW. Thank you very much.

Senator Roberts, our soon-to-be Chairman, if I give him the gavel. We may wrestle for that.

[Laughter.]

Chairwoman STABENOW. Senator Roberts.

Senator ROBERTS. Things will not change much.

Madam Chairwoman, thank you for holding the hearing on this important topic, and, Chief Weller, welcome. I have noted with interest your background in the House on the Appropriations Committee, then the White House on the budget, and that obviously gave you a good background for all of this. Some of this gets pretty specific, to say the least.

My statement says voluntary conservation programs are talked about in shops all across Kansas not only as a way to protect viable land and water resources, but also for the ability of farmers and ranchers to continue operating. That is why you mentioned that you are the shield to protect producers from regulations that exceed the cost-benefit yardstick.

There is, however, a palpable fear, particularly in the western part of my State, that the Federal Government is already too close to mandating how cattlemen raise livestock, how and where farmers can plant crops, whether or not they will be allowed to pass their family businesses to the next generation.

One of the perceived threats is the listing of the lesser prairie chicken as a threatened species, which you, I think, mentioned. Many Kansans, including myself, believe that the listing decision was unwarranted, especially during a tough drought, when voluntary conservation efforts were already underway to increase population of the species. That drought lasted 3 years. We are still short on rain.

In February, Congress required the Department to conduct a 90-day review and an analysis on all efforts that pertain to the conservation of the bird, including the Lesser Prairie Chicken Initiative, CRP, and EQIP. While the U.S. Fish and Wildlife Service and the Department of Interior I know oversees and enforces the Endangered Species Act, the Department and the NRCS have many of the tools and the voluntary programs that could and should have prevented a listing.

Now, earlier this year, the Department publicly stated that the report on the effectiveness of the Lesser Prairie Chicken Conservation Programs would be submitted to Congress the week of May the 5th. I know you are busy down there, but that was nearly 7 months ago. The absence of the report has caused additional frustration with a lack of transparency between the public and the Federal Government.

So my question is: Why has the report not been submitted to the Congress? Who or what is holding it back? When will the USDA finally release it?

Mr. WELLER. So the lesser prairie chicken has been a focus of our agency now for many years. We have created a landscape initiative just very much focused on the lesser prairie chicken, and we have tried to target our resources to help——

Senator ROBERTS. Well, where is the report?

Mr. WELLER. The report is still in departmental clearance, I am afraid to say, and it should be released imminently. It has been finalized by our agency, and it——

Senator ROBERTS. What is "imminently"? A couple of weeks?

Mr. WELLER. Hopefully within the next week to 2 weeks.

Senator ROBERTS. Within the next week, good. Well, that is good news.

In a similar vein, do you have any update on the effectiveness of the NRCS-run Lesser Prairie Chicken Initiative, i.e., are populations of the bird increasing? We hear they are.

Mr. WELLER. We hear anecdotally that, yes, they are, so we have, as I said, this initiative where we focused close to $30 million to work with ranchers and farmers to put in place practices. Those practices have treated over a million acres in the core area for the lesser prairie chicken, and we think it is having a very beneficial impact on the populations in these core areas where we have targeted the resources. So we think it is working.

Senator ROBERTS. Let me move to the waters of the United States that Senator Boozman mentioned. Nine Senators met with the Administrator of the EPA, Gina McCarthy, on the final day of the Congress before we adjourned—well, we did not adjourn, we are back. But at any rate, we really basically just asked her why we cannot roll back these regulations. While voluntary conservation measures are popular in Kansas to preserve and improve our water quality and availability, the EPA's proposed Waters of the United States is a major concern. I just attended the annual Farm Bureau dinner, about 1,000 farmers out in Kansas. That was the number one issue, lesser prairie chicken number two. You would think it would be a lot of other things, but that is just the way it was. I was disappointed that the Department and the NRCS were involved with the EPA's efforts through this additional interpretive rule. I want you to cooperate, and I want you to communicate, more especially with lesser prairie chicken, and that is good. But the interpretive rule has created confusion among the countryside, singling out 56 NRCS technical standards as qualifying for exemptions. Now, I would defy any farmer, their CPA, or any farm organization to try to wade through those 56 and make sense out of it to the degree that they feel that they are doing things the right way according to the NRCS.

The Clean Water Act already exempts normal farming and ranching activities from many of the permitting requirements, so basically why did the NRCS spell out 56 exemptions when the law already has one?

Mr. WELLER. So the intent was, I think, a good one. Unfortunately, I know there have been a lot of concerns raised by stakeholders here in Congress as well as among our farming and ranching stakeholders. It was a process that NRCS, sitting down with the Army Corps and EPA, identified practices, activities that occur, may occur in the Waters of the U.S. These are not upland practices. In these cases, they could be like stream crossings, actual wetland restorations themselves, where, when producers have had to get permits, in some cases it has taken months or years to get a permit; or as an agency, we have had to invest hundreds of hours of staff time trying to get a permit to do a 0.8 acre wetland restoration.

So the intent was to streamline those activities that actually occur in the Waters of the U.S., to not have to go through a permitting process. But that said, as has been pointed out previously, a lot of stakeholders were very much concerned about both the proposed rule as well as the interpretive rule that EPA and the Army Corps promulgated and produced. I understand that EPA and the Army Corps are very carefully considering options on how to address concerns on the interpretive rule.

Senator ROBERTS. So that has still not been finalized with regards to the 56 as opposed to one. My question I think has already been answered, and I am over time, and I apologize to my colleagues. Who wanted the clarification of the exemptions? Before this rule, the farmers in my State certainly were not asking for it.

Mr. WELLER. I think we have heard from our customers themselves, and a lot of this then is, I think, variability between Corps districts. There are some Corps districts that have a very strict interpretation, and there are other Corps districts that do not.

Senator ROBERTS. Will you consider withdrawing the interpretive rule and any guidance already issued until the full Waters of the United States rule is finalized?

Mr. WELLER. I defer to EPA and Army Corps on what they ultimately want to do, but, yes, that is one of the options that are being considered.

Senator ROBERTS. What do you think about that?

Mr. WELLER. I think we need to take very close heed and pay attention to the concerns from farmers in this confusion that the interpretive rule unfortunately has created, and if anything, it needs to be simplified so that it's a little more clear as to what the intent was and what the benefits are.

Senator ROBERTS. Are changes to the interpretive rule or guidance, are you considering all the comments you have received? Because you have received a bunch, I know.

Mr. WELLER. Yes. I know, absolutely, EPA and the Army Corps are considering the comments they have received, over a million comments on the proposal.

Senator ROBERTS. All right. Thank you, sir.

Chairwoman STABENOW. Thank you very much.

Senator Donnelly?

Senator DONNELLY. Thank you, Madam Chair.

Chief Weller, thank you for being here. I am from Indiana. I am a huge supporter of cover crops, our State is, a huge supporter of clean waterways, good agricultural management by our farm and agriculture community. In my time, I have never seen our waters cleaner in our State. Yet, no one wants cleaner waters than the farmers who live right there on the farm with their own children, their own family there. There is a real feeling, I think, in our ag community of what has become an us-against-them situation in regards to the Waters of the United States, that our farmers feel we work nonstop every single day to voluntarily comply to make our waters cleaner, to make things better. All we hear is more Government regulation.

I think what has happened is those actions have lost the confidence of our ag community, that they sit and work every single day to make our waters cleaner and say all we do is get more hassles every day. So where is the connection between the voluntary actions we are taking, the reality of what is going on in our State and I am sure other States, and where Government regulations have gone?

Specifically, I also want to ask you about one of the things that has struck me the most were concerns from conservation supporters that the interpretive rule may actually have a negative impact on producers' implementing conservation practices. Many Hoosier farmers have said they were unaware conservation practices trigger Clean Water Act permitting requirements, and by creating specific exemptions, an assumption has been created without a State exemption other practices requiring a CWA permit before being implemented. Did you think about this consequence and about what would happen?

Mr. WELLER. I know there was a lot of careful consideration put into the interpretive rule, and there are experiences in other States where producers want to put in place practices, and they have had to go through a permitting process that has been in some cases pretty difficult. So I think the intent was, again, to help streamline, but we are also aware of the unintended consequences of, if nothing else, confusion but also perceptions about the need for permitting or disincentivizing actions. It was something that—I will just say it was at least personally to me a surprise.

Senator DONNELLY. You know, as was said, there are over a million comments, and they are from folks who love the land, who love what they are doing, who have no desire to see our waters become in lesser condition at any point. Do you understand the frustration and the feeling that our farmers have when they look up and they go, "Our Government is supposed to be my partner and instead they seem like my adversary"?

Mr. WELLER. I definitely appreciate the frustration. In my home State of California, farmers there, I think more than anywhere, are actually very heavily regulated, whether it is for air, for wildlife, and for water. When I visit producers in the Central Valley or along the coast, I understand both the palpable frustration but also the bottom-line business costs that regulation creates. So it is a perception elsewhere in the country.

Senator DONNELLY. These are smart business people who understand that dirty water does not increase their bottom line; it makes it more difficult; that the ability to run their operations with effective clean water and good situations makes them more profitable, but not only makes them more profitable, but at the end of the day they are—they are the conservationists and the environmentalists who are on the front line, who are there dealing with it every single day. I guess I would just urge you and the EPA as we look at this to have more confidence and more faith in our farmers, our ag community, and others that they want to solve the problem without having to get another layer of regulation put on top of them.

Additionally, I also wanted to ask you about when we are incentivizing a large group of farmers to implement voluntary conservation practices, we have limited financial resources. One of the things we are looking at is whether we can demonstrate that a number of these practices make direct financial sense for farmers through increased yields, reduced input costs. We might see these practices take off. What are your keys for us to continue to increase the number of folks planting cover crops and implementing other voluntary conservation practices? Because as I said, I am a huge believer in cover crops, of what it has done to hold the nutrients in the ground, to help reduce runoff, to help keep our rivers and streams cleaner. What are the things you think of that we can do to help increase voluntary conservation practices?

Mr. WELLER. So I think there are two things that are critical. Number one is to find more farm advocates, and this is increasingly—it is less a problem in Indiana. Indiana in many cases is the hotbed of the soil health movement. But to have actual—and the former panel talked about this, to have farmers—the best form of, I guess, salesmanship is a farmer-to-farmer conversation, peer pressure. So where farmers see how cover crops can be incorporated, how they work, can actually help their bottom line, that is the best kind of, I think, pioneer or piloting approach to demonstrate the power and effectiveness of cover crops. So we are working with partners to help identify those pioneers, those leading-edge conservationists to show the power of cover crops.

The second thing is then to just get the economics down, to really show the bottom line is saving money. It is saving money through optimizing inputs, but also by helping them improve the overall resiliency of their soils. It is helping them be productive whether it is through wet or through dry periods as well.

Senator DONNELLY. I know how busy you are. I would ask you, though, to stay in close touch not only with everybody else's ag communities, but especially, as you said, in Indiana. We are strong believers in cover crops, of what it can do on a voluntary basis for our water condition, for our water cleanliness, for nutrient maintenance. I think the closer you stay towards being in contact on a constant basis not only with my ag community but everybody else's, I think you will find there are a lot more solutions there than you could ever imagine.

Thank you, Madam Chair.

Chairwoman STABENOW. Thank you very much.

Senator Hoeven?

Senator HOEVEN. Thank you, Madam Chairman. I appreciate it.

Chief Weller, good to have you here. The first thing, I would like you to come out to my State and meet with my farmers. Would you be willing to do that?

Mr. WELLER. Yes, sir.

Senator HOEVEN. Thank you. I would appreciate it, and I think it is obviously very good for them to have you out there, but I think it is beneficial to have you out there as well in terms of your job and what you do.

Waters of the U.S. is a big problem for our farmers and ranchers. What are you doing to solve the problem? What do you feel can be done to solve the problem of Waters of the U.S.?

Mr. WELLER. So as USDA generally, NRCS specifically, we are not regulatory, and the Waters of the U.S. rule is an EPA and Army Corps regulation. While we did provide technical advice on the interpretive rule, which is a tangential effort, the overall proposed rule on the Waters of the U.S., I would defer to EPA and Army Corps on taking into account the million-plus comments they have received from the public and from stakeholders.

Senator HOEVEN. But you are hearing from farmers on what a big problem it is?

Mr. WELLER. Yes, absolutely.

Senator HOEVEN. It is my strong belief it needs to be rescinded. Our farmers and ranchers are looking at 56 different practices they are supposed to try to understand, track, and follow. I mean, this thing is just absolutely unworkable.

Senator Roberts asked you what you can do to help. I guess I would just ask for your assistance. This is a big problem, and I think you are hearing that very directly from farmers and ranchers.

Mr. WELLER. Yes, we are, sir.

Senator HOEVEN. On the conservation compliance issue, I want to ask you about what you are calling an "obvious wetland." So in terms of conservation compliance, one of the things that NRCS is using is they are talking—they are using a criteria in approaching or managing wetlands, calling certain areas "obvious wetlands" as a part of their conservation compliance measurement. Can you define what an "obvious wetland" is?

Mr. WELLER. So under the 1985 Food Security Act, we have sort of a three-step approach to identifying what a wetland is: Number one, does it have hydric soils? Number two, is it inundated with water sufficient so that site would support hydrophytic vegetation? Three, under normal conditions, would it actually grow hydrophytic vegetation?

So those three characteristics, those are the three tests we use for identifying a wetland, and that is what we would use to identify an obvious wetland.

Senator HOEVEN. What response have you had from the farmers using that approach? What is their reaction? Is this something that—look, the problem they have is the uncertainty. When they are out on their farm, those wetlands change all the time, as based on conditions. They need to have some kind of certainty in terms of understanding what they are allowed to do and how you are going to approach it. How do you give them more certainty in that process?

Mr. WELLER. So what the farm bill, the Farm Security Act, provides then is that certainty where you get a certified wetland determination from NRCS. We then stand behind that certification. We will then identify for a producer whether there are or are not these wetland conditions on the farm and whether or not they were prior converted or not prior to the 1985 act itself. So it is that certification that is what provides that certainty to a producer.

Senator HOEVEN. Well, I think that is part of the problem is when they go through that certification process, they always feel like they are kind of guessing as to where you are going to come down on it. How do you make that a more certain process?

Mr. WELLER. So we are trying to do a lot of different things, both within North Dakota but I think across the Nation, is bring more of that certainty. So one of the things we are going through right now is the methods we use for—first, starting with the off-site method for determining wetlands. We are trying to bring state-of-the-art science using LiDAR technology, aerial photography, remote sensing technology so that we can efficiently and quickly provide those determinations, those preliminary determinations to a producer. They can always request an on-site determination, though. If they want to have a field service person come out and actually walk the field with them and do the soil tests and the site determinations, that is always available. They have an appeals process to go through. There are a lot of protections in there to assure that a good, credible, transparent, science-based process has been used to really—because we take it very seriously.

Senator HOEVEN. Well, and that is where interaction with the farmers, by you as well as your people, I think is helpful so that there is some understanding in terms of what your approach is going to be, so that, they can—they know what they can and cannot do.

What about use of conservation groups, NRCS' use of conservation groups? That obviously creates some concerns with the farm groups. Have you talked to the farm groups and met with them on that? Give me your thinking on that and what your approach is going to be in terms of—I think with any of these practices, you need to be communicating with the farm groups so they know what you are doing, why you are doing it, it is transparent, and they are comfortable with it.

Mr. WELLER. Absolutely. We are not going to partner with an organization that does not have a good relationship with farming. We often partner with organizations across the country to help amplify our field workforce, and we are really trying to stretch the public tax dollar as far as possible. But to be clear, we do not hire conservation organizations to do wetland determinations. That is a Federal role. That is the determinations we do. We may hire consultants, engineering operations, folks who have agronomy degrees, that they provide us determinations, and at the end of the day it is NRCS that is still making that determination itself. But we do not hire conservation organizations or advocacy organizations to do wetland determinations.

Senator HOEVEN. Have you communicated that to the farm groups? Do they understand that?

Mr. WELLER. I have communicated that, yes, but I know there is still a concern about the relationship the NRCS has with conservation organizations in North Dakota. To be clear, those contractual arrangements are really about providing the technical assistance, planning, and farm bill program delivery. It is not wetland determinations that we are doing with those groups.

Senator HOEVEN. One final piece that I want to ask is in the farm bill, we included the Regional Conservation Partnership Program, and you are obviously well familiar with it. In North Dakota, in the Red River Valley, which affects North Dakota and Minnesota—to a lesser degree our good friends in South Dakota—but primarily North Dakota and Minnesota, we have tremendous flooding. We have it every year almost. We need a holistic solution that addresses it not only for the urban areas—Fargo and Moorhead—but also for the rural areas and addresses it for the small towns and for our farmers as well.

That Regional Conservation Partnership Program is very, very important to us. It is a big area of focus. We need it in that area as part of a total flood protection plan that protects the rural areas as well as the communities. I ask for your strong participation and help in that multi-State effort. You are an important part of the solution.

Mr. WELLER. Well, thank you, sir. We really appreciate the tools that this Committee and you have provided us through the new program to help provide those locally driven solutions, so thank you.

Senator HOEVEN. Thanks, Chief.

Senator DONNELLY. [Presiding.] Senator Thune.

Senator THUNE. Thank you, Mr. Chairman. I want to, first of all, I know it has been talked about already, but just make clear, from my State and the people I represent, that one of the biggest issues and concerns in the State of South Dakota and its number one industry, agriculture, is this proposed rule concerning Waters of the United States, which was published earlier this year by EPA.

There is not anything that I have been familiar with initiated by EPA, or any other Federal department, for that matter, that has resulted in so much concern and fear in my home State.

Since you are here today, Chief Weller, I wanted to reiterate to you and remind you of your obligation and responsibility as well as that of Secretary Vilsack and others at USDA to make absolutely certain that you guard the welfare and well-being of production agriculture and our farmers and ranchers as EPA appears to be moving forward with this rule in spite of broad bipartisan opposition from across the country. I just wanted to put that on the record.

I do want to ask a question with regard to an issue that we have had in eastern South Dakota. As eastern South Dakota is ground zero when it comes to the prairie pothole region, and farmers particularly in northeastern South Dakota have been challenged by flooding on and off now for the past several years. Many of these farmers, in order to comply with the conservation compliance provisions in the 2014 farm bill have requested wetland determinations from the NRCS. It is an issue I have been deeply involved with and appreciate your agency sending personnel from Washington, DC, at my request, this past summer to a wetlands meeting that we had in Aberdeen, South Dakota, where we had more than 300 farmers and ranchers attend. As a follow-up to that meeting, I am wondering perhaps if you can provide me with an update on the wetlands determinations backlog in South Dakota and what progress has been made since that meeting that we had last July.

Mr. WELLER. Absolutely. So since that meeting in July, we have reduced the backlog in South Dakota by an additional 10 percent, so now it is down to less than 2,600 requests for determinations to be made. We are making good progress. I am optimistic. Our State conservationist there, Jeff Zimprich, is absolutely totally focused on this, and he has a lot of responsibilities, but he gets the importance of this. While we have made progress, that is not sufficient. He has 18 staff dedicated full-time just doing wetland determinations. He is going to bring an additional four people on full-time, so over 20 people dedicated full-time doing nothing but wetland determinations. He has another eight people working half-time on this.

I recently just sent an additional million and a half dollars, the majority of which is going to South Dakota, to hire additional staff, additional resources to get more determinations done quickly. We have a 3-year plan to get all the backlog completely wiped out across all four prairie pothole States, and I am holding the State conservationists accountable for getting that backlog cleared out. So while we have made progress, it is not sufficient, it is not acceptable, and so we are going to get those determinations made as quickly as possible.

In terms of that Aberdeen meeting, I understand that Jeff left that with a 45-step action plan. He has already started implementing it. He is well on his way to getting that rolled out. In January, he is going to be sending out letters to customers, updating them where they are at, basically acknowledging that we have received your request, we are on top of it, here is our estimated timeline to get to you. So we really are going to do a much better job with the customer service that I think you expect of us.

Senator THUNE. Thank you. I appreciate that, and like I said, I appreciate your folks coming out for the meeting in July, and I know it was a very spirited meeting, because it is something that we hear a lot from our farmers and ranchers up in that area of South Dakota. I appreciate the sort of singular focus you have put on that, and I look forward to your continued responsiveness. It sounds like you have got a plan in place. We are delighted to hear that. We hope that it will work that backlog down because it is something that has been a lingering problem that has created great consternation for a lot of our producers in that region of South Dakota. So I appreciate that. Thank you.

Mr. Chairman, thank you.

Senator DONNELLY. Thank you, Senator.

Chief, thank you very much. I want to thank all the witnesses for being here today. Any additional questions for the record should be submitted to the Committee clerk 5 business days from today, so that is by 5:00 p.m. on Wednesday, December 10th.

This hearing is adjourned.

[Whereupon, at 1:16 p.m., the Committee was adjourned.]

APPENDIX

DECEMBER 3, 2014

STATEMENT FOR THE RECORD
Senator Thad Cochran
Committee on Agriculture, Nutrition and Forestry
Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Water
December 3, 2014

Madam Chairwoman, thank you for holding this hearing today. The topic of today's hearing will cover a very important issue regarding conservation partnerships between agricultural producers and the Federal government that address natural resource concerns, specifically water quality.

The witness panels invited to testify will cover voluntary partnerships and initiatives like those currently carried out through USDA's Natural Resource Conservation Service (NRCS), such as the Mississippi River Basin Initiative, the Chesapeake Bay Watershed Initiative, the Great Lakes Restoration Initiative, the Bay Delta Initiative and others that offer financial incentives to producers for implementing best management practices on their operations resulting in positive environmental outcomes. It is my hope that this hearing will highlight the successes, quantifiable impacts, and environmental benefits these types of voluntary activities produce without the need for additional Federal regulation.

The Agricultural Act of 2014 continues significant investment in voluntary, incentive based conservation programs which have a longstanding history of success with producers in the countryside. While the intent of the hearing today is to showcase the successes of voluntary conservation partnerships, it is also my hope that today's hearing will serve as an opportunity for the U.S. Department of Agriculture (USDA) to provide an update with regards to implementation of the Farm Bill's Title II conservation programs.

Additionally, given the attention surrounding the Environmental Protection Agency's (EPA) and the U.S. Army Corps of Engineers proposed rule defining the scope of waters to be protected under the Clean Water Act – the Waters of the United States (WOTUS) rule and the agricultural interpretive rule – there are many concerns from the agricultural community about the broad reach and impact of this regulation from the countryside. Today's hearing should also provide the opportunity for a constructive dialogue about the serious concerns with the proposed WOTUS rule and the agricultural interpretive rule. There are many reasons for us to hope that research and new technologies will build upon existing work that USDA and producers have conducted to date on incentive-based best management practices that impact water quality and that continued investment will naturally lead to more practices being adopted by producers on a voluntary basis rather than through a regulatory regime.

I am pleased to introduce our distinguished witness, Trudy Fisher, who has traveled from Mississippi to join us for this morning's hearing. Most recently, Ms. Fisher served as Executive Director of the Mississippi Department of Environmental Quality (MDEQ) for eight years having been first appointed by Governor Haley Barbour in 2007 and then current Governor Phil Bryant. As the Executive Director of the Mississippi Department of Environmental Quality, Ms. Fisher managed a staff of more than 400 people, a budget of over $250 million, and led the agency through multiple natural and man-made disasters. While serving as Executive Director, Ms. Fisher also served as the State Co-Chair of the Hypoxia Task Force and Co-Chair of the Gulf of Mexico Alliance.

Growing up on a family row crop farm in central Mississippi and farming herself for several years, she became increasingly aware of the opportunities and challenges that face the agricultural community. While at the Mississippi Department of Environmental Quality, she also formed and led the Mississippi Delta Sustainable Water Task Force, which brings local, state, and federal partners to the table to address water supply and water quality issues. During her term, she led the successful Katrina Recovery $640 million water and wastewater infrastructure program. Trudy also served as the State's trustee in the Natural Resource Damage Assessment process and was the State's designee for the RESTORE Council while serving as Executive Director.

An attorney by profession, Ms. Fisher returned to the private sector this fall and is with the Butler Snow law firm in Mississippi.

I want to thank the members of the panel for their testimony on this issue of great significance.

STATEMENT OF SENATOR TOM HARKIN
FARMERS AND FRESH WATER: VOLUNTARY CONSERVATION TO PROTECT OUR LAND AND WATERS
SENATE COMMITTEE ON AGRICULTURE, NUTRITION, AND FORESTRY
December 3, 2014

Thank you, Chairwoman Stabenow, for convening this important hearing today and for your support and efforts for agricultural conservation. I want to express my gratitude and appreciation to you, to Senator Cochran, our Ranking Member and former Chairman, and to all members of this Committee for your courtesy and collegiality over the years – and to commend you for your hard work and commitment in behalf of farmers, ranchers, and rural communities, as well as consumers and citizens across our nation and the world.

This hearing is timely because it is clear agriculture faces very serious challenges in protecting water quality. This is not a new challenge, of course, but we currently see greatly increased awareness, interest, and focus on agriculture-related water quality problems. It is vitally important to address these problems effectively. Highly-publicized images, such as those from Lake Erie and the Gulf of Mexico, have drawn a huge amount of public attention to water quality and agriculture. Consequently, there is not only the water quality problem itself to solve, but also a public relations issue for agriculture as well.

Water quality problems are, however, far broader and deeper than just those that receive a lot of news coverage. Impaired water quality is a health issue and an economic burden for local water treatment facilities -- in Iowa and across the country. Impaired water quality also means impaired quality of life – for people of all ages, but especially children – who need clean lakes and streams for swimming, fishing, boating, water skiing, and other outdoor recreation.

Our focus in this Committee is naturally on agriculture. That does not mean we ignore the role of urban areas in water quality problems – whether it is lawns, golf courses, parking lots, or sewage and wastewater. We know, however, that agriculture is typically the dominant source of the excessive nitrogen and phosphorus that is greatly impairing our nation's water quality. Work of the U.S. Geologic Survey confirms the severity of this impairment from nutrients, as well as the continuing problem of agricultural pesticides in water.

Iowans have been pioneers in water quality, as in the work of the Practical Farmers of Iowa, founded in 1985, the landmark Iowa Groundwater Protection Act of 1987, and the research and leadership of the Leopold Center at Iowa State University. In that spirit of leadership, Iowa's soybean, corn, and pork producer organizations have recently established and funded the Iowa Agriculture Water Alliance. The Alliance supports the Iowa Nutrient Reduction Strategy devised by our Department of Agriculture and Land Stewardship and Department of Natural Resources to encourage Iowa farmers to adopt voluntarily conservation practices to reduce nitrogen and phosphorus in Iowa waterways by 45 percent.

Sean McMahon is the executive director of the Iowa Agriculture Water Alliance since its formation in August, and I am pleased he has traveled to Washington to testify. He is very well qualified to lead the Alliance, having worked on natural resources policy for over twenty years, most recently as the director of the North America agriculture program for The Nature Conservancy and previously as the director of TNC's Iowa Chapter.

I am proud of the work we have done in this Committee to support water quality practices and other conservation measures in the numerous farm bills I have participated in crafting. I remember working with Chairman Leahy, as he pushed for conservation in the 1990 farm bill, to include a program I authored entitled the Water Quality Incentives Program and designed to help farmers reduce nutrients and pesticides in water. WQIP was later combined with other programs to form EQIP in the 1996 farm bill.

In the 2002 and 2008 farm bills, as Chairman of this Committee, I am proud that we added over $22 billion in funding, distributed across the several conservation programs – with a heavy emphasis on water quality. Water quality is also a big part of the Conservation Stewardship Program, which I authored in the 2002 farm bill, then named the Conservation Security Program. In combination, the two versions of CSP have enrolled 83.6 million acres in total across the nation, with cumulative payments of $4.2 billion, according to recent data from the Natural Resources Conservation Service.

To make progress in conservation, voluntary approaches and partnerships involving agricultural producers and interested organizations and entities are tremendously important. That is why we created the partnerships and cooperation initiative in the 2002 farm bill and modified and continued it in the 2008 farm bill. I commend you, Chairwoman Stabenow, for continuing and updating that initiative in the 2014 farm bill. It is essential for agricultural producers to step up, participate, and make these voluntary approaches work – because if voluntary water quality efforts fail, pressure for federal regulatory action can only increase. I say that as one who has worked very hard in numerous farm bills to supply assistance to farmers to help make voluntary approaches work.

Again, thank you, Chairwoman Stabenow, for holding this hearing and for your continuing support for conservation. Thank you to all of the witnesses for appearing and providing your testimony.

Senator Patrick Leahy - VT
Statement for the Record
U.S. Senate Committee on Agriculture, Nutrition and Forestry
"Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters"
December 3, 2014

Thank you Chairwoman Stabenow for convening this important hearing on Farmers and Freshwater. Water quality is of utmost concern right now in Vermont as parts of Lake Champlain were also hit by severe algae blooms this summer shortly after Toledo's stark wake-up call. The relationship between farming and water quality is such an important issue that in August I brought U.S. Secretary of Agriculture Tom Vilsack to the shores of Lake Champlain to see the problem first-hand and to be able to talk face-to-face with farmers and shoreline property owners.

Secretary Vilsack told Vermonters that because farms are a large source of the nutrients affecting many of our lakes, farmers also need to be part of the solution. I strongly agree with the Secretary that we will make progress most quickly through voluntary implementation of conservation practices by farmers, but only if we have sufficient technical and financial support from the federal government. That is why I worked closely with you, Chairwoman Stabenow, to ensure that the 2014 Farm Bill included a strong conservation title to support the important work by our nation's farmers to investment in the conservation of private working lands. As a result the 2014 Farm Bill provides the necessary tools to make sure the Department of Agriculture is a strong partner in agricultural water quality work.

I want to thank Chief Weller for testifying today and for the great work by his team in Vermont to move forward quickly to implement the 2014 Farm Bill. Vermont's State Conservationist Vicky Drew is doing a fantastic job and her team at NRCS, along with partners, has accelerated their outreach and as a result there has been a big increase in the use over-winter cover crops and similar practices supported by the Environmental Quality Incentives Program (EQIP) this year. The pace of adoption of cover crops has been slow in the past but interest is now challenging the NRCS staff capacity to keep up with the demand for financial and technical support. As more and more farmers come in to participate in USDA conservation programs, due in large part to NRCS promotion of those programs and the state's focus on reducing phosphorus in Lake Champlain, the capacity of NRCS and its partners to keep pace with demand for assistance will be further challenged in Vermont without additional resources. I look forward to working with Chief Weller to ensure that NRCS in Vermont has the resources needed to accelerate work in the Lake Champlain watershed and ensure that financial assistance is fully accessed by Vermont farmers and goes to the highest priority projects.

I appreciated seeing the wonderful Vermont "Before & After" example in your slide show, but I have to tell you that picture does not even begin to do it justice. I heard from my staff who visited that farm this summer and they were blown away by the positive reactions from the farmer who had nothing but great things to say about working with NRCS to make those changes to his manure system and solving drainage and runoff problems in his barnyard. Not only is the farmer happier, but so are his cows, and our local waterways and tributaries are benefiting as well.

Enforcement and regulatory intervention by the EPA and state agencies do have a role to play in protecting water quality, and need to remain on the table for all parties, including agricultural producers. However, efficient implementation of voluntary conservation work through the Farm Bill programs is by far the preferred approach.

Statement of Mayor D. Michael Collins
City of Toledo
Before the Senate Agriculture, Nutrition and Forestry Committee

December 3, 2014

"Impact of Harmful Algal Blooms Requires Action"

Chairman Stabenow and esteemed members of the Senate Agriculture, Nutrition and Forestry Committee, thank you for allowing me the honor of testifying before you today.

On the weekend of August 2nd 2014, the City of Toledo made headlines nationally and internationally when we were impacted by Harmful Algal Blooms; creating a situation where a "Do not consume" order was given to the more than 400,000 customers of our public water system which includes Northwestern Ohio and parts of Southeast Michigan. We weathered the 72 hour incident because our community pulled together, there was no violence, no one became ill. Water was supplied to those who were in need, stores were restocked and the water was deemed again safe to consume. Toledo has taken additional steps to prevent our water supply from being impacted by the microcystin toxin that is a result of the algal blooms. It has impacted our region financially, businesses lost several million dollars when public water was not available and millions have been spent by the City for additional chemicals and treatment processes.

I am here today because though as Mayor, I would love the pictures of the lines of those waiting for water or the images of the green algae to be forgotten; if we forget what happened in Toledo, it is doomed to be repeated. Toxic algal blooms are not new, we have as a nation failed in studying the reasons why they continue and in taking steps to reduce or eliminate their occurrence. There are many theories as to why, but we have not identified all the causes, phosphorus in Lake Erie has been reduced dramatically since the 1960s, however problems still remain; is it the new formulation of fertilizers? Open Lake dredging? Invasive species interfering with the ecology of the Lake? We do not know for certain.

This is not just Toledo's problem or Ohio's problem, it is an international problem, more than 80% of the water in Lake Erie comes from the Great Lakes to the West and North via the Detroit River. Standards developed by the World Health Organization in 1996 have not been evaluated or confirmed by our Federal EPA. Testing is not standardized or even required in all areas impacted by algal blooms.

I urge Congress to work together with the Administration to recognize that Lake Erie and our Great Lakes are national treasures and to make our region's water quality issues a priority by taking the following actions: First – provide additional research funding for the causes and solutions for improving water quality. Second – EPA should set a Federal water quality standard for toxic algal blooms. Third – the Federal Government must prioritize and target funding for infrastructure and conservation funding to those watersheds that most affect the water quality of Lake Erie. If we continue to delay the harm may be irreparable. Thank you for allowing me to share this information and to have it included as part of the record.

TESTIMONY TO THE U.S. SENATE COMMITTEE ON AGRICULTURE, NUTRITION & FORESTRY

Kristin Weeks Duncanson
Duncanson Growers
December 3, 2014

Thank you Chairwoman Stabenow, Ranking Member Cochran, and members of the Committee for the opportunity to share with you today a farmer's perspective on how stewardship of working landscapes can help improve water quality.

I am Kristin Weeks Duncanson, owner and partner of Duncanson Growers, a 5th generation family farm in southern Minnesota where we grow corn, soybeans, and vegetables and raise hogs. I have been engaged in farming and agricultural policy for 28 years. I currently serve as an Advisor to AGree. I previously served as Chair of the Minnesota Agri-Growth Council, President of the Minnesota Soybean Growers Association, and director of the American Soybean Growers Association.

For many of us in the agriculture community, a deep and abiding stewardship of our own land runs in our veins. It is a tradition passed through the generations that we are very proud of.

Farmers and landowners working *together* to manage our water resources also goes back many generations. In Minnesota, we have a ditch system. Our challenge with water is usually too much, not too little. Though for many years we focused entirely on making sure that we had infrastructure to move excess water off of our land, we have learned in more recent years that we need to make sure that we do that in a way that does not lead to erosion of streambanks or filling up the streams with eroded soils and excess nutrients.

My farming community lies in both the Blue Earth and Le Seuer watersheds, which flow into the Minnesota River and on to the Mississippi River about 80 miles away. We've worked together on Blue Earth County Ditch 57. A few years ago, we designed a two-tiered ditch system with a holding pond and planted with native grasses that gets the water off of our fields but slows the water down and absorbs the nutrients it carries with it. This helps improve water quality downstream.

The process for the new Ditch 57 was neither quick nor easy. It took several years of negotiating with the owners and getting a design, funding and approvals. But the outcomes we achieved were increased productivity for the working lands and a decrease in flooded areas in both the farm fields and many of the houses in the nearby town.

We and many of our neighbors have also learned to use cover crops to help build the health of our soils – which are the foundation of our productivity and profitability. Cover crops also help keep both sediment and nutrients out of the water. By retaining nutrients in the soil, we use less fertilizer, which also contributes to our bottom line.

We are learning more and more that we need to do conservation differently if we are to be sure that we are doing what is needed to improve water quality while we maintain and improve our productivity and profitability over the long term. And forward-looking producers and landowners are ready to provide leadership.

- We need to focus on water quality outcomes at the watershed level, not just as individual operators.
- Producers, with technical support from universities, agencies, or the private sector, need to measure baselines regarding both agricultural practices and environmental outcomes at multiple scales and measure change over time.
- Producers need to work together to identify what a basic standard of stewardship should look like in their watershed – what performance standards or practices should be expected of producers regardless of cost share being available.
- We need to focus cost share and public dollars on the structural practices needed to achieve outcomes, and to put them where we can achieve the most cost-effective impact.

Government too needs to do things differently.

- Prioritize resources to where the natural resource problems are found.
- Invest in collecting baseline data and monitoring change over time at multiple scales.
- Provide regulatory certainty to those producers who voluntarily demonstrate continuous improvement to achieve water quality goals.
- Share data more freely among agencies within USDA, other agencies, universities, and the private sector so that we can better understand the relationships between conservation practices, yield resilience, and environmental outcomes in specific agronomic circumstances. Of course we must ensure that proprietary data remains private and that data voluntarily shared cannot be used for regulatory action.

As a member of the Advisory Committee of AGree, an effort that brings together a variety of producers with companies along the food and ag supply chain, environmental organizations, and public health and international development experts, I have worked with other producers to develop an approach we believe can successfully engage farmers and ranchers in achieving improved outcomes in working landscapes. What we are calling Working Lands Conservation Partnerships would be producer-led, watershed-scale, cooperative efforts to enhance both long-term productivity and improve environmental outcomes in a manner that could be recognized both by the public and public agencies as well as the supply chain. This approach is summarized in the infographic included in my written testimony.

The Regional Conservation Partnership Program authorized in the 2014 Farm Bill is an excellent example of a federal program that is well-aligned with our Working Lands Conservation Partnership approach. Allocating resources to specific areas of natural resource concern to undertake watershed scale projects that involve multiple partners and that leverage non-federal dollars makes sense. AGree recommends, and I strongly support, shifting up to half of agricultural conservation dollars toward programs like RCPP that utilize partnership-driven approaches to achieve outcomes at a watershed scale. This does not require trimming current programs. It means implementing them in a different way to support watershed-scale cooperative conservation projects. The limited resources available should be focused in a manner in which they can be leveraged to have the greatest impact. Through cooperative conservation, communities can identify together where and how conservation investments can achieve the greatest impact and leverage additional state and private funds.

Through the AGree process, we also have set some specific targets and timetables for natural resource stewardship that we believe represent the scope and pace of change that is needed. For example, AGree is calling for reducing by 30 percent over the next 10 years the number of rivers, lakes and streams currently designated as impaired primarily because of legacy and current nutrient, pesticide, and sediment runoff from agricultural operations. I am also including AGree's recommendations on working landscapes with my written testimony.

There are a growing number of us in the agricultural community who are eager to provide leadership to efforts to achieve such goals.

Thank you for your attention, and I look forward to your questions.

AGree
Transforming
Food & Ag Policy

Cooperative Conservation: A Producer-Led Approach to Achieving Healthy Agricultural Landscapes

By Kristin Weeks Duncanson, Jim Moseley, and Fred Yoder

September 2014

www.foodandagpolicy.com

Foreword

AGree drives transformative change by connecting and challenging leaders from diverse communities to stimulate policy innovation and develop initiatives that address critical challenges facing the global food and agriculture system. AGree believes we must elevate food and agriculture policy as a national priority.

AGree's work addresses four broad challenges facing the global food and agriculture system:

- Meet future demand for food;
- Conserve and enhance water, soil, and habitat;
- Improve nutrition and public health; and
- Strengthen farms and communities to improve livelihoods.

We have taken a deliberative, inclusive approach to develop a policy framework and ongoing, complementary initiatives to meet these challenges. To overcome traditional obstacles to change, we engage a broad array of stakeholders whose insights and commitment contribute to meaningful solutions. AGree's work, building on our research to better understand problems and assess options, aims to stimulate creative ideas and encourage new perspectives while fostering the linkages key to catalyzing effective action.

Drawing on decades of farming experience, three Midwestern farmers chart a path forward for agricultural conservation through producer-led, cooperative watershed or landscape-scale efforts focused on achieving measurable agriculture and conservation outcomes. Their proposed approach, "Working Lands Conservation Partnerships," envisions groups of landowners and producers, supported by robust technical assistance, driving efforts at a watershed or landscape scale to identify and agree on locally-appropriate conservation performance benchmarks to which all landowners and producers in an area would hold themselves accountable as a group. The Partnerships would test alternative approaches to meeting these benchmarks while also achieving production goals and assess the productivity and profitability of these practices over the long term. The Partnerships would be accountable to state and federal agencies for ensuring agriculture's active participation in efforts to meet state and federal environmental standards, and those who actively participate would receive safe harbor from regulatory action. The authors also provide case studies of successful conservation initiatives from across the country that exemplify components of their approach.

This publication is part of a series intended to broaden discussion and complement AGree's consensus recommendations on policies and actions focused on food and agriculture. While the concepts presented in this paper have greatly enriched the deliberations of the AGree Co-Chairs and Advisors, the perspectives and positions do not represent consensus among them.

We hope you find this paper a helpful resource.

Deb Atwood

Deborah Atwood
Executive Director

Contents

About the Authors

Kristin Weeks Duncanson is an owner and partner of Duncanson Growers, a diversified family farm in Southern Minnesota, former Director of the American Soybean Growers Association, and a member of the AGree Advisory Committee.

Jim Moseley is former Deputy Secretary of the U.S. Department of Agriculture, an Indiana farmer with 40 years of experience producing grain, vegetables, and hogs, and an AGree Co-Chair.

Fred Yoder is a fourth generation Ohio farmer, past President of the National Corn Growers Association, and an AGree Advisory Committee member.

Introduction: Achieving Healthy Agricultural Landscapes

Great strides have been made in American agriculture to align productivity, profitability, and environmental outcomes. New knowledge, technologies, and management practices have resulted in significant increases in yields alongside significant decreases in soil and nutrient loss. For years, many of us have been actively innovating to keep our soils healthy through conservation tillage, cover crops, attention to microbial life, and other techniques. We have been developing new drainage and water management technologies and strategies to retain moisture and nutrients for crops while reducing nutrient leaching and improving water quality. Farmers and ranchers are working with a wide range of partners to advance common goals, both through on-the-ground projects (see Box 1: Conservation Partnerships on the Ground) as well as national initiatives (see Box 2: Soil and Water Research and Education Partnerships). Pioneers in conservation continue to lead the way in aligning productivity, profitability, and natural resource conservation. It is a great American tradition of which we are very proud (see Box 3, Conservation Pioneers, for links to examples of conservation leaders).

And yet, though we have improved dramatically on the whole, we continue to lose far too much soil and far too many nutrients from our fields.[1] In too many places, the health of our soils is declining as is the quality of our water.

Why? The latest management tools and up-to-date agronomic advice are not available to or affordable for all producers. Best practices are not universally known and adopted. Too often, we don't have the data to tell us which specific fields under which management conditions are particularly vulnerable to nitrogen or phosphorus leaching. Those who operate these lands often are not aware of the vulnerability.

In a Nutshell

For American agriculture to succeed over the long term, we need to take a different approach to agricultural conservation. We must protect the long-term health of our lands and the communities, families, and enterprises that depend on the land for their livelihoods and way of life. We must move towards performance-based, cooperative, and adaptive approaches to management at multiple scales. We must support producers and landowners in taking the lead and provide the tools and knowledge necessary for success. We in agriculture need to hold one another accountable for good stewardship of our landscapes, and those who are actively participating in landscape conservation should have safe harbor from regulatory action.

Most importantly, we have come to recognize that we cannot adequately address these natural resource challenges as individual producers. The current approach to agricultural conservation is not enabling us to succeed in what we need to do: align productivity, profitability, and environmental quality at the field *and* watershed/landscape scale.

Achieving improved environmental outcomes while maintaining and enhancing productivity and profitability requires that we work together in our watersheds to understand the natural resource systems and how they respond to various agronomic practices and systems. We need to target structural practices to the places where they will add the greatest value for the least cost, and we must agree on what farmers and ranchers should expect of ourselves and our neighbors in terms of basic stewardship.

AGree

Box 1: Conservation Partnerships on the Ground

The following collaborative conservation efforts highlight many aspects of our proposed approach for establishing conservation partnerships in local communities:

Lime Creek Watershed Improvement Association, located in Northeast Iowa, has used a community-based approach to engage local landowners to achieve a set of agreed-upon nutrient reduction goals. Forty-five percent of watershed residents are engaged in the program, with 23 percent using the Iowa Phosphorus Index, Corn Stalk Nitrate test, and Soil Conditioning Index to better understand soil health on their land and compare management scenarios. Participants are paid incentives for sustainable land stewardship as measured by improved index scores and reduced corn stalk nitrate. The Association has successfully improved environmental outcomes by leveraging incentives, harnessing data and metrics, and engaging the local community.

Little Snake River Conservation District, Wyoming has completed an array of watershed restoration projects in a highly variable and complex landscape where agriculture, livestock grazing, and recreation are the primary uses, and ownership is split between private and federal entities. A wide range of projects to improve water quality and restore and conserve habitat have been undertaken to address the needs of listed and candidate endangered species and to remove streams from EPA's 303(d) list of impaired waterways. The District has been highly successful in conducting outreach, building trust with and a sense of ownership among landowners, engaging agencies, and securing project funds – all of which are critical ingredients to successful cooperative watershed projects.

Nebraska's Natural Resource Districts are a unique system among U.S. conservation districts in that they are governed by locally elected boards, organized by river basins to improve watershed management, and have the ability to assess local property taxes to fund projects. They provide technical and cost-share assistance as well as local regulations where necessary to improve conservation and natural resource management across the state, including flood control, groundwater quantity and quality, soil erosion, and irrigation runoff. Self-funded, locally governed, and with jurisdictional boundaries that match resource management concerns, Nebraska's Natural Resource Districts are models of effective conservation institutions.

Yahara Pride Farms Conservation Board is a voluntary, incentive-based coalition of Dane County, Wisconsin, landowners and producers, agronomists and technical advisors, recreational interests, and business leaders working to address phosphorous and sediment loading in the lakes in the Madison area and build a sustainability certification program. Partnering with NRCS, University of Wisconsin Extension, and the Clean Lakes Alliance and supported by private grants and member contributions, the Board has worked with local producers to improve their practices, engage in peer-to-peer learning, and leverage state and federal programs and technical assistance to gain the benefits of sustainability certification, including improved stewardship, expedited permitting from regulatory agencies, discounts from business partners, and brand recognition. Another ongoing project is the **Yahara Watershed Improvement Network** (WINs), a collaboration with the Madison Metropolitan Sewerage District (MMSD) to pilot an adaptive management approach to reducing nutrient runoff from non-point sources.

Box 1 (Continued):

Indian Creek Watershed Project, Illinois was established in 2009 to support area farmers working toward improved nutrient management and water quality. The Conservation Technology Information Center (CTIC), in collaboration with Illinois EPA, NRCS, and the Livingston County Soil and Water Conservation District, provides farmers with technical, informational, and financial support for conservation practices and technologies while also providing on-farm education and demonstration projects. Led by a steering committee headed by local producers, the project has garnered strong community support- 55 percent of local farms have enrolled. Partners in local government provide technical support through lake monitoring services, including regular data collection on sedimentation, fish habitat, nutrient loading, and other project concerns to help participants track progress and engage in adaptive management.

Sand County Foundation's Ag Incentives Program provides financial support to farmers for experimenting with new nutrient management practices to improve water quality in Midwestern rivers and lakes and the Gulf of Mexico. The project measures the results of such efforts to ensure progress and adaptive management. Current projects include work on the Milwaukee River, Boone River, and Yahara Lakes.

Sage Grouse Initiative is a Natural Resources Conservation Service (NRCS)-led collaborative effort to bring ranchers, agencies, researchers, conservation organizations, and the private sector together to proactively conserve sage grouse and sage grouse habitat to prevent the species' listing under the Endangered Species Act. Voluntary projects, such as conservation easements, new grazing systems, and invasive species and fence removal, are ongoing across 11 western states.

We are increasingly concerned about the erosion and nutrient pollution coming from agricultural landscapes because of what they mean for the long-term future of agriculture. First and foremost, we must protect the natural resources on which our livelihoods depend. That is our stewardship responsibility. We also must take heed of the general public's increased concern about the environmental impacts of agriculture – for if these concerns are not met with leadership and action by us in agriculture, others may well take action that is not friendly toward agriculture.

Indeed, there is a growing drumbeat to regulate agricultural activities driven by the evidence that agriculture is a significant – though not the only – contributor to nutrient loading (see Box 4: Growing Pressure to Regulate Agriculture). We who are leaders in our agricultural communities need to take initiative to ensure that all producers and landowners are participating in reasonable conservation measures or we risk losing consumer and public support for farming activities and being subject to increased regulatory actions.

We need to work together as farmers and ranchers in our watersheds and landscapes. We need to partner with others along the supply chain – both our input suppliers and our customers – as well as the variety of organizations and agencies focused on conservation in agricultural landscapes and the environmental impact of agriculture on water, air, and habitat.

We believe that production agriculture must move towards cooperative conservation of working lands at multiple scales in order to secure the long-term health of our individual operations and our watersheds and landscapes. Our proposed approach is informed by the successes and challenges of agricultural conservation projects in our own communities and across the United States. We have highlighted in sidebars some of the successful projects that have most informed our thinking.

Box 2: Soil and Water Research and Education Partnerships

The following are projects that incorporate many of the elements we are advancing in this paper, including an emphasis on the alignment of productivity, profitability, and stewardship; the importance of collaborative, cross-sector approaches; and farmer and rancher leadership and engagement:

Soil Health Partnership is a collaboration among National Corn Growers Association, Monsanto, and Walton Family Foundation, with support from environmental NGOs, academics, and USDA representatives. Over five years, the Partnership will work to test, measure, and publish findings on the productivity and environmental benefits of innovative soil management practices. Following report publication, the Partnership will support networking and technical assistance to help producers improve their soil health.

The Soil Renaissance is a collaborative initiative supported by the Farm Foundation and the Samuel Roberts Noble Foundation that seeks to make soil health a priority consideration in land management decisions. Representatives from agriculture, research, and policy communities are working on improving soil health measurement, economic valuation, research, and education.

Unlock the Secrets in the Soil is a USDA Natural Resources Conservation Service educational campaign designed to raise awareness about the benefits of healthy soils and the opportunities to take advantage of soil health management systems. Resources include soil health fact sheets and checklists; information on NRCS resources to assist landowners and producers in building healthy soils; and, testimonials from U.S. farmers discussing how maintaining healthy soils has increased their productivity, profitability, and sustainability.

On-Farm Network, sponsored by the **Iowa Soybean Association**, engages farmers to accelerate the use of precision agriculture tools and technology, including remote sensing, GPS, and yield monitors, to improve nutrient use efficiency. Growers work with agronomists on a range of research projects to determine the best combination of inputs and practices that enhance yields, nutrient management, profitability, and environmental stewardship.

Box 3: Conservation Pioneers

Examples of outstanding conservation leadership and innovation by landowners and producers include recipients of:

The Sand County Foundation's **Leopold Conservation Award**.

The **Environmental Stewardship Award** sponsored by NRCS, National Cattlemen's Beef Association, U.S. Fish and Wildlife Service, National Cattlemen's Association, and Dow AgroSciences.

The Department of the Interior's **Partners in Conservation and Cooperative Conservation Awards**.

A Producer-Led Approach: Working Lands Conservation Partnerships

Local leadership: We propose that in agricultural watersheds/landscapes that groups of local landowners/producers be formed to cooperatively establish and advance long-term productivity and conservation goals for their watersheds through engagement and support of producers and landowners and guided by sound science. This group might be called a Working Lands Conservation Partnership (WLCP) board or committee (if it functions under an existing board). In many places, an institution or group of institutions may already exist that could take on the WLCP mission, such as a conservation, watershed, drainage, or weed control district board. In other places, a new institution might be

Box 4: Growing Pressure to Regulate Agriculture

Growing public pressure to regulate non-point sources of water pollution, including agriculture, is largely the result of nutrient pollution, much of which comes from agriculture.

In Ohio, for instance, pressure is growing to reduce nutrient pollution to Lake Erie following a series of toxic algal blooms threatening Toledo's drinking water supply. Because agricultural runoff plays a key role in causing these blooms, the state and federal government have begun to move toward tighter restrictions on agricultural nutrient application. Most recently, in June 2014, Ohio passed a law phasing in requirements for farmers to become certified through a state educational program on improved nutrient management before applying fertilizer. Implementation of Ohio's State Nutrient Reduction Strategy to reduce excess nutrients causing the dead zone in the Gulf of Mexico as well as Total Maximum Daily Load (TMDL) restrictions affecting agriculture throughout the state are ongoing. Public health and environmental advocates, as well as a growing share of the public following recent drinking water shutoffs in Toledo, are calling for further action to prevent future drinking water impairments.

In Minnesota, too, pressure for action to reduce agricultural runoff is building. Voters in Minnesota demonstrated their strong support for improved water quality by passing a Legacy Amendment taxing themselves to support a state Clean Water Fund that generated over $339 million between 2009-2012 alone.[2] Like Ohio, Minnesota is required to implement a State Nutrient Reduction Strategy to improve water quality in the Mississippi River basin and is administering TMDLs across the state to reduce the number of impaired local water bodies affected by agricultural runoff and other factors. Minnesota has adopted an ordinance requiring 50 foot buffers on all agricultural land along lakes and streams. The Minnesota Agricultural Water Quality Certification Program, a voluntary program to provide regulatory certainty to farmers engaged in certified conservation practices, is being developed. Despite these efforts, observers continue to call for further regulatory action to reduce agricultural runoff that contributes to water quality impairments.

California landowners and producers are among the more highly regulated in the country on many environmental issues. For instance, the state requires all potential nonpoint dischargers, including farmers and ranchers, to create plans specifying the best management practices they will implement to meet regional and state water quality goals as well as a timeline for implementation and a description of a monitoring program for groundwater as well as rivers and streams. Landowners may submit individual plans, but many choose to work with a group of similar dischargers to create a third-party plan that is developed and administered by outside representatives through institutions called water quality coalitions. These organizations take advantage of economies of scale for efficient planning, monitoring, and technical support.

In these states and around the country, there is increasing public concern about non-point sources of water pollution. Farmers and ranchers, many of whom are already doing good work to manage nutrients and reduce runoff, should step up and take the lead now to ensure agriculture is doing its part to address these concerns. Our WLCP approach will allow them to do just that.

needed. In addition to its work within the community of producers/landowners, the WLCP board/committee would serve as a focal point for the agricultural community to engage with other sectors and interests responsible for and/or concerned about environmental outcomes in working landscapes. Funding for the WLCP might be provided through a combination of producer/landowner self-assessments, state and federal grants and funding streams, and (perhaps even) other private sector funding streams.

Baseline conservation performance and practice standards: We propose that the WLCP leadership work with producers and owners of working lands to develop specific performance benchmarks (goals that include specific metrics and targets) at a watershed/landscape scale, as well as basic practice requirements and/or performance benchmarks (appropriate to the location, size, and scope of an operation) at a farm scale. These locally-established baseline conservation performance and practice standards would be designed to enhance the long-term productivity of agricultural landscapes, help meet basic environmental quality standards, and contribute to the profitability of farm operations and the long-term value of working lands. Baselines would be established, and the proposed performance and practice standards would be tested, refined, and over time become an expectation of producers in the watershed. At the individual landowner/producer scale, standards would contain performance benchmarks where measurement and monitoring are practical and economically feasible. Where they are not, evidence-based practice standards would be used. At the watershed/landscape scale, standards would be entirely outcome oriented and measurable. When edge of field and in-stream practices and infrastructure that go beyond the locally-established baseline standards are required to address resource concerns, the WLCP board would take responsibility for identifying where they should be undertaken to achieve the greatest effect for the watershed/landscape at least cost and for financing them, through a combination of financial self-assessment and partnerships/cost-share with public and private sector organizations.

Supporting Producers to Achieve Productivity, Profitability, and Environmental Quality

The Working Lands Conservation Partnerships approach draws on a wide range of experience and lessons learned from past and current efforts to provide producers with (1) the tools they need to understand the impacts of their operations on the broader watershed and (2) the information and technical support necessary to adopt pragmatic approaches to improving agricultural operations in order to reduce impacts on the watershed while maintaining or improving productivity and profitability.

Technical resources: WLCPs would need to employ significant technical resources to: measure baselines, monitor conditions, and track management practices; assist producers in developing integrated resource management plans; aggregate data, ensure its privacy, and assess the effectiveness of plans and practices; identify in-field and edge-of-field performance and/or practice standards and systems sufficient to meet performance goals; and, design landscape-scale conservation plans. Such assistance could be provided by conservation districts and universities in the area, federal and state agencies, private sector suppliers and advisors, and/or the WLCPs own hired experts. The WLCP board/committee would ensure that producers are engaged in the design and oversight of data gathering. We imagine that every 3 – 5 years boards would assess the effectiveness of their baseline conservation standards and off-field infrastructure in achieving performance outcomes and make adjustments as needed. State and federal programs could be tapped to provide financial resources to the WLCP and its members to cover all or part of the costs of measurement and monitoring at various scales.

Framework of mutual accountability: To be effective, WLCPs would need to be part of a framework of mutual accountability among producers, local boards, and federal/state agencies. Watershed/landscape conservation plans would be developed by the WLCP board, oriented to achieving both local conservation goals as well as state and federal environmental quality standards. The WLCP would in effect serve as a buffer between producers/landowners and federal and state regulators. In our vision, the WLCP would represent the agricultural sector in the watershed/landscape and would work with relevant state and federal agencies for ensuring producer/landowner participation in efforts to meet state and federal environmental standards. To the extent state or federal law now or in the future requires action by agriculture to meet environmental quality standards, we propose that the WLCP would be accountable to the relevant agencies for implementing a plan they approve as sufficient to make progress toward meeting state and federal standards. Agencies would, in turn, be accountable to producers and landowners for recognizing and supporting their efforts by granting to the board and all of its actively participating members safe harbor from additional regulatory action related to environmental outcomes addressed in the plan. Agencies should also be accountable for exercising their discretion in a manner that enables and supports the WLCP in achieving its mission. If producers/landowners choose not to fully participate in the WLCP program, they would not be protected from regulatory action. If the agronomic practices of such individuals prevent the broader community from achieving environmental quality goals, communities might consider some kind of informal or formal enforcement mechanism.

The supply chain: Growing interest in "sustainable sourcing" among major food brands, processors, and retailers creates opportunities to integrate company sustainability objectives with locally-led collaborative landscape management. Rather than focus only on a single company's relationships with individual producers around sustainability metrics, certifications, and checklists, the WLCP-approach provides an opportunity for multiple buyers to work together and in partnership with producers/landowners in a landscape/watershed to achieve environmental outcomes at both

Box 5: Key Elements of the WLCP Approach

Strong local leadership by farmers/landowners, inclusion of all key stakeholders, and involvement across the supply chain.

- **Performance-based, cooperative, and adaptive approach to management** of watersheds/landscapes.
- **A basic standard of on-farm care:** conservation performance and practice standards established by producers and technical experts locally that can reasonably be expected of landowners/producers in the area that are tested, assessed, and adapted over time.
- **Additional infrastructure and on-farm practices** necessary to achieve goals, funded by a combination of cost-share, community assessments, and grants.
- **Local conservation goals and plans aligned with local, state and federal goals and plans with regulatory certainty/safe harbor for participating producers/landowners.**
- **Recognition for farmer/landowner stewardship** in supply chain companies' sustainable sourcing initiatives.
- **Robust technical and administrative support and monitoring infrastructure** to establish baselines, measure progress, and develop and implement effective strategies.
- **Coordination and collaboration wi th local districts and boards** (conservation, irrigation, drainage, weed control, etc.), **as well as research, education, and extension resources.**

the individual operation scale as well as the landscape scale. Ideally, WLCPs would have a single set of criteria and metrics for producers focused on continuous improvement that address local, state, federal, and supply chain sustainability goals, enabling a streamlined system adapted to local conditions that works well for producers.

The Path Forward

We are convinced that broad-based stewardship among producers through baseline conservation standards and jointly taking responsibility for additional practices and infrastructure necessary to achieve environmental outcomes will help position agriculture, both in fact and in perception, as a vital part of the solution to existing environmental quality challenges while ensuring the long-term economic sustainability of agriculture. We believe the time is ripe for a working lands conservation partnerships approach to take root more broadly and comprehensively. However, the institutional capacity for fully integrated watershed/landscape governance at multiple scales is not in place and will require significant realignment and integration of authorities and capacities. Skilled volunteer and professional leadership to effectively engage landowners/producers at the grassroots level must be developed. Much better data on both practices on the land and outcomes from field to large landscape scale as well as scientific analysis to understand their relationship is needed. Widespread implementation is a long-term prospect, requiring intensive efforts across the nation for the next ten to twenty years.

Given the inherent variability and complexity in both agricultural and natural systems, we have to work together, community by community, watershed by watershed, to ensure the health and vitality on our farms and ranches and across our landscapes. Taking this approach will bring divergent groups together, strengthen bonds, and build leadership– all of which benefit and enrich communities in numerous ways. Furthermore, we anticipate that over time, those watersheds and landscapes in which producers, landowners, and other stakeholders work together to improve conservation outcomes will develop a competitive advantage when marketing to the growing number of large purchasers who are concerned about the sustainability of their supply chains.

The future of agriculture in America is bright – if we conserve and enhance the soil, water, and habitat for the generations that follow us. To succeed, we must work together. We invite you to offer your suggestions about how the concepts we have presented can be improved, and how we can together make progress toward a new vision for agricultural conservation.

Endnotes

1 U.S. Department of Agriculture. 2010. 2007 Natural Resources Inventory: Soil Erosion on Cropland, Natural Resources Conservation Service. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012269.pdf.

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2 "Clean Water, Land & Legacy Amendment: Making Minnesota Better." 2014. Minnesota Department of Natural Resources. http://www.dnr.state.mn.us/legacy/index.html.

About AGree

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AGree is a collaborative initiative of nine of the world's leading foundations, including the Ford Foundation, Bill & Melinda Gates Foundation, The David and Lucile Packard Foundation, W.K. Kellogg Foundation, The McKnight Foundation, Robert Wood Johnson Foundation, Rockefeller Foundation, Surdna Foundation, and The Walton Family Foundation, and will be a major force for comprehensive and lasting change.

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Working Landscapes: Achieving Productivity, Profitability, and Environmental Outcomes

2014

Challenges

Initiatives

- Food & Nutrition
- Immigration Reform
- International Development
- Local Food
- Next Generation
- Research & Innovation
- Risk Management
- Working Landscapes

AGree brings together a diverse group of producers, environmentalists, processors, supply chain companies, and academics who have widely divergent views of the issues and opportunities facing U.S. agriculture. Despite our differing perspectives, however, we share a common vision: a 21st century food system in which farms and ranches are productive and able to meet growing demand for affordable and nutritious food; farming and ranching are profitable enterprises; soil, water, and biodiversity are conserved and enhanced; and environmental quality is maintained or improved. We believe that American farmers and ranchers have had remarkable success to date in achieving many aspects of this vision. Challenges remain in maintaining and improving soil health, water quality, and habitat in many agricultural regions, and as agriculture moves forward, new challenges associated with a changing climate, shrinking water supplies, shifting dietary preferences, and growing populations must also be addressed.

We have developed a set of strategies and initiatives that will be essential to trigger and sustain transformative change on an effective and meaningful scale. While public policy, regulation and publicly-funded research will play a role in enabling needed innovations, we strongly believe the solutions necessary to attain our common vision will largely emerge from the efforts of those directly engaged in food and agriculture enterprises working in their businesses and communities. Models of innovation that create new sorts of linkages and are laser-focused on problem-solving are needed to set the stage for aligning efforts to achieve positive economic, social, and environmental outcomes across U.S. and international supply chains. Innovative problem-solving must engage producers, commodity groups and associations, researchers, educators, NGOs, and businesses, as well as public policy and institutions. Building trust and promoting cooperation among these stakeholders is essential. We know this is possible because we have seen it work in diverse circumstances across the United States.

We acknowledge that there is anxiety in the agricultural community with government-driven regulatory approaches to farm and land management. We believe that government's role is to set goals and support producers, landowners and businesses in their achievement, ensuring accountability for meeting goals and avoiding prescribing specific practices as much as possible. And, when regulation is essential to ensure public health and safety and conservation of natural resources, it must be fair, sensible, effective, and flexible.

To set U.S. agriculture more firmly on a path toward achieving our common vision, even as new challenges and opportunities emerge, we recommend the following strategies:

- Embrace diverse agricultural systems to ensure achievement of sustainability, productivity, and profitability goals. Stakeholders must move beyond debates about big vs. small, organic vs. conventional or low vs. high tech to focus on what works best to achieve these concrete outcomes: reliable and consistent production of affordable, safe, and nutritious food; healthy working lands and ecosystems, and prosperous farms and communities. All producers must have the tools and resources they need to successfully and sustainably deliver agricultural products while serving diverse consumer values and markets. Food value chains everywhere must be sufficiently resilient to adapt to changing market and environmental conditions and to recover from short-term weather, market, or resource-based crises.

- Expand producer-led cooperative conservation across U.S. working lands. U.S. agriculture should capitalize on and extend proven successes of producer- and landowner-led efforts to advance conservation and improve environmental outcomes. Farmers, ranchers, and landowners should be empowered by federal policy to take the lead in initiating efforts to:

    - determine a basic standard of care — performance and practice standards that should reasonably be expected of landowners and producers in their watersheds or regions and should be in place whether or not public cost-share dollars are available;
    - encourage all producers to participate in meeting those standards, and test innovative approaches to meeting these standards while also achieving production goals;
    - assess the productivity and profitability of these practices over the long term;
    - work with relevant agencies, technical experts, and organizations to identify additional on-farm practices and infrastructure that support achievement of natural resource conservation goals;
    - determine implementation and financing strategies and identify sources of funding to support implementation; and
    - provide safe harbor to those who are willing to take voluntary action to achieve desired outcomes or early adopters who achieve such outcomes in an unconventional or extraordinary manner.

"Taking the lead" does not mean "doing it alone." The value of public research and extension systems in providing science-based advice is well-recognized and will be an essential complement to producer-led efforts. Indeed, strengthening public agricultural education and extension would facilitate additional acceptance and implementation among producers, landowners, community groups, and state and federal agencies to advance effective conservation at both the farm and landscape scale.

- Improve soil health and water quality and quantity through targeted investments. Farmers and other stakeholders should take an integrated, systems-oriented approach to soil, water, and nutrient management tailored appropriately to local conditions and farming practices. While soils vary dramatically across topography, they are the most basic, precious and critical resource for agricultural production. Degraded soil quality reduces the effectiveness for roots to access both water and nutrients, which leads to the need for higher levels of applied fertilizer and irrigation water when crops are actively growing. Farmers must have the correct levels of nutrients for their crops to perform and need access to the knowledge and tools necessary to maintain and improve long-term fertility by promoting soil quality. In summary, improvements in soil quality benefit society with lower food costs, cleaner water and reduced atmospheric carbon while landowners experience higher land values due to greater productivity from the resilience naturally inherent in improved soil.

    - Federal and state agencies as well as commodity groups and business leaders should invest in the research, education, and tools needed by farmers to more efficiently manage soil, water, and nutrients so that long-term productivity, profitability, and ecosystem health are improved and sustained.

- Increase understanding of the overall benefits, costs, and health and safety of agricultural inputs, practices, and systems. Well integrated and publicly available data and further analyses are needed to accelerate progress, as are better aligned goals and standards:

    - Invest in baseline data collection, long-term monitoring, research, and the merging, mining, and analysis of existing public and private databases (while effectively protecting proprietary information) to understand the relationships between production systems, conservation practices, yields, resilience, and environmental outcomes and to support both on-farm management and watershed/landscape scale natural resource conservation.
    - Craft widely accepted goals, standards, and associated metrics relevant to producers and landowners, commodity groups and associations, policymakers, supply chain leaders and the public to focus activities of multiple sectors and actors, and leverage public and private investments around commonly shared objectives.

- Develop knowledge that can be used to design programs and incentivize conservation practices and systems that result in long-term productivity, resilience, and environmental quality. Increase capacity of the federal government to conduct independent and transparent, government-funded assessments of the agronomic effectiveness and human and ecological health impacts of new agronomic tools, technologies, and systems while modifying and streamlining the regulatory permitting processes to accelerate timely use of new tools and technologies that meet environmental, health, and safety standards.

- Foster collaboration across the supply chain to drive innovation and improved environmental outcomes: Move from checklists where large companies make demands of farmers and ranchers to mix and match "sustainable" practices to collaborative partnerships among food companies and producers focused on improving the "triple bottom line" (economic, social and environmental outcomes) at both farm and watershed/community scales, and indeed all along food value chains. Adopt new policies to promote and reward the widespread adoption of successful models. The goal is to create an equitable distribution of costs and benefits associated with transformative system changes, and create and share added value along the entire supply chain through high-quality engagement, commitment to ethical principles, and continuous learning.

Much work is already underway to advance these strategies, with leadership from producers and landowners, the supply chain, and the conservation community. But the challenges are also growing more complex and U.S. agriculture faces new competition and threats, both from inside the United States and globally. To amplify current efforts and accelerate progress, we propose the following specific goals, which we believe are indicative of the scope, scale, and pace of change necessary to realize our vision. The achievement of these goals will require the integrated pursuit of the strategies identified above.

1. **Shift up to 50 percent of USDA conservation program spending to support producer-led models for watershed-based cooperative conservation** by engaging 20 percent of working lands in producer-led, cooperative conservation projects in areas with significant resource concerns by 2025, 50 percent by 2035, and 75 percent by 2045.

2. **Increase continuous no-till where compatible with regional farm and crop practices by 50 percent and plant cover crops on 65 percent of annual row crop acreage to decrease soil degradation ratings** by 2025.

3. **Increase water supplies suitable for irrigation by 33 percent and mitigate overdraft of aquifers by 2025** by increasing irrigation water efficiency, increasing environmentally sound water storage and recharge, reducing losses in water conveyance, and bringing into greater alignment the water needs of crops/livestock grown in regions and long-term projections (including potential for enhancement) of water supply.

4. **By 2025, reduce by 30 percent the number of rivers, lakes and streams currently designated as impaired primarily because of legacy and current nutrient, pesticide, and sediment runoff from cultivated cropland.**

5. **Universalize methods of nutrient application that result in efficient uptake by plants, retention of nutrients in the soil, and reduced release into water and air.** Acceptable levels of nitrogen and phosphorus use efficiency will vary by region, soil, type of irrigation (if any), and source of nutrient. In impaired watersheds, require producers who chose not to participate in voluntary efforts to conduct nutrient management planning and other practices necessary to reduce offsite environmental effects of nitrogen and phosphorus and protect the watershed.

6. **Integrate and/or manage USDA (e.g., NASS, ERS, NRCS, etc.) on-farm data collection programs** so that detailed, comprehensive farm-specific information is available to quantify the impacts of farm enterprise design, farming system choices, conservation practices and systems, technology, and policy on all critical aspects of farm-level and watershed/landscape-scale performance, impacts, resilience, and sustainability.

Progress toward these goals will demonstrate that U.S. agriculture is on a trajectory to meet the challenges of aligning productivity, profitability, and environmental outcomes. These goals and programmatic recommendations are not intended to be comprehensive, nor the final word, but are offered as an essential starting point. For a more detailed and comprehensive set of strategies, please see *Annex to AGree Consensus Recommendations: Achieving Productivity, Profitability and Environmental Outcomes in U.S. Agriculture*.

Although all the individuals formally affiliated with AGree may not agree completely with every statement noted, they are committed to working together to find solutions to the challenges facing food and agriculture. AGree Advisors participated as individuals, not as official representatives of their organization.

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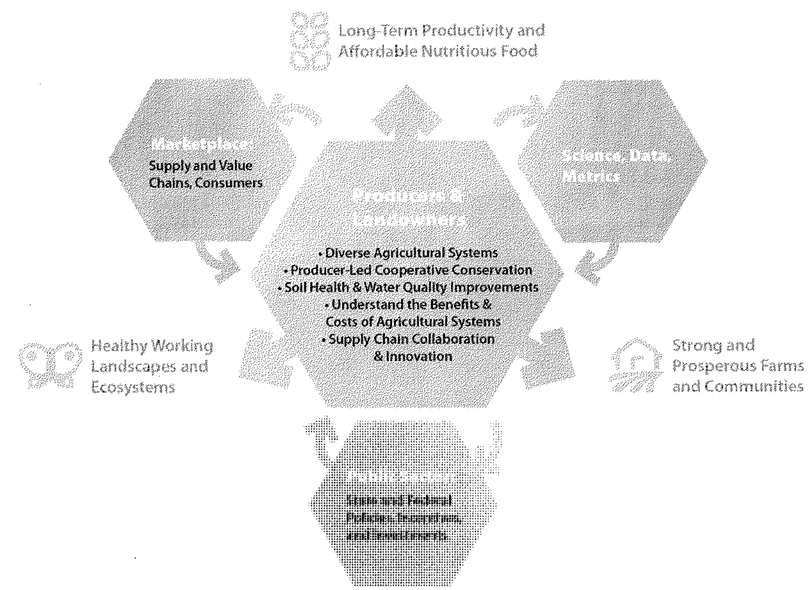
Framework for Transformative Change to Achieve Productivity, Profitability, and Environmental Outcomes



United States Senate Committee on Agriculture, Nutrition & Forestry

"Farmers and Freshwater: Voluntary Conservation to Protect Our Land and Waters"

Written Testimony of Trudy D. Fisher

December 3rd, 2014.

My name is Trudy Fisher, and I am the former Executive Director of the Mississippi Department of Environmental Quality.

I will focus my comments today on two topics. I will first discuss the voluntary agricultural practices utilized in Mississippi to address nutrient reduction and improve water quality. We accomplish this through vital collaborative partnerships with the Natural Resource Conservation Service, agricultural producers, and many other partners focused on a common purpose.

As former director for 7 ½ years I have witnessed firsthand the power of partnerships, true collaboration, and common purpose around improving water quality.

I will conclude my testimony with a few comments on the proposed "waters of the United States" rule.

Voluntary Conservation Practices for Water Quality Improvement

Nutrient reduction is not only a prevalent topic in the Mississippi River Basin, it's a pervasive topic throughout the country. The Mississippi River drains 43% of the United States and two provinces in Canada. The River is the lifeblood of the US economy and drives coastal productivity in the Gulf of Mexico. The Mississippi River Basin is also the proverbial bread basket of agriculture in the United States. Over 80% of corn and soybeans grown in the US are grown within the basin. With this intensive agriculture comes the potential for increased nutrients moving downstream, and impacting water quality. Mississippi is one of only two states that border both the Mississippi River and the Gulf of Mexico. The 7000 square miles known as the Yazoo-Mississippi River Delta and the Gulf of Mexico are economic engines for both our state and the country. For that reason Mississippi has been in the forefront of understanding how we can improve our environment and water quality, while concurrently sustainably intensifying agriculture. The sustainable intensification of agriculture has to go hand-in-hand with conservation. Conservation in the 21st century has to make economic sense. Mississippi has focused on a strategy that has turned potentially competing paradigms into voluntary leveraged opportunities.

As a coalition, the Mississippi River states, as well as federal partners have created the Hypoxia Task Force that is charged with identifying opportunities to improving water quality in the Gulf of Mexico. Mississippi was the first state to co-lead the Hypoxia Task Force. One of the visions that needs to be fully comprehended is that the coastal water quality issue in the Gulf of Mexico is a coastal problem with an inland solution. The inland solution is designing systems that work well with agriculture to reduce the amount of nutrients delivered downstream. Mississippi is also positioned to engage both the Hypoxia Task Force as well as the Gulf of Mexico Alliance (GOMA) – a coalition of Gulf States trying to holistically improve ecosystem conditions in the Gulf. Mississippi was the first state to lead GOMA and the associated Nutrients Priority Team. By being able to connect the Hypoxia Task Force to the Gulf of Mexico Alliance, Mississippi had a strategic ability to understand what was needed from an individual state to tackle the problem of hypoxia.

Each state has its own way to go about addressing the nutrient reduction problem. Mississippi was the very first state in the entire Mississippi River Basin to tackle this problem at a grass roots level. We devised a nutrient reduction strategy that is meaningful and will work. This could not have been accomplished without the support of our agricultural producers, Natural Resource

Conservation Service, and many others. We weren't just first in undertaking a nutrient reduction strategy, but also first in designing, creating, implementing, and showcasing how well it works. The nutrient reduction strategy that has now been replicated up and down the river basin was a collaborative effort between Mississippi Department of Environmental Quality, a state agency, and a nonprofit organization called Delta FARM (Farmers Advocating Resource Management). This effort was based on a couple of simple tenants:

- We know that there are clear connections between the Gulf of Mexico and what is happening on the ground on our farms.
- To really improve water quality we need to understand this connection.
- We understand tangible connections between high level strategies of the Hypoxia Task Force, the Gulf of Mexico Alliance and other federal agencies and how it is translated to effective conservation practices on the ground.
- Any conservation practice that is implemented needs to make economic sense. Sustainable intensification is rooted in that conservation practices need to make economic sense to our farmers.

Mississippi also took a different approach from the beginning to understand solutions to water quality improvement. Knowing that we were advocating a voluntary strategy for the implementation of conservation practices, our nutrient reduction strategy didn't ask what is the number we were aiming towards for improvement. Rather, we decided to ask a tougher set of questions that was centered on: what nutrient reductions are achievable? The other questions were: What will these strategies cost? What is the value to each stakeholder of these reductions? and What nutrient reductions will protect Mississippi waterbodies and the Gulf of Mexico.

Mississippi uses a three part strategy: 1) form partnerships, 2) find a common purpose to everything we do, and 3) we leverage everything. Partnership goes beyond the typical getting together and discussing the creation and development of the strategy. We engage state, federal, non-governmental organizations and most importantly the farmers together to build the nutrient reduction strategy. But after building it, we continue this partnership. Our monitoring efforts of what is achievable are completely coordinated – federal and state agencies are in close and constant communication so that efforts are in unison. Our story is told at multiple scales.

We leverage other projects and programs into our study watersheds to help answer those tough questions – we leverage state dollars, federal dollars, private research dollars all towards the common purpose. Whether someone is doing research, outreach, or extension – everyone's purpose is the same, everyone is aiming to understanding our system better and to communicate our results to all of our stakeholders. We have also taken this communication to another level. Our communication pathways include innovative technologies showcasing conservation practices, we use short video features that last on average 2 minutes or 120 seconds that package how the practice works, what it means to the agricultural community, and how it improves water quality. Our strategy was the first of its kind and so was our implementation approach. It is all good to have a strategy in place, to partner and leverage, but if we don't have results or truly document the impact it is all for naught. Mississippi has done just that. We have documented our successes. Understood our failures. We are coordinated in measuring our impacts. Our successes are tangible. We are seeing measurable improvements to water quality moving to downstream environments.

Near the beginning of this briefing I talked about the sustainable intensification of agriculture and how it, in tandem with conservation in Mississippi has been turned from competing paradigms into leveraged opportunities. Let me give you some concrete examples of how that works in Mississippi. Again, I want to reiterate when we address the use of conservation practices we value its role in agriculture just as heavily as we value its role in addressing water quality concerns. Let me talk to two specific examples.

The first example I would like to give you is land leveling.

- Agricultural land that is un-even and not level has some significant agricultural and conservation challenges. Yield distribution is uneven. Irrigation of this land is difficult, and distribution of water is not efficient and uneven. Because of slopes, runoff from storm events are high, carrying sediments and nutrients downstream.
- Land-leveling is the act of smoothing out of the land and creating a uniform grade to the field.
- It is a practice that is cost-shared by the USDA
- By leveling the land, yields are now more consistent. Yields are typically higher because you have better drainage. Yields are higher because irrigation is delivered more efficiently. Input costs are decreased because irrigation of graded land is more efficient.
- Levelled land decreases runoff velocities of storm events. Decreased velocities means less sediment and nutrients moving downstream.
- Levelled land means more efficient uptake and utilization of nutrients by crops. This means better yields, and less nutrients available to move downstream.

The second example I would like to give you is the use of the most ubiquitous feature of every agricultural landscape across the US – the drainage ditch.

- The drainage ditch is a vital feature for adequate drainage for the farm landscape.
- Often though drainage ditches are too narrow, too shallow, and don't drain as well as they could in storm events causing back flooding of agricultural lands and potential loss of yield or entire crops.
- Drainage ditches also serve as conduits of sediments and nutrients moving downstream.
- In Mississippi, over the last 5 years, we have worked diligently in redesigning the drainage ditch, and putting in innovative water control structures. Both the redesign and implementation of structures can be incentivized by USDA.
- By opening up the ditch you do remove some agricultural land out of production but often that land is very low-yielding land and makes better economic sense in this capacity.
- By implementing water control structures you will see significant improvements in water quality moving downstream. Research has shown that in a new ditch configuration, they do not alter the drainage capacity of the system and thus do not impact back flooding on agricultural lands.

I want to wrap up this section with applying our lessons. These are some take home messages that we can stand on:

1. We have a common goal when it comes to putting together a strategy that is implementable for water quality improvement. It has importance for all stakeholders. It needs to be implementable – it needs to work. This means making sure that farmers can implement these strategies as well as sustainably intensify agriculture. It needs to provide the information for the state departments of environmental qualities so that we can document improvements to aquatic systems of the state. And also important for the regional EPA offices to highlight protection of waters of the US.
2. Though we are dealing with water quality, often conservation practices integrate with improvements in water quantity. This integration is pervasive across the US. Our approach has been to understand what is actually achievable in terms of water quality and quantity improvement versus placing an arbitrary number for reductions and going with that number that maybe over promising improvement delivery.
3. We don't look at a conservation practice solely for its potential for water quality improvement but rather how it can integrate with agriculture to achieve sustainable intensification.
4. Each state is going to have their own respective problems and concerns as it pertains to water quality and quantity. But we can lean on each other – look for cross state collaborations and opportunities for leveraging and cooperation. Mississippi has helped out other states and stands ready to continue leading the pack in understanding water

quality improvement, what is achievable, and coordinating, leveraging, and partnering across administrations and agencies to the good of the environment as well as agriculture.

Proposed Waters of the United States Rule

Where we are on the proposed rule is not a mere "communication issue" as the Environmental Protection Agency (EPA) submits. Where we are with the proposed rule is a classic case of "no input" equals "no buy in". As a former regulator, you cannot successfully enforce what the intended regulated community has not bought into. The EPA maintains a robust social media campaign and listening tour, but are we truly listening or plodding forward?

The EPA and the Army Corps of Engineers (Corps) proposed "waters of the United States" rule is one of the most controversial rules proposed and should be withdrawn. I have attached comment letters to my testimony and ask that they be included in the record.

I will share with you a few lessons learned as a former state agency director:

- A legally required comment period is not dialogue.
- Activity is not achievement.
- Diverse polarization of opinion on a proposed rule usually means the solution is somewhere in the middle.
- No dialogue means no buy in especially in the agricultural sector where voluntary programs are so successful.

As evidenced in my earlier testimony, the agricultural community in Mississippi and throughout the country are voluntarily employing conservation practices on their properties. These practices are employed on a voluntary nature because farmers recognize the benefits to the environment, clean water, to agriculture, and the economy. Often these practices result in changes to drainage systems, the creation of holding ponds, and as such would then be under the juris of the new proposed rule. Further alterations to these practices would also potentially have regulations and permitting requirements associated with them under the new rule. With this new rule, rather than creating an environment where farmers are included in enhancing clean water and helping them put conservation efforts in the ground, the new rule does the absolute opposite by forcing farmers into a regulatory environment in any effort to do so. This would only lead to the agricultural community backing away from conservation practices that makes conservation and agricultural sense.

EPA and the Corps hit the "pause" button on the proposed rule. I submit it is time for EPA to hit the "rewind" button and withdraw the proposed rule.

STATE OF MISSISSIPPI
PHIL BRYANT
GOVERNOR
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
TRUDY D. FISHER, EXECUTIVE DIRECTOR

July 7, 2014

Ms. Damaris Christensen
Office of Water (4502-T)
Environmental Protection Agency
1200 Pennsylvania Avenue N.W.
Washington D.C. 20460

Mr. Chip Smith
Office of Deputy Assistant
Secretary of the Army (Policy and Legislation)
108 Army Pentagon
Washington D.C. 22310

Re: Interpretive Rule Comments
Federal Register Notice

Greetings:

The Mississippi Department of Environmental Quality is responsible for protecting the state's air, land, and water. Our mission is to safeguard the health, safety, and welfare of present and future generations of Mississippians by conserving and improving our environment and fostering wise economic growth through focused research and responsible regulation. In that spirit, the Department offers the following comments:

I. Current practices for "normal farming" activities: It is unclear how many commonly occurring "normal farming" practices will no longer be exempt as a result of the interpretive rule. The Department feels an effort was made to be inclusive of most activities. However, there are conservation practices in Mississippi that were not included that have shown great environmental benefit in Mississippi. We would like the opportunity to have those practices added and/or to have the flexibility to determine the best practices for our state at the state level in coordination with our state NRCS office.

II. The interpretive rule purpose: The goals expected to be achieved with the interpretive rule is unclear. While there are outlined activities that will obtain exemptions from 404 permitting, it is difficult to follow how these activities will be considered for other federal permitting actions. It is also unclear when these activities may not be considered an established farming operation. For instance, if a farm is expanding into waters including wetland areas not previously included in the

Exhibit 1
Testimony of
Trudy Fisher

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farming operation and is employing a conservation practice standard, would a permit be required for this expansion? Will this interpretive rule apply to farming operations that have been fallow for several years and wetland vegetation has been allowed to re-establish?

III. Voluntary conservation programs: Currently, the Department is working in partnership with other state and federal agencies as well as conservation groups to address both water quality and water quantity issues through the implementation of Nutrient Reduction Strategies and Conjunctive Water Management Strategies. There are practices, such as NRCS Practice Code 410 (large overfall pipes and low grade weirs) and 607 (2-Stage Ditches) which have demonstrated environmental benefits in Mississippi that were not exempt in the rule. The Department has concerns that this rule may complicate the continued implementation of some of the most promising voluntary conservation practices and programs.

IV. Potential for unintended impacts: There are instances where a landowner may follow the NRCS practice standards but not be operating with NRCS oversight, In the event that a landowner deviates from the practice standard, it is unclear what regulatory roles would be involved. Also a landowner may be following the NRCS practice standards but not be considered an ongoing farming operation. Further information is needed to clarify what is intended by an ongoing farming operation.

Thank you for the opportunity to comment on this matter. The Department looks forward to obtaining additional clarification and information on this issue. Should you have any questions about the comments provided, please contact Mike Freiman, Chief of the Surface Water Division at (601) 961-5271.

Sincerely,

Trudy D. Fisher
Executive Director
Mississippi Department of Environmental Quality

cc: Mr. Richard Harrell, Director, Office of Pollution Control
Mrs. Kay Whittington, Director Office of Land and Water
Mr. Mike Freiman

STATE OF MISSISSIPPI
PHIL BRYANT
GOVERNOR
MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY
GARY C. RIKARD, EXECUTIVE DIRECTOR

November 14, 2014

Ms. Donna Downing
Office of Water
Environmental Protection Agency
Mail Code 2822T
1200 Pennsylvania Avenue NW
Washington, DC 20460

Ms. Stacey Jensen
Regulatory Community of Practice
U.S. Army Corps of Engineers
441 G Street NW
Washington, DC 20314

RE: Docket ID No. EPA-HQ-OW-2011-0880
Waters of the United States Proposed Rule

Dear Ms. Downing and Ms. Jensen:

The Mississippi Department of Environmental Quality (Department) has the delegated authority to implement in the Clean Water Act in Mississippi. The Department has held that authority since 1974, and has extensive expertise and experience in implementing the Clean Water Act. The Department's mission is to safeguard the health, safety, welfare of present and future generations of Mississippians. With both its mission and experience in mind, the Department offers its comments on the proposed Waters of the United States rule.

Mississippi requests this proposed rule be withdrawn and amended to fully address the comments and concerns that have been expressed since the rule was released. The Department asserts that the implementation of the rule will have negative unintended consequences which have not fully been discussed and weighed. The proposed rule could, in fact, have dire impact on the significant economic drivers in our state, such as agriculture.

Exhibit 2
Testimony of Trudy Fisher

The Department specifically offers the following comments about the proposed rule:

1. **This rule could cause further confusion and expand the scope of jurisdictional waters in Mississippi.** The goal of the rule may have been to simplify and clarify issues caused by recent court decisions, but it has instead created more uncertainty for both the regulated public and the state regulatory agencies. Terms, such as those used in defining

"tributary" on page 22202 in the Federal Registry *(A tributary, including wetlands, can be a natural man-altered, or man-made water and includes waters such as river, streams, lakes, ponds, impoundments, canals, and ditches...)*, can be interpreted and applied at the local level in different ways. Field staff from EPA and the Corps of Engineers will be required to evaluate circumstances that could in practice expand federal jurisdictional protection to areas that have never been considered waters of the U.S. In a worst case scenario, for example, there are man-made ditches that may become regulated, where they have never previously been regulated, simply because this ditch eventually drains to a presently defined water of the U.S. Since the rule relies heavily on best professional judgment as to how "less than perennial flow" will be determined, there will be areas regulated that otherwise should not be.

2. **This rule will have a negative impact on the continued implementation of some of the most promising voluntary conservation practices and programs.** The Department is working in partnership with other state and federal agencies and conservation groups, in both the public and private sectors, to address both water quality and water quantity issues in Mississippi. The Nutrient Reduction Strategies and Conjunctive Water Management Strategies include water conservation practices that have demonstrated environmental benefits in the state. The proposed rule through the definition of "tributaries" may, in fact, cause some Best Management Practices widely used in the Yazoo-Mississippi Delta for conservation to come under the jurisdiction of the EPA and the Corps. Subjecting those Best Management Practices to Clean Water Act regulation, and more particularly the financial and other burdens that come with such regulation, would significantly hamper conservation efforts and, ironically, negate years of hard work toward improving water quality.

   For example, tailwater recovery systems allow a farmer to capture the irrigation water applied to the fields and hold this water for recirculation in the irrigation system. These systems may also have an outfall structure to allow water to exit the irrigation pond in the event of a significant rainfall event. This necessary outfall structure creates a potential connection to downstream waters that could possibly be considered a tributary and subject to federal regulation. The rule would thus be a significant obstacle to making meaningful strides to address both water quality and water quantity in the agriculture community of Mississippi. It is imperative that changes be made to the proposed rule to specifically address these types of agricultural conservation practices.

3. **The proposed rule fails to provide a clear definition of a floodplain resulting in more confusion.** Evaluating jurisdictional waters in a floodplain has been weakly defined. Floodplain (pg. 22207 of the Federal Register) means *an area bordering inland or coastal waters that was formed by sediment deposition from such water under present climatic conditions and is inundated during periods of moderate to high water flows.* Floodplains and flooding events can vary widely even within a state. In addition, floodplains are sometimes altered to reduce the size and frequency of flooding events. The rule does not address how the floodplain is determined and how man-made activities affect the jurisdictional determination over time. The appropriate entities within Mississippi should be consulted to provide specific information on floodplains.

4. **The proposed rule does not address how other Section 404 permitting requirements and processes will be affected should the proposed rule be implemented.** In particular, the rule will affect how the Mitigation Rule is implemented. For example, will tributaries be treated as streams, wetlands, or types of jurisdictional waters for purposes of satisfying the Mitigation Rule in the 404 permitting process? Given the definition of a tributary, it seems that mitigation for tributaries could be achieved through various forms. The rule must address how identifying waters as tributaries affect mitigation requirements as outlined in the Mitigation Rule for Section 404 permits.

5. **There is no regional guidance for the implementation of the proposed rule.** In the absence of regional guidance, it can be assumed that the rule extends federal jurisdiction to area not previously recognized as waters of the U.S. The terrain, landscape uses, and geomorphology vary widely across the nation, and jurisdictional waters have different characteristics in various ecoregions. The rule must recognize the impact that such variation can have in distinguishing the chemical, physical, and biological impacts to waters of the U.S. The development of regional guidebooks is the key to implementation. The rule must recognize that regional guidance is imperative to manage the reach of a jurisdictional determination.

6. **The proposed rule extends federal action into states' jurisdiction.** The EPA and the Corps of Engineers failed to reach out to the individual states to determine what waters have been defined by the states. For example, Mississippi's statutory definition of state waters includes waters defined in the proposed rule as well as waters excluded in the rule such as groundwater. However, the rule applies to *all waters, including wetlands, adjacent to a water identified in paragraphs (a)(1) through (5) of this section* (page 22263 of the Federal Register). Adjacent waters (page 22207 of the Federal Register) includes riparian areas defined as *an area bordering a water where surface or subsurface hydrology directly influence the ecological processes and plant and animal community structure in that area.* This definition allows for an interpretation to include groundwater. Because groundwater connections may be used to determine jurisdiction for surface waters, the assumption can be made that the groundwater itself must be regulated to protect water quality in the streams, thus expanding federal jurisdiction beyond what is provided for under the Clean Water Act. The rule must eliminate the potential for overreaching into waters clearly not intended for federal regulation.

7. **Mississippi has statutory authority to establish the minimum flow requirements in waters of the state.** As the rule states: *The agencies specifically seek comment on the appropriate flow regime for a ditch excavated wholly in uplands and draining only uplands....* (page 22203). Mississippi has the sole responsibility and statutory authority to determine the appropriate flow regimes in streams. This is another example of where the proposed rule extends federal action into state jurisdiction. Therefore, the rule as currently proposed should be withdrawn.

8. **Development of the rule failed to acknowledge the need for education and outreach to the regulated public and the regulatory community.** EPA has failed to provide adequate explanation, demonstration, and assurance to either the regulated or regulatory

communities about how this rule will be implemented. Without adequate, detailed education that includes specific examples by region of what will or will not be waters of the U.S., the EPA and the Corps of Engineers risk creating more confusion. Further, by ignoring this important condition of making major changes to the Clean Water Act, the agencies risk perpetuating suspicion and time-consuming delays. The proposed rule should be with withdrawn until this vital missing piece is developed.

9. **The rule poses a financial hardship to the regulated public and the economy of Mississippi.** Significant work and the development of tools are needed to make implementation of a rule feasible. Without the appropriate tools, the amount of time needed to complete a jurisdictional determination will cause an undue economic burden to applicants. Should this rule be implemented in the current form, it will have unnecessary regulatory and implementation costs for both the state and the regulated public. For example, more accurate mapping tools must be developed to ensure that permitting timeframes are not further extended. Development and use of these kinds of tools is important to ensure there is not an even greater economic burden placed upon applicants. Likewise, the states must have adequate resources to implement a burdensome new rule.

Finally, the EPA and the Corp of Engineers did not collaborate with the states in developing the proposed rule. Mississippi and the other states will eventually be responsible for bearing a significant load of the implementation of the rule. Meaningful collaboration among all the agencies, both federal and state, is necessary to develop new rules and to identify the necessary resources to implement them. This was not the case with the waters of the U.S. proposed rule. Given the concerns outlined above, as well as comments provided by others, the rule must be withdrawn and not be reconsidered until there are significant amendments. The Department requests the opportunity to offer further comments once these outlined concerns are addressed.

Sincerely,

Gary C. Rikard
Executive Director

November 14, 2014

Gina McCarthy
Administrator
United States Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

John M. McHugh
Secretary of the Army
101 Army Pentagon
Washington, DC 20310-0101

Re: Proposed Rule to Define "Waters of the United States," Docket ID No. EPA-HQ-OW-2011-0880

Dear Administrator McCarthy and Secretary McHugh:

In April 2014, the Environmental Protection Agency and the U.S. Army Corps of Engineers (the Agencies) proposed a rule to redefine "waters of the United States" under the Clean Water Act (CWA), 79 Fed. Reg. 22,188 (Apr. 21, 2014). *After* its release, the Agencies reached out to States, the regulated community, and environmental groups in a series of meetings, speeches, and webinars seeking to explain the proposed rule and answer questions. The Agencies' belated efforts to outreach do not support an assertion that the Agencies sought public input.

Such efforts ignore the role States play as co-regulators under the Clean Water Act. The Clean Water Act is based on cooperative federalism. Under Section 303 of the Clean Water Act *all* States identify the designated uses of regulated waters within the State and the criteria to protect those uses. Under Section 401 of the Clean Water Act, *all* States review federal actions and certify whether that action will meet State water quality standards. Under Section 402 of the Clean Water Act, forty-six out of fifty States implement the NPDES permitting program. Under Section 404 of the Clean Water Act, two States implement the dredge and fill permitting program. In addition, States have their own statutes authorizing State water regulatory programs and defining waters of the State in some cases more broadly than the federal definition.

State regulators were not meaningfully consulted *before* the Agencies issued the proposed rule, and therefore were not afforded the opportunity to point out concerns in advance. We recognize that Agency representatives have expressed a willingness to make changes to the rule based on comments received during the comment period. We appreciate that willingness. However, our concerns relate to the legal rationale for the proposal and the implications of that rationale for State programs. Accordingly, we believe that the scope of changes necessary to respond to State concerns will be extensive. In such a situation, it is appropriate to withdraw or suspend a rulemaking and issue a supplemental proposal. This would allow the Agencies to consult with States *before* issuing a new proposal and receive public comment on new legal rationales and a revised jurisdictional scope.

Some of our specific concerns are discussed below.

I. Legal Rationale.

Exhibit 3

Testimony of Trudy Fisher

A. Jurisdiction Based on Ecosystem Connections.

According to the preamble to the proposed rule, the Agencies believe that the federal government can assert jurisdiction over water if they determine that the water has a "significant nexus" to a navigable or interstate water or territorial sea. The Agencies base this belief on language from the opinion of Justice Kennedy in *Rapanos v. United States,* 547 U.S. 715 (2006):

> Because Justice Kennedy identified significant nexus as the touchstone for CWA jurisdiction, the agencies determined that it is reasonable and appropriate to apply the significant nexus standard for CWA jurisdiction that Justice Kennedy's opinion applied to adjacent wetlands to other categories of water bodies as well (such as to tributaries of traditional navigable waters or interstate waters, and to other waters) to determine whether they are subject to CWA jurisdiction, either by rule or on a case-specific basis. 79 Fed. Reg. at 22,192.

The Agencies also assert a nexus that makes water jurisdictional can be based on use of water as habitat, water supply, or water retention, referring to that nexus as "connectivity." 79 Fed. Reg. at 22,195-96. The Agencies then specifically rely on a report developed by EPA's Office of Research and Development that summarizes studies of connections based on movement of organisms and water storage. *Id.* at 22,196.[1] Based on the Draft Report, the Agencies conclude that the following have a "significant nexus" to a navigable or interstate water or territorial sea:

- All tributaries (defined in the proposal to include manmade channels, ephemeral channels, and channels that flow underground), and

- All water that is "adjacent" (defined in the proposal to include all water located in (1) a "floodplain" (defined as an area formed by sediment deposition from inland or coastal waters under "present climactic conditions" and that is inundated during periods of "moderate to high flows"), (2) a "riparian area" (defined as an area where surface or subsurface hydrology directly influences ecological processes and plant and animal community structure), (3) an area that has a shallow subsurface hydrologic connection (not defined), or (4) an area with a confined surface hydrologic connection (not defined) to such water.

In addition, the Agencies propose to assert jurisdiction on a case-by-case basis over water that is not covered by the tributary or adjacent water categories where the Agencies determine the water has a significant nexus to a navigable or interstate water or territorial sea, alone or in combination with other similarly situated waters in the region. The determination of whether water falls in a category that is *per se* jurisdictional or is an "other water" with a significant nexus is left solely to the best professional judgment of EPA or Corps officials.

This legal rationale places no limits on federal jurisdiction, and accordingly, is a basis for asserting unlimited federal authority over land and water use. The EPA Science Advisory Board

[1] Referring to "Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence" (September 2013 External Review Draft, EPA/600/R–11/098B) (hereinafter Draft Report).

(SAB) panel of scientists that reviewed the Draft Report appears to have concluded that all waters are connected. In fact, their letter dated October 17, 2014 questions why the Agencies do not assert jurisdiction over groundwater, and questions the basis for *any* exclusions from federal jurisdiction.[2]

We do not dispute the validity of scientific connections within an ecosystem. However, we strongly dispute any attempt to use such connections as a valid basis for defining the scope of federal jurisdiction. As noted by the SAB review panel, there are connections among surface water, groundwater, land, birds, insects, and mammals. The Clean Water Act does not, however, grant the Agencies authority to regulate on the basis of such connections.

These concerns arise in particular from the use of water retention, biological connections, and groundwater connections to assert federal jurisdiction. The Clean Water Act protects the quality of navigable water. To provide that protection, it also encompasses other, non-navigable surface water. It does not give the Agencies authority to control the allocation of water, to protect animals or habitat, or to regulate groundwater. Despite this, the legal rationale for the proposed rule suggests that the Clean Water Act includes all of these ecosystem components, giving the statute unlimited scope in contravention of its plain meaning and precedential interpretation.

B. Failure to Recognize the Limits of the Clean Water Act.

Contrary to the legal rationale put forth by the Agencies, the Clean Water Act is a grant of limited authority.

1. There is no Clean Water Act authority to control the allocation of water.

The Agencies propose to assert jurisdiction over water based on retention and flood control functions; however, the Clean Water Act expressly reserves that authority to states:

> It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State.

CWA § 101(g).

Section 101(g) was added to the Act in the 1977 amendments. According to its sponsor:

> This amendment came immediately after the release of the Issue and Option Papers for the Water Resource Policy Study now being conducted by the Water Resources Council. Several of the options contained in that paper called for the use of Federal water quality legislation to effect Federal purposes that were not strictly related to water quality. Those

[2] *See* letter dated October 17, 2014 to Gina McCarthy from Dr. David T. Allen, Chair, EPA Science Advisory Board.

> other purposes might include, but were not limited to Federal land use planning, plant siting and production planning purposes. This State's jurisdiction amendment reaffirms that it is the policy of Congress that this act is to be used for water quality purposes only.

123 Cong. Rec. &. S19677-78, (daily ed., Dec. 15, 1977) (emphasis added) (floor statement of Senator Wallop).

EPA's role in the allocation of water is specified in Section 102(b) of the Act. That role is limited to *recommendations* for storage of water for water quality control in *federal* projects and *federal* licenses issued by the Federal Power Commission. In addition, Section 102(d) directed EPA to consult with States and river basin commissions and submit a report to Congress that analyzes the relationship between Clean Water Act programs (on the one hand) and programs by which of other federal agencies and States that allocate quantities of water (on the other hand).[3]

The statute and its legislative history are clear. The allocation of water is not within the purview of the Clean Water Act. Accordingly, jurisdiction cannot be based on water supply and water retention functions.

2. *There is no Clean Water Act authority to regulate birds, mammals, insects or their habitats.*

The Agencies propose to assert jurisdiction over water based on its use by birds, mammals, and insects. In *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers (SWANCC),* 531 U.S. 159 (2001) the Supreme Court reminded us that the focus of the Clean Water Act is not just water quality generally, but the quality of navigable waters. This case recognizes that the Clean Water Act left many waters subject to State control. The Court held that the rock quarry at issue in that case was a "far cry, indeed, from the 'navigable waters' and 'waters of the United States' to which the statute by its terms extends." *Id.* at 173. In particular, the Court noted its concern that asserting jurisdiction over water based on use by migratory birds had the potential to impose on the States' traditional and primary power of land and water use. *Id.* at 174.

The quality of water to protect aquatic life is important, and States designate water for aquatic life uses and establish water quality criteria to protect those uses. Nevertheless, the fact that a bird, insect or mammal may move from one body of water to another is not relevant to the protection of water quality. If use by birds, insects, or mammals is a basis for establishing federal jurisdiction, there is no water beyond federal authority. Accordingly, we disagree that the Agencies can assert jurisdiction over water that lies wholly within a State on this basis.

3. *There is no Clean Water Act authority to regulate groundwater.*

The Agencies propose to assert jurisdiction over surface water based on groundwater connections. This basis for asserting federal jurisdiction is overly broad. As discussed below (See II., A.), it will impinge on State authority over both groundwater and land.

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[3] EPA developed a draft report in 1979. Section 102(d) was repealed by P.L. 104-66.

II. Impacts of the Proposed Rule on State Programs.

The proposed rule will impact State regulatory programs in ways that the Agencies have not considered.

A. Expansion in the Number of Point Sources and State Budgetary Impacts.

One potential consequence of the proposed rule is the expansion in the number of regulated point sources along with increased State budget impacts.

Although the Agencies disavow the intent to regulate the groundwater itself, they claim authority to regulate water that disappears underground (under the definition of "tributary") and water with "shallow subsurface hydrologic connections" (under the definition of "neighboring" which is a component of adjacency). It appears that, under the rule, the Agencies are treating groundwater as a conveyance. That rationale has significant implications that the Agencies may not have considered or have ignored.

State agencies authorize the location of waste treatment lagoons and solid waste disposal units. If groundwater is considered a conduit to a water of the U.S., then waste disposal into a State authorized lagoon or disposal unit could be considered a discharge into a water of the U.S. that EPA can regulate through a permit under Section 402 of the Act. In fact, some may argue that the water in the lagoon or the leachate from a landfill should be considered a water of the U.S.

In litigation, citizen plaintiffs have taken the position that if a discharge onto land or into groundwater can move through groundwater and reach a water of the U.S. that discharge is subject to regulation under the Clean Water Act. Some courts have agreed.[4] In one case, the Conservation Law Foundation alleged that septic systems are point sources that must obtain NPDES permits because nutrients from septic systems move through groundwater and impact navigable water. In that case, EPA disagreed that the septic systems were categorically point sources, arguing that an NPDES permit can be required for a discharge to groundwater *only* where it is directly and immediately connected hydrologically to surface water. *Conservation Law Foundation et al. v U.S. EPA, et. al.*, Case No. 1:10-cv-11455-MLW, Memorandum in Support of Defendants' Motion for Summary Judgment, at 20-21 (also noting that a hydrological connection to surface water via groundwater is a site-specific determination).[5]

In contrast to the position EPA took in its summary judgment motion in the *Conservation Law Foundation* case, in the proposed rule the Agencies take the position that groundwater connections *categorically* form the basis for Clean Water Act jurisdiction. Since the rule was

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[4] In *Hawai'i Wildlife Fund v. County Of Maui* , 2014 U.S. Dist. LEXIS 74256, *31 (D. Hawaii, May 30, 2014) the court held that the County of Maui is liable for discharging effluent into a wastewater reclamation facility without a NPDES permit where the effluent went into on-site injection wells to a shallow groundwater aquifer and eventually to the Pacific Ocean. In *N. Cal. River Watch v. City of Healdsburg,* 496 F.3d 993 (9th Cir. 2007), *cert. denied,* 552 U.S. 1180 (2008), the court held that a manmade pond created to treat sewage was a water of the U.S. due to a groundwater connection and the possibility of flooding.

[5] The court dismissed the case on jurisdictional grounds, holding the plaintiffs did not have standing.

proposed, more cases have been filed relying on this misguided theory. *See Wildearth Guardians v. The Western Sugar Cooperative,* (Case 1:14-cv-01503-BNB) (D. Colo., May 29, 2014) (alleging on-site wastewater ponds are point sources that discharge to waters of the U.S. through groundwater that has a significant biological, chemical and physical nexus to the South Platte River).

As a result, if finalized, the rule could vastly expand the number of waste management units and land-based activities and point sources under the Clean Water Act, greatly increasing the workload and budget constraints of the forty-six States implementing the permitting program.[6] We emphatically note that the Agencies did not acknowledge the impact of this increased workload in their economic analysis of the proposed rule.[7]

B. Expansion of Federal Control Over Land and Water Use.

By asserting jurisdiction over areas of land where water flows in direct response to precipitation, the Agencies are blurring the distinction between nonpoint source runoff and point source discharges. If the area through which water runs is a water of the U.S., then the federal government has control of the use of that area. This is federal land use control that will affect State economic development decisions.

Indeed, all activities that drive economic development in the States would be affected by the proposed rule, including highway and road construction, pipeline projects, transmission line projects, farming, flood control, and public works projects. With federal permitting also comes the potential for a federal veto of State economic development projects.

For example, stream and wetland mitigation costs for state highway projects in the State of Washington can range anywhere from $180,000 to $2.28 million each.[8] The likelihood that roadside ditches would now be included as jurisdictional federal waters would increase those costs exponentially. The proposed rule could also have similar impacts on States that choose to build significant infrastructure related to renewable energy or natural gas projects in order to comply with EPA's proposed guidelines for states to reduce emissions from existing power plants under § 111(d) of the Clean Air Act.

In addition, assertion of jurisdiction based on groundwater impacts directly affects States' authority to allocate water resources. The implications of this rationale became very clear in a recent draft directive issued by the National Forest Service, titled: "Proposed Directive on Groundwater Resources Management" ("Directive"), 79 Fed. Reg. 25,815 (May 6, 2014).

[6] This increase in the universe of regulated point sources could be the straw that breaks the back of State water quality permitting programs that already are struggling to meet the workload demands of regulating pesticide spraying and implementing new regulations, while funding decreases.

[7] The March 2014 Economic Analysis of Proposed Revised Definition of Waters of the United States fails to analyze or even consider any impacts on section 402 permitting programs and yet concludes that such impacts will be minimal.

[8] Washington State Department of Transportation, WSDOT Project Mitigation Costs Case Studies (May 2003).

Under this Directive, the Forest Service claims the authority to evaluate all applications for groundwater withdrawals not only on Forest Service lands, but also on adjacent lands, due to "hydraulic continuity." As in the proposed rule, the Directive has no clear definition of "adjacent." If, like EPA and the Corps, the Forest Service believes all waters are connected, it could likely claim that all state water rights applications must be evaluated by the Forest Service regardless of the distance from federal lands. Thus, the theory of federal jurisdiction espoused by EPA and the Corps has implications even beyond the Clean Water Act.

C. Failure to Provide Consistency and Clarity.

One stated purpose of the proposed rule is to provide consistency and clarity. See 79 Fed. Reg. at 22,189. However, the Agencies acknowledge geographic differences among the states.[9] In fact, in the same section of the preamble where the Agencies claim that the proposed rule promotes consistency, clarity, and certainty, they acknowledge that the definitions of riparian area and floodplain are not consistent, clear, or certain and will be left solely to the best professional judgment of EPA and Corps officials. 79 Fed. Reg. at 22,209-10.

The definition of tributary poses similar problems. The Agencies acknowledge geographic differences in determinations of whether or not an ordinary high water mark is present. See 79 Fed. Reg. at 22,202. These determinations too are left solely to the best professional judgment of EPA and Corps officials.[10]

We agree with the Agencies that there are geographic differences around the country, but giving federal officials authority to change the scope of federal jurisdiction based on location provides for inconsistency, obscurity, and uncertainty. To avoid this outcome, federal jurisdiction should be limited to water that is clearly subject to Clean Water Act authority based on navigability or a demonstrated ability to impact the quality of navigable water. Regulation of other water may be appropriate depending on location and function, but decisions based on such geographic differences are best left to the discretion of State officials. Federal jurisdiction must be consistent, clear, and certain.

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[9] 79 Fed. Reg. at 22,196 (recognizing differences in degree of connectivity based on geography); 79 Fed. Reg. at 22, 198 (recognizing jurisdiction over other water will vary based on geographic variability); 79 Fed. Reg. at 22,208-09 (seeking comment on placing geographic limits on the use of shallow subsurface hydrologic connections and confined surface hydrologic connection).

[10] There is reason for questioning that judgment. Corps officials admit that the identification of Ordinary High Water Marks (OHWMs) is inconsistent and subjective. See Matthew K. Mersel, U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Development of National OHWM Delineation Technical Guidance (Mar. 4, 2014), *available at* http://insideepa.com//index.php?option=com_iwpfile&file=apr2014/epa2014_0760.pdf. Examples were provided in a March 30, 2004, hearing of the Water Resources and Environment Subcommittee of the House Committee on Transportation and Infrastructure on "Inconsistent Regulation of Wetlands and Other Water (House Doc. No. 108-58). In that hearing, one witness testified that a Corps official found that a tributary extended beyond its channel via a manmade ditch and a 25-year old skidder rut to establish a connection to a wetland. *Id.* at 81-82. Under the proposed rule, Corps officials would remain free to conclude that a skidder rut has an OHWM. Alternatively, the proposal would allow them to conclude that the skidder rut is a "confined surface hydrologic connection" that makes an otherwise isolated wetland a water of the U.S.

D. Expansion of the Scope of State Regulatory Programs

Another consequence of the proposed rule that the Agencies have overlooked is the impact on States' water quality standards programs. Like the impacts on permitting programs, the economic analysis accompanying the rule asserts, without analysis, that impacts on water quality programs implementing Section 303 of the Act will be minimal.

Currently, not all States include ephemeral waters in their regulatory programs. In comments on the 2011 guidance, Kansas noted that expanding federal jurisdiction to include ephemeral water would bring approximately 100,000 miles of dry erosion features into their State clean water act program, and Kansas would then be compelled to assign water quality standards and develop total maximum daily loads (TMDLs) for "what amounts to surface depressions that function only during sufficient precipitation."[11] After an extensive stakeholder process, the State of Missouri recently adopted changes to its stream classification program, expanding it to include all streams represented in the 1:100,000 scale of the USGS National Hydrology Dataset.[12] The decision to exclude default classification of smaller streams (those represented at the 1:24,000 scale) was based on an evaluation of the aquatic resources of the state.[13]

This increase is not limited to Kansas and Missouri. Indeed, it would be similar in most States. States are required under Section 305(b) of the Act to submit to EPA a description of the water quality of all federal waters within their borders. The most recent State reports can be found on the EPA's website.[14] Comparing the "waters of the United States" reported by States to recent USGS maps released by EPA shows a 131% increase in federal waters.

The Agencies have failed to quantify the burden on State regulators from this increased federal jurisdiction. EPA's ATTAINS database that tracks TMDL development reports a total of 3,533,205 river and stream miles in the United States based on data reported by States using the National Hydrography Dataset (NHD). The NHD is a database that interconnects and uniquely identifies the millions of stream segments or reaches that comprise the Nation's surface water drainage system and is based on the USGS 1988 1:100,000-scale Digital Line Graph (DLG)

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[11] July 14, 2011 Comments of the State of Kansas on EPA and Army Corps of Engineers Guidance Regarding the Identification of Waters Protected by the Clean Water Act.

[12] *See* 10 CSR 20-7.031(2)(A) (adopting fishable, swimmable standards for: "1. All perennial rivers and streams; 2. All streams with permanent pools; 3. All rivers and streams included within the 1:100,000 scale National Hydrography Dataset (NHD) described in subsection (1)(R) of this rule."). This decision expanded the miles of classified streams in Missouri from 25,025 to a total of 109,870. Missouri Department of Natural Resources, Regulatory Impact Report, In Preparation for Proposing, An Amendment to 10 CSR 20- 7.031, Missouri Water Quality Standards (June 3, 2011), at 26.

[13] Missouri Department of Natural Resources, Regulatory Impact Report, In Preparation for Proposing, An Amendment to 10 CSR 20- 7.031, Missouri Water Quality Standards (June 3, 2011), at 35.

[14] http://water.epa.gov/lawsregs/guidance/cwa/305b/upload/2000_06_28_305b_98report_appenda.pdf

hydrography dataset integrated with reach-related information from the USEPA Reach File Version 3.0-Alpha release (RF3-Alpha).[15]

According to EPA's report on "The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-arid American Southwest" (EPA/600/R-08/134) (Nov. 2008), even the high resolution NHD "may grossly underestimate the number and length of drainage networks," *i.e.,* ephemeral streams. ("Heine et al. (2004) reported that USGS 1:24,000-scale maps under-represented drainage networks by 64.6 percent in a study in Kansas").

EPA's currently approved Information Collection Request (ICR) (EPA ICR No. 1560.10, Nov. 2011) for both water quality reporting and TMDL development activities estimate the cost to States for those programs at $193,568,080 a year. Of that amount, $21,390,991 is for assessment activities. The remaining costs of $172,267,089 are for TMDL development and EPA assumes 4000 TMDLs a year, averaging $43,000 per TMDL.

If a final rule includes all ephemeral drainages and all "adjacent water" as waters of the U.S., then the cost to States to include these in their water quality programs will increase significantly. While the Agencies have failed to include these costs in the regulatory impact analysis of the proposed rule, some States have provided cost estimates. According to the State of Missouri, if it had to regulate all stream miles discernible at the 1:24,000 scale of the National Hydrology Dataset, it would add an additional 158,565 miles of stream (183,591 miles total) to its existing classified waters network and would more than double the State's monitoring costs from about $11.2 million a year to $24.2 million.[16]

The Agencies may argue that EPA will not require States to set standards for these waters or include them in monitoring programs; however, Section 303 of the Act applies to all waters of the U.S., and citizen plaintiffs could sue EPA for failing to force States to take such actions.[17]

This is a real impact of the rule on State regulatory programs that the Agencies must include in their economic analysis and take into account in the amount of federal funding provided for State programs under Section 106 of the Clean Water Act.

III. Failure to Comply With Executive Order 13121.

We note that the U.S. Small Business Administration Office of Advocacy recently sent a letter requesting the Agencies to withdraw the rule due to the failure to evaluate impacts on small

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[15] EPA's ATTAINS database also reports a total of 107,700,000 wetlands acres.

[16] *See supra* n.12 at 25, 35. If existing standards do not apply to the newly regulated waters, States also will have to incur significant costs developing new water quality standards.

[17] Indeed, such a lawsuit was filed in Missouri. *Missouri Coalition for the Environment v. Lisa P. Jackson,* Case No. 10-04169-CV-C-NKL. In that case, the court agreed with EPA that imposing federal standards was a discretionary action. However, the same issue currently is being litigated in the Fifth Circuit in *Gulf Restoration Network v. EPA,* Case No. 12-cv-677.

businesses as required under the Regulatory Flexibility Act.[18] Similarly, the Agencies have failed to evaluate the federalism impacts as required under Executive Order 13132.

The Agencies have certified that: "This action will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government." 79 Fed. Reg. at 22,220 We disagree. Under the Executive Order, federalism implications include "substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government." As discussed above, the proposed rule will have these effects.

We acknowledge that the Agencies held some briefings for State and local governments on the subject of the proposed rule in 2011. Nevertheless, given the new direction the Agencies have taken with their reliance on ecological connections, water retention, and groundwater to establish federal jurisdiction, and the resulting impact on State authorities, we urge you to fully comply with Executive Order 13132 and conduct a meaningful dialogue with State governments.

In particular, we ask that the Agencies fully comply with the "Fundamental Federalism Principles" of section 2 and the "Federalism Policymaking Criteria" of section 3 of the Executive Order. The Agencies should strictly adhere to constitutional principles and statutory authority, providing States with maximum administrative discretion and relying on State policies to the maximum extent practicable. To do so, the Agencies must develop a supplemental proposal.

Before issuing a supplemental proposal, we ask the Agencies to work with States to identify the problems you are seeking to address and to focus the rulemaking on solving those problems. An after-the-fact explanation of a federal agency proposal is not sufficient. States support the goals of protection of water quality and clarity and want to work with the Agencies on the development of a rule that achieves those goals while recognizing geographic differences. An after-the-fact explanation of the intent of a proposed rule does not appropriately recognize the role that the Clean Water Act designates to States.

Only by working with States as co-regulators will the Agencies be able to fully comply with the Federalism Executive Order. Specifically, the dialogue we are requesting is necessary for the Agencies to be able to develop "a federalism summary impact statement, which consists of a description of the extent of the agency's prior consultation with State and local officials, a summary of the nature of their concerns and the agency's position supporting the need to issue the regulation, and a statement of the extent to which the concerns of State and local officials have been met."

Conclusion

In summary, the proposed rule would fundamentally alter the ability of States to make decisions regarding the use of land within our borders. Such an expansion would also impact our ability to convey water supplies. Finally, such an expansion would impose significant costs on States by

[18] Letter dated October 1, 2014 from Winslow Sargeant, Ph.D., Chief Counsel for Advocacy.

requiring States to designate the uses and assess the conditions of more waters, to develop total maximum daily loads for waters not meeting their uses, and to issue permits for more activities. Given the fact that States often regulate more waters than are encompassed by the current definition of "waters of the United States", it is not clear what benefit this expansion of federal authority is designed to achieve. It appears that the Agencies did not even consider existing State authorities when developing the proposed rule.

For all of these reasons, we request that the Agencies withdraw or suspend this rulemaking and work with States to develop a supplemental proposal.

Sincerely,

Alabama Department of Environmental Management

Lance R. LeFleur
Director
***

Arizona Department of Environmental Quality

Henry R. Darwin
Director
***

Indiana Department of Environmental Management

Thomas Easterly
Commissioner
***

Kansas Department of Health and Environment

John W. Mitchell
Director
***

Louisiana Department of Environmental Quality

Peggy M. Hatch
Secretary
***

Mississippi Department of Environmental Quality

Gary Rickard
Executive Director
***

Oklahoma Department of Environmental Quality

Scott Thompson
Director
***

Wyoming Department of Environmental Quality

Todd Parfitt
Director
***

cc: Ken Kopocis, EPA

STATEMENT OF MARTY D. MATLOCK, PhD, PE, BCEE

Executive Director, Office for Sustainability
Professor, Biological and Agricultural Engineering
University of Arkansas

Before the US Senate Committee on Agriculture, Nutrition, and Forestry
Room 328a, Russell Senate Office Building, Washington, DC
December 3, 2014

"Farmers and Fresh Water: Voluntary Conservation to Protect Our Land And Waters"

Chairwoman Stabenow, Ranking Member Cochran, Senator Boozman, and members of the Committee, thank you for this opportunity to testify at today's hearing, and to discuss an important issue for US agricultural producers.

I have spent the past 25 years investigating agricultural impacts on water quality, including stream ecosystem function and structure. I have worked with USEPA, USDA-ARS, USDA-NRCS, various state, county and local organizations, and farmers to improve water quality at watershed scales using a variety of best management practices (BMPs). I have also worked with municipal and industrial facilities that have regulated water quality criteria under the Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit program. I have seen the benefits and challenges associated with both strategies for protecting water quality.

Regulatory approaches such as the NPDES permit program are very effective at implementing thresholds and enforcing limits where there are clear and unambiguous sources of pollution. Municipal and industrial wastewater treatment facilities and concentrated animal feeding operations (CAFOs) have discrete discharge points (usually pipes) that can be monitored, managed, and regulated. Non-point sources of impacts (those that are not from a pipe or other conveyance) are more difficult to regulate because there is no point of discharge.

Water quality in a river, stream, reservoir or estuary is the product of the cumulative activities upstream in the watershed. Human activities throughout the watershed impact water quality. Existing and changing land uses, including urbanization, residential development, agricultural production, and forestry, change the way water interacts with and moves across the landscape. Paving, plowing, grading, and other landform modifications increase runoff volume, water flow velocity, and the contaminants carried into water bodies.

The mechanisms of impacts of agricultural activities on water quality are well known. Crop tillage practices can result in soil erosion, ultimately increasing sediment pollution. Nutrients, particularly nitrogen and phosphorus, are transported to streams either in solution or attached to soil particles. In some cases pesticides can be transported to streams via the same mechanism, or through overspray into waterways. Animal production grazing systems can result in field and stream bank erosion. Bacteria from animal manure can also reach waterways, either as a result of land application of the manure for fertilizer or direct runoff from production units.

Best management practices (BMPs) have been developed over the past 100 years for each of these categories of water quality impact across the agricultural landscape. Recently many of these BMPs have been translated to urban systems, referred to as Low Impact Development (LID) practices or green infrastructure design. In agricultural landscapes BMPs are part of integrated National Resource Conservation Service (NRCS) conservation strategies and include elements such as conservation tillage practices to reduce erosion and increase soil health, nutrient management planning to reduce N and P loss, vegetative filter strips to capture soil and nutrients, and riparian zone conservation areas to provide. Implementation of these BMPs is often called "voluntary", when a more accurate term would be "incentivized". Agricultural producers who participate in any USDA program (EQIP, crop insurance, etc.) must also implement conservation plans. The specific criteria for these practices vary by region but water quality protection is a common criterion for conservation plans.

The incentivized adoption strategy employed by USDA NRCS has resulted in dramatic improvements across the US agricultural landscape. In the nearly 80 years since the formation of the US Soil Conservation Service the US landscape has been transformed from an ecological wasteland to the most efficient, effective, and productive agricultural landscapes on Earth. The SCS has evolved to become the Natural Resource Conservation Service; conservation districts have been established with local farmer governance and expertise in every county in every state in the Nation, and the US Extension Service has become the world's most effective instrument for agricultural innovation and stewardship. In 2014 the United States is projected to produce almost 37 percent of the world's corn on 20 percent of global planted acres, and 31 percent of the world's soybeans on 27 percent of global planted acres (USDA, 2014). US production and efficiency for corn and soybeans are the highest in the world.

The US agricultural community recognizes this is not enough to insure sustained prosperity across the heartland. In 2007 representatives from the US agricultural supply chain met to develop a strategy for insuring the sustainability of US agriculture, focusing on agronomic crops (corn, soybeans, cotton and wheat). This organization became *The Field to Market Alliance for Sustainable Agriculture*, a multi-stakeholder collaboration of representatives from the entire US agricultural supply chain. I serve on the Executive Committee for Field to Market, and have worked with this group over the past seven years to develop first-tier key performance indicators (KPIs) for row crop agriculture.

Across the entire agriculture supply chain – from the farm gate to the restaurant counter – the challenge of meeting demand for a rapidly growing population, while conserving natural resources, has become increasingly complex. With the world population estimated to exceed 9.5 billion by 2050, the entire food chain must work together to efficiently and responsibly lay the groundwork for the future. Field to Market defines sustainability as meeting the needs of the present while improving the ability of future generations to meet their own needs. This means that US farmers must work across the agricultural and food value chain in order to:

1. Increase productivity to meet future food, fuel and fiber demands;
2. Improve the environment;
3. Improve human health
4. Improve the social and economic well-being of agricultural communities

Field to Market is composed of a diverse group of grower organizations; agribusinesses; food, fiber, restaurant and retail companies; conservation groups; universities and federal agency

partners who focus on promoting, defining and measuring the sustainability of food, fiber and fuel production. We defined as criteria for adoption of any KPI that they must be:
1) Science driven,
2) Outcomes based,
3) Technology neutral, and
4) Transparent.

Field to Market is in the process of developing and benchmarking KPIs across all three domains of sustainability: environmental, social, and economic. The five first-tier environmental KPIs developed by Field to Market were:

a. Soil Erosion
b. Energy Use
c. Greenhouse Gas Emissions
d. Water Use
e. Land Use

Next tier KPIs include biodiversity, nutrient use efficiency and water quality. KPIs for social and economic domains are also being developed for 2015.

The Field to Market team analyzed metrics over the past 30 years (1980-2011) for each environmental KPI at the US national level for the major US crops: corn, soybeans, cotton, wheat, potatoes and rice (Field to Market, 2012). During that period yield per planted acre increased for all crops. The most dramatic increases were with corn (+64%), potatoes (+58%), soybeans (+55%), and rice (+53%); moderate increases were achieved with cotton (+43%), and wheat (+25%) (Field to Market, 2011). This report is included as an annex to this testimony.

Soil erosion reduction has been a major sustainability success in US agriculture. On a unit of production basis (tons of soil lost per ton of crops produced) soil erosion decreased over the past 30 years for all six crops: corn (-67%), cotton (-68%), soybeans (-66%), potatoes (-60%), rice (-34%), and wheat (-47%). Similar efficiency improvements were achieved across the other four KPIs. These improvements have been the product of research and innovation in plant genetics, tillage practices, smart implements, and constant and incredible effort by producers.

In spite of the incredible improvements US agricultural producers have made across first tier environmental KPIs we still have a number of challenges ahead. Soil loss across US agricultural lands decreased in total mass by 41 percent in the past 30 years, but the amount of soil eroding each year is still too high (USDA, 2013). However, we are not done yet; erosion in 2010 was essentially unimproved from 2007. Soil erosion is not an inevitable cost of agricultural production. We can do better.

The process of continuous improvement is the essence of sustainability. The Field to Market initiative provides a framework for continuous improvement for outcomes-based KPIs for agricultural producers. Producer organizations like Cotton Incorporated and the United Soybean Board define sustainability goals for KPIs like soil erosion and water quality. Improvements across each KPI will be measured and reported using transparent and scientifically appropriate methods in order to accelerate improvements in outcomes.

The Fertilizer Institute, one of Field to Market's members, initiated the 4R program to enhance nutrient stewardship by farmers (http://www.nutrientstewardship.com). This program provides nutrient management guidance for applying the Right fertilizer source at the Right rate, the Right time and on the Right placc. The 4R program has been implemented nationally with targeted implcmentation in high nutrient sensitive areas such as the Great Lakes region. This is one example of the many Examples of instructional materials are included as an annex to this testimony.

In conclusion, it is my assessment that US agricultural producers are more engaged than ever before in programs and practices that will continue to improve efficiency and reduce impacts from production. These non-regulatory programs provide a platform for innovation based on the freedom to explore new technologies and try new practices. Regulations tend to dis-incentivize innovation because compliance is the outcome, not continuous improvement for a metric. The sustainability initiatives led by Field to Market will revolutionize targeted implementation of practices across the agricultural landscape, resulting in measurable improvements in KPIs. This process is occurring now, without regulation.

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Statement of Sean McMahon
Executive Director, Iowa Agriculture Water Alliance
Senate Agriculture Committee Hearing
"Farmers and Fresh Water:
Voluntary Conservation to Protect our Land and Waters"
December 3rd, 2014

Good morning, Chairwoman Stabenow, Ranking Member Cochran and members of the committee. Thank you for the opportunity to testify today and provide information to the committee on water quality, voluntary conservation incentives, the Iowa Nutrient Reduction Strategy and the Iowa Agriculture Water Alliance. I am here for the purposes of helping to educate and inform and not to advocate or lobby on any particular legislation that is currently before Congress.

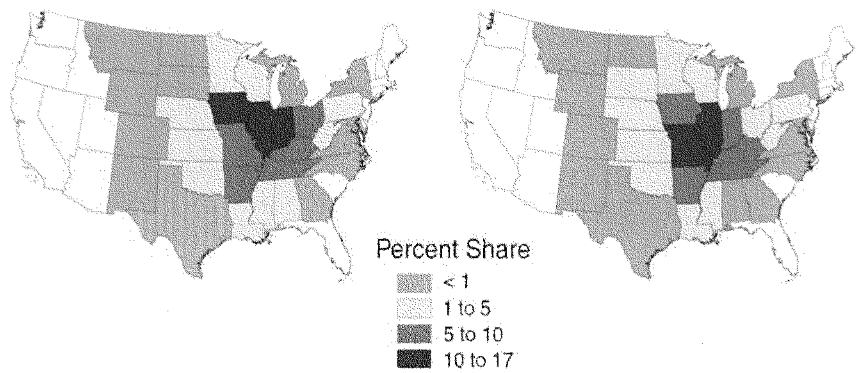
I would like to thank the committee for its work earlier this year and dating back to the previous Congress to pass a bipartisan Farm Bill that contained the strongest Conservation Title of any Farm Bill in history. This is the first Farm Bill to ever have more funding in the Conservation Title than the Commodities Title. The recent Farm Bill includes an innovative new program called the Regional Conservation Partnership Program. This program codifies the principle of targeting conservation practices to where they can have maximum impact, and ushers in a new era of public private partnerships. The new Farm Bill also recouples crop insurance with conservation compliance for the first time since 1995, which will ensure more soil conservation on Highly Erodible Lands while preventing wetlands from being drained and native prairie from being ploughed. I would like to thank the entire committee for their excellent work on the recent Farm Bill, but in particular I would like to single out Chairwoman Stabenow for her tremendous persistence and tireless efforts to pass this historic legislation.

As Executive Director of the Iowa Agriculture Water Alliance, I am partnering with many organizations including the Natural Resources Conservation Service (NRCS) to help to implement the Farm Bill and deliver conservation more effectively in Iowa. The Iowa Agriculture Water Alliance was launched on August 25th of this year. It was created by three leading Iowa agricultural associations – the Iowa Corn Growers Association, Iowa Pork Producers and Iowa Soybean Association. The purpose of the Iowa Agriculture Water Alliance is to increase the pace and scale of implementation of the Iowa Nutrient Reduction Strategy [Iowa Strategy].

Iowa is blessed with some of the most productive soils in the world. Iowa's fertile soils and cropping systems help feed the world, but also contribute to water quality concerns. Many streams and lakes in Iowa are listed as impaired waters. The dominant corn and soybean cropping systems in Iowa are inherently "leaky," meaning that nitrogen and phosphorous are easily transported to streams. Excessive nutrients in agricultural run-off are impacting Iowa's waters as well as the Gulf of Mexico.[i] Iowa is one of the largest annual contributors of nitrogen and phosphorous to the Gulf of Mexico hypoxic zone.

Nutrient delivery to the Gulf of Mexico
State shares of the total annual nutrient flux

Nitrogen **Phosphorous**



Alexander et al, *Environ. Sci. Techn.*, in press. Graphic courtesy of IDALS

That is not to suggest that nutrient impairment in Iowa is chiefly due to mismanagement of fertilizer and manure. On the contrary, it has more to do with precipitation, soil types and historic changes to land use and hydrology. Soils with high organic matter will lose nitrogen even without any fertilizer application.[ii] Parts of Iowa, including the Des Moines Lobe in north central Iowa, are extensively drained with subsurface tiling. This altered hydrology accelerates nutrient transport. In recent decades Iowa has seen a considerable increase in corn and soybean row crop acres and a decrease in pasture and small grains. The loss of perennial vegetation and shorter crop rotations have contributed to water quality concerns by having mostly bare row crop ground in the spring when Iowa typically receives the heaviest precipitation. It is worth noting that only an estimated 5% of all nitrogen inputs and 4% of all phosphorous fertilizer inputs in watersheds are lost to Iowa streams. The rest is removed by harvest, grazing, volatilization, and denitrification or is immobilized in the soil (Libra et al., 2004).[iii]

The Iowa Strategy, released on May 29th, 2013, is a science-based framework to assess nutrient loading and reduce the impacts of excessive nitrogen and phosphorous loads to Iowa waters and the Gulf of Mexico. It directs efforts to cost-effectively reduce surface water nutrients from both point sources, such as wastewater treatment and industrial facilities, and nonpoint sources, such as farm fields.[iv] This coordinated approach between the point source and nonpoint source strategies allows for collaboration among agricultural, municipal and industrial interests to meet the overall goals of the Iowa Strategy in a cost-effective manner. Iowa leaders from agriculture, municipalities and industry representing the point source and non-point source communities are working together to implement the Iowa Nutrient Reduction Strategy through the Water Resources Coordinating Council.

The Iowa Strategy calls for overall reductions of Iowa's nitrogen and phosphorous loads to Iowa waters and the Gulf of Mexico by at least 45%. The majority of the reductions will come from nonpoint sources. The Iowa Strategy calls for a 41% decrease in nitrogen and a 29% decrease in phosphorus from nonpoint sources in the overall state-wide nutrient load, primarily from reducing nutrient loss in agricultural run-off. The Strategy also calls for a 4% reduction of nitrogen and 16% reduction in phosphorous in the overall state-wide nutrient load from point sources. Point sources account for 8% of the total nitrogen load and 20% of the total phosphorous load in Iowa annually. Nonpoint sources account for 92% of the total nitrogen load and 80% of the total phosphorous load in Iowa annually. Both the nonpoint and point sources play important roles in determining Iowa's water quality on both an annual and seasonal basis. While point source loading is considerably less than nonpoint loading on an annual basis, during times of the year with seasonally low flows and droughts, point sources can be the dominant factor in determining water quality in some watersheds.[v]

The Iowa Nutrient Reduction Strategy was developed in response to the 2008 Gulf Hypoxia Action Plan which calls for all states along the Mississippi River to develop strategies to reduce nutrient loading to the Gulf of Mexico.[vi] It is the first state strategy of its kind to lay out a plan to meaningfully address Gulf Hypoxia. The Strategy was developed over a two year period by the Iowa Department of Agriculture and Land Stewardship (IDALS), Iowa State University and the Iowa Department of Natural Resources (IDNR). IDALS led the development of the nonpoint source strategy; the ISU College of Agriculture and Life Sciences led the development of the nonpoint source science assessment; while the IDNR led the development of the point source strategy. More than 1,700 comments were reviewed before the Strategy was finalized. The Strategy continues reliance on voluntary conservation activities for nonpoint sources and will require permitted point source facilities to further reduce nitrogen and phosphorous in their discharge water. Achieving those reductions will likely be extremely expensive for municipalities and industries, so the Strategy calls for the State of Iowa to develop a water quality trading system to potentially lower compliance costs.[vii] A trading system or framework would enable point source facilities to pay for farmers and other landowners to implement conservation practices. In return, the point source facilities would receive credits for the nutrient reductions that would result from the conservation practices they paid for, helping them to meet their permit obligations.

The Iowa Strategy follows the framework provided by the EPA in a March 16, 2011 memorandum titled "Recommended Elements of a State Framework for Managing Nitrogen and Phosphorous Pollution."[viii] The Strategy's approach is to achieve nutrient load reductions through technology based actions while continuing to assess and evaluate nutrient water quality standards.

There have recently been increasing calls to regulate agriculture under the Clean Water Act. Our current voluntary approach to private lands conservation is under increasing pressure and criticism. I personally believe that regulating non-point agricultural runoff in Iowa would be a very expensive and ineffective experiment due to the scale and variability of agriculture in Iowa. Iowa has approximately 92,000 farms.[ix] By comparison, there are only 6,579 Major National Pollution Discharge Elimination System (NPDES) permittees and 87,000 Non-Major NPDES permittees in the entire nation as of July, 2014.[x] It is difficult to fathom how regulation would work at that scale when one considers that there would be approximately as many nonpoint permittees in Iowa as there are currently point source permittees throughout the entire United States. Agriculture is highly variable in Iowa. There are ten different Major Land Resource Areas (MLRAs) in Iowa that vary greatly in terms of geology, climate, hydrology, soil types, slopes, land uses and crop yields.[xi] Soils are known to vary a great deal even within a single field, let alone across different MLRAs. A prescriptive one-size-fits-all regulatory approach is not conducive to such variability. In my opinion, it is better to focus on outcomes, and let farmers decide which practices will work best for their particular fields to improve water quality rather than prescribe specific practices that may not be suited to every location through a regulatory model. Finally, it would be extremely challenging to police regulating nonpoint agricultural run-off since fertilizer management practices are non-structural in nature and therefore difficult to ascertain and detect. It is not practical to measure edge-of-field water quality on 92,000 farms. That would take an extraordinary amount of financial and human resources. The people of Iowa and its natural resources would be much better served by allocating appropriate resources for voluntary conservation measures that will improve water quality.

Three agricultural associations – the Iowa Soybean Association, Iowa Corn Growers Association, and Iowa Pork Producers – are committed to ensuring the success of the Iowa Strategy through voluntary conservation actions. In an effort to foster better collaboration among Iowa's agricultural groups and produce quantifiable results to improve water quality at meaningful scales, these organizations recently established the Iowa Agriculture Water Alliance. The mission of the Iowa Agriculture Water Alliance is to unite agricultural groups and other committed partners to implement a statewide effort to improve water quality that is both accountable and credible, improving the state's water quality while maintaining and improving agricultural productivity.

The Iowa Agriculture Water Alliance is collaborating with IDALS, NRCS, ISU, University of Iowa, local Soil and Water Conservation Districts, agricultural retailers, Agribusiness Association of Iowa and many other committed partners to pursue voluntary approaches to implementing the Iowa Strategy and addressing nonpoint source pollution by continuing to reduce nutrient transport to water resources. The Iowa Agriculture Water Alliance is committed to working with our partners to further the Iowa Strategy by raising awareness of the strategy among farmers, driving increased adoption of conventional conservation practices, pairing the most effective in-field and off-field conservation practices for cumulative impacts, targeting practices for maximum conservation effectiveness, and helping to develop market driven approaches to conservation.[xii]

Nonpoint Source Science Assessment

The Iowa Science Assessment, conducted by a science team led by ISU, entailed a comprehensive literature review by 23 ISU and government agency experts. The Science Assessment identifies management practices, land use practices, and edge-of-field practices that are effective in reducing nitrogen and phosphorous, quantifies load reductions for those practices and estimates the cost of each practice in terms of cost per pound of reduced nutrients. This extensive review provides a valuable reference for implementing the Iowa Strategy and prioritizing practices.[xiii]

The science team evaluated the following conservation practices for effectiveness at reducing nitrogen and phosphorous loading.

Nitrogen Management Practices

- Application (Timing, Rate, Placement, Source)
- Drainage Water Management
- Extended rotations
- Cover crops
- Alternative land uses (Energy Crops, Perennial Crops, Land Retirement)
- Buffers
- Targeted Wetlands
- Bioreactors[xiv]

	Practice	Comments	% Nitrate-N Reduction*	% Corn Yield Change**
			Average (SD*)	Average (SD*)
Nitrogen Management	Timing	Moving from fall to spring pre-plant application	6 (25)	4 (16)
		Spring pre-plant/sidedress 40-60 split Compared to fall-applied	5 (28)	10 (7)
		Sidedress – Compared to pre-plant application	7 (37)	0 (3)
		Sidedress – Soil test based compared to pre-plant	4 (20)	13 (22)**
	Source	Liquid swine manure compared to spring-applied fertilizer	4 (11)	0 (13)
		Poultry manure compared to spring-applied fertilizer	-3 (20)	-2 (14)
	Nitrogen Application Rate	Nitrogen rate at the MRTN (0.10 N:corn price ratio) compared to current estimated application rate. (ISU Corn Nitrogen Rate Calculator – http://extension.agron.iastate.edu/soilfertility/nrate.aspx can be used to estimate MRTN but this would change Nitrate-N concentration reduction)	10	-1
	Nitrification Inhibitor	Nitrapyrin in fall – Compared to fall-applied without Nitrapyrin	9 (19)	6 (22)
	Cover Crops	Rye	31 (29)	-6 (7)
		Oat	28 (2)	-5 (1)
	Living Mulches	e.g. Kura clover – Nitrate-N reduction from one site	41 (16)	-9 (32)
Land Use	Perennial	Energy Crops – Compared to spring-applied fertilizer	72 (23)	
		Land Retirement (CRP) – Compared to spring-applied fertilizer	85 (9)	
	Extended Rotations	At least 2 years of alfalfa in a 4 or 5 year rotation	42 (12)	7 (7)
	Grazed Pastures	No pertinent information from Iowa – assume similar to CRP	85	
Edge-of-Field	Drainage Water Mgmt.	No impact on concentration	33 (32)	
	Shallow Drainage	No impact on concentration	32 (15)	
	Wetlands	Targeted water quality	52	
	Bioreactors		43 (21)	
	Buffers	Only for water that interacts with the active zone below the buffer. This would only be a fraction of all water that makes it to a stream.	91 (20)	

Image courtesy of IDALS

Phosphorous Management Practices

- Cover Crops
- Alternative land uses (energy crops, perennial crops, land retirement)
- Extended rotations
- Application (rate, placement, source and timing)
- Tillage and residue management
- Buffers
- Erosion control practices and structures[xv]

	Practice	Comments	% P Load Reduction[a]	% Corn Yield Change[b]
			Average (SD[c])	Average (SD[c])
Phosphorus Management Practices	Phosphorus Application	Applying P based on crop removal – Assuming optimal STP level and P incorporation	0.6[d]	0
		Soil-Test P – No P applied until STP drops to optimum	17[e]	0
	Source of Phosphorus	Liquid swine, dairy, and poultry manure compared to commercial fertilizer – Runoff shortly after application	46 (45)	-1 (13)
		Beef manure compared to commercial fertilizer – Runoff shortly after application	46 (96)	
	Placement of Phosphorus	Broadcast incorporated within 1 week compared to no incorporation, same tillage	36 (27)	0
		With seed or knifed bands compared to surface application, no incorporation	24 (46)	0
	Cover Crops	Winter rye	29 (37	-6 (7)
	Tillage	Conservation till – chisel plowing compared to moldboard plowing	33 (49)	0 (6)
		No till compared to chisel plowing	90 (17)	-6 (8)
Land Use Change	Perennial Vegetation	Energy Crops	34 (34)	
		Land Retirement (CRP)	75	
		Grazed pastures	59 (42)	
Erosion Control and Edge-of-Field Practices	Terraces		77 (19)	
	Buffers		58 (32)	
	Control	Sedimentation basins or ponds	85	

Image courtesy of IDALS

The Iowa Strategy allows for additional practices to be evaluated and approved. Saturated buffers were included as an approved practice under the Iowa Strategy in 2014. Other practices that may be considered in the future might include Science-based Trials of Row Crops Integrated with Prairie Strips (STRIPS, see http://www.nrem.iastate.edu/research/STRIPs/), stream bank stabilization and two-stage ditches. According to the Iowa Strategy, "there is still a need for development of additional practices, testing of new practices, further testing of existing practices, and verifying practice performance at implementation scales. The strategy encourages the development of new science, new technologies, new opportunities, and the further engagement and collaboration of both the public and private sectors." [xvi]

The Science Assessment concluded that it will require a combination of in-field and off-field practices to achieve the goals of the Iowa Strategy.[xvii]

Nonpoint Source Strategy and Estimated Costs

The science team led by ISU developed scenarios of combinations of practices that could achieve the nonpoint goals of the strategy. Three example scenarios were developed that meet both the 41% nitrogen and 29% phosphorous nonpoint source goals. Initial investment costs of the three scenarios range from $1.2 billion - $4 billion, while annual costs range from $77 million per year to $1.2 billion per year. [xviii]

Point Source Strategy and Estimated Costs

A total of 102 major municipal facilities serve the wastewater treatment needs of 55-60% of Iowa residents and treat more than 80% of all wastewater handled by Iowa cities. Among permitted industrial facilities, there are 28 that discharge significant amounts of nitrogen and phosphorus to Iowa waters. Under the Iowa Strategy, for the first time, discharge permits issued to these 130 facilities will require implementation of technologically and economically feasible process changes for nutrient removal. These changes are intended to achieve reductions of at least two-thirds in the amount of nitrogen and three fourths in the amount of phosphorous from current discharge levels from those facilities. If successful, this strategy will reduce the amount of nitrogen and phosphorous loading from point sources by 11,000 tons per year and 2,170 tons per year, respectively. This approach is anticipated to cost approximately $1.5 B if implemented in full.[xix]

Watershed Prioritization and Demonstration Projects

The Iowa Strategy calls for implementing watershed demonstration projects in nine priority watersheds. Eight projects were awarded a total of $4,166,000 in 2013. These projects generated over $8,000,000 in additional match from project partners and landowners.

WQI HUC12 Watershed Applications - 2013 Awarded Projects

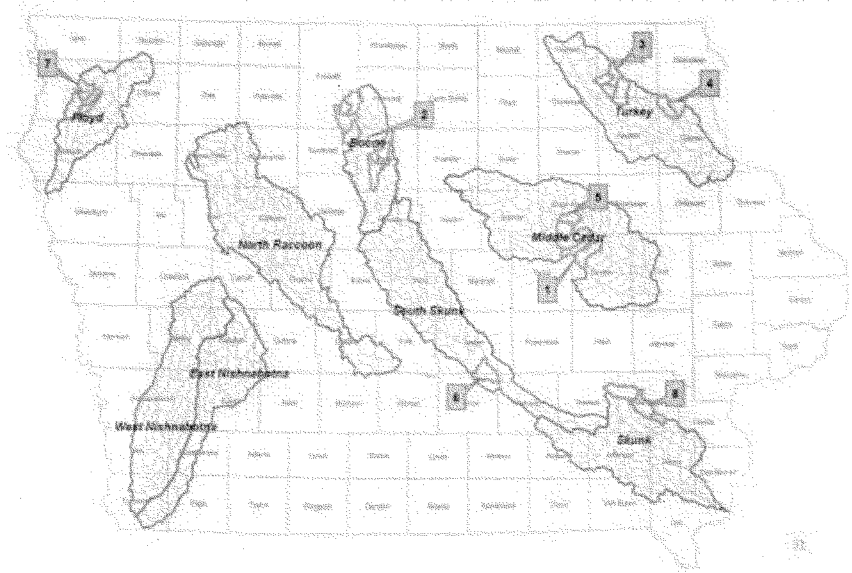


Image courtesy of IDALS

Demonstration projects involve engagement among numerous partners and stakeholders and include a commitment to implement a wide variety of practices within the project area to demonstrate their effectiveness and adaptability.[xx] IDALS issued a Request for Applications for additional demonstration projects in October, 2014.

<u>Iowa Nutrient Research Center</u>

The Iowa Nutrient Research Center [the Center] was established by the Iowa Legislature in 2013 for the purpose of pursuing a science-based approach to nutrient management research. The Center will build upon the work conducted in the science assessment by continuing to evaluate the performance of current and emerging nutrient management practices. The Center will use an adaptive management framework for providing recommendations regarding the implementation of current nutrient management practices as well as the development of new nutrient management practices.[xxi]

The Center is also helping to track progress toward implementing the Iowa Strategy beyond ambient water quality monitoring. The Center is working on a public-private framework for gathering better baseline data and tracking conservation practice adoption and calculated or modeled load reductions resulting from practice adoption.[xxii]

Conclusion

Achieving the goals of the Iowa Strategy is a daunting challenge. It will take many committed partners and will likely take decades to realize 45% reductions in state-wide nitrogen and phosphorous loads. We have had a century and a half of agriculture's impacts on water quality in Iowa and there is already a great deal of "legacy" nutrients and sediment in Iowa's waterways. Yet Iowa farmers are committed to helping lead an effort based on sound science that will fulfill the goals of the strategy and help to improve water quality both in Iowa and downstream to the Gulf of Mexico.

It will take new revenue streams and partnerships with the private sector and municipalities to fund and implement the Iowa Strategy. Public sector funding through NRCS Farm Bill conservation programs and IDALS cost-share programs alone is not adequate. Nascent partnerships among the agricultural sector, cities and municipal wastewater utilities to help fund conservation practices hold tremendous promise. The Iowa League of Cities is exploring how best to create a policy framework to help bring those partnerships to fruition and the cities of Dubuque and Storm Lake have indicated their interests in that effort. The City of Cedar Rapids recently partnered with the Iowa Soybean Association, Iowa Corn Growers, IDALS, IDNR, The Nature Conservancy, Iowa Farm Bureau Federation and local Soil and Water Conservation Districts on a recent Regional Conservation Partnership Program (RCPP) proposal to fund edge-of-field nitrate treatment conservation practices and conservation planning throughout the Middle Cedar River which will help to improve water quality and to a lesser degree address flooding for Cedar Rapids. RCPP advances the principle of targeting conservation practices to where they can have the biggest positive impacts for conservation in priority watersheds and landscapes. NRCS has made tremendous strides in recent years in moving away from the "first in, first offered" approach to increasingly focus Farm Bill resources to deliver conservation outcomes while getting the biggest return for American taxpayers. The recent Farm Bill codified that principle thanks to the efforts of this committee.

The Iowa Agriculture Water Alliance is engaging with additional private sector partnerships and public-private partnerships around nutrient stewardship, soil health and sustainability to help promote conservation practices that improve water quality. The 4R Nutrient Stewardship Program has received some much-deserved attention and momentum in recent years for its work to promote the Right form of fertilizer applied at the Right time, in the Right place and at the Right rate (4Rs). Information about the 4R program can be found at www.nutrientstewardship.com and at the International Plant Nutrition Institute's 4R Nutrient Stewardship Portal at http://www.ipni.net/4R. Fertilizer companies, agricultural retailers, agricultural cooperatives and certified crop advisors are using the 4R program to help producers improve their nutrient management and seek to ensure that fertilizer is taken up by crops more efficiently while reducing nutrient loss and improving water quality. The Iowa Agriculture Water Alliance also supports the Soil Health Partnership, a project of the National Corn Growers Association that is supported by Monsanto, as well as the NRCS Unlock the Secrets in the Soil campaign. These campaigns to improve soil health help to promote practices such as no till, strip till and cover crops which help to improve agricultural productivity as well as water quality. As more producers understand that there is a strong value proposition inherent in these practices that improve productivity and profitability over time, adoption rates for those practices will increase dramatically. Additionally, the Iowa Agriculture Water Alliance is a member of Field to Market, the Alliance for Sustainable Agriculture. Field to Market is a broad-based sustainable agriculture supply chain initiative that unites agribusinesses, food and beverage companies, retailers, agricultural associations, conservation organizations, academic institutions and government agencies in working toward continuous improvement in productivity, environmental quality and human well-being.

In summation, I will conclude with a quote from the Iowa Strategy regarding how Iowa must take its rightful place as a leader in conservation. "*Iowa is a national and global leader in the production of food and renewable fuels, so a goal of this strategy is to make Iowa an equal national and global leader in addressing the environmental and conservation needs associated with food and renewable fuels production.*"[xxiii] The Iowa Agriculture Water Alliance, a farmer led initiative, is committed to helping to bring this goal to fruition.

Thank you for the opportunity to present my views before the committee and for your invaluable work to promote conservation on our nation's private lands and help America's farmers meet the growing domestic and international demand for food, feed, fiber and fuel in an increasingly sustainable manner.

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[i] Iowa Nutrient Reduction Strategy Presentation. John Lawrence, Iowa State University. https://www-nutrientstrategy.sws.iastate.edu/sites/default/files/documents/brief.pdf. 2014.

[ii] Lawrence. 2014.

[iii] Iowa Nutrient Reduction Strategy *A science and technology-based framework to assess and reduce nutrients to Iowa waters and the Gulf of Mexico.* Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources and Iowa State University College of Agriculture and Life Sciences. Updated September, 2014.

[iv] Reducing Nutrient Loss: Science Shows What Works. Iowa State University Extension and Outreach. SP 435. September, 2014.

[v] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[vi] Iowa Nutrient Reduction Strategy Updated September, 2014.

[vii] Iowa Nutrient Reduction Strategy Updated September, 2014.

[viii] Iowa Nutrient Reduction Strategy Updated September, 2014.

[ix] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[x] Issuance of Clean Water Act National Pollution Discharge Elimination System Compliance Monitoring Strategy. EPA Memorandum from Lisa Lund. July 21, 2014. http://www.epa.gov/compliance/resources/policies/monitoring/cwa/npdescms.pdf

[xi] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[xii] Iowa Nutrient Reduction Strategy Presentation. Matt Lechtenberg and Shawn Richmond, Iowa Department of Agriculture and Land Stewardship. December, 2013.

[xiii] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[xiv] Lechtenberg and Richmond. 2013.

[xv] Lechtenberg and Richmond. 2013.

[xvi] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[xvii] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[xviii] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[xix] Iowa Nutrient Reduction Strategy. Updated September, 2014.

[xx] Lechtenberg and Richmond. 2013.

[xxi] Lechtenberg and Richmond. 2013.

[xxii] Lechtenberg and Richmond. 2013.

[xxiii] Iowa Nutrient Reduction Strategy. Updated September, 2014.

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Before the Committee on Agriculture, Nutrition and Forestry
United States Senate

December 3, 2014

Good morning Chairwoman Stabenow, Ranking Member Cochran, and members of the Committee. Thank you for the opportunity to be here today to discuss the importance of voluntary conservation for protecting and improving our nation's land and water resources and in particular, the role of Natural Resources Conservation Service (NRCS) programs in improving water quality in our lakes and rivers through voluntary conservation practices.

Introduction

For almost 80 years, NRCS has been a pioneer in voluntary conservation, working with agricultural producers; forest managers; local, state, and federal agencies; Tribes; local communities; and innumerable partners to maintain healthy and productive working landscapes.

Our nation's agricultural producers are leaders in developing and implementing new technologies in crop production systems. This innovation has allowed United States agriculture to feed our growing population here at home and around the world. In addition to adopting new technologies for crop production, our farmers and ranchers have also developed and implemented conservation strategies that will protect the valuable soil on the farm as well as the water and related resources off the farm. NRCS, in conjunction with our partners, has been supporting these locally led efforts through the technical and financial assistance made available through Farm Bill and other long-standing conservation authorities. While much has been accomplished, more remains to be done and continued efforts are required to meet our nation's need for clean water.

Water Quality and Agriculture

Excess nutrients, streambed sediment, and disturbance of vegetative cover along streams and rivers are among the greatest stressors on our nation's rivers. Two nutrients, phosphorus and nitrogen, are by far the most widespread stressors, with 40 percent of the nation's river and stream length having high levels of phosphorus and 28 percent having high levels of nitrogen. In order to ensure healthier waters for future generations the need exists to address the many sources— including runoff from urban areas, wastewater, and agricultural practices.

Providing the Solutions

NRCS is helping meet the challenge of improving water quality in the nation's rivers and streams. With 70 percent of our nation's lands privately owned and nearly 90 percent of all surface water occurring on private land, the quality of our environment depends on millions of individual decisions private landowners make every day. NRCS works with landowners through voluntary conservation planning and assistance designed to benefit soil, water, air, plants, and animals that result in productive lands and healthy ecosystems.

To assist producers and landowners with conservation, NRCS uses a well-defined conservation planning process. Conservation planning helps identify and address resource concerns, such as water quality. To be most effective, conservation practices should not be implemented randomly, but as part of a system of practices designed to address specific natural resource concerns.

For water quality concerns such as sediment or nutrients, a cornerstone of this approach is encouraging producers to implement a system of practices that Avoid, Control, or Trap these materials, A-C-T for short. Avoidance generally involves using practices that optimize nutrient recovery by the crop, thereby reducing nutrient losses. The principal conservation practice to avoid nutrient losses is Nutrient Management, where we assist operators in implementing the 4-R concept of applying the Right amount of nutrients from the Right source, in the Right place, and at the Right time. Controlling soil and nutrient losses on the farm means keeping them from being mobilized by wind or water and moving off the field. Example practices include residue management, crop rotation, cover crops, terraces, and contouring. The last line of defense is to trap or treat sediment and nutrients before they can enter downstream water bodies. Such practices include filter strips, riparian buffers, constructed wetlands, drainage water management, and use of bioreactors.

Scope of our Investments

Beginning with the 2008 Farm Bill and continuing through 2014, NRCS technical and financial assistance utilized $3.4 billion dollars to enable the application of over 86 million acres of conservation practices that specifically provide water quality benefits, and help make our nation's waters cleaner. The most commonly applied NRCS conservation practices for improving water quality are Prescribed Grazing, Nutrient Management and Integrated Pest Management.

Prescribed grazing, implemented on over 29 million acres, is used to manage vegetation with grazing or browsing animals. It not only improves the vigor of plant communities and the quantity and quality of forage for animals but also helps to maintain and improve water quality. Nutrient management was implemented on over 14 million acres between fiscal years 2008 and 2014, helping to keep nutrients in place for plant uptake and minimize potential losses to water or air.

Conservation Effects

The voluntary, incentives-based approach is achieving conservation goals across the nation. The Conservation Effects Assessment Project (CEAP) has demonstrated that employing conservation systems using this approach has significantly reduced nutrient and sediment losses from agricultural lands. CEAP uses a two pronged approach, beginning with statistically valid data collection. From 2003-2006, approximately 30,000 data points associated with cultivated cropland were sampled. That data is then used to inform two process-based models, which provide estimates of conservation and land use impacts. These studies estimate that from 2003-2006:

- Practices in place reduced sediment loss by 53%, resulting in a reduction of 278.1 million tons of sediment per year from agricultural lands.
- Practices in place reduced surface nitrogen loss by 41%, resulting in a reduction of 1.7 billion pounds per year from agricultural lands.
- Practices in place reduced subsurface nitrogen loss by 31%, resulting in a reduction of 2.1 billion pounds of nitrogen per year from agricultural lands.
- Practices in place reduced phosphorus loss by 44%, resulting in a reduction of 584.1 million pounds of phosphorus per year from agricultural lands.

Improving Effectiveness through Targeting

Agricultural conservation measures have the most significant impact on water quality when systems of practices are applied to the most vulnerable acres and are most apparent when focused on small priority watersheds. The CEAP cropland studies have consistently found that it is critical to assess and plan conservation practice implementation at the watershed scale for more effective water quality outcomes. NRCS has designed and delivered a number of initiatives to catalyze partnerships and accelerate focused conservation for improving water quality in small priority watersheds across the nation. Three examples of these initiatives are summarized in the following testimony. The Mississippi River Basin Healthy Watersheds Initiative (MRBI) focuses on the main stem of the Mississippi River. The Great Lakes Restoration Initiative (GLRI) accelerates efforts to protect and restore the largest system of fresh surface water in the world — the Great Lakes. The nationwide National Water Quality Initiative (NWQI) targets financial and technical assistance for conservation in high-priority, small watersheds in all 50 states.

Mississippi River Basin Initiative (MRBI)

MRBI has a strong partnership component, with more than 600 active partners throughout the initiative area. These partners include diverse stakeholders including Conservation Districts, Industry and Commodity Groups, State Agencies, Universities, and others. Together, partners have contributed more 500 staff years of assistance to the projects and approximately $20 million in financial assistance and in-kind services to advance MRBI projects. Targeted investments in MRBI have more than doubled the adoption of critical water quality conservation practices, such as cover crops and nutrient management, in the majority of MRBI project areas. Over its first five years, MRBI invested almost $400 million in technical and financial assistance across 123 projects. The effectiveness of MRBI's small watershed targeting and conservation systems approach was modeled under CEAP in April 2013. For conservation systems under contract with farmers through MRBI between FYs 2010 and 2012, when fully applied it is projected that the per acre benefits of these systems will be 1.7 times greater for sediment reduction, 1.4 times greater for phosphorus reduction, and 1.3 times greater for nitrogen reduction compared to a non-targeted approach.

Great Lakes Restoration Initiative (GLRI)

Since 2010, NRCS has entered into approximately 1,580 GLRI funded contracts to address resource concerns on over 300,000 acres in priority watersheds draining into the Great Lakes. Using funding from the U.S. Environmental Protection Agency (EPA) —$23.2 million in 2014 and approximately $122 million since 2010— and authorities of the Farm Bill, NRCS assists producers in the Great Lakes to implement proven, science-based conservation systems on their lands. Through these systems of practices, farmers are able to conserve water, plant, air, and wildlife resources while maintaining agricultural production and profitability.

Since 2012, NRCS has been working with partners to target assistance where phosphorus inputs have been related to the occurrence of Harmful Algal Blooms in the Great Lakes. The targeted sub-watersheds are located within the Maumee River, Saginaw River, and Lower Fox River Watersheds. These priority small watersheds were selected based on their potential for high impact phosphorus reduction practices, the presence of watershed management plans, the percentage of agricultural land, and local interest.

In addition to direct contracts with farmers, NRCS is investing GLRI funds in innovative efforts to further conservation in the Great Lakes. In the Lower Fox River Watershed of Wisconsin, NRCS is providing financial assistance and technical advice to support the development of a pilot phosphorus trading market to increase private sector funding for voluntary conservation on private lands. This project is being conducted through a contribution agreement with the Great Lakes Commission. GLRI funding is also being used to develop networks of demonstration farms that will showcase conservation systems that reduce phosphorus and sediment delivery. These demonstration farms can help increase the adoption of innovative conservation practices by showing them in practice on real world farms and harnessing the power of farmer-to-farmer information sharing.

National Water Quality Initiative (NWQI)

In 2012, NRCS launched the NWQI, in collaboration with the EPA and state water quality agencies, to reduce nonpoint sources of nutrients, sediment, and pathogens related to agriculture in small high-priority watersheds in each state. These priority watersheds have been selected by NRCS State Conservationists in consultation with state water quality agencies and NRCS State Technical Committees.

NWQI provides a means to accelerate voluntary, private lands conservation investments to improve water quality with dedicated financial assistance through NRCS's Environmental Quality Incentives Program (EQIP), and to focus water quality monitoring and assessment funds where they are most needed. A key part of the NWQI targeting effort includes the implementation of conservation systems that avoid, trap, and control run-off in these high-priority watersheds.

Since 2012, NRCS has obligated more than $88 million in funding for water quality–related conservation systems in high-priority watersheds throughout the country—this is funding above and beyond general NRCS EQIP program funding. In FY 2014 alone, NRCS has worked with more than 600 farmers and ranchers and planned or implemented conservation on more than 95,000 acres.

In FY 2013, NWQI provided the necessary funding to complete projects in seven high-priority watersheds. These watersheds, located in Maine, Tennessee, Nebraska, and Oregon, have had a long-standing NRCS and partner commitment to addressing impairments from agricultural sources. While work in the watersheds will continue, the need for accelerated financial assistance has been met, and these funds will be moved to other areas that need it.

NRCS state offices worked closely with state water quality agencies in FY 2013 to identify watersheds where monitoring is most needed. In FY 2013, EPA issued guidance to states requiring them to implement in-stream water quality monitoring in at least one NWQI watershed per state. Long-term monitoring is an essential part of ensuring that NRCS, partners, and producers are implementing conservation systems that will have the greatest impact on improving water quality.

Success Stories

Voluntary, incentive-based conservation efforts are making a real difference in many watersheds around the county. Impaired streams listed on state and EPA 303(d) lists are being cleaned up and removed from the list. The following are two examples of such successes.

Oklahoma is one of the leading states in reducing nutrient and sediment losses to water and has been able to use funding provided by the Farm Bill Conservation Title, EPA 319 Federal Clean Water Act, and state sources to partner with landowners to deal with some of Oklahoma's most difficult water quality problems. In 2014, Oklahoma was recognized by EPA for its work in removing nine of Oklahoma's streams from the 303(d) list of impaired streams and was reportedly second among all states for its work in improving stream water quality. These nine streams are located in Bryan, Choctaw, Coal, Garfield, Grant, Kay, Logan, McIntosh, Osage, and Pontotoc Counties.

This is just part of the story in Oklahoma. Going back to 2012, Oklahoma's Non-Point Source Program led the nation in reducing phosphorus losses using voluntary conservation practices. Shanon Phillips, Oklahoma Conservation Commission Water Quality Division Director said, "Water quality monitoring data for these EPA success stories shows improvements which can be attributed to voluntary conservation practices. We have the strong partnership between landowners, conservation districts, USDA Natural Resources Conservation Service (NRCS), Oklahoma Conservation Commission (OCC), and the Oklahoma Association of Conservation Districts (OACD)." This work is continuing in Oklahoma.

In Arkansas, water quality in the St. Francis River has been impacted by soil erosion from agricultural fields resulting in high turbidity levels, leading the Arkansas Department of Environmental Quality to identify two river segments as impaired and placed on the state's 2006 Clean Water Act 303(d) list.

Watershed stakeholders and conservation partners—including agricultural producers, local conservation districts, The Nature Conservancy, Arkansas Natural Resource Commission, Arkansas Department of Environmental Quality, EPA, and NRCS made a concerted effort to implement practices for improving water quality in the river. NRCS's contribution included five Mississippi River Basin Healthy Watershed Initiative projects in which local partners began participation in 2010. Working through conservation partners, NRCS invested $14.2 million in those five projects, working with 479 landowners who provided $3.5 million of their own finances to help implement conservation practices on over 80,000 acres.

As a result of these efforts by agricultural producers, with the support of numerous partners in the watershed, the turbidity levels have decreased. The 2014 state water quality assessment showed turbidity decreased to levels that allowed Arkansas to remove two reaches of the river from Arkansas' 2014 section 303(d) list for turbidity impairment.

The Future of Conservation Efforts

While much has been accomplished, much remains to be done. NRCS and our conservation partners will utilize the tools, programs and authorities provided through The Agricultural Act of 2014 to continue to support US agricultural producers in implementing practices to protect and restore our nation's waters as well as optimize other benefits and services we receive from well-managed agricultural lands, such as enhanced carbon storage and sequestration in soils and forests. One of the most important lessons learned over the past decades of conservation activity is the need for, and benefit of, targeting our resources and utilizing the strengths of our partners. The new Regional Conservation Partnership Program (RCPP) will allow us to fully capitalize on these two important strategies. The first sign-up for RCPP was held in July of 2014 and interest was overwhelming. Over 600 pre-proposal submissions were received covering all 50 states and requesting $2.8 billion in program funding. This demonstrates the level of interest from our agriculture and conservation community for expanding participation in voluntary, incentive-based programs. Utilizing the strength of such partnerships and targeting our conservation efforts will greatly increase our ability to achieve measureable and meaningful improvements in water quality, as well as other resource benefits.

Conclusion

Chairwoman Stabenow, let me conclude by saying that our nation's farmers and ranchers have a tremendous track record of success in conserving our nation's soil and water resources. Through the work of your committee in providing the programs of the 2014 Farm Bill, NRCS has the tools in place to continue to provide them the assistance they need to improve on that record. Their level of interest, and the interest of our partners, can be seen in the overwhelming response to these new programs. Voluntary conservation is working, and with our continued collective efforts we can be successful in protecting and improving our nation's valuable water resources. Thank you for the opportunity to be here today and update the Committee on our agency's efforts on this important topic.

DOCUMENTS SUBMITTED FOR THE RECORD

DECEMBER 3, 2014

National Association of Conservation Districts

National Association of Conservation Districts

Testimony

Submitted by the National Association of Conservation Districts

United States Senate Committee on Agriculture, Nutrition and Forestry

Regarding: "Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters."

December 11, 2014

The National Association of Conservation Districts (NACD) appreciates the opportunity to submit testimony for the record for the December 3, 2014 hearing titled, "Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters."

NACD is the nonprofit organization that represents America's 3,000 conservation districts their state and territory associations, and the 17,000 men and women who serve on their governing boards. Conservation districts are local units of government established under state law to carry out natural resource management programs at the local level. Districts are the local government part of the conservation delivery system and work with millions of cooperating landowners and operators to help them manage and protect land and wate resources on all private lands and many public lands in the United States.

The association was founded on the philosophy that conservation decisions should be made at the local level with technical and funding assistance from federal, state and local governments and the private sector. As the national voice for conservation districts, NACD supports voluntary, incentive-based natural resource conservation programs that benefit all citizens.

Voluntary conservation efforts to protect our land and water go hand in hand, particularly related to water quality and soil health. The benefits of improved soil health reach far beyond the farm. In addition to providing farmers with the economic benefit of increased yields, healthy soils lead to higher water quality by allowing for better nutrient cycling anc reducing sediment runoff; a better ability to manage water and reduce flood damage; and an increase in the amount of carbon sequestered in the soil itself.

Due to its increased water-holding capacity, healthy soil is also more resilient against drought and is naturally less prone to disease and pest problems, thereby allowing farmers to optimize their use of crop protectants. And because healthy soil requires fewer petroleum-based products for tillage, it also saves on energy use and costs.
The economic benefits of soil health and improved water quality are not limited to improved yields or increased efficiency. There is growing interest within the regulated community for agricultural-based solutions to environmental regulations. For the first time, within the last year interstate water quality credits have been traded in the Ohio River Basin watershed between regulated point sources and farmers who adopt conservation practices. As opportunities for environmental markets continue to mature, farmers will increasingly have additional economic benefits for voluntarily adopting conservation practices.

In the past several years, NACD and its member conservation districts and associations have been working hard to put a renewed national focus on the benefits of soil health. These efforts include partnering with the USDA Natural Resources Conservation Service (NRCS) on an integrated campaign to increase the adoption of soil health management practices by America's farmers and private landowners. We anticipate conservation districts providing guidance to determine their local soil health needs and finding ways to best implement a suite of practices aimed at improving soil health. It is important that districts remain the boots on the ground to help solve local natural resource issues. By increasing the health of our soils, the campaign ultimately seeks to produce systemic, landscape-scale improvements in water, air, and wildlife – all while enhancing long-term agricultural productivity and providing the best return on the nation's conservation investment.

NRCS and conservation districts are not alone in this effort – we're seeing an increasing interest from a wide range of stakeholder groups, organizations and businesses that recognize the potential benefits of healthy soil to improved water quality, production, sustainability, profitability and resource protection – all of which are advantageous to their stakeholders. Many of these organizations, in partnership with local conservation districts, are poised to achieve even greater results for water quality and soil health through programs like the Regional Conservation Partnership Program (RCPP).

In summary, to make measurable improvements in water quality and soil health at the landscape level will require a locally-led, voluntary, coordinated effort. Because of their strong relationships with local landowners, as well as their strong reputation as a trusted source of conservation planning and implementation at the local level, conservation districts are well poised to continue to play a leading role in these efforts, in close partnership with local, state and federal partners.

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NACWA

A Clear Commitment to America's Waters

Testimony of

Thomas Sigmund, Executive Director

NEW Water

Green Bay, Wisconsin

Chair, Resource and Utility Management Committee

National Association of Clean Water Agencies

1816 Jefferson Place, NW

Washington, DC

Senate Environment and Public Works

Water and Wildlife Subcommittee

United States Senate

Tuesday, December 2, 2014

Chairman Cardin, Ranking Member Boozman, and Members of this Subcommittee, thank you for inviting me to testify today to share some of the innovations underway within the municipal wastewater sector.

My name is Tom Sigmund and I am the Executive Director at NEW Water, the innovative brand of the Green Bay Metropolitan Sewerage District, in Green Bay, Wisconsin. As a regional provider of wastewater conveyance and treatment services in Northeast Wisconsin, NEW Water serves 18 municipalities and 220,000 people. NEW Water operates two treatment facilities that treat an average of 38 million gallons per day of wastewater from residential, commercial, and industrial users.

I also serve as Chair of the Utility and Resource Management Committee for the National Association of Clean Water Agencies (NACWA) and I am pleased to also be testifying on behalf of that organization today. NACWA represents nearly 300 public agency members that collectively treat the majority of the nation's wastewater, protect public health, improve the environment, and support the economic vitality of our communities and the nation.

The Water Resources Utility of The Future is Today

Forty years after the passage of the Clean Water Act, clean water agencies are transforming the way they deliver clean water services. At the heart of this transformation is the emergence of new technologies and innovations that can stretch ratepayer dollars, improve the environment, create jobs, and stimulate the economy. The most progressive of today's clean water agencies are defining what is meant by the Water Resources Utility of the Future (UOTF), and I am proud to lead one of those utilities.

For decades terms like "sewage treatment" or "sewerage agencies" were used to describe our nation's wastewater treatment agencies, but these terms are changing. These utilities are now being called "clean water agencies," "enterprises," or "resource recovery agencies". What does this mean? Instead of solely collecting and transporting wastewater to central treatment plants and viewing that material simply as waste to be treated and disposed of at the lowest cost, these utilities are recovering valuable resources from this material, partnering in local economic development, and aligning themselves as members of the watershed community in order to deliver maximum environmental benefits at the least cost.

Today's clean water utilities are doing this by reclaiming and reusing water, extracting and finding commercial uses for nutrients and other constituents in the waste stream, capturing waste heat and latent energy in biosolids and liquid streams, generating renewable energy using their land and other horizontal assets, and using green infrastructure to manage stormwater - all of which results in a profound improvement to the quality of life for members of their communities. They also are developing collaborations with upstream partners to address more complex water quality challenges, such as nutrient-impaired surface waters.

NEW Water is Leading Innovation for Green Bay, Wisconsin

At NEW Water, we have embraced innovation in much of what we do so that we can provide better services to our ratepayers and better environmental outcomes for our community.

Green Bay, Wisconsin, is founded on a heritage of industry, agriculture, and football. The greater Green Bay metropolitan area has enjoyed a strong economy and is a great place to raise a family, but the water environment has taken some hits along the way. Green Bay is located at the mouth of the world's largest freshwater estuary, and is blessed with an abundance of water. However, our waters are impaired and burdened by excessive nutrients and algae, which at times create a hypoxic area or "dead zone" in the bay.

This is the backdrop facing NEW Water as we strive to be a good community leader in resource management, water quality improvement, and serve as a Water Resources Utility of the Future for generations to come.

To launch this journey, NEW Water embraced a new attitude that is reflected in its new brand. We're working in the watershed with agricultural producers to improve water quality, reduce phosphorus, and tackle the dead zone in Green Bay. We're embarking on a new biosolids facility that will recover energy through electrical generation and heat recovery, as well as harvest a beneficial by-product that will be incorporated into commercial fertilizers.

To reflect our new attitude and to better tell our story, we realized it was time to change our name from the *Green Bay Metropolitan Sewerage District* to something that will better resonate with the wide variety of stakeholders we interact with. We removed sewerage from our name, replacing it with the more positive word, water, which people can easily rally around. NEW has a double meaning: NEW as in the Northeast Wisconsin region, which is a commonly used acronym in our area, and "new" as in newly created product (clean water) - which is what we do each day.

In the publicly owned and operated clean water industry, rebranding is a pretty revolutionary concept. As with all things, change takes time for people to accept. More than a year on, our rebranding has been a success, and has helped launch our water quality improvement efforts in the watershed.

NEW Water Takes Lead on Nutrient Challenge

Perched amidst the Great Lakes, Green Bay's waters are impaired with excessive nutrients – the Lower Fox River is considered an Area of Concern by the EPA. We say that we are cleaning the bay, 38 million gallons per day, because our effluent is cleaner than the receiving water. Green Bay delivers one-third of the total nutrients that enter Lake Michigan.

Algae are a significant problem in Green Bay. NEW Water has been thrust in the middle of this issue due to significantly more stringent phosphorus regulations for point source dischargers.

After 40 years of ever-increasing regulatory pressures on US clean water agencies, most of the easy and cost-effective solutions are already in place. Achieving further reductions in pollutant loadings from wastewater treatment plants will be disproportionately expensive relative to potential gains in ambient water quality. These reductions are also far more expensive relative to the cost of achieving the same or, in many cases, far better ambient water quality improvements, by addressing unregulated sources of pollutants or other forms of water quality impairment. This suggests that from a community or broader social perspective, everyone would be better off if the Clean Water Act (CWA) and state equivalents formally encouraged processes that would enable local innovation around least-cost watershed-scale water quality solutions.

When effluent standards based on conventional wastewater treatment technology under the Clean Water Act are unable to produce ambient water quality that meets criteria for designated uses of the receiving water, the CWA provides the states and EPA the authority to establish a Total Maximum Daily Load (TMDL) for pollutants of concern from all sources so that criteria will be met. States then allocate loadings of this pollutant to all point and nonpoint sources in the watershed. Since only point sources are regulated, the TMDL process must rely on voluntary actions to control nonpoint sources. Often the result is load reductions disproportionately allocated to point sources rather than nonpoint sources which are largely exempt from the Act's enforceable regulations.

NEW Water is required to further reduce the amount of phosphorus in its effluent from its two treatment facilities; the amount discharged is less than 3% of the total phosphorus delivered by all sources in the Fox River watershed to the bay. The new phosphorus limits are 80 percent lower than current limits. To meet these new discharge limits, it is projected that NEW Water would need to build facilities at its two water resources reclamation facilities at a capital cost exceeding $220 million. In our opinion, this makes little economic or environmental sense. In lieu of that, NEW Water is exploring a program authorized by the State of Wisconsin, called Adaptive Management, which is a community-wide approach to improving water quality.

The term "Adaptive Management" in its broadest sense refers to the philosophy of using new information to modify actions within a long-term project strategy. The Wisconsin Department of Natural Resources (DNR) has incorporated the term in a somewhat more narrowly defined manner to describe a regulatory compliance strategy whereby a permitted source (or group of sources) will work towards water quality compliance with a state designated water quality standard by developing partnerships within the watershed to balance load reduction efforts by both point and nonpoint sources. The intent is to reduce discharges of the parameter of concern to the water body by the most cost-effective method rather than relying strictly on reductions by point sources through installing costly tertiary treatment. Point source dischargers are afforded flexibility and can defer or avoid costly infrastructure installation by facilitating load reductions within the agriculture or other nonpoint sectors. Adaptive Management differs from water quality trading in that it doesn't require trade ratios or margins of safety, but does require a demonstration of eventual compliance with the ambient water quality criteria in the receiving water. Adaptive Management activities often achieve complementary improvements in the watershed in addition to reduction of specific parameters of concern.

NEW Water has convened a group to tackle a four-year Adaptive Management Pilot Project in Silver Creek, a 4,800 acre sub-watershed in our community that drains to Green Bay. The stakeholder group includes: the Oneida Tribe of Indians, US Fish and Wildlife Service, US Department of Agriculture's Natural Resources Conservation Service, US Geological Service, University of Wisconsin-Green Bay, Brown and Outagamie County Land and Water Conservation Departments, The Nature Conservancy, and Ducks Unlimited. The pilot project will demonstrate improvements to water quality when best management land practices are implemented. Water quality monitoring will occur throughout the project, and scientific data will be tracked to indicate the project's progress. At the project's completion, it is hoped that Silver Creek will provide a guide to improve water quality, which can then be replicated on a larger scale in Adaptive Management projects elsewhere in the watershed.

NEW Water is Leading on Resource Recovery for Energy Needs

At our water resources recovery facilities, NEW Water is completing the design phase of an innovative biosolids project, Resource Recovery and Electrical Energy, known as R2E2. This forward-looking project is a new approach to solids handling through thermal processing, electrical energy generation, and heat recovery. Two anaerobic digesters will break down biodegradable material in the absence of oxygen to produce a methane gas, which will be captured and processed onsite into a biofuel, which will be used to produce electricity. NEW Water's annual energy costs are slated to be reduced by more than 50% in the first year of operation, resulting in a reduction of greenhouse gas emissions by about 22,000 metric tons per year.

Nutrient recovery is another exciting aspect of R2E2, and represents a new attitude in viewing what is sent to our facilities as a resource to be recovered, rather than a waste to be disposed of. Through R2E2, we will be recovering struvite, a phosphorus based by-product of the wastewater treatment process that can be problematic as it tends to clog equipment and piping. Struvite is also an important ingredient in agricultural fertilizer. By harvesting struvite from our influent, we'll be reducing maintenance costs associated with its removal from our equipment, and creating a beneficial reuse product: commercial fertilizer. This win-win means both resource recovery and supplemental non-rate based revenue.

Like many clean water agencies, NEW Water has been the best kept secret in town: out of sight, out of mind; flush and forget. Today, we are outside the fence of our treatment facilities, working out in our community's watershed, classrooms, and boardrooms, serving as a community partner and leader in creating a more sustainable community on our Water Resources Utility of the Future journey.

National Policy Can Help Lead this Evolution

As NEW Water demonstrates, the market for innovation in the clean water sector is strong. Resistance to change, however, is also significant, and is reinforced by several key trends: regulatory pressures; strained utility/local, state and federal budgets; customer confusion about the benefits of innovation; skyrocketing demands for capital competing for every dollar; risk and regret associated with technology failure; and venture capital looking elsewhere for faster and safer returns.

To meet its regulatory and customer level of service requirements, over the last five years NEW Water has increased its debt load by 93 percent ($50 million) and raised its user charge rates by 70 percent. Beginning a $220 million capital project to treat phosphorus soon after a $150 million solids handling project would put even more strain on the finances of NEW Water's customers. This example shows how funding for capital investments in clean water has shifted dramatically over the last 30 years from a shared, intergovernmental approach to an almost exclusively local user-financed approach.

Nothing short of a national strategic imperative to reform the U.S. water sector is likely to drive the kind of change that will be needed to fully address future challenges. NACWA's Water Resources Utility of the Future Task Force, which I was honored to chair, developed several policy recommendations for driving this change, including several actions that Congress can undertake.

First, Congress can help us raise awareness here in DC about these innovations. We are pleased that the Clean Water Caucus was formed in the House this year Chaired by Congressman John Duncan of Tennessee and Congressman Tim Bishop of New York to provide a forum for discussing innovative clean water solutions and we welcome the opportunity to work with you and your colleagues in the Senate to form a similar caucus in this chamber.

Specific legislative action we would encourage Congress to take include:

- Refocusing existing federal grant programs to support Water Resources Utility of the Future initiatives such as the Clean Water State Revolving Fund, which to some extent you did in the recent revisions made to the program in the Water Resources Development Act package, but there may be additional targeting that is possible.

- Establishing an aggressive research program to support our engineering and scientific sectors to advance resource recovery technology for clean water utilities.

- Creating a program for early stage technology and innovation investment for the water sector similar to programs that exist in the energy sector.

- Developing, clarifying, and expanding tax credit and incentive programs that will encourage clean water agencies and their private sector partners to engage in UOTF-related activities, especially in energy conservation and production, water reuse, resource recovery, and green infrastructure.

- Revising the Clean Water Act and Safe Drinking Water Act to bolster the important role recycled water can play in public health and safety.

There are also several actions that the Executive branch can undertake to support innovation, such as: review procurement policies to see how they can support greater water reuse and other types of innovation, establish an intergovernmental working group to address water sector resiliency needs in the face of changing weather patterns, and, create and support market-based approaches to efficiently and more equitably address watershed-scale water quality challenges.

One of the key drivers of innovation at the local level is ever increasing costs associated with the traditional regulatory compliance approaches. The more flexibility clean water utilities have to comply with requirements under the Clean Water Act, including compliance schedules and our ability to work with nonpoint sources, the greater our ability will be to undertake new and innovative approaches. With this in mind, NACWA also recommends that innovative and non-traditional compliance approaches are built into the EPA's Integrated Planning and Permitting Framework.

Finally, we need to consider and explore a new 21st Century Watershed Act that can drive the water sector toward the emerging Water Resources Utility of the Future model with other partners within a watershed that can help address our water quality challenges.

Final Thoughts

For decades, the traditional operating model for the municipal clean water sector worked well to the point where more than 90 percent of the US population is centrally served today and more than $500 billion in public clean water assets have been created. Utilities are investing about $55 billion a year and removing more than 90 percent of organic inputs, an estimated 55 percent of nutrients, and nearly all harmful bacteria. And, environmental outcomes are equally impressive – according to EPA and state analyses, municipal wastewater discharges account for less than 10% of remaining water quality impairment of the nation's rivers, streams, lakes, reservoirs, and coastal shoreline and only about 30% of impaired estuaries.

In the 40 years since the passage of the CWA, a lot has changed: unit removal costs are high – we've done the easy things; existing infrastructure is old and needs replacement; new regulations, especially on wet weather flows, layer on compliance costs; the federal intergovernmental financing system that underwrote so much of our past water quality gains has all but disappeared; and, if you look carefully at water quality trends, we're at best stalled and in more and more watersheds, we're losing ground.

So, this leaves clean water utilities in a difficult position: doing much, much more with much, much less. The Water Resources Utility of the Future is learning to turn waste products into resources that can be reused, sold, and generate additional revenue for operations. We are learning to reduce demand by installing more efficient treatment technology, and finally, we are learning to manage our operations to squeeze as much value as possible out of our systems and operations.

We are leading our communities in innovation around our water needs and becoming Water Resources Utilities of the Future today.

I appreciate your interest in these efforts and we welcome the opportunity to work with your committee on supporting policy reforms to promote these activities. I am including a 2013 report entitled "The Water Resources Utility of Future Blueprint for Action," a collaborative effort by NACWA, the Water Environment Federation, and the Water Environment Research Foundation, which discusses in more detail the transformation taking place, its benefits to the overall economy, and provides a number of examples of other utilities from around the country engaged in this change. Also attached is an essay that I wrote for the recently published book "The Value of Water: A Compendium of Essays by Smart CEO's".

Thank you and I'll be happy to answer any questions you might have.

The Changing Value Paradigm of a Clean Water Utility

By: Thomas Sigmund, Executive Director, NEW Water, Green Bay, Wisconsin

Published in: The Value of Water: A Compendium of Essays by Smart CEOs, September 2014

Clean water utilities have performed a valuable service in the United States and the world over the last 80 years. In the United States, water borne diseases have been virtually eliminated and water quality for commerce and recreation has been greatly improved, primarily as a result of improvements in treatment of wastewater that is returned clean to the environment.

Water is one of the earth's most valuable commodities. However, in parts of the U.S. we often treat the supply of clean water as limitless and have not given our water supply the respect that it deserves. Clean water utilities are being called on to do more to protect and improve the water supply. As clean water is valued more, the role played by clean water utilities and the value they provide not only to the rate payers, but to the population in general will become more important.

Today's utilities have moved beyond the paradigm of treating wastewater to simply meet permit conditions to a paradigm of managers of valuable resources and partners in improving the water environment and economic vitality of their communities. Today's clean water utilities must find ways to improve efficiency of their operation to reduce operating cost and embrace automation, recover valuable materials from the influent stream and convert them for maximum economic benefit, and work proactively in the watershed when those efforts offers the highest value.

The value of clean water utilities today lies in their ability to innovate and take advantage of process and technology innovation opportunities to improve service, and at the same time reduce cost to the customer. Utility managers are driven to this model as they face increasingly stringent environmental regulations that require expensive treatment solutions, aging infrastructure that must be replaced at considerable cost, and the loss of an intergovernmental partnership that historically provided federal and state financial support to help pay for these mandates. Improved cost effectiveness of resource recovery technologies applicable to clean water utilities is allowing those managers to take advantage and implement these innovations to the benefit of their rate payers.

Utilities are being called on to become more energy and operationally efficient, reuse treated effluent to supplement potable water supplies, recover an increasing large amount of inherent energy from influent and biosolids, recover nutrients and other valuable materials, and work with watershed interests to improve water quality, all while keeping rate increases as low as possible.

Recent industry analyses states that there is enough heat and embedded energy in biosolids alone to meet up to 12% of the U.S. electricity demand and that influent wastewater contains many times the energy needed to run those treatment facilities. The challenge has been recovering that energy in a cost-effective manner. Utilities have generated combustible gas using anaerobic digestion for decades and have used that gas to either generate electricity or heat for use within the treatment facilities or flared the gas to the atmosphere.

As the cost of utility generated electricity has risen and the technology to generate electricity onsite from digester gas has improved, more utilities are performing a cost-benefit evaluation and finding that on-site generation has an acceptable payback period (10 years or less) and are generating electricity to replace purchased carbon-based fuel utility power. Modern digester gas fueled engine generators are increasingly more efficient at the conversion of gas to electricity and can be equipped with devices to further recover the excess heat from engine exhaust gas and cooling water to be used within the facility.

Clean water utilities are also finding that high-strength industrial waste can be added to anaerobic digesters along with municipal waste to significantly increase gas and electricity production. In decisions that benefit both clean water utilities and generators of suitable high-strength industrial waste, the material can be transported to the utility and added directly to anaerobic digesters to significantly increase the amount of combustible gas that can be produced. In these business transactions, a nominal fee is charged that is typically less than what the industry would spend to otherwise dispose of the material, and the utility receives value in the form of additional digester gas that can be used to produce heat or electricity, offsetting purchased energy and benefitting utility rate payers.

NEW Water, the regional clean water utility in Green Bay, Wisconsin has a goal to offset 50% of its purchased energy bill in the first year of operation (over $2 million per year) through generation of electricity and recovery of heat energy. After the initial 10 year payback period, the program will save the utility over $2 million in energy costs every year for an additional 10-15 years. Other utilities have set and achieved goals to become energy neutral or a net exporter of energy.

As little as ten years ago, utilities talked about the value of nutrients that accompany wastewater into clean water utilities that were not being recovered for commercial use. Today, many utilities have installed phosphorus and nitrogen recovery facilities that generate valuable products recovered from the waste water that are sold to and reused by agriculture and generate significant revenue for the clean water utilities. The phosphorus recovery technology is gaining wide acceptance and has proven to be cost-effective for utilities that have both anaerobic digestion and stringent effluent phosphorus limits.

Research efforts are underway to commercialize processes that will recover valuable metals, inorganic chemicals, and other materials from waste water. As technology improves and these trace materials become more valuable, clean water utilities will be presented with opportunities to reclaim these materials and sell them to businesses that will incorporate them into new products. These revenues can again be used to benefit the utility's rate payers.

In addition to recovery and reuse of materials from the influent, clean water utilities are employing solutions focused on improvements in the watershed versus solely on point source effluent controls. Through over four decades of continual improvements in water reclamation facilities, clean water utilities have moved far out on the cost removal effectiveness curve. Incremental improvements at water reclamation facilities to remove small additional amounts of pollutants are very expensive. Opportunities through water quality trading and adaptive management are promised to provide enhanced environmental benefits in the watershed at a lower cost than building the infrastructure at the treatment facilities.

Clean water utilities are looking to partner with others in the community to solve community-wide watershed problems involving nitrogen, phosphorus, and sediment, and achieve the greatest environmental benefit at the lowest cost. Across all watersheds impaired by nitrogen and phosphorus, agricultural sources cause three to four times more impairment than municipal sources, underscoring the need to focus the efforts in the agricultural sector where the greatest return on the investment can be seen.

NEW Water is faced with spending over $200 million to install infrastructure at its two treatment facilities to meet permit driven effluent limits that will remove less than two percent of the phosphorus and sediment being delivered by the entire watershed to the bay of Green Bay. Under Wisconsin's Adaptive Management option, NEW Water is conducting a pilot test program over the next several years working in conjunction with agricultural producers in the watershed to install and implement Best Management Practices (BMPs) for those producers to meet water quality objectives at the lowest overall cost.

The option to partner with nonpoint sources of pollutants in the watershed is available to some clean water utilities as a way to achieve desired environmental benefits at the lowest cost to rate payers. Clean water utilities are entering into relatively uncharted waters as they begin working with urban and rural nonpoint entities, some of which may not be customers of the utility, to ensure that the removals are achieved. In exchange for avoiding construction of expensive gray infrastructure at treatment facilities, clean water utilities support and fund installation of BMPs in rural installations in the watershed.

Adaptive management requires demonstration of eventual compliance with ambient water quality criteria in the receiving water. Adaptive management activities often achieve complementary improvements in the watershed, like reduction in sediment loadings and improvements in habitat in addition to the reduction of the specific parameter of concern. Agricultural BMPs can also reduce operating costs for producers since they keep more fertilizer and soil on the land requiring less fertilizer to be purchased and applied. Clean water utilities are now working collaboratively with the myriad of the water quality interest groups in the watershed to achieve these benefits at the lowest cost to rate payers.

How do clean water utilities today deliver value to their customers and communities? The value is provided far in excess of customer savings from operational efficiency, energy recovery, materials reuse, and the like. Economic value is delivered in the form of improved water quality that makes waterfront land more valuable, draws people to water in urban communities, creates jobs, increases demand for locally produced food and products, and improves entertainment and recreation.

From an economic perspective, the return on investment in clean water is impressive: employment opportunities in family supporting jobs, enhanced productivity in the private economy, higher standards of living, and a more favorable trade balance. These benefits are being provided by clean water utilities while providing its rate payers high-quality services at a fair price.

The U.S. Department of Commerce's Bureau of Economic Analysis states that for every job serving the clean water industry, 3.68 jobs are created to support it. For every $1 billion invested in wastewater infrastructure, $2.6 to 3.5 billion of demand is created for labor, goods, and services, much of it locally sourced.

Through enlightened leadership, clean water utilities are transforming how they do business to become much more efficient, extract as much value as they can from the materials they receive, and be as creative as possible while still providing the highest level of public health protection. This level of sophistication couldn't have been contemplated as little as 10 years ago. The old paradigm of disposing of waste at as low cost as possible is being transformed by innovative utility managers and technology providers into a paradigm where organizations are using principles once thought to be reserved only for private business. This value paradigm that embraces new technology signals the private sector to make investment in new technology that will further advance this vision.

WATER RESOURCES UTILITY OF THE FUTURE

A CALL FOR FEDERAL ACTION

WHAT IS THE WATER RESOURCES UTILITY OF THE FUTURE?

Forty years after the passage of the Clean Water Act, public agency leaders are transforming the way they deliver clean water services. At the heart of this transformation is the emergence of new technologies and innovations that can stretch ratepayer dollars, improve the environment, create jobs and stimulate the economy. The most progressive of today's clean water agencies are defining what is meant by the Water Resources Utility of the Future (UOTF).

For decades terms like "sewage treatment" or "sewerage agencies" were used to describe our nation's wastewater treatment agencies, but these terms are changing. These utilities are now being called "clean water agencies," "enterprises," or "resource recovery agencies". What does this mean? Instead of solely collecting and transporting wastewater to central treatment plants, these utilities are recovering valuable resources, partnering in local economic development, and aligning themselves as members of the watershed community in order to deliver maximum environmental benefits at the least cost.

Today's clean water utilities do this by reclaiming and reusing water, extracting and finding commercial uses for nutrients and other constituents in the waste stream, capturing waste heat and latent energy in biosolids and liquid streams, generating renewable energy using their land and other horizontal assets, and using green infrastructure to manage stormwater - all of which results in a profound improvement to the quality of life.

These actions signal that the market for innovation in the clean water sector is strong. Resistance to change, however, is also significant, and is reinforced by several key trends: regulatory pressures; strained utility/local, state and federal budgets; customer confusion about the benefits of innovation; skyrocketing demands for capital competing for every dollar; risk and regret associated with technology failure, and venture capital looking elsewhere for faster and safer returns.

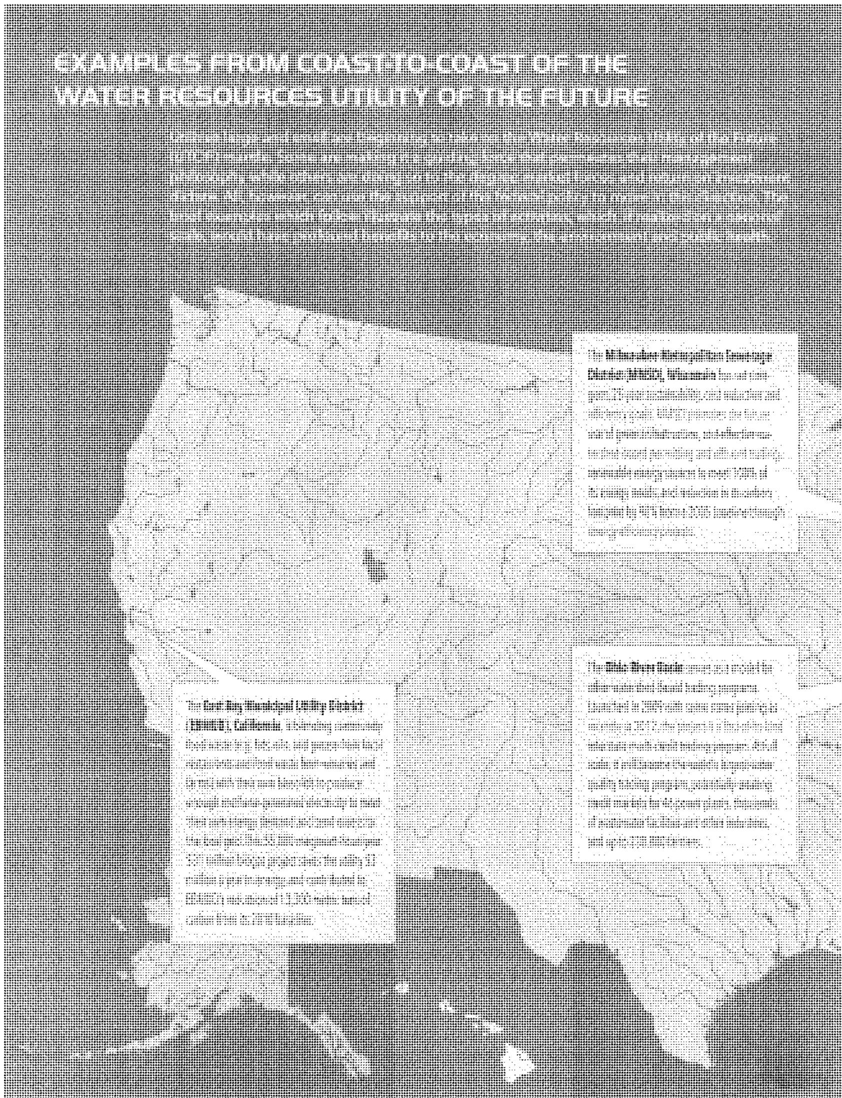
Nothing short of a national strategy to reform the U.S. water sector is likely to drive the kind of change that will be needed to fully address future challenges and embrace new opportunities. This Call for Federal Action defines tangible steps that we can take as a nation to realize a shared vision for the future. It presents ten priority actions that Congress and the federal government can take to help the Water Resources Utility of the Future become a reality. We call on Congress, the U.S. Environmental Protection Agency, the U.S. Department of the Interior, the U.S. Department of Agriculture, the U.S. Department of Energy, and other key federal agencies to rethink their relationship to the water sector, take these ten key actions, and make the UOTF possible for all utilities.

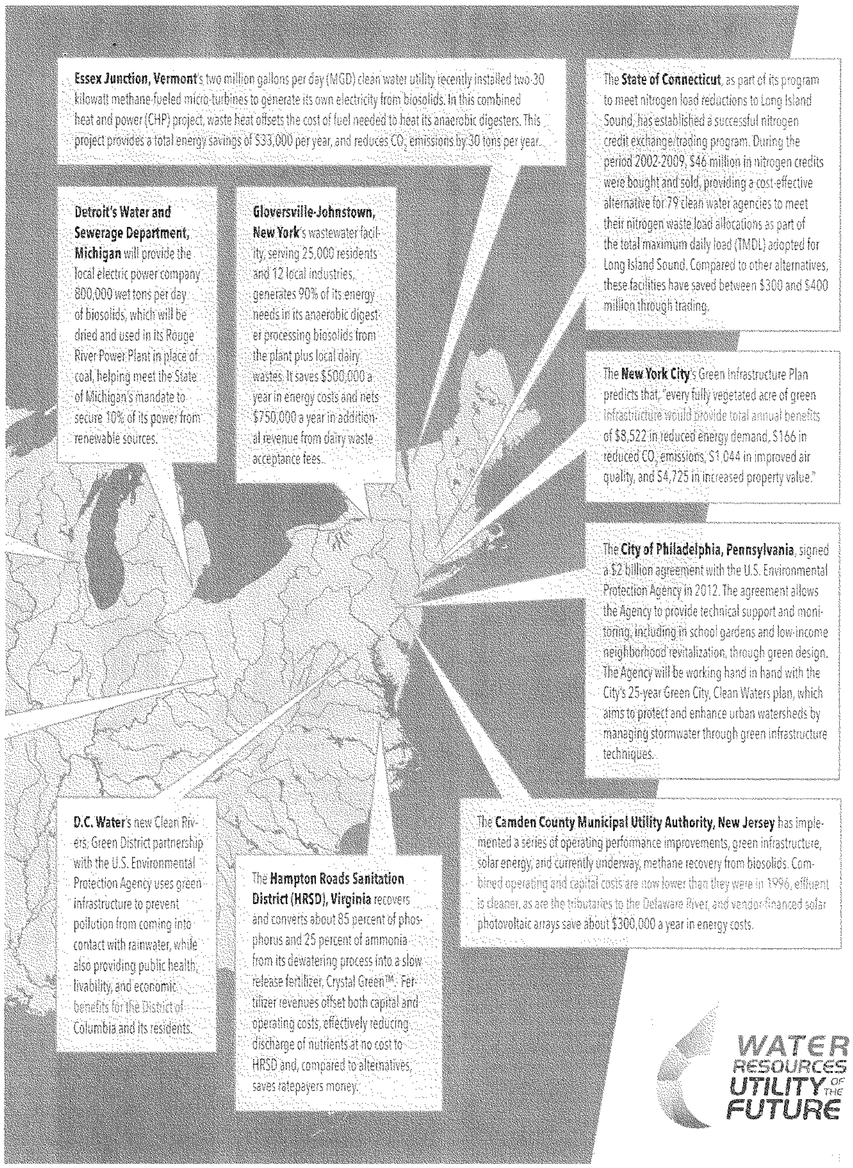
This publication draws from the *Water Resources Utility of the Future... A Blueprint for Action*, developed by the National Association of Clean Water Agencies (NACWA), the Water Environment Research Foundation (WERF), and the Water Environment Federation (WEF).

MOTIVATION	ACTIVITY	INNOVATION
Reduce Cost	Energy Efficiency	Energy Efficient Equipment & Networks
	Energy Recovery	Methane & Hydrogen Recovery, Heat Recovery
	Operating Efficiency	Automation and Smart Operations, Asset Management, Sourcing
Diversify Revenue	Water Reuse	Industrial Cooling, Recharge, Landscape, Golf Course Irrigation
	Materials Recovery	Phosphorous Compounds, Nitrogen Compounds, Metals
	Materials Conversion	Bioplastics, Pyrolysis Fuel Oil, Algal Biomass, Solid Fuels, Fertilizers
	Biosolids Reuse	Liquid Fertilizer
	Energy Generation	Photovoltaics, Wind Turbines
Support Community & Economy	Growth Planning	Sector Expansion, Targeted Upgrades, Managed Package Plants
	Community Partnering	Nonpoint Source Controls, Biowaste Conversion to Methane, Green Infrastructure

TEN PRIORITY ACTIONS FOR CONGRESS AND THE FEDERAL GOVERNMENT

WATER RESOURCES UTILITY OF THE FUTURE


EXAMPLES FROM COAST-TO-COAST OF THE
WATER RESOURCES UTILITY OF THE FUTURE



Essex Junction, Vermont's two million gallons per day (MGD) clean water utility recently installed two-30 kilowatt methane-fueled micro-turbines to generate its own electricity from biosolids. In this combined heat and power (CHP) project, waste heat offsets the cost of fuel needed to heat its anaerobic digesters. This project provides a total energy savings of $33,000 per year, and reduces CO_2 emissions by 30 tons per year.
Detroit's Water and Sewerage Department, Michigan will provide the local electric power company 800,000 wet tons per day of biosolids, which will be dried and used in its Rouge River Power Plant in place of coal, helping meet the State of Michigan's mandate to secure 10% of its power from renewable sources.
Gloversville-Johnstown, New York's wastewater facility, serving 25,000 residents and 12 local industries, generates 90% of its energy needs in its anaerobic digester processing biosolids from the plant plus local dairy wastes. It saves $500,000 a year in energy costs and nets $750,000 a year in additional revenue from dairy waste acceptance fees.
The State of Connecticut, as part of its program to meet nitrogen load reductions to Long Island Sound, has established a successful nitrogen credit exchange/trading program. During the period 2002-2009, $46 million in nitrogen credits were bought and sold, providing a cost-effective alternative for 79 clean water agencies to meet their nitrogen waste load allocations as part of the total maximum daily load (TMDL) adopted for Long Island Sound. Compared to other alternatives, these facilities have saved between $300 and $400 million through trading.
The New York City's Green Infrastructure Plan predicts that, "every fully vegetated acre of green infrastructure would provide total annual benefits of $8,522 in reduced energy demand, $166 in reduced CO_2 emissions, $1,044 in improved air quality, and $4,725 in increased property value."
The City of Philadelphia, Pennsylvania, signed a $2 billion agreement with the U.S. Environmental Protection Agency in 2012. The agreement allows the Agency to provide technical support and monitoring, including in school gardens and low-income neighborhood revitalization, through green design. The Agency will be working hand in hand with the City's 25-year Green City, Clean Waters plan, which aims to protect and enhance urban watersheds by managing stormwater through green infrastructure techniques.
D.C. Water's new Clean Rivers, Green District partnership with the U.S. Environmental Protection Agency uses green infrastructure to prevent pollution from coming into contact with rainwater, while also providing public health, livability, and economic benefits for the District of Columbia and its residents.
The Hampton Roads Sanitation District (HRSD), Virginia recovers and converts about 85 percent of phosphorus and 25 percent of ammonia from its dewatering process into a slow release fertilizer, Crystal Green™. Fertilizer revenues offset both capital and operating costs, effectively reducing discharge of nutrients at no cost to HRSD and, compared to alternatives, saves ratepayers money.
The Camden County Municipal Utility Authority, New Jersey has implemented a series of operating performance improvements, green infrastructure, solar energy, and currently underway, methane recovery from biosolids. Combined operating and capital costs are now lower than they were in 1996, effluent is cleaner, as are the tributaries to the Delaware River, and vendor-financed solar photovoltaic arrays save about $300,000 a year in energy costs.
WATER RESOURCES UTILITY OF THE FUTURE

The *Water Resources Utility of the Future... A Call for Federal Action* is based on *The Water Resources Utility of the Future.... A Blueprint for Action*. The *Blueprint* was a cooperative effort between NACWA, the Water Environment Research Foundation (WERF), and the Water Environment Federation (WEF), and defines the evolving environmental, economic, and social roles that clean water utilities are playing in their communities. You can download a copy of *The Water Resources Utility of the Future... A Blueprint for Action* at *www.nacwa.org/blueprint*.

The National Association of Clean Water Agencies (NACWA) is the leading advocate for responsible national policies that advance clean water. NACWA represents the collective interests of America's clean water utilities – dedicated public servants and true environmental champions. For over 40 years, NACWA has been the clean water community's voice in Congress, at the U.S. Environmental Protection Agency, in the media and in the courts.

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December 3, 2014

To the Honorable Senators of the Agriculture, Nutrition and Forestry Committee,

We thank Chairwoman Debbie Stabenow and the Committee for recognizing the importance of voluntary conservation programs and for highlighting such an important topic at today's hearing, *"Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters."* We also applaud the Committee, under the leadership of Chairwoman Stabenow, for delivering the Agriculture Act of 2014, legislation which provides our industry with certainty, risk management, and conservation programs.

Michigan farmers have a long history of caring for the fresh water around them. They understand the importance of farming in the heart of the Great Lakes, which hold 20% of the world's fresh surface water. Conservation practices to help keep soil, nutrients, and pest control measures on farm fields are vital to that concern. Working proactively with partners such as agriculture and environmental agencies, farming and agribusiness suppliers, Conservation Districts, and Michigan Farm Bureau, farmers can implement the practices that will continue to improve both agricultural production and protection of Michigan's fresh water resources.

One of the primary ways farmers in Michigan voluntarily maximize their conservation efforts is through the Michigan Agriculture Environmental Assurance Program, or MAEAP. Started in 2002 by farmers who wanted to improve their farm management for protecting watersheds, the program developed a holistic approach to environmental protection that helps farmers evaluate their entire farm and make sustainable management decisions balancing the environment and economics. The Michigan Department of Agriculture and Rural Development (MDARD) established third-party verification of those farm practices. As the program developed, it attracted over 50 partners including universities, the Environmental Protection Agency, farm and commodity organizations, the Natural Resources Conservation Service (NRCS), and others. Then in 2011 the program was signed into law by Governor Rick Snyder, which provided farmers with additional incentives for following environmental standards. This allowed the practices to not only receive additional support, but also to give farmers and the public the peace of mind that their practices follow approved science.

Now over 2,500 verifications on Michigan farms provide producers with the tools necessary to actively protect Michigan waters, using practices such as filter and buffer strips, conservation wetlands, restricting livestock access to streams, nutrient management plans, conservation tillage, drain management, responsible manure and fertilizer storage and use, and many others. Because of voluntary action through the MAEAP program, MDARD reports that Michigan farmers have:

- Implemented responsible manure application and other conservation practices on almost 700,000 acres of Michigan farmland.
- Kept over 1 million tons of farming soil where it belongs: in farm fields. EACH YEAR, that's almost 32,000 10-yard dump trucks of soil not reaching streams and lakes.

- Reduced phosphorus delivery to lakes and streams through sedimentation by 1.7 million pounds in the last 3 years. That's almost 600,000 pounds PER YEAR through MAEAP, enough to grow almost 150,000 TONS of algae in lakes and streams.
- Implemented approved pesticide management on over 600,000 acres in the last 3 years.
- Installed over 14,000 acres of filter strips, stabilized 2,800 gullies in the last 3 years.
- Reduced enough phosphorus and nitrogen in the last three years to grow algae over 83% of Houghton Lake.

These statistics represent just the farmers who have completed the rigorous verification process. Each year over 1,500 farmers are working with MAEAP technicians on risk assessments for their farms, and over 6,000 are attending education sessions to begin the process of MAEAP and learn about environmental stewardship. In addition, NRCS technical and financial assistance helps farmers voluntarily implement conservation practices on hundreds of thousands of acres of farmland. Clean Water Act and Great Lakes Restoration Initiative programs also help farmers implement hundreds of conservation practices each year, all voluntarily, and all using funds and time from the farmers' own pockets in addition to the money and time spent by the programs' sponsoring agencies.

Research shows that environmental problems, such as the recent bloom of algae and cyanobacteria in western Lake Erie that shut down Toledo's water system, have increasingly complex causes. Agriculture is a popular scapegoat in popular media, but these blooms are occurring despite a decreasing use of phosphorus fertilizer over the last 30 years in the watershed, according to the Ohio Lake Erie Phosphorus Task Force. Invasive species such as mussels have changed water quality and clarity. Increasing populations place increasing demands on water systems. Total phosphorus in the Lake has remained the same but the ratio of dissolved reactive phosphorus is increasing. Simple solutions cannot solve these concerns. This is the advantage of MAEAP when it comes to agriculture's part of the solution: it is a living system, annually updated with new science and findings about what works in environmental stewardship. Best of all, because it was started by farmers and supported by so many partners, it has the ability to really help farmers adapt to increasing complexity and the need for new practices to solve new problems.

Michigan Farm Bureau, representing over 46,500 farming families across Michigan, is proud to support the MAEAP program. Our members believe in proactive, responsible action to protect water quality, and will continue to help farmers of all sizes and types become MAEAP verified. We understand that when conservation is done for the right reasons—because farmers see its value to protect fresh water and farms—the practices will be continued and farmers will continue to be leaders in environmental stewardship across our state.

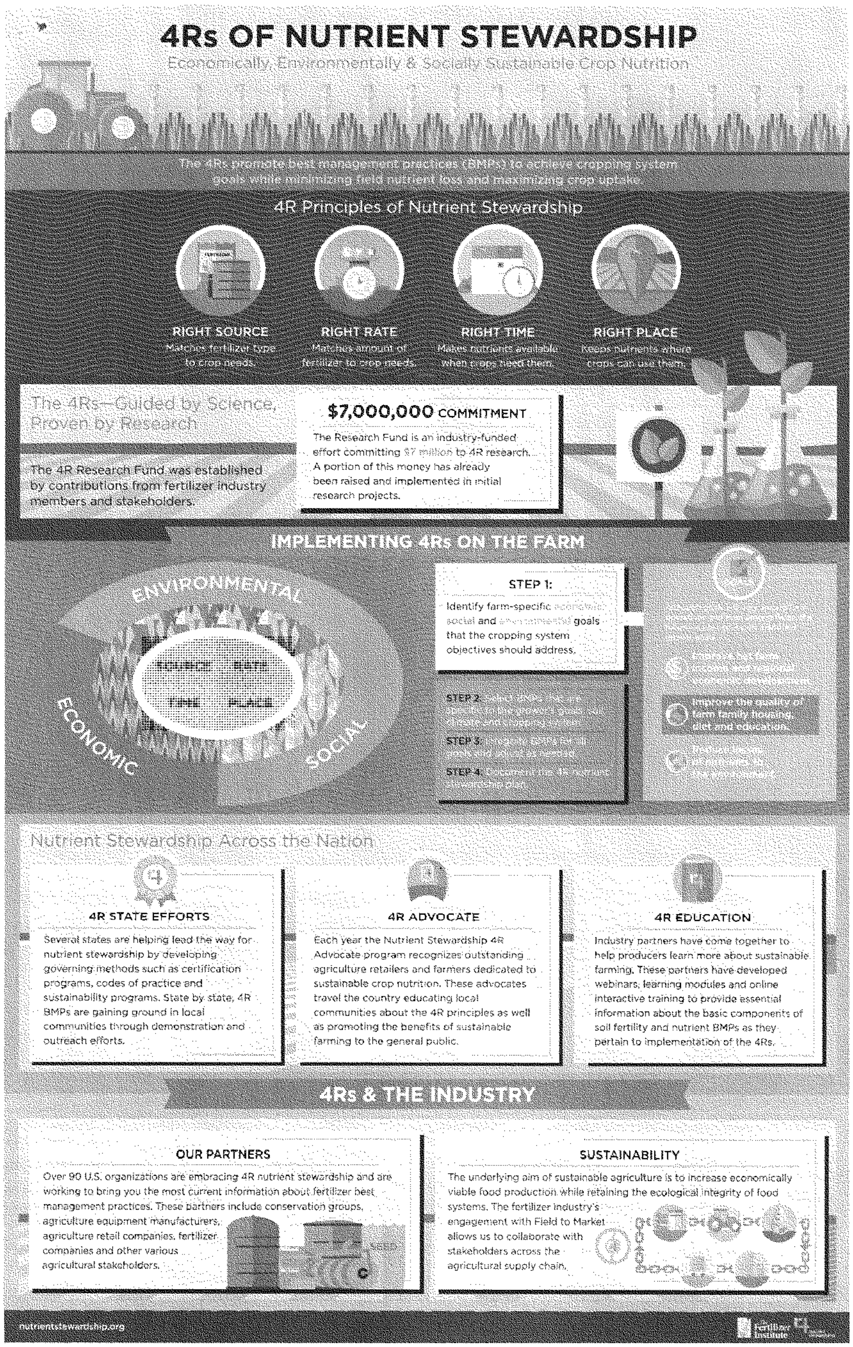
Thank you for your time and attention.

Sincerely,

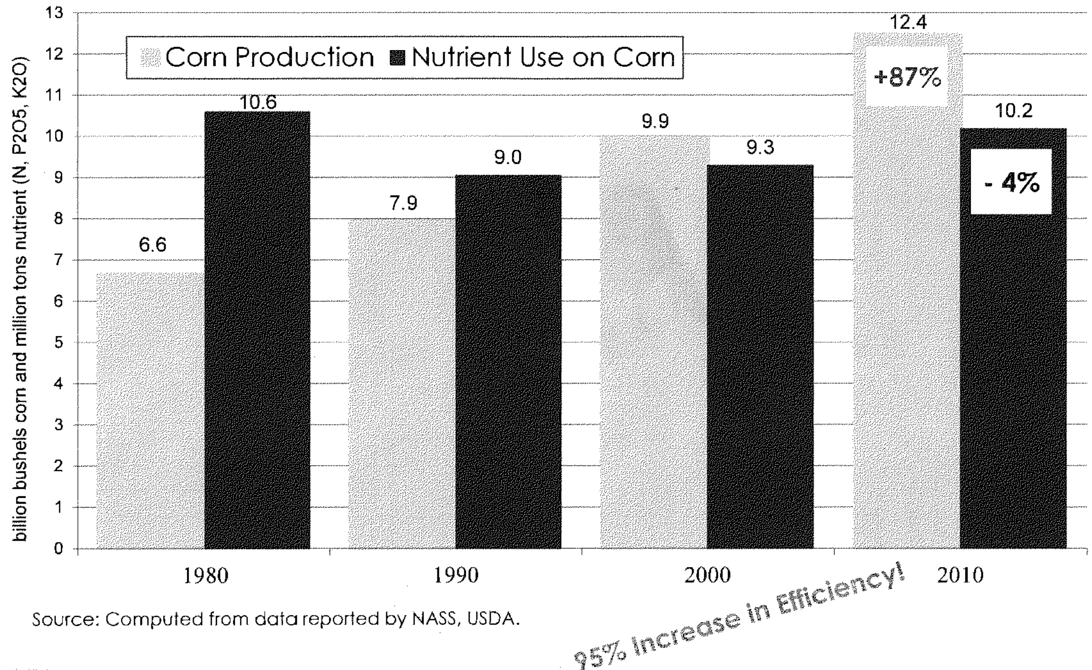
Wayne H. Wood

Wayne Wood, President
Michigan Farm Bureau

4R FARMERS & THE LAKE
4R PRINCIPLES OF NUTRIENT STEWARDSHIP
food security
50% of food production is the result of fertilizer use
RIGHT SOURCE
Account for all sources of nutrients in recommendations
RIGHT RATE
Conduct soil tests regularly in uniform areas less than 25 acres
Document crop yield goals based on crop history
Base nutrient application on Tri-state recommendations, or adaptive management using soil test and yield goals
Calibrate nutrient application equipment annually
RIGHT PLACE
Variable rate application
Phosphorus injection, subsurface banding, or broadcasting with immediate incorporation
Don't broadcast apply nutrients without incorporation unless the risk of phosphorus loss is demonstrated to be low
Apply nutrients using minimum setbacks from identified areas
RIGHT TIME
Don't apply phosphorus on frozen or snow covered ground
Don't apply phosphorus or nitrogen if a large rainfall is in the weather forecast
WESTERN LAKE ERIE BASIN 4R CERTIFICATION PROGRAM
TRAINING & EDUCATION REQUIREMENTS
MONITORING 4R IMPLEMENTATION
Maximize crop nutrient uptake and minimize losses
Positively impact local water bodies
Provide up-to-date information on nutrient stewardship
Help the agricultural sector adapt to new research and technology
Retail and service provider staff undergo training and demonstrate knowledge of the 4Rs
Professionals maintain current certification in good standing
4R update training completed every two years
Provide 4R educational opportunities for growers
3rd party audit of retailer and service provider 4R actions occur every three years
Audits review training and education, recommendations to growers, and application records
For more information visit 4rcertified.org
4R ADVOCATES
THE 4R ADVOCATE PROGRAM
BRAND DAIRY FARM


4Rs OF NUTRIENT STEWARDSHIP
Economically, Environmentally & Socially Sustainable Crop Nutrition
The 4Rs promote best management practices (BMPs) to achieve cropping system goals while minimizing field nutrient loss and maximizing crop uptake.
4R Principles of Nutrient Stewardship
RIGHT SOURCE
Matches fertilizer type to crop needs.
RIGHT RATE
Matches amount of fertilizer to crop needs.
RIGHT TIME
Makes nutrients available when crops need them.
RIGHT PLACE
Keeps nutrients where crops can use them.
The 4Rs—Guided by Science, Proven by Research
The 4R Research Fund was established by contributions from fertilizer industry members and stakeholders.
$7,000,000 COMMITMENT
The Research Fund is an industry-funded effort committing $7 million to 4R research. A portion of this money has already been raised and implemented in initial research projects.
IMPLEMENTING 4Rs ON THE FARM
ENVIRONMENTAL
ECONOMIC
SOCIAL
SOURCE
RATE
TIME
PLACE
STEP 1:
Identify farm-specific economic, social and environmental goals that the cropping system objectives should address.
STEP 2: Select BMPs that are specific to the grower's goals, soil, climate and cropping system.
STEP 3: Integrate BMPs for all goals and adjust as needed.
STEP 4: Document the 4R nutrient stewardship plan.
Improve net farm income and regional economic development.
Improve the quality of farm family housing, diet and education.
Nutrient Stewardship Across the Nation
4R STATE EFFORTS
Several states are helping lead the way for nutrient stewardship by developing governing methods such as certification programs, codes of practice and sustainability programs. State by state, 4R BMPs are gaining ground in local communities through demonstration and outreach efforts.
4R ADVOCATE
Each year the Nutrient Stewardship 4R Advocate program recognizes outstanding agriculture retailers and farmers dedicated to sustainable crop nutrition. These advocates travel the country educating local communities about the 4R principles as well as promoting the benefits of sustainable farming to the general public.
4R EDUCATION
Industry partners have come together to help producers learn more about sustainable farming. These partners have developed webinars, learning modules and online interactive training to provide essential information about the basic components of soil fertility and nutrient BMPs as they pertain to implementation of the 4Rs.
4Rs & THE INDUSTRY
OUR PARTNERS
Over 90 U.S. organizations are embracing 4R nutrient stewardship and are working to bring you the most current information about fertilizer best management practices. These partners include conservation groups, agriculture equipment manufacturers, agriculture retail companies, fertilizer companies and other various agricultural stakeholders.
SEED
SUSTAINABILITY
The underlying aim of sustainable agriculture is to increase economically viable food production while retaining the ecological integrity of food systems. The fertilizer industry's engagement with Field to Market allows us to collaborate with stakeholders across the agricultural supply chain.
nutrientstewardship.org
The Fertilizer Institute

U.S. Corn Production and Nutrient Use on Corn



Source: Computed from data reported by NASS, USDA.

The Fertilizer Institute

The
Fertilizer Institute
Nourish, Replenish, Grow

Chris Jahn
President

December 3, 2014

The Honorable Debbie Stabenow
Chairwoman
Committee on Agriculture, Nutrition and Forestry
SR-328A Russell Senate Office Building
Washington, DC 20510

The Honorable Thad Cochran
Ranking Member
Committee on Agriculture, Nutrition and Forestry
SR-328A Russell Senate Office Building
Washington, DC 20510

RE: December 3, 2014 hearing entitled: "Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters"

Dear Chairwoman Stabenow and Ranking Member Cochran:

On behalf of the members of The Fertilizer Institute (TFI), thank you for the opportunity to provide comments on the December 3, 2014 hearing entitled "Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters." Our comments below will focus on the fertilizer industry's continued commitment to environmental stewardship by providing an overview of the many actions we are undertaking to improve the adoption of fertilizer best management practices to improve the sustainability, efficiency and productivity of agricultural systems, which can subsequently reduce nutrient runoff and positively impact water quality.

The Fertilizer Institute is the leading voice of the fertilizer industry, representing the public policy, communication and statistical needs of producers, manufacturers, retailers and transporters of fertilizer. The Institute's members play a key role in producing and distributing vital crop nutrients, such as nitrogen, phosphorus and potassium, which are used to replenish soils throughout the United States that in turn produce healthy and abundant supplies of food, fiber and fuel.

The World's population is predicted to reach 9.4 billion people by 2050. Industry experts agree that increased food production will only be achieved by intensified crop production and not by an expanded arable land base. As a result, commercial fertilizers have a critical role to play in boosting crop production to the levels necessary to meet the demands of this rapidly growing world population. Crop nutrients such as nitrogen, phosphorus, potassium, and secondary and micronutrients such as sulfur, calcium, zinc and iron are responsible for between 40 and 60 percent of today's total food production and will be a necessary component in producing

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nutritious food in the most environmentally sensitive manner possible.

4R Nutrient Stewardship

Meeting global food demand is not enough and the fertilizer industry today is also committed to promoting science-based, sustainable fertilizer best management practices that boost crop production while minimizing impacts to the environment. At the heart of that commitment is what is known as 4R nutrient stewardship, a framework to achieve cropping system goals, such as increased production, increased farmer profitability, enhanced environmental protection and improved sustainability.

The 4R nutrient stewardship principles are the same globally, but how they are used locally varies depending on field and site specific characteristics such as soil, cropping system, management techniques and climate. The scientific principles of the 4R framework include:

Right Source – Ensure a balanced supply of essential nutrients, considering both naturally available sources and the characteristics of specific products, in plant available forms.

Right Rate – Assess and make decisions based on soil nutrient supply and plant demand.

Right Time – Assess and make decisions based on the dynamics of crop uptake, soil supply, nutrient loss risks, and field operation logistics.

Right Place – Address root-soil dynamics and nutrient movement, and manage spatial variability within the field to meet site-specific crop needs and limit potential losses from the field.

It is important to stress that all four "Rs" must be used together because there is no single practice or "silver bullet" that will prevent nutrients from being lost to the environment.

In 2011, the United States Department of Agriculture (USDA) revised its standard for managing farm nutrients with a goal of encouraging farmers to employ new technologies to reduce nutrient runoff and improve water quality. The 4Rs are a component of this Natural Resources Conservation Service (NRCS) Conservation Practice Standard Code 590. For more information on 4R nutrient stewardship, I invite you to visit http://www.nutrientstewardship.com.

4R Research Fund: Demonstrating the Impacts of 4R Nutrient Stewardship

In addition to the 4R Nutrient Stewardship Program, the fertilizer industry has established the 4R Research Fund with the goal of developing sustainability indicators and environmental impact data for implementation of 4R nutrient stewardship across North America. It provides needed resource support with a focus on measuring and documenting the economic, social and environmental impacts of 4R Nutrient Stewardship. The fertilizer industry has already committed $7 million towards the research fund.

Having just completed its first year in existence, to date the fund has granted nearly $2.4 million in support of science-based research aimed at addressing cropping system productivity and concerns regarding nutrient losses into the environment. USDA's Agricultural Research Service (ARS), for example, has been awarded funds for a project in partnership with Heidelberg University, Ohio State University, The Nature Conservancy and the International Plant Nutrition

Institute (IPNI) to evaluate the impacts of adopting practices associated with 4R Nutrient Stewardship, as well as the impact of the Western Lake Erie Basin (WLEB) 4R Certification program on crop productivity and profitability, water quality, and perceptions of growers, nutrient service providers and residents. For additional information on the 4R Research fund and the list of current projects, I invite you to visit http://www.nutrientstewardship.com/funding.

4R Nutrient Stewardship Certification Program

This year, the agriculture community in Ohio, specifically in the Western Lake Erie Basin launched the 4R Nutrient Stewardship Certification Program for fertilizer retailers. The program is a stakeholder driven initiative aimed at the long-term improvement of Lake Erie's water quality. This new program provides a consistent, recognized standard for agricultural retailers in Indiana, Michigan and Ohio where surrounding waters drain into Lake Erie.

The 4R Nutrient Stewardship Certification Program ensures that participating agricultural retailers, service providers and other certified professionals utilize proven best management practices based on the 4Rs when providing agronomic advice or services to farmers. This approach provides a science-based framework for plant nutrition management and sustained crop production, while considering specific individual farms' needs. We are pleased to inform you that 49 agricultural retailers have already signed up for the program. Requirements and additional details about the program are available at www.4Rcertified.org.

Increased Fertilizer Use Efficiency

Data released by the U.S. Department of Agriculture in May 2011, shows that between 1980 and 2010, U.S. farmers increased corn production 87.5 percent while using 4 percent fewer fertilizer nutrients (see attached). Although the factors that contribute to increasing food prices and food scarcity are complex, one thing is certain – the use of fertilizer is a necessary component in the solution to further increase efficient and environmentally sensitive production of food for the world.

TFI would like to thank the Committee for the opportunity to submit these comments for the hearing record. We look forward to continuing to work with you on this and other important agriculture issues. If you or your staff would like to discuss this letter or the enclosed materials, please contact TFI Vice President of Legislative Affairs, Clark Mica via email at cmica@tfi.org or telephone at (202) 515-2725.

Sincerely,

Chris Jahn
President

Enclosures

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Educational Background

Ph.D. Biosystems Engineering, 1996. Oklahoma State University, Stillwater, Oklahoma. United States Department of Agriculture Water Science National Needs Fellow. Dissertation Title: "A Lotic Ecosystem Trophic Status Index using the Periphytic Community as a Bio-Indicator."

M.S. Plant Physiology (Department of Botany), 1989. Oklahoma State University, Stillwater, Oklahoma. Thesis Title: "Identification of the Mechanism of Aluminum Toxicity in Wheat Roots."

B.S. Soil Chemistry (Department of Agronomy), 1984. Oklahoma State University, Stillwater, Oklahoma.

Professional Experience

Executive Director, Office for Sustainability (July 2012 – Present) University of Arkansas, Fayetteville, Arkansas.

Professor of Ecological Engineering, Biological and Agricultural Engineering Department (July 2009 – Present) University of Arkansas, Fayetteville, Arkansas.

Area Director, Center for Agricultural and Rural Sustainability, UA Division of Agriculture (November 2007 – August 2013) University of Arkansas, Fayetteville, Arkansas.

Associate Professor of Ecological Engineering, Biological and Agricultural Engineering Department (August 2003 – June 2009) University of Arkansas, Fayetteville, Arkansas.

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Professional Certifications

- **Professional Engineer**, License Number 88864, Texas Board of Professional Engineers, Austin, TX, 2001 – Present.
- **Certified Ecological Designer,** American Ecological Engineering Society, 2011-2016
- **Board Certified Environmental Engineer**, American Academy of Environmental Engineers, 2011-Present
- **Certified Senior Ecologist**, Ecological Society of America, 2007-2012

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Books

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Patents

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Technical Publications

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Brown, A., C. Powell, **M. Matlock**, 2012. A US Food Processing Facility Water Risk Framework. Prepared for The Sustainability Consortium. Center for Agricultural and Rural Sustainability, UA Division of Agriculture, Fayetteville, AR.

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Johnson, R. and **M. Matlock**, 2011. Geospatial Climate Data. The Sustainability Consortium Sustainability Series, February 2011. TSC, Fayetteville AR and Tempe, AZ

Brown, A. and **M. Matlock**, 2011. A Review of Water Scarcity Indices and Methodologies. The Sustainability Consortium Sustainability Series, April, 2011. TSC, Fayetteville AR and Tempe, AZ

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Thoma, Greg, Jennie Popp, David Shonnard, Darin Nutter, Richard Ulrich, **Marty D. Matlock**, Dae Soo Kim, et al. 2010. Greenhouse Gas Emissions from Production of Fluid Milk in the US. University of Arkansas & Michigan Technological University.

M. Matlock, E. Cummings. 2010. A National Assessment of Impacts of Agriculture on Water Quality and Aquatic Ecosystem Health. CARS Report 10-10A. Keystone Alliance for Sustainable Agriculture, Washington, DC.

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M. Matlock, A. Brown, B. Haggard and E. Cummings. 2009. An Ecological Assessment of Osage and Spring Creeks, Northwest Arkansas, 2007-2009. CARS Report 09-12A.

M. Matlock, E. Cummings, K. Kruger, and S. Foster. 2008. An Ecological and Geomorphic Assessment of Urban Streams in Fayetteville, Arkansas, 2004-2007. CARS Report 08-06A.

E. Cummings, **Matlock, M.**, S. Manning, M. Vargas. 2007. Water Quality and Biological Assessment of Selected Segments in Mossy Lake/Coffee Creek, Southeast Arkansas. USEPA Region VI Technical Report. Dallas, TX.

Technical Notes Volume 2, Issue 1 (2005). **Matlock, M., Editor.** Semi-annual peer-reviewed newsletter of the American Ecological Engineering Society.

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Chaubey, I. **M. Matlock**, and B. Haggard. 2003. Managing aquatic ecosystem processes at the watershed level: an ecological engineering approach. *Resource* (5)15-18.

Program and Report Reviews

FAO, 2012. Sustainability Assessment of Food and Agricultural Systems (SAFA). Natural Resources Management and Environment Department, Food and Agriculture Organization

of the United Nations, Rome, Italy, January, 2012.
World Economic Forum, 2012. Putting the New Vision for Agriculture into Action: A Transformation is Happening. 2011. Nayyar, S. and L. Dreier, Editors. World Economic Forum. The New Vision for Agriculture Initiative. Geneva, Switzerland.
Environmental Engineering Body of Knowledge Task Force, 2009. The Environmental Engineering Body of Knowledge. AAEE, Anapolis, MD. http://www.cece.ucf.edu/bok/pdf/EnvE_Body_of_Knowledge_Final.pdf

Membership in Professional Societies

AAEES – American Academy of Environmental Engineers and Scientists – Board Certified Environmental Engineer, 2011-Present

AEES– America Ecological Engineering Society – Past-President 2008-2009; President, 2007-2008; Vice President, 2005-6. Founding Member, Newsletter Editor

ASABE – American Society of Agricultural and Biological Engineers

ASCE - The American Society of Civil Engineering – Environmental Engineering Committee

ASEE - The American Society of Engineering Education

ESA – Ecological Society of America

AWRA – American Water Resources Association

Honors and Awards

2014 61st Progressive Architecture Honorable Mention from *Architect* magazine. For *Fayetteville 2030: Food City Scenario*, a collaborative plan and policy platform. The Progressive Architecture (P/A) Awards committee selected 10 submissions from 150 applicants to honor for holistic approach to design with an eye toward practical realization.

2013 WAN Urban Design Award sponsored by World Architecture News. For *Fayetteville 2030: Food City Scenario* Food City is a collaborative plan and policy platform involving the Fay Jones School of Architecture, Department of Biological and Agricultural Engineering, Center for Agricultural and Rural Sustainability, School of Law and LL.M. Program in Agricultural and Food Law, Department of Food Science, and the City of Fayetteville. Preparation of Food City was sponsored in part by a grant from the Clinton Global Initiative and the American Institute of Architects under their Decade of Design initiative.

2011-2012 ACSA Collaborative Practice Award. *Low Impact Development: a design manual for urban areas* by the American Collegiate Schools of Architecture.

2011 American Society of Landscape Architects Award of Excellence in Communications: *Low Impact Development: a design manual for urban areas* was developed by UACDC and the UA Ecological Engineering Group under a grant from the U.S. EPA and the Arkansas Natural Resources Commission.

2011 American Institute of Architecture Honors Award in Regional and Urban Design: *Low Impact Development: a design manual for urban areas*, developed by UACDC and the UA Ecological Engineering Group under a grant from the U.S. EPA and the Arkansas Natural Resources Commission.

2011 EDRA Great Places Book Award: Finalist. Environmental Design Research Association (ERDA), for Low Impact Development: a design manual for urban areas

2010 American Institute of Architecture (AIA) Education Honors Award. Porchscapes: An Affordable LEED for Neighborhood Development.

2010 Residential Architect Design Merit Award (AIA). Porchscapes: An Affordable LEED for Neighborhood Development.

2009 American Architecture Awards sponsored by The Chicago Athenaeum: Museum of Architecture and Design. The award for "Porchscapes: A LEED Neighborhood Development" "honors and celebrates the most outstanding new achievements and innovation for new architecture designed and built in the United States by leading American and international firms practicing in the USA. The awards identify new cutting-edge design direction, urban philosophy, design approach, style, and intellectual substance in American Architecture today."

2009 AIA Honor Award for Regional and Urban Design from the American Institute of

Architects (AIA). Porchscapes: An Affordable LEED-Neighborhood Development (LEED-ND), a 50-unit green neighborhood development, is sponsored by the US Environmental Protection Agency and the Arkansas Natural Resources Commission. Students from the Department of Architecture and the Department of Biological and Agricultural Engineering have been participating in project planning and design with faculty and consultants since Spring 2007. UACDC received the award with its partners: The Ecological Engineering Group/Department of Biological and Agricultural Engineering, and McClelland Consulting Engineers, Inc.

2009 Progressive Architecture Award from *Architect* magazine. The Progressive Architecture Awards (P/A), along with the American Institute of Architects Honor Awards, are the most venerated. The P/A Awards recognize the "the most progressive work on the boards" in North America. One of the program's goals is to raise awareness for innovative un-built work in support of the project's realization.

2008 American Society of Landscape Architects Honor Award in Planning and Analysis. Porchscapes: An Affordable LEED-Neighborhood Development (LEED-ND), a 50-unit green neighborhood development, is sponsored by the US Environmental Protection Agency and the Arkansas Natural Resources Commission. Students from the Department of Architecture and the Department of Biological and Agricultural Engineering have been participating in project planning and design with faculty and consultants since Spring 2007.

2008 Institute Honor Awards for Regional and Urban Design from the American Institute of Architects (AIA). "Habitat Trails: from infill house to green neighborhood design", a collaboration among UACDC, the University of Arkansas Ecological Engineering Group, Department of Biological and Agricultural Engineering, Department of Landscape Architecture, Morrison Shipley Architects, and JKJ Architects in Rogers, AR

2008 Arkansas Institute of Architecture Citation Award. Porchscapes: An Affordable LEED-Neighborhood Development (LEED-ND), a 50-unit green neighborhood development, is sponsored by the US Environmental Protection Agency and the Arkansas Natural Resources Commission.

2008 Gunlogson National Design Competition in Biological Engineering – Third Place. Project Title: "Hydrologic and Ecological Engineering Design for a Green Residential Development." This was a Senior Design project by students Jeff Burns, David Gershner and Russell Tate. Tom Costello and Marty Matlock, associate professors in biological and agricultural engineering, served as the team mentors.

2008 Arkansas Planning Association 2008 Achievement in Urban Development Award. *Porchscapes: An Affordable LEED-Neighborhood Development (LEED-ND)*, a 43-unit green neighborhood development, is sponsored by the US Environmental Protection Agency and the Arkansas Natural Resources Commission.

2007 ACSA/AIA Housing Design Education Award for Excellence in a Housing Education Course. The award was for the Habitat for Humanity/Rogers housing course involving UACDC, Marty Matlock in the Dept of Biological and Agricultural Engineering, and Mark Boyer in the Dept of Landscape Architecture.

2007 Charter Design Award, Congress for New Urbanism, the leading organization promoting walkable, neighborhood-based development as an alternative to sprawl. The CNU Charter Awards were awarded internationally to twenty planning and architecture projects that manifest principles of exemplary urbanism as defined by the CNU.

2007 National Council of Architectural Registration Boards NCARB Prize, awarded annually to six initiatives in architecture programs based on their "creative integration of practice and education in the academy".

2007 Outstanding Mentor, University of Arkansas, Recognized as one of two outstanding mentor teams for mentoring undergraduate students.

2006 Design Honor Award, Arkansas Institute of Arkansas, for the UA Community Design Center's Habitat Trails Project a 5-acre green neighborhood development consisting of 17 dwelling units for Habitat for Humanity of Benton County, Inc. in Rogers.

2006 Places Award for Sustainable Development from the Environmental Design Research Association, for the UA Community Design Center's Habitat Trails Project. The

EDRA/*Places* Awards are unique among the programs that recognize professional and scholarly excellence in environmental design.

2006 Planning and Design Honor Award from the American Society of Landscape Architects (ASLA) for Habitat Trails, a green community designed for Habitat for Humanity.

2006 Education Honor Award of the American Institute of Architects, with the UA Community Design Center, for Habitat Trails Low Impact Development Design, 2006. http://www.aia.org/

2006 American Association for the Advancement of Science/NSF Competition for Science Visualization, Finalist, for the UA Community Design Center's Habitat Trails Project, a 5-acre green neighborhood development consisting of 17 dwelling units for Habitat for Humanity of Benton County, Inc. in Rogers, AR.

2006 Outstanding Mentor, University of Arkansas, Recognized as one of two outstanding mentor teams for mentoring undergraduate students.

2005 Acknowledgement Prize for Sustainable Development from the Holcim Foundation – an international competition with over 5000 entries in 2005, with the UA Community Design Center, for Warren, AR Stream Restoration. http://www.holcimfoundation.org/awards/nam/nam.html

2005 Honor Award of the American Institute of Architects (AIA). Ecological Engineering Group and UA Community Design Center, for Warren, AR Stream Restoration, 2005. http://www.aia.org/aiarchitect/thisweek05/tw0107/0107ha_urban.htm

2005 Citation Design Award of the Arkansas Chapter of the American Institute of Architects, with the UA Community Design Center, for Warren, AR Stream Restoration.- 2004.

2005 Award for Professional Excellence, American Agricultural Economics Association. M. Matlock (UA), M. Selman (WRI), and T. Nguyen and R. Woodward (TAMU). First Place Poster Award for Nutrient Net: A nutrient trading market model.

Outstanding Agricultural Engineer of the Year Award – Arkansas State Chapter ASAE – 2004.

Departmental Outstanding Teacher of the Year, Biological Engineering, 2003.

Senior Research Fellow, Institute for Science, Technology, and Public Policy – George H. Bush School of Government and Public Service 1998 – Present

Honorable Mention, Outstanding Publication of 2000 – ASAE Transactions, for Matlock M. D., D. E. Storm, M. D. Smolen, M. E. Matlock, A. McFarland and L. Hauck. 1999. Development and application of a lotic ecosystem trophic status index. *Transactions of ASAE*. 42(3): 651-656.

Invited Activities

Governor's Task Force for the Illinois River, 2013 - Present
Board of Directors, BlueInGreen, LLC, 2004-2014, Fayetteville AR (Owner/Founder)
Secretary of Agriculture's AC21 Committee for the Future of Agriculture in the US, 2011-Present
Executive Committee, The Keystone Alliance for Sustainable Agriculture, 2010-Present
Chair, Measures and Metrics Committee, UN Foundation Solutions From The Land Initiative, 2010-Present
Senior Science Advisor, Stewardship Index for Specialty Crops, 2009-Present.
Advisory Committee, Alliance for Water Stewardship, 2010-Present
National Science Foundation Biological Sciences REU Leadership Council, 2009 - Present
Water Resources Editor, 2007- Present. Encyclopedia of Earth, www.eoearth.org
Invited Author and Reviewer, ASCE-AEEAP Body of Knowledge, 2008.
Environmental Protection Commission, The Cherokee Nation, October 2005 - Present.
Delegate, Mid-East Peace Process, Foreign Agriculture Service, USDA 2008-2009
Invited Academic Program Reviewer, USDA, 2008.
Sustainability Advisor, Dairy Management, Inc., 2009 – Present
Science Advisor Committee, Mars Corporation, 2008 - Present
Sustainability Advisor, Kellogg Corporation, 2009 – Present
Sustainability Advisor, General Mills Corporation, 2009 – Present
Sustainability Advisor, Kashi Corporation, 2009 – Present
Sustainability Advisory Committee for Agriculture, Wal-Mart Corporation , 2009 – Present
Sustainability Advisor, Ben and Jerry's Ice Cream, 2011-Present

Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States

Second Report (Version 2), Revised December 2012

How to Cite this Report

Field to Market (2012 V2). Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States: Second Report, (Version 2), December 2012. Available at: www.fieldtomarket.org

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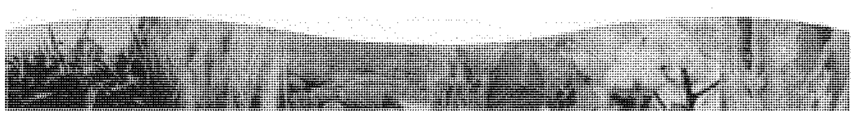
Note on this version: This report (Version 2, December 2012) replaces the report released in July 2012 (Field to Market (2012). Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States: Second Report, July 2012). This version corrects errors related to the energy and greenhouse gas results for corn, cotton, soybeans, and wheat. While the overall conclusions found in this report remain the same, this version contains new charts and data for total, per acre, per unit of output, and overall percent change values for these indicators and crops. The error in the July 2012 version of the report was related to the use of USDA ARMs data for average fertilizer (N,P,K) application rates for corn, cotton, soybeans, and wheat. Specifically, the rates used in the July 2012 report did not include the impact of the share of acres of these crops not treated with any fertilizer and instead assumed treatment of all planted acreage. Given that fertilizer use varies considerably across crops and that the proportion of treated acreage for a given crop also varies by year, the correction has different impacts for the revised results for each of the crops. For all crops, the revision results in a decrease in actual total, per acre, and per unit of output levels of energy use and greenhouse gas emissions. The impact of the correction on the average percent change trend for the full study period (1980 to 2011) was variable: the direction of change stayed the same in all but two instances (wheat energy use per acre and cotton emissions per acre) while rate of change increased in some instances and decreased in others.



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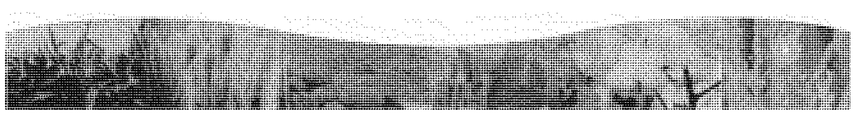
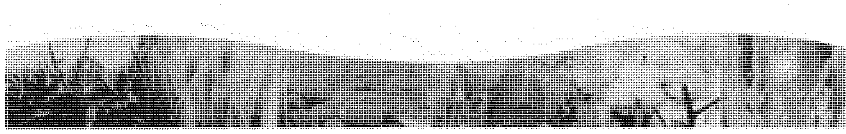


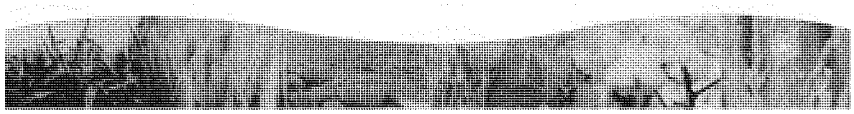


Acknowledgements

Field to Market is a collaborative stakeholder group of producers, agribusinesses, food, fiber and retail companies, conservation organizations, universities, and agency partners that are working together to define, measure, and develop a supply-chain system for agricultural sustainability. Field to Market member organizations provide oversight and technical guidance for the development of Alliance metrics and tools. Member organizations as of the date of this revised publication (December 2012) include:

- American Farm Bureau Federation
- American Soybean Association
- Bayer CropScience
- BASF
- Bunge
- Cargill
- CHS Inc.
- Conservation Technology Information Center
- Cotton Incorporated
- CropLife America
- CropLife International
- *Ducks Unlimited
- DuPont Pioneer
- Environmental Defense Fund
- Fleishman-Hillard
- General Mills
- Illinois Soybean Association
- Indiana Soybean Alliance
- International Plant Nutrition Institute
- Innovation Center for U.S. Dairy
- John Deere
- Kellogg Company
- Land O'Lakes
- Manomet Center for Conservation Sciences
- Monsanto Company
- National Alfalfa & Forage Alliance
- National Association of Wheat Growers
- National Corn Growers Association
- National Cotton Council of America
- National Potato Council
- Natural Resources Conservation Service (NRCS)
- North Carolina State University
- Penton Media
- The Fertilizer Institute
- The Coca-Cola Company
- The Nature Conservancy
- Syngenta Corporation
- *Unilever
- United Soybean Board
- University of Arkansas Division of Agriculture
- University of Wisconsin-Madison College of Agricultural and Life Sciences
- USA Rice Federation
- *Walmart
- World Resources Institute
- World Wildlife Fund – US

*Members marked with an asterisk (*) have joined since the first publiction of this report in July 2012



Field to Market

IHS Global Insight provides independent technical analysis and consulting in the development of Field to Market metrics and tools. In particular, Field to Market would like to acknowledge Stewart Ramsey, (Senior Principal) and Pon Intarapapong, (Senior Economist) for their work on this report. Field to Market would also like to thank Catherine Campbell, Marker Campbell Consulting, for her significant contributions in working closely with IHS/ Global Insight to develop the report.

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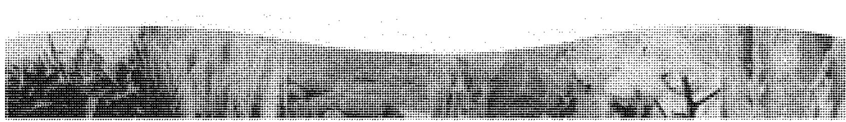
- Barry Ward - Ohio State University

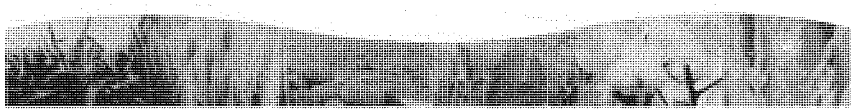
Field to Market was convened and is facilitated by The Keystone Center, an independent, non-governmental organization specializing in collaborative
decision-making processes for environment, energy, and health policy issues.

For more information about Field to Market, please visit www.fieldtomarket.org.



Abstract

Field to Market, the Keystone Alliance for Sustainable Agriculture, is a collaborative stakeholder group of producers, agribusinesses, food and retail companies, conservation and non-profit organizations, universities, and agency partners that are working together to define, measure, and develop a supply-chain system for agricultural sustainability. This 2012 report presents environmental and socioeconomic indicators for measuring outcomes of on-farm agricultural production in the United States. The report analyzes trends over time at the United States national scale for each of the indicators. Part I analyzes environmental indicators (land use, soil erosion, irrigation water applied, energy use, and greenhouse gas emissions) for six crops (corn, cotton, potato, rice, soybeans, and wheat), demonstrating trends over time from 1980-2011. Results are presented in three formats: resource use/impact per unit of production, resource use/impact per acre, and total resource use/impact. Part II analyzes socioeconomic indicators (debt/asset ratio, returns above variable costs, crop production contribution to national and state gross domestic product, non-fatality injury, fatality, and labor hours) for five crops (corn, cotton, rice, soybeans, and wheat). Each section also highlights additional relevant indicators for consideration given availability of appropriate methodology and datasets. Results demonstrate areas of progress as well opportunities for continued improvement. National scale indicators tracking trends over time in agricultural sustainability outcomes can provide broad perspective, prompt industry-wide dialogue, and identify priorities for more localized investigations and efforts.



Executive Summary

Introduction

Field to Market, The Keystone Alliance for Sustainable Agriculture, is a collaborative stakeholder group of producers, agribusinesses, food and retail companies, conservation and non-profit organizations, universities, and agency partners that are working together to define, measure, and develop a supply-chain system for agricultural sustainability. A proactive approach by a broad-based group will help all in agriculture prepare for the future.

Nearly all estimates of future demand for agricultural goods suggest a need to double agricultural production by 2050, if not before, in order to maintain adequate supplies for a growing world population that will use its expanding income to purchase fiber and fuel products and to diversify diets with more meat, dairy, fruits and vegetables. Field to Market believes this increased production must be accomplished in a manner that does not negatively impact – and actually improves – overall environmental and societal outcomes.

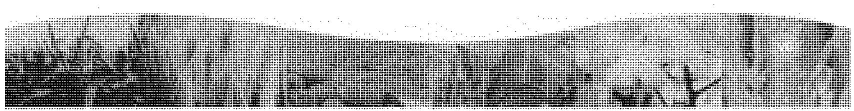
As an initial step, the group has defined sustainable agriculture as meeting the needs of the present while improving the ability of future generations to meet their own needs by focusing on these specific, critical outcomes:

- Increasing agricultural productivity to meet future nutritional needs
- Improving the environment, including water, soil, and habitat
- Improving human health through access to safe, nutritious food; and
- Improving the social and economic well-being of agricultural communities

It is within this context that the group is developing metrics to measure the environmental, health, and socioeconomic outcomes of agriculture in the United States at the national, regional, and field scales. These metrics will facilitate quantification and identification of key impact areas and trends over time, foster productive industry-wide dialogue, and promote continued progress along the path toward sustainability.

Objectives and Scope

While global demand, production, and sustainability trends are influenced by a myriad of complex drivers and conditions at a variety of scales, Field to Market's exploration of sustainability metrics focused on United States agriculture and the science-based measurement of outcomes associated with the production of commodity crops. This focus provides important insights for sustainability of U.S. commodities, which represent a significant proportion of the cropland in the United States and are often associated with complex supply chains that require innovative approaches to measurement and data sharing. This current focus provides a starting point for further analysis and for the development of methodologies and approaches that could be further adapted and applied to other contexts.



The objectives of this report are as follows:

1. **Analyze trends** in progress in environmental and socioeconomic performance for U.S. commodity cropping systems over time.
2. **Establish baseline** trends against which to monitor future improvements.
3. **Create enabling conditions** for stakeholders in the United States to contribute to discussion and development of sustainable agriculture metrics and their application toward advancing sustainable practices.
4. **Advance an outcomes-based, science-based approach** for defining and measuring agricultural sustainability that can be considered and adapted for other geographies and crops.

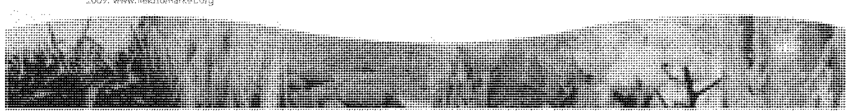
Criteria for development and inclusion of Field to Market indicators in this report include:

1. **National scale** – Analyzes national level sustainability performance of crop production. National scale indicators can provide perspective and prompt industry-wide dialogue and context that can be ultimately scaled to more localized investigations and efforts.
2. **Trends over time** – Metrics that allow comparison of trends over time rather than a static snapshot of farm activity.
3. **Science-based** – Utilizes best available science and transparent methodologies.
4. **Outcomes-based** – Provides an inclusive mechanism for considering the impacts and sustainability of diverse agricultural products and practices.
5. **Public dataset availability** – Utilizes publicly available data. Public, national-level datasets provide a transparent, accessible, and fundamental means to understand sustainability trends.
6. **On-farm** – Focuses on outcomes resulting from agricultural production within the farm-gate.
7. **Grower direct control** – Focuses on impacts over which a producer has direct influence through his or her management practices and decisions.

This report provides an update to Field to Market's first report, released in 2009, analyzing environmental indicators for four crops. This 2012 report achieves the following specific advances relative to the 2009 report:[1]

1. Incorporates the most recently available public datasets to extend the environmental trends analyses presented to 2011.
2. Revises the environmental indicator methodologies as appropriate to improve accuracy and reflect best available science.
3. Analyzes two additional crops for environmental indicators (potatoes and rice).
4. Analyzes socioeconomic indicators.

[1] Field to Market. 2009. Environmental Resource Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States, First Report, January 2009. www.fieldtomarket.org



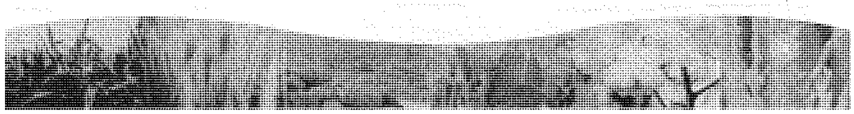
Part I of this 2012 report analyzes national-scale trends for six crops (corn, cotton, potatoes, rice soybeans, and wheat) and five environmental resource indicators (land use, soil erosion, irrigation water applied, energy use, and greenhouse gas emissions); data are analyzed for the United States, 1980 to 2011. Because this 2012 report utilizes updated methodologies, the results presented vary somewhat from those presented in 2009, and are not intended for comparison against the values in the original report. Results in this report are updated for the full time series of 1980 to 2011.

Part II of this 2012 report includes analysis of national-level metrics for socioeconomic indicators for five crops (corn, cotton, rice, soybeans, and wheat). The socioeconomics chapter analyzes trends over time for six indicators (debt/asset ratio, returns above variable costs, crop production contribution to national and state gross domestic product, non-fatality injury, fatality, and labor hours). In addition, the chapter identifies many other potentially relevant socioeconomic indicators for agricultural production that, although they do not fully meet the Field to Market criteria described above, remain important given available data and appropriate consideration of the factors that complicate their analysis.

Environmental Indicators: Results Overview

Over the study period (1980-2011), on average at the national scale in the United States, the following trends were observed. Percent change is relative to single crop and based on the average trend line for the entire study period:

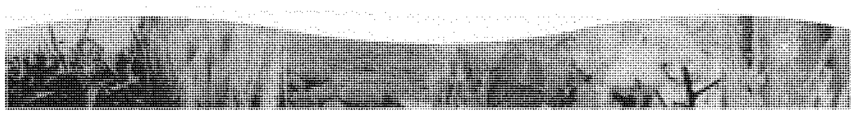
- **Production and Yield**
  - o Total production increased for corn (+101%), cotton (+55%), potatoes (+30%), rice (+53%), and soybeans (+96%); total wheat production decreased (-16%).
  - o Yield per planted acre increased for all crops: corn (+64%), cotton (+43%), potatoes (+58%), rice (+53%), soybeans (+55%), and wheat (+25%).
- **Land Use**
  - o Land use per unit of production (e.g., bushels, cwt and pounds) has improved (decreased) for all six crops because of increased yields: corn (-30%), cotton (-30%), potatoes (-37%), rice (-35%), soybeans (-35%), and wheat (-18%).
  - o Total land use (planted acres) has increased for corn (+21%), cotton (+11%), rice (+9%) and soybeans (+24%) but decreased for potatoes (-15%) and wheat (-33%).
- **Soil Erosion**
  - o Soil erosion per unit of production has improved (decreased) for all six crops: corn (-67%), cotton (-68%), potatoes (-60%), rice (-34%), soybeans (-66%), and wheat (-47%).
  - o Per acre soil erosion has improved (decreased) for corn (-43%), cotton (-50%), potatoes (-34%), soybeans (-41%), and wheat (-34%) and remained constant for rice (rice has historically had low rates of soil erosion). However, improvements in per acre soil erosion for corn, cotton, soybeans, and wheat occurred primarily in the earlier part of the study period; per acre soil erosion has remained relatively constant for these crops in recent years.
  - o Total soil erosion has improved (decreased) for corn (-31%), cotton (-42%), potatoes (-42%), soybeans (-28%), and wheat (-57%) and increased for rice (+9%) (rice has historically had low levels of total soil erosion and increases are likely associated with increased acreage). However, improvements (decreases) in total soil erosion for corn and soybeans occurred primarily in the first half of the study period, with increases occurring in more recent years associated with increased production.



- **Irrigation Water Applied**
  - o Irrigation water applied per unit of production has improved (decreased) for all six crops: corn (-53%), cotton (-75%), potatoes (-38%), rice (-53%), soybeans (-42%), and wheat (-12%).
  - o Per acre irrigation water applied has improved (decreased) for corn (-28%), cotton (-46%), rice (-25%), and soybeans (-9%) and decreased slightly for potatoes (-2%); per acre irrigation water applied increased for wheat (+6%).
  - o Total irrigation water applied decreased for cotton (-35%), rice (-18%), and wheat (-12%) and increased for corn (+27%), potatoes (+31%), and soybeans (+271%).
- **Energy use**
  - o Energy use per unit of production has improved (decreased) for all six crops: corn (-44%), cotton (-31%), potatoes (-15%), rice (-38%), soybeans (-48%), and wheat (-12%).
  - o Per acre energy use improved (decreased) for corn (-6%), cotton (-2%), rice (-3%), and soybeans (-17%), increased for potatoes (+33%) and wheat (+9%).
  - o Total energy use decreased for wheat (-26%), and increased for corn (+14%), cotton (+9%), potatoes (+11%), rice (+6%), and slightly for soybeans (+3%).
- **Greenhouse gas emissions**
  - o Greenhouse gas emissions per unit of production have improved (decreased) for all six crops: corn (-36%), cotton (-22%), potatoes (-22%), rice (-38%), soybeans (-49%), and wheat (-2%).
  - o Per acre greenhouse gas emissions improved (decreased) for rice (-4%) and soybeans (-18%), and increased for corn (+8%), cotton (+9%), potatoes (+23%), and wheat (+21%).
  - o Total greenhouse gas emissions decreased for wheat (-17%), increased slightly for potatoes (+3%) and soybeans (+1%), and increased for corn (+31%), cotton (+20%), and rice (+5%).

In summary, over the study period, all six crops demonstrated progress in their respective national average trends for resource use/impact per unit of production on all five environmental indicators. Improvements in efficiency were driven, at least in part, by improvements in yield for all crops. Due in part to overall increases in production for five of the six crops (excluding wheat) and increases in total land use for four of the six crops (excluding potatoes and wheat), total resource use/impact increased for many crops on many indicators. Per acre resource use/impact was more variable across crops.

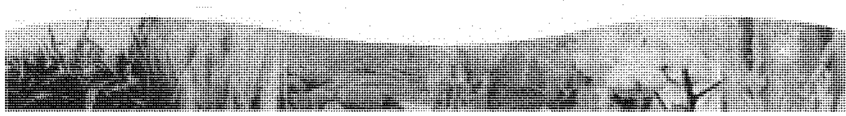
These trends – increasing efficiency per unit of production balanced (in some cases) by increasing total resource use or impact – suggest that a challenge for the future will be to continue efficiency improvements such that overall resource limits (e.g., land, water, and energy) are not reached.



Socioeconomic Indicators: Results Overview

- **Debt to asset ratio** (1996-2010)
  - The debt to asset ratio decreased (improved) (-37%) for general cash grain farms.
- **Returns over variable costs** (1980–2011)
  - Returns over variable costs for corn, rice, soybeans and wheat decreased during the 1980s, increased in the early to mid-1990s with a slight decrease in the late 1990s and an increase beginning in approximately 2002, providing a w-shaped curve for the time period.
  - Returns over variable costs for cotton decreased in the early 1980s, maintained flat growth with some variability from the late 1980s to approximately 1998, and then decreased again until the early 2000s when returns stabilized. There has been an increase in returns over variable costs for cotton since approximately 2009.
- **National and state gross domestic product** (1997–2009)
  - The national growth rate trend has increased (69%) for the agricultural sector contribution to the national GDP.
- **Non-fatality injury** (1995–2010)
  - The number of work related injuries decreased (-55%) for all crop-producing farms with eleven or more employees.
  - The number of lost work days (-76%) and the incidence of one or more work days lost (-49%) due to injury both decreased for crop farms (excluding fruit, vegetable, and other specialty crops).
- **Fatality** (1993–2010)
  - Fatalities decreased (-32%) for crop farms (excluding fruit, vegetable, and horticulture farms).
- **Labor hours** (1990–2011)
  - The implied time to produce corn (-59%, -75%), cotton (-69%, -75%), rice (-43%, -58%), and soybeans (-66%, -74%) decreased both per acre and per unit of production, respectively.
  - The implied time to produce wheat decreased (-12%) per bushel but remained relatively flat (-1%) per planted acre.

In summary, the indicators for debt to asset ratio, fatalities, and non-fatality injury decreased (improved) over their respective time periods and farm classification. Returns over variable costs have been inconsistent over the indicator's respective time period, but have been increasing for all crops, excluding cotton, since approximately 2002, and for cotton since 2009. Labor hours have decreased for all crops excluding wheat. Overall, the agricultural sector's contribution to national GDP has increased over the explored time period.



Conclusions and Next Steps

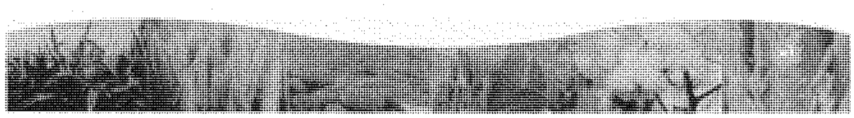
This report does not define a benchmark level of sustainability for agriculture. Rather, it explores broad-scale, commodity-level progress relevant to key challenges and indicators for agricultural sustainability and provides methods by which to measure and track trends over time. The results presented in this report demonstrate important advancements on a variety of environmental, social, and economic indicators as well as continued opportunities and challenges. For example, gains in productivity and per unit of production resource use efficiency are important in meeting the challenges of increasing demand and limited resources, yet increases in total levels of resource use in order to meet these demands underscores the importance of continued improvements given absolute resource limits. Similarly, sustaining and accelerating improvements demonstrated in this report for many social and economic dimensions of agriculture will be fundamental to sustainable production, and will also be influenced by evolving patterns in demand, urbanization, demographics, and supply chain expectations.

The trends presented here can help inform the sustainability conversation, enhance our understanding of progress, challenges, and opportunities and provide a broad-scale baseline against which to monitor future change. This broad-scale understanding and context enables stakeholders to have better-informed discussions of the priorities and opportunities for improvement at the field and farm level. Field to Market recognizes that while the analyses contained in this report are important and necessary to understanding sustainability, they alone are not sufficient for fully comprehending and ultimately addressing sustainability challenges. Accordingly, Field to Market's work on outcomes-based indicators for agricultural sustainability continues, with the following specific and significant considerations for future analyses.

Expansion of indicators. The indicators presented in this report do not represent the full suite of sustainability indicators for agriculture. Expansion of the current indicator set to include additional crops as well as additional environmental and socioeconomic indicators may occur given available methods and datasets. In particular, Field to Market continues to explore development of metrics for water quality and biodiversity.

Refinement of methods and data. Methodologies and datasets for the current national/regional/state level indicators provided here may be updated as appropriate to reflect best available science as well as the release of public data. Capacity to continue and enhance these kinds of analyses is dependent on the availability of the public data sources upon which it relies. Public, national level datasets provide a transparent, accessible, and fundamental means to understand sustainability trends.

Scaling of approaches. Downscaled analyses may require more sophisticated methodologies and datasets to allow for higher resolution, better interpretation of trends at local levels, and better understanding of how specific decisions affect specific resources and geographies. This report utilizes methods that strive for high scientific sophistication while also recognizing the limits of working with public data and at a broad-scale. More locally-scaled analyses may utilize and even require methods not feasible and data not available at the national scale, as local decisions will require more specific information to inform management and decision-making.

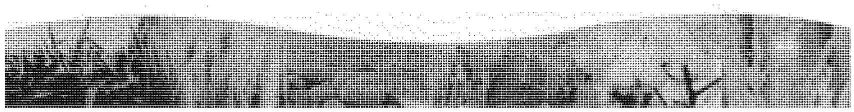


Exploration of impacts. Further analyses at all scales are needed to better understand the total impacts of crop production. For example, within our environmental indicators, efficiency and total use trends at the national scale do not capture the specific challenges associated with resource limitations and impact, including those at smaller scales. While many national trends show improvement for particular crops, whether for efficiency measures or total resource, overall national or even global resource limitations cannot be overlooked, nor can specific local examples of continued challenges. For example, sustainability can be impacted by nationally and globally available cropland and energy sources, as well as by groundwater availability for a particular regional or local aquifer. Conversely, some national trends may show overall increases in total uses for a particular crop even while success stories may be occurring at more local levels or may be occurring in consideration of all crops grown in a particular area.

Aggregation of results across all crops. Further analyses are needed to better understand the cumulative or aggregate impacts of all crop production. While crop-by-crop analyses provide important information for commodity sectors and supply chains, aggregation of data for all crops may provide further insight into directional changes in total uses. For example, increases or decreases in resource use for a single crop may actually be offset by decreases or increases for another crop, and aggregate results may in some cases be directionally different than by-crop results, both at the national and local scale. Aggregate total resource uses may also vary in direction at the local scale as compared to national scale; for example, due to land use change either away from agricultural production (e.g., conversion to urban land) or into production (e.g., release of Conservation Reserve Program land back into production). Similarly, for socioeconomic indicators, further analyses at additional scales and for the aggregate of agricultural production are needed, as are enhanced measures of impact on the farmer and farm community.

Evaluation of context and drivers. Further analyses are also needed to better understand both the context and drivers underlying the trends reported here. Context and drivers can include conditions both internal and external to agricultural systems – such as resource limitations and conditions, at a variety of scales, individual farmer choices, availability of new science and technology, supply chain and economic conditions, price signals, consumer behaviors, demographic changes, policy and governance changes. Because agriculture is an incredibly complex system and analysis of context and drivers equally complex, Field to Market does not attempt in this report to analyze nor speculate on them unless they are explicitly evident in the datasets used to build the metrics themselves.

Examination of recent trends versus historical trends. Further analyses are also particularly needed to better understand the most recent trends, drivers, and contexts for sustainability. This report highlights results in summary form – for example, percent change over the full 30-year study period – and also includes data demonstrating the full time series of trend lines for each crop and indicator. There are many more stories to be further explored and explained within the data provided in this report, including, and especially, those for which more recent trends may represent accelerations, decelerations, or reversals of the overarching 30-year trend-lines. The longer time period provides important historical context and the most recent trends may signal important considerations for the future.



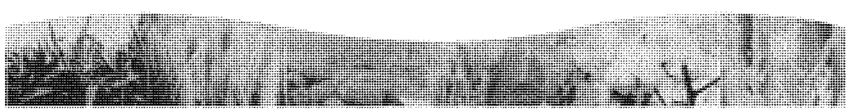
Expansion to additional crops and geographies. Field to Market's primary focus is currently on commodity agricultural production in the United States. However, the Alliance seeks to inform efforts focused on other crops and geographies by facilitating information-sharing, coordination and collaboration regarding methodologies and approaches. As an example, Field to Market's 2009 report was recently adapted for Canadian field crops to explore trends over time for eight different Canadian crops including wheat, oat, lentil, canola, peas and flax.[2] Field to Market continues exploration of opportunities to leverage and adapt the current work to new contexts, both within and beyond the United States.

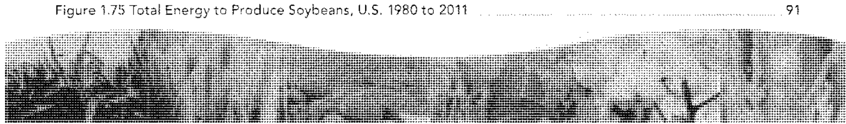
Connecting trends to individual grower education and action. Field to Market's analysis of broad-scale trends provides a mechanism to measure overall progress. Yet what moves the "needle" of sustainability outcomes at the broad scale are individual practices and outcomes at the field and farm scale. Complementing its efforts to analyze broad-scale trends, Field to Market has also developed the Fieldprint Calculator, a free, online educational and awareness tool that allows individual growers to analyze the outcomes of their own management practices at the field level and compare them to broader-scale benchmarks as well as to trends within their own peer or pilot groups (www.fieldtomarket.org). Field to Market is actively engaged in piloting these tools and methodologies with farmers to identify future improvements and understand the utility of these tools in informing management actions and driving continuous improvements.

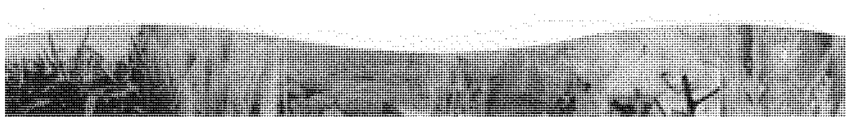
The above-recommended future investigations represent significant opportunities for which this report is intended as a starting place. Through this report and Field to Market's advancement of agricultural sustainability metrics and tools that quantify the impacts of cropping practices at a variety of scales, the Alliance seeks to enable an outcomes-based, science-based discussion on the definition, measurement, and advancement of sustainability. The hope and intent is that such approaches will ultimately inform mechanisms to promote continuous improvements at the field level that aggregate, in turn, to continued, significant and broad-scale progress toward meeting sustainability challenges for production, resource use and impacts, and social and economic well-being.

[2] Serecon Management, for Pulse Canada, Canadian Canola Growers Association, Canadian Wheat Board, Ducks Unlimited, Flax Council of Canada, and General Mills. 2011. Application of Sustainable Agriculture Metrics to Selected Western Canadian Field Crops: Final Report. Edmonton, Alberta. http://www.pulsecanada.com/fieldtomarket

List of Figures and Tables







Part I: Environmental Indicators Report

1. Introduction

Field to Market, The Keystone Alliance for Sustainable Agriculture, is a collaborative stakeholder group of producers, agribusinesses, food and retail companies, conservation and non-profit organizations, universities, and agency partners that are working together to define, measure, and develop a supply-chain system for agricultural sustainability. A proactive approach by a broad-based group will help all in agriculture prepare for the future.

Nearly all estimates of future demand for agricultural goods suggest a need to double agricultural production by 2050, if not before, in order to maintain adequate supplies for a growing world population that will use its expanding income to purchase fiber and fuel products and to diversify diets with more meat, dairy, fruits and vegetables.[3] Field to Market believes this increased production must be accomplished in a manner that does not negatively impact – and actually improves – overall environmental and societal outcomes.

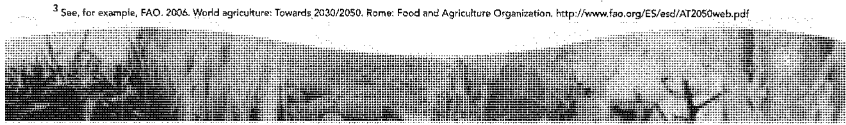
As an initial step, the group has defined sustainable agriculture as meeting the needs of the present while improving the ability of future generations to meet their own needs by focusing on these specific, critical outcomes:

- Increasing agricultural productivity to meet future nutritional needs
- Improving the environment, including water, soil, and habitat
- Improving human health through access to safe, nutritious food; and
- Improving the social and economic well-being of agricultural communities

It is within this context that the group is developing metrics to measure the environmental, health, and socioeconomic outcomes of agriculture in the United States at the national, regional, and field scales. These metrics will facilitate quantification and identification of key impact areas and trends over time, foster productive industry-wide dialogue, and promote continued progress along the path toward sustainability.

While global demand, production, and sustainability trends are influenced by a myriad of complex drivers and conditions at a variety of scales, Field to Market's exploration of sustainability metrics has focused on United States agriculture and the science-based measurement of outcomes associated with the production of commodity crops. This focus provides important insights for sustainability of U.S. commodities, which represent a significant proportion of the cropland in the United States and are often associated with complex supply chains that require innovative approaches to measurement and data sharing. This current focus provides a starting point for further analysis and for the development of methodologies and approaches that could be further adapted and applied to other contexts.

[3] See, for example, FAO. 2006. World agriculture: Towards 2030/2050. Rome: Food and Agriculture Organization. http://www.fao.org/ES/esd/AT2050web.pdf



In January 2009, Field to Market released a report on national-scale trends in environmental resource indicators for corn, cotton, soybean, and wheat production in the United States.[4] Using publicly-available data, national-scale metrics were developed to measure outcomes for five environmental indicators: land use, soil erosion, irrigation water applied, energy use, and climate impact (greenhouse gas emissions). The metrics were applied to quantify environmental outcomes for four commodity crops –corn, cotton, soybeans, and wheat—produced through agricultural practices in the United States. The report quantified trends over time for these crops and indicators from 1987-2007.

The objectives of both the 2009 and 2012 environmental indicator reports are:

1. Analyze trends in progress in environmental and socioeconomic performance for U.S. commodity cropping systems over time.
2. Establish baseline trends against which to monitor future improvements.
3. Create enabling conditions for stakeholders in the United States to contribute to discussion and development of sustainable agriculture metrics and their application toward advancing sustainable practices.
4. Advance an outcomes-based, science-based approach for defining and measuring agricultural sustainability that can be considered and adapted for other geographies and crops.

This 2012 report seeks to further address and advance the objectives described above and also achieve the following specific advances relative to the 2009 report:

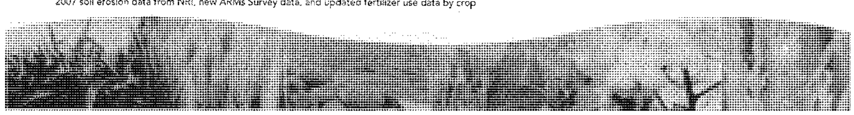
1. Incorporate the most recently available public datasets to extend the environmental trends analyses.[5]
2. Revise the environmental indicator methodologies as appropriate to improve accuracy and reflect best available science.
3. Analyze additional crops – rice and potatoes.
4. Analyze socioeconomic indicators (Part II of this report).

Part I of this 2012 report updates the 2009 environmental indicators approaches to include the most recent publicly available data, revises and updates the methodology for the five original resource indicators listed above, and analyzes potatoes and rice in addition to the four crops included in the 2009 report. Since 2009, Field to Market has also actively been working to evaluate indicators for water quality and biodiversity at the national and field/farm scales. A brief overview of this work is provided in this report.

Because this 2012 report utilizes updated methodologies, the results presented vary somewhat from those presented in 2009, and are not intended for comparison against the values in the original report. Results in this report are updated for the full time series of 1980 to 2011.

[4] Field to Market. 2009. Environmental Resource Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States, First Report, January 2009. www.fieldtomarket.org

[5] Examples of new datasets include: productivity estimates through 2010 from NASS, 2007 Agricultural Census and 2008 Farm and Ranch Irrigation Survey, 2002 and 2007 soil erosion data from NRI, new ARMs Survey data, and updated fertilizer use data by crop



2. Data and Methods

2.1. Data and Methods Overview

Consistent with the 2009 Field to Market report, criteria for development and inclusion of Field to Market indicators in the 2012 report are as follows:

1. National scale – Analyzes national level sustainability performance of crop production. National scale indicators can provide perspective and prompt industry-wide dialogue and context that can be ultimately scaled to more localized investigations and efforts.
2. Trends over time – Metrics that allow comparison of trends over time rather than a static snapshot of farm activity.
3. Science-based – Utilizes best available science and transparent methodologies.
4. Outcomes-based – Provides an inclusive mechanism for considering the impacts and sustainability of diverse agricultural products and practices.
5. Public dataset availability – Utilizes publicly available data. Public, national-level datasets provide a transparent, accessible, and fundamental means to understand sustainability trends.
6. On-farm – Focuses on outcomes resulting from agricultural production within the farm-gate.
7. Grower direct control – Focuses on impacts over which a producer has direct influence through his or her management practices and decisions.

For this study, data has been retrieved and assembled across six primary crops in the United States:

Crop	Yield Unit	Description
Corn	bu.	Bushel, 56lbs. of corn grain per bushel
Cotton	lb. of lint	Pounds (lbs.) of lint
Potatoes	cwt	Hundred weight, (100 lbs.)
Rice	cwt	Hundred weight, (100 lbs.)
Soybeans	bu.	Bushel, 60 lbs. of soybean seed per bushel
Wheat	bu.	Bushel, 60 lbs. of wheat grain per bushel

Together, the production of these six crops has comprised approximately 73 percent of the acres of agricultural cropland use in the United States for the past several decades. In 2011, these crops comprised 73.9 percent of the 293.4 million acres of U.S. agricultural crops harvested and had combined crop value of $119 billion; they accounted for roughly 58% of U.S. crop cash receipts during the period 2007 through 2011.[6] It is our intention that the methods used could be applied to a full range of technology choices and to other crops produced in the United States or elsewhere assuming sufficient data and, perhaps, with some modification.

This report focuses on five important environmental indicators for agricultural sustainability:

1. Land use
2. Soil erosion
3. Irrigation water applied
4. Energy use
5. Greenhouse gas emissions

In selecting environmental indicators, Field to Market strove to identify a discrete and relatively small set of key outcome indicators critical for agricultural sustainability. The five indicators listed above, along with water quality, total water use, and biodiversity, were prioritized by the multi-stakeholder membership of Field to Market.

[6] USDA Economic Research Service (ERS). 2012. Farm Income and Costs: 2012 Farm Sector Income Forecast. http://www.ers.usda.gov/Briefing/FarmIncome/nationalestimates.htm

Water quality, total water use, and biodiversity are recognized by Field to Market as important environmental indicators of agricultural sustainability, and continued discussion of appropriate metrics for these areas continues within the Alliance. A brief discussion of these indicators is included in the Methods section below.

Consistent with the outcomes approach taken by this group, the impacts of product inputs such as pesticide and fertilizer use are accounted for in outcomes indicators such as energy use, greenhouse gas emissions, biodiversity, and water quality. The methodology for incorporating these inputs into the current energy and greenhouse gas emissions indicators is explained below.

Results for each indicator are presented in three formats – all are valuable and additional discussion of the relative values and caveats for each is provided later in the report:

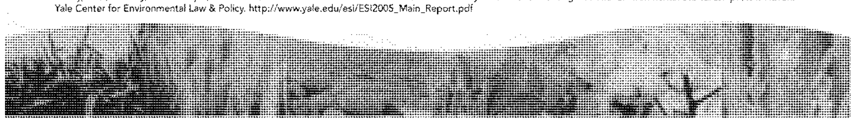
1. "Efficiency"[7] indicators showing resource indicator (use or impact) per unit of production. "Efficiency" measures show change in use or impact over time relative to our ability to meet productivity demands and normalizes the metrics to a common unit of comparison for producers and stakeholders.
2. Per acre resource use or impact. Per acre resource use similarly normalizes the metrics to a common unit of comparison, however it should be noted that an equal amount of resources may be used per acre with varying production levels achieved.
3. Total use indicators showing the annual use or impact per acre multiplied by total acres harvested. Total resource use or impact indicators are essential for informing conversations regarding total resource restraints or limits.

Results are expressed graphically in three forms:

1. A summary table of percent change over the full study period (based on a least squares trend analyses from 1980-2011) for each crop, indicator, and unit of analysis, found in the summary of results for each crop.
2. A summary spidergram for "efficiency" indicators over time, found in the summary of results for each crop. The spidergram visually demonstrates the change in the overall efficiency footprint or "Fieldprint" over time. In order to facilitate comparison and evaluate relative changes over time across multiple indicators with differing units of measure (e.g., BTU for energy vs. CO_2e for greenhouse gas emissions in carbon dioxide equivalents), each efficiency indicator is indexed where actual values observed in the year 2000 are set equal to 1. Therefore, a 0.1 unit change in the index value of an individual indicator is equal to a 10% percent change relative to the actual value in the year 2000. Trends that demonstrate movement toward the center of the spidergram (toward a value of zero, or a shrinking of the "Fieldprint") represent an improvement of efficiency, or resource use/impact per unit of production, over time. Other prominent sustainability metrics, both pertaining to agriculture and apart from agriculture, have relied on normalized metrics including measures such as per capita, per unit of production, or per unit of value of production. In the widely acknowledged *2005 Environmental Sustainability Index*,[8] the authors suggest "...sustainability is a characteristic of dynamic systems that maintain themselves over time; it is not a fixed endpoint that can be defined;" under this interpretation, normalization becomes optimal in that it allows us to compare trends over time.

[7] Efficiency is typically defined and expressed as output/input. For our purposes, to emphasize the importance of considering the resources needed to produce a unit of crop, we produce inverse efficiency measures that are normalized to a unit of production, thus expressing input/unit of output, e.g., energy use per bushel of corn produced.

[8] Esty, D.C., M. Levy, T. Srebotnjak, and A. de Sherbinin. 2005. 2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship. New Haven: Yale Center for Environmental Law & Policy. http://www.yale.edu/esi/ESI2005_Main_Report.pdf

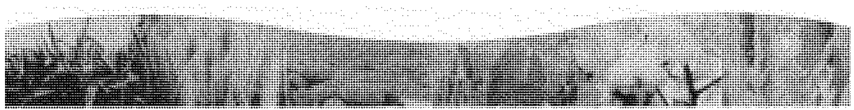


3. **Individual line graphs** for each crop, indicator, and unit of analysis (production, acre, and total) are also found in each crop summary section. The graphs chart actual resource values (e.g., actual BTU per bushel) by year for the entire study period (1980-2011). The regression equations and R2 values for each line graph are provided. The line graphs provide additional resolution regarding changes over time and the conformity of those changes with average trend line for the full study period.

Data and methods have been standardized as closely as possible across all crops. The data used in this report have been retrieved from numerous sources – all are within the public domain. Where national averages are constructed through the aggregation and weighting of various practices and geographies, the weighting was typically performed on a planted acre basis due to the fact that most data underlying the indicators were expressed on a per acre basis; however, there were some exceptions, for example, where data were based on total production, weighting was conducted based on production. Data and methods for each environmental resource indicator are further explained below. Data analysis and summary have been completed by IHS/Global Insight, an economic, financial analysis, forecasting and consulting firm with more than 40 years of experience.

This report utilizes methods that strive for a high degree of scientific sophistication while also recognizing the limits of working with public data and at a broad-scale. More locally-scaled analyses may utilize and even require methods not feasible and data not available at the national scale; examples include more complex models of nitrous oxide emissions (N_2O) or soil erosion that are available at the field scale but were not within the scope of this study to execute and/or aggregate at the national scale. In these cases, a simpler approach is justified by the national-scale nature of the trends analyses conducted here. Methodologies and datasets for the current indicators provided here may be updated as appropriate to reflect best available science as well as the release of public data.

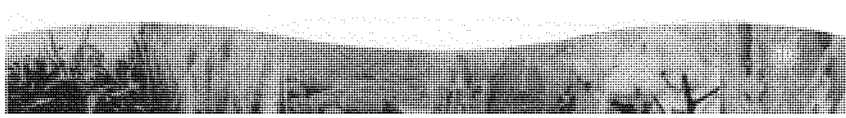
A draft report was shared with 9 peer reviewers (see Acknowledgments) and feedback was incorporated wherever possible to correct, clarify, or better frame the methodology and the scope of the report.



2.2. Overview of Updated Methods for the 2012 Report

Field to Market has updated its methodologies for this report in several areas, to reflect best available science and learnings that have occurred since the 2009 report. Most notably, the updates include:

- **Threshold for inclusion of a practice or input:** As a guiding principle, to be included in the calculation of the metric, a particular production practice or input must contribute at least 1% of the resource use or impact for the indicator in question to be included as a separate factor. For example, if a practice contributes less than 1% of total BTU to an energy footprint, and is not already captured by an included activity, it is not included. In the prior (2009) report, no such threshold was set; this threshold allows for better consistency across all crops and indicators, ensures inclusion of practices that influence the calculation of a particular metric, and also sets a standard for allowing practices with relatively negligible impact on the calculation to be omitted. This approach is considered appropriate given the scope and intent of the analyses in developing national-scale averages. However, it should be noted that there are some exceptions under which practices representing less than 1% of the metric are included; these include circumstances in which available data capture a suite of practices, some of which may fall below the 1% threshold, as well as specific examples for which a practice may represent less than 1% of the footprint at a national-average level but has more significant impact at a more local level and was deemed important to incorporate. An example of the latter exception is the harvest of crop residue; the harvesting of wheat straw can have significant impact both economically and for greenhouse gas emissions at a regional level, however, at the national scale it represents less than 1% of total emissions for wheat. Should the practice become more prevalent on a national scale, its influence on national average greenhouse gas emissions for wheat would similarly increase.
- **Defined end-point for measurement:** Field to Market's 2012 report now clearly defines the end-point for calculation of the environmental footprint as the point of sale of the crop. By specifying the point-of-sale as the end point for measurement, this approach is consistent with the criterion that metrics represent practices and actions within a grower's control. The point of sale can vary by farmer and by crop; for example, some growers may deliver their crop to a grain elevator or mill while others sell their crop at the farm bin or point of storage. In the example of the grain being sold at the farm, the impact of transporting the crop to the mill would not be part of the farmer's crop field-print.



- **Planted versus harvested acres:** The 2009 Field to Market report considered only harvested acres. The rationale was that harvested acres are most often used in data reporting and are most familiar to agriculture producers. However, the use of planted acres accounts for abandonment due to weather or other adversity that causes the crop not to be harvested and therefore is a more comprehensive measure. At the national scale, inclusion of abandonment is an important means of understanding the impacts of losses on the overall efficiency of input usage and the relationship between impacts and productivity. In this 2012 report, we now analyze data and present results in terms of planted acres. The use of intentional land fallowing or double cropping are not explicitly captured in the 2012 report nor were they captured in the 2009 version. Attempts to better attribute land resources to these practices may be made in future updates.
- **Co-products and by-products:** The 2012 methodologies now account for economic allocation of co-production of cotton seed and wheat straw. The economic allocation formula determines the share of the primary product as a proportion of the total dollar value of product sold. The five-year average from 2005 to 2009 was used. In the case of cotton the share of the lint value divided by the lint plus seed values was determined to be 0.83 or 83%. The 83% factor is then applied to the absolute level of a given resource:

Primary product share for cotton lint = lint value/(lint value + seed value associated with a pound of lint)

Primary product share for cotton lint = $0.55/($0.55 + $0.11) = 83%

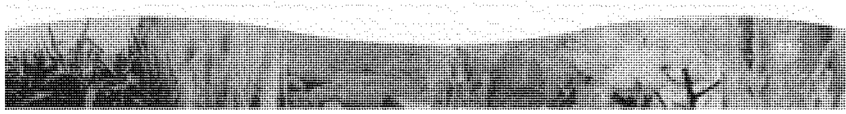
The economic importance of wheat straw as a co-product of wheat varies in the U.S. by region and year. Cotton seed is an economically important co-product of cotton and is a consistent component of income for all U.S. cotton producers. Values representing wheat and cotton lint may be converted to values representing that required to produce all economic yield components by multiplying wheat (bu) and cotton lint (lb lint) by 1.034 and 1.17, respectively.

- Metric-specific changes:

o With the exception of an adjustment to account in this report for planted acres rather than harvested acres, the land use and irrigation water applied methodologies remain the same as those reported in 2009.

o The 2012 soil erosion methodology no longer compares soil erosion above tolerable (T) level. Now the metric includes total soil erosion, allowing for reporting of trends in reduction below T and recognizing that T is a highly location-specific concept.

o For energy and greenhouse gas calculations, additional practices and contributors are considered; for example, the methods now account for embedded energy and emissions from seed and drying, and include updated N_2O factors. Soil carbon is no longer counted as an offset for greenhouse gas emissions.



2.3. Land Use Indicator

Land is a primary requirement to produce agricultural goods. By its very nature, agriculture domesticates the land under production. A 2001 USDA Economic Research Service Report stated, "Land quite literally underlies all economic activity, but nowhere more than for agriculture. Land is the primary input for crop production and grazing livestock, a source of rural amenities, and a store of value for farmland owners."[9] According to 2007 land use data from the USDA, the United States composes 2.3 billion acres in total; 17.7% of these are cropland, or 406 million acres (this represents a decrease in total cropland from that reported by 2002 USDA land used data, which reported 19.5% of these acres are cropland, or 442 million acres).[10] [11]

Other land uses include pasture, forest, special uses and other.[12] These categories can be divided further into more specific uses such as grassland, urban, rural parks and wildlife, cropland used for pasture, and cropland idled to name a few.[13] [14] Each type of land use contributes its own challenges and opportunities for sustainability, especially agriculture as a result of its high level of productivity per acre and large land use percentage.[15] [16]

The focus of this report is on changes over the study period (1980-2011) in U.S. cropland use, which will be referred to as agriculture for corn, cotton, potatoes, rice, soybeans and wheat. We do not attempt to analyze or compare current agriculture against a pre-industrial baseline. Field to Market recognizes that land use decisions by U.S. agricultural producers are guided by many factors, including international price signals, Farm Bill policies and programs, and biofuel policies. The complex interaction of many drivers can influence whether a farmer plants one crop over another or chooses to enroll in or exit a conservation program that provide incentive to idle land, e.g., the Conservation Reserve Program or Wetlands Reserve Program.[17] There is evidence of recent declines in CRP enrollment (since 2007), with implications for total land use as well as for other sustainability indicators influenced by increases in planted area.[18]

9 USDA. 2001 Sep 13. Urban Development, Land Use and Agriculture. Washington, D.C.: United States Department of Agriculture.

10 Lubowski RN, Vesterby, M, Bucholtz, S, Baez, A, and MJ Roberts. 2006. Major Uses of Land in the United States, 2002. United States Department of Agriculture, Economic Research Service; Report nr EIB-14.

11 United States Department of Agriculture, National Agricultural Statistics Service (NASS), Research and Development Division, Geospatial Information Branch, Spatial Analysis Research Section. 2009. 2007 Census of Agriculture, United States Summary and State Data.

12 USDA. 2007, Dec 21. Major Land Uses. Washington, D.C.: United States Department of Agriculture. http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp

13 Lubowski RN, Vesterby, M, Bucholtz, S, Baez, A, and MJ Roberts. 2006. Major Uses of Land in the United States, 2002. United States Department of Agriculture, Economic Research Service: Report nr EIB-14.

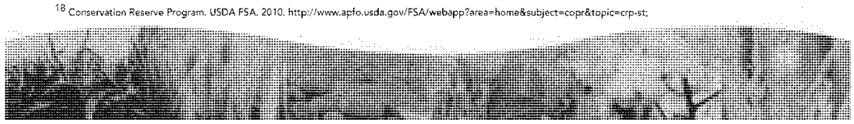
14 USDA. 2007, Dec 21. Major Land Uses. Washington, D.C.: United States Department of Agriculture.

15 Prince, SD, Haskett, J, Steininger, M, Strand, H, and R Wright. 2001. Net Primary Production of U.S. Midwest Croplands from Agricultural Harvest Yield Data. Ecological Applications 11:1194-1205.

16 Turner II, B L, Lambin, EF, and A Reenberg. 2007. Land Change Science Special Feature: The Emergence of Land Change Science for Global Environmental Change and sustainability. PNAS 104

17 U.S. Farm Bill Conservation Titles. http://www.nationalaglawcenter.org/assets/farmbills/conservation.html#environmental; Agriculture: A Glossary of Terms, Programs, and Laws, 2005 Edition. http://ncseonline.org/nle/crsreports/05jun/97-905.pdf; Sodsaver: Protecting Prairie and Producers. http://www.iwla.org/index.php?ht=d/ContentDetails/i/1359/pid/223; Conservation Title Food, Conservation and Energy Act of 2008. http://www.nacdnet.org/policy/agriculture/farmbill/2007/NACD%20Farm%20Bill%20Conservation%20Title%20Summary.pdf

18 Conservation Reserve Program. USDA FSA. 2010. http://www.apfo.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp-st;



There is also evidence that agricultural land is being converted to suburban and urban areas.[19 20] Field to Market recognizes that these and other trends are important drivers underlying changes in amount and patterns of land use for particular crops, and that they influence production choices and sustainability outcomes on working lands. However, consistent with the overall scope and approach of this report, here we focus on reporting changes in cropland use for the production rather than providing an analysis of the drivers.

Data used in this analysis are on a planted basis; the use of planted acres accounts for abandonment due to weather or other adversity that causes the crop not to be harvested. At the national scale, inclusion of abandonment is an important means of understanding the impacts of losses on the overall efficiency of input usage and the relationship between impacts and productivity.

Yield data are derived from U.S. Department of Agriculture's Annual Crop Production report.[21] Data for measuring land use have come from the National Agricultural Statistics Service (NASS), a division of the United States Department of Agriculture (USDA). The data were drawn from the final estimates provided in the Annual Crop Production report released in January 2012.[22] USDA's survey estimates of yield and farmed land area are considered the best measure available for U.S. agriculture, as well as much of the agriculture around the world.[23]

- *Total Land Use = Planted Acres*
- *Yield = Unit of Production per Planted Acre*
- Land Use "Efficiency" Indicator = Planted Area per Unit of Production

The land use "efficiency" indicator is thus a simple inverse of yield, yet provides a unique perspective that emphasizes and normalizes resource use against a unit of production; as with other "efficiency" indicators presented throughout this report, normalization against a unit of production provides a new mechanism of comparison and a complement to the total use and yield measures.

Results are presented as total resource use (acres), yield (production per acre), and inverse-efficiency (acre per unit of production). Average trends for the entire study period are calculated using a least squares trends analysis. Efficiency data are indexed where the year 2000 equals 1 and displayed with other resource indicators on a summary spidergram by crop.

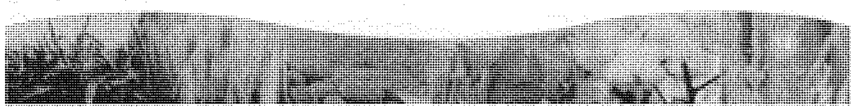
[19] Hart, JF. 2001. Half a Century of Cropland Change. Geographical Review 91:525-543.

[20] Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Washington D.C.: Island Press. http://www.millenniumassessment.org/documents/document.356.aspx.pdf

[21] USDA NASS. 2008. Crop Values 2007 Summary. Washington, D.C.: United States Department of Agriculture, National Agricultural Statistics Service. http://www.usda.gov/nass/PUBS/TODAYRPT/cpvl0208.pdf

[22] U.S. Department of Agriculture National Agriculture National Agriculture Statistics Service. 2012. Crop Production 2011 Summary. Washington, D.C.: United States Department of Agriculture, National Agrigcultural Statistics Service. http://usda01.library.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2012.pdf

[23] Yilmaz, MT, Hunt, ER Jr, and TJ Jackson. 2008. Remote sensing of vegetation water content from equivalent water thickness using satellite imagery. Remote Sensing of Environment 112:2514-2522.



2.4. Soil Erosion Indicator

Soil is fundamental to efficient and economical food production. While renewable over the long-run, excessive soil erosion can have significant adverse effects on agricultural productivity and environmental health. Beyond the loss of productivity, movement of soil from the field has negative implications on surface water quality and the ecosystems involved.

Soil erosion processes are predominantly caused by wind and water, and have been occurring on the land as long as there has been soil. Tillage practices that result in soil exposed to these elements without vegetative cover greatly accelerate the rates of soil erosion. Agricultural practices in the early part of the 20th Century coincided with a regional drought to produce the collapse of agro-ecosystems across the Great Plains, commonly referred to as the Dust Bowl. Great storms of soil were transported by wind across Texas, Oklahoma, and Kansas (and observed as far east as Ohio), and became a symbol of the need for conservation practices in agricultural production.

While many models exist to predict soil erosion due to wind and water erosion, this report utilizes soil erosion data as measured in a government report called the National Resource Inventory (NRI) from the Natural Resources Conservation Service (NRCS); the most recent data from the NRI is for 2007.[24] This section provides an overview of the NRI data, how they were developed by NRCS, and how they are utilized by Field to Market. Field to Market did not collect or model soil erosion for this report; all sampling and modeling procedures (and associated assumptions and parameters) were established by NRCS and reported in NRI (please refer to references for additional information about the NRI methodology and data).

The NRI survey program is scientifically based, employing recognized statistical sampling methods. The 2007 NRI was conducted by NRCS in cooperation with Iowa State University's Center for Survey Statistics and Methodology (ISU-CSSM), which serves as the NRI Statistical Unit providing statistical and survey methods support to the NRI survey program.

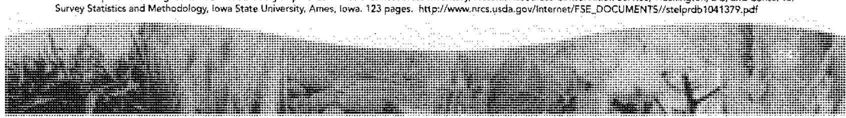
The NRI provides the following overview of its sampling methodology:[25]

> "The universe of interest for the NRI survey consists of all surface area (land and water) of the United States. The sample covers all land ownership categories including Federal, although NRI data collection activities have historically concentrated on non-Federal lands. The NRI sample was selected on a county-by-county basis, using a stratified, two-stage, area sampling scheme. The two stage sampling units are (1) nominally square segments of land, and (2) points within the segments. The segments are typically half-mile-square parcels of land equivalent to 160-acre quarter-sections in the Public Land Survey System, but there are many exceptions in the western and northeastern United States. Three specific sample point locations were selected for most selected segments, although two were selected for 40- acre segments in irrigated portions of some western States, and some segments originally contained only one sample point."

From 1982 to 1997 these NRI data were collected on five-year cycles, but beginning in 2000 they were collected annually. The data were collected for 800,000 sample sites from 1982-1997, but in 2000 forward the data were collected from about 200,000 sample sites.

[24] U.S. Department of Agriculture Natural Resources Conservation Service. 2010. 2007 National Resources Inventory, Soil Erosion on Cropland. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_012269.pdf

[25] U.S. Department of Agriculture. 2009. Summary Report: 2007 National Resources Inventory, Natural Resources Conservation Service, Washington, DC, and Center for Survey Statistics and Methodology, Iowa State University, Ames, Iowa. 123 pages. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS//stelprdb1041379.pdf



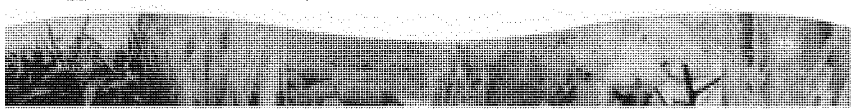
Processing these data required aggregation at many levels for comparison. The NRI describes the computation of erosion data using models for water (the Universal Soil Loss Equation or USLE) and wind (the Wind Erosion Equation) (please see the NRI summary document for additional information, including the conservation practices evaluated using USLE):[26]

> "NRI erosion estimates are based upon erosion prediction models rather than on-site measuring of soil detachment, transport, and deposition. The erosion prediction models provide estimated average annual (or expected) rates based upon the cropping practices, management practices, and inherent resource conditions that occur at each NRI sample site. Climatic factors used in the erosion prediction equations (models) are based upon long-term average conditions and not upon one year's actual events. NRI estimates of sheet and rill erosion utilize standard Universal Soil Loss Equation (USLE) technology rather than revised USLE (RUSLE) methodology so that it is possible to make comparisons back to the year 1982. Erosion estimates are currently made only for cropland, CRP land, and pastureland. Erosion prediction models for rangeland are currently under development and evaluation."

The NRI database contains both computed (estimated) soil loss and the individual factors, for both the USLE and WEQ, for all points that are Cropland, Pastureland, or CRP land in a given year. Erosion data are not given for points that are any other land cover/use. If a sample point changes land cover/use between two points in time, it has erosion equation factors for the years it is Cropland, Pastureland, or CRP land – but not for any years that is some other land cover/use. This is an important factor to keep in mind when trying to estimate erosion rates for a particular area – to only account for those sample points with a land cover/use of Cropland, Pastureland, or CRP land. It is incorrect to average USLE rates over the land area of an entire State, rather than just some portion of the agricultural land.

NRCS summed data for wind and water (sheet and rill) erosion to estimate total erosion from cultivated cropland by state for the reference years 1982, 1987, 1992, 1997, 2002, and 2007. Working with the statisticians at NRCS and the NRI databases, area-weighted estimates were developed using data on a crop planted area on a county basis to quantify the soil erosion by crop, by state, for the comparison years.

[26] Ibid.

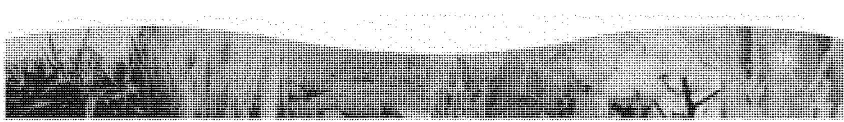


Results are presented as total resource impact (tons), resource impact per acre (soil erosion per planted acre) and inverse-efficiency (soil erosion per unit of production). Efficiency data are indexed where the year 2000 equals 1 and displayed with other resource indicators on a summary spidergram by crop.

In the 2009 report, Field to Market presented results relative to the T value (soil loss tolerance value) as defined by NRCS and the NRI; T is the average annual erosion rate (tons/acre/year) that can occur and still permit a high level of crop productivity to be sustained economically and indefinitely. Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre. In the earlier Field to Market report, T was subtracted from the average soil erosion rate and the difference was reported; in the event that soil erosion was less than T, it was assigned a zero value. However, in this 2012 report, Field to Market is presenting the absolute rather than net soil erosion rates. This change was made in recognition of the site-specific nature of T, debate regarding the merit of T as a management tool, and in order to recognize soil erosion rates below T. A reviewer of the current report noted that more complicated physical metrics could provide a better indicator against which to assess the importance of existing erosion rates, and an economic rationale could be used by comparing the erosion rate and crop yield; given the scope of this exercise, additional comparative analyses have not been conducted but could be the subject of other studies.

In general, while more sophisticated approaches for estimating soil erosion may be utilized at smaller scales and with private data to better predict and measure site-specific soil erosion, disaggregate water and wind erosion reporting, and otherwise improve reporting and analysis for soil erosion at the field level, the use of the NRI data is appropriate given the scope of this report in analyzing trends at the national scale and utilizing publicly available, national-scale datasets. Field to Market explored the possibility of updating its national-scale methodology for soil erosion by moving from the use of USLE to RUSLE2; however, the NRI currently evaluates soil erosion trends at this scale only using USLE. As a measure of relative change over time, USLE remains appropriate, however, RUSLE2 provides more accuracy in terms of absolute numbers and Field to Market will utilize it for its national scale reporting if and when NRI makes this transition (Field to Market currently uses RUSLE2 in its Fieldprint Calculator field-scale methodology).

Results are presented as total resource loss (total tons of soil erosion), average soil erosion per acre, and soil erosion per unit of production. Average trends for the entire study period are calculated using a least squares trends analysis. Efficiency data are indexed where the year 2000 equals 1 and displayed with other resource indicators on a summary spidergram by crop.



2.5. Irrigation Water Applied Indicator

Water is becoming an increasingly scarce resource[27] due to greater demands associated with population growth, urbanization and accessibility.[28,29] Increased population means increased food requirements.[30] These increased demands on water create more competition for this finite resource.

Water is an important limiting factor for crop production.[31] Without an adequate and timely water supply, crop production is not possible.[32,33] The 2008 Farm and Ranch Irrigation survey reported 18 percent of harvested cropland in the U.S. is irrigated.[34] In 2005, irrigation water withdrawals in the U.S. accounted for 31 percent of total withdrawals.[35]

This report presents a method for calculating total irrigation water applied, average irrigation water applied per acre, and average irrigation water applied per incremental unit of production achieved due to irrigation. We focus on irrigation water applied as a primary resource over which growers have direct control. Irrigation water applied does not necessarily equal irrigation water use in all contexts, as use is dependent on plant processes that either utilize the water for growth or result in the return of water to the watershed. This report recognizes this distinction and does not attempt to analyze the actual use of irrigation water by plants nor the rate of return of water applied back to the watershed or aquifer.

[27] Gonzalez-Alvarez, Y, AG Keeler, and JD Mullen. 2006. Farm-level irrigation and the marginal cost of water use: Evidence from Georgia. Journal of Environmental Management 80:311-317.

[28] Hren, J and HR Feltz. 1998. Effects of irrigation on the environment of selected areas of the Western United States and implications to world population growth and food production. Journal of Environmental Management 52:353-360.

[29] USDA. 2004. Briefing Room; Irrigation and Water Use. Washington, D.C.: United States Department of Agriculture

[30] Khan, S and MA Hanjra. 2008. Sustainable land and water management policies and practices: A pathway to environmental sustainability in large irrigation systems. Land Degradation and Development 19:469.

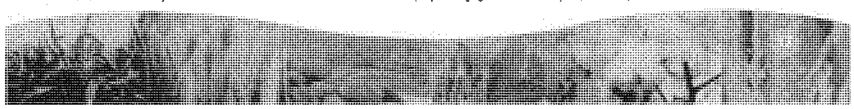
[31] USDA. 2004. Briefing Room: Irrigation and Water Use. Washington, D.C.: United States Department of Agriculture.

[32] World Commission on Environment and Development. (1987). Our Common Future. New York: United Nations.

[33] Khan, S and MA Hanjra. 2008. Sustainable land and water management policies and practices: A pathway to environmental sustainability in large irrigation systems. Land Degradation and Development 19:469.

[34] USDA NASS. 2009. 2008 Farm & Ranch Irrigation Survey. In: United States Department of Agriculture, National Agricultural Statistics Service (NASS), Research and Development Division. Geospatial Information Branch, Spatial Analysis Research Section. 2009. 2007 Census of Agriculture, United States Summary and State Data.

[35] USGS. 2009. Summary of estimated water use in the United States in 2005. http://pubs.usgs.gov/fs/2009/3098/pdf/2009-3098.pdf



Field to Market also strongly recognizes the importance of annual rainfall and groundwater resources in providing context for irrigation decisions and the impacts of irrigation in a given geographic area[36] as well as the importance of different "types" of water – green, blue, and gray – and how their usage can impact water stress. The decision to irrigate will be driven in part by the geographic context, and the impacts of irrigation on the watershed will vary based on specific regional and local context, including water scarcity and availability, aquifer recharge rates, etc. For example, for aquifers such as the Ogallala, where withdrawals (for all uses, including agriculture) significantly outpace recharge rates, irrigation water applied must be compared against overall limitations to truly understand water sustainability issues for that region. Important work to characterize geographic variability and total water use indices is being developed by others; consistent with the scope and purpose of this current work, Field to Market focuses here on overall national trends.

This report focuses on total irrigation water applied as well as the incremental benefit of that irrigation water in terms of additional production achieved. Irrigation water applied is the anthropogenic application of water on land to facilitate the growing of crops, pastures and recreational lands in order to maintain vegetative growth.[37]

Although it is recognized that irrigation sources vary,[38] in this report, these differences will not be addressed; the focus of the report is on irrigation water applied, irrespective of source. To the extent that irrigation source and mechanism (e.g., gravity fed vs. pumping) drives energy use, these practices are captured in the energy use metric.

Data used for the irrigation analysis for the report were taken from the "Farm and Ranch Irrigation Survey," part of the Census of Agriculture.[39 40 41 42] This data source was chosen because it is the only consistent and peer-reviewed source available for national data on water use and water management practices in the United States.[43 44 45] The benchmark years of data used in this analysis are 1984, 1988, 1994, 1998, 2003, and 2008. The reference year for the Farm and Ranch Irrigation Survey is generally the year following the general NASS Agriculture Census. Survey methodology included a mail-out survey to nearly 20,000 randomly selected operators who had noted irrigation use in previous census years. While participants were randomly selected, leading irrigation states were well represented. The population was stratified into Water Resource Area, state, and the number of irrigated acres in order to increase the probability that an operator would be selected based on irrigation usage.[46]

[37] USGS. 2008. Water Science for Schools; Irrigation Water Use. Washington, D.C.: United States Geological Survey.

[38] Chakravorty, U. and C. Umetsu. 2003. Basinwide water management: A spatial model. Journal of Environmental Economics and Management 45:1.

[39] USDA NASS. 1992. 1994 Farm & Ranch Irrigation Survey. In: Census of Agriculture 1992. Washington, D.C.: United States Department of Agriculture, National Agricultural Statistics Service. http://www.census.gov/prod/1/agr/92fris/

[40] USDA NASS. 1997. 1998 Farm & Ranch Irrigation Survey. In: Census of Agriculture 1997. Washington, D.C.: United States Department of Agriculture, National Agricultural Statistics Service. http://www.nass.usda.gov/census/census97/fris/fris.htm

[41] USDA NASS. 2002. 2003 Farm & Ranch Irrigation Survey. In: Census of Agriculture 2002. Washington, D.C.: United States Department of Agriculture, National Agricultural Statistics Service. http://www.agcensus.usda.gov/Publications/2002/FRIS/fris03.pdf

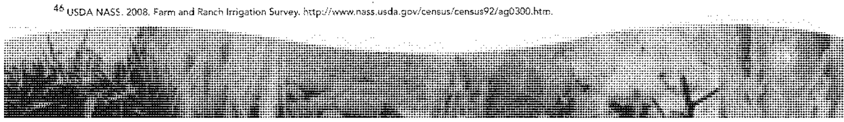
[42] USDA NASS. 2009. 2008 Farm & Ranch Irrigation Survey. In: United States Department of Agriculture, National Agricultural Statistics Service (NASS), Research and Development Division, Geospatial Information Branch, Spatial Analysis Research Section. 2009. 2007 Census of Agriculture, United States Summary and State Data.

[43] Maxwell, SK, Wood, EC and A Janus. 2008. Comparison of the USGS 2001 NLCD to the 2002 USDA Census of Agriculture for the Upper Midwest United States. Agriculture, Ecosystems & Environment 127:141-145.

[44] USDA. 2008 Oct. Commodity Costs and Returns. Washington, D.C.: United States Department of Agriculture.

[45] Chang, T and PS Kott. 2008. Using calibration weighting to adjust for nonresponse under a plausible model. Biometrika 95:555.

[46] USDA NASS. 2008. Farm and Ranch Irrigation Survey. http://www.nass.usda.gov/census/census92/ag0300.htm.



This survey provides information on the sources and uses of irrigation water for 48 states, not including Hawaii and Alaska. Information obtained from survey participants included the source and amount of water used for irrigation, the number of acres irrigated, the type of distribution system used for irrigation, the number of wells and their characteristics, the amount of water use for each crop type, the average crop yields, the participant's irrigation practices, the capital spent on irrigation, the maintenance costs, the type of energy used, and the types of new technologies employed.

Data used from the Farm and Ranch Survey for this metric include quantity of water applied by crop, acres of irrigated crop, yield for the irrigated crop and yield for non-irrigated production on farms that irrigate. Given that the data presented in the Farm and Ranch Irrigation Survey are collected for farms that do irrigate we feel that it is appropriate for purposes of this analysis to compare the irrigated and non-irrigated yields on these farms and the differential between them. However, it is recognized that the reasons for irrigating or not irrigating are complex and often are not simply a matter of equal land capability class; this report assumes that the dryland comparison from the same farm provides a "control" condition that for various reasons may not provide a clean, unbiased comparison. For rice and potatoes, data for non-irrigated production are not available and consequently we consider the total yield to be attributable to irrigation, i.e., non-irrigated yield is assumed to be zero for calculation of the metric.

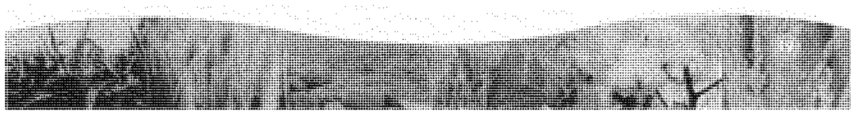
The national average yield for each crop (yields for farms that irrigate, including the irrigated and non-irrigated yields on these farms) was calculated by averaging the values for the six census years stated above. Using the averages of these six benchmark years, the relationship between the national average yield, irrigated yield and non-irrigated yield was established for each crop. National averages for irrigated and non-irrigated production, yield, and water use are based on state level acreage and water use weights. Then, by linear interpolation, the outcomes were used to estimate irrigated and non-irrigated yields and water applied per acre for years without census data. These years were based on annual data from NASS and their crop production report. In addition, the average share or portion of total acreage irrigated for each crop was calculated. This was done by dividing the amount of land irrigated by the total amount of land planted for each crop:

- *Irrigated acres/total planted area (acres) = irrigated share*

The share of irrigated acreage for reference years was used to estimate the irrigated acreage for non-survey years by linear interpolation. Between survey values, water application rates were estimated by linear interpolation; after 2008, they were assumed to be constant at the 2008 level.

Non-irrigated yield for farms that irrigate was subtracted from irrigated yield for farms that irrigate in order to determine difference in yield between the two practices(again, yields were only compared for farms that do irrigate; yields were not compared against farms that do not irrigate) Data were averaged over all six reference years before the overall differential was established:

- *Irrigated yield – non-irrigated yield = Net Impact of Irrigation on Yield*

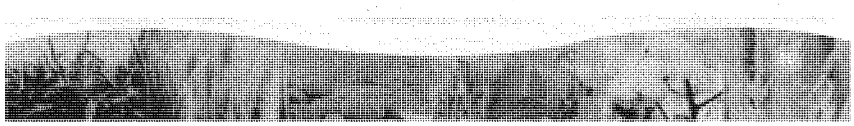


The average amount of water applied is expressed in acre inches and divided by the irrigation yield differential to determine the acre inches of water used per unit of incremental production:

- *Total acre inches /difference in yield*

We recognize the limited number of data points as a limitation to our methods. However, at the national level, a suitable alternative was not found. Smaller scale studies may provide more regular annual data at the state or regional level. For the same reason, a small n value for reference years, statistical analyses for significance were not performed.

Results are presented in total irrigation water applied, irrigation water applied per planted acre, and irrigation water applied per unit of incremental production due to irrigation. Average trends for the entire study period are calculated using a least squares trends analysis. Efficiency data are indexed where the year 2000 equals 1 and displayed with other resource indicators on a summary spidergram by crop.



2.6. Energy Use Indicator

From the generation of electricity and production of nitrogen fertilizer to the drying and transportation of grain, agriculture uses energy in many forms. Numerous studies have estimated the energy use, both direct and indirect, from crop production (see Piringer and Steinberg 2006, Shapouri 2004, West and Marland 2002, and Lal 2004 for energy estimates and summaries of other studies).[47 48 49 50] However, these studies typically look at energy use at a point in time, rather than as a time-series, as we are doing in this study.

Our analysis includes the major energy intensive areas of on-farm crop production: direct usage including operation of farm equipment, pumping irrigation water, and crop drying utilizing various energy products (diesel, electricity, gasoline, natural gas, and liquefied petroleum gas) and indirect usage including fertilizer production and crop protectant production. Our analysis does not quantify the energy associated with manufacturing farm equipment or other structures such as grain bins, buildings, etc.; these items typically contribute very little to the total energy or greenhouse gases given that they last many years and are often recycled/scrapped at the end of their usable life.

Direct usage includes average energy use for irrigation and transportation to move the crop to on-farm storage and ultimately to the point of sale. The 2012 energy use indicator is more comprehensive than that in the 2009 report in many ways, among the changes are the inclusion of embedded energy in seed and the handling energy associated with manure. Other additions to the energy metric include corrections for power generation efficiency, crop drying, and crop transport.

This 2012 study also attempts to capture the efficiency improvements over time in off-farm processes such as nitrogen production and electric power generation. An example of these efficiency changes is the significant reduction in the amount of natural gas it takes to produce nitrogen fertilizer (according to Fertilizer Institute data through 2006).

Data from several USDA sources, as well as other sources, were used to build estimates of the total energy use by crop by year. At the heart of the analysis of the energy used to produce corn, soybeans, wheat, cotton, and rice are the USDA's Agriculture Resource Management (ARMs) surveys; such comprehensive data were not available for potatoes and thus some values were taken from university crop enterprise budgets and used where needed. Our study also draws data from USDA's Agricultural Chemical Usage reports as well as the Greenhouse Gas Regulated Emissions and Energy Use in Transportation (GREET 1.8d) model from Argonne National Laboratory. All energy requirements are converted into British Thermal Units (BTU) for comparison purposes. Greenhouse gas emissions and embedded energy values for pesticides are taken from a Cranfield University study titled "Estimation of the greenhouse gas emissions from agricultural pesticide manufacturing."

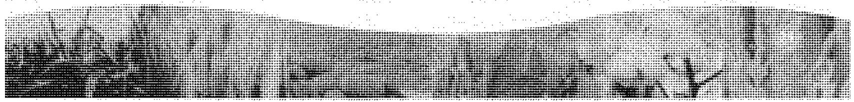
47 Piringer, G and L Steinberg. 2006. Reevaluation of Energy Use in Wheat Production in the United States. Journal of Industrial Ecology 10: 1-2: 149-167.

48 Shapouri, H, Duffield, J, McAloon, A and M Wang. 2004. The 2001 net energy balance of corn-ethanol. Washington, D.C.: United States Department of Agriculture. http://www.usda.gov/oce/reports/energy/net_energy_balance.pdf

49 West, TO and G Marland. 2002. A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: Comparing tillage practices in the United States. Agriculture, Ecosystems, and Environment 91:217-232.

50 Lal, R. 2004. Carbon emission from farm operations. Environmental International 30 (2004) 981-990. http://cirit.osu.edu/clusterone/LASCANET/pdf%20files/Lal_3.pdf

51 Audsley, E, Stacey, K, Parsons, DJ, Williams, AG. 2009. Estimation of the greenhouse gas emissions from agricultural pesticide manufacture and use. https://dspace.lib.cranfield.ac.uk/bitstream/1826/3913/1/Estimation_of_the_greenhouse_gas_emissions_from_agricultural_pesticide_manufacture_and_use-2009.pdf



2.6.1 Fuel and Electricity

The approach used to calculate fuel and electricity energy in the 2012 metric is very different than that in the 2009 report. The 2009 report used USDA estimates for the dollar value of all fuel- and energy-related expenses and used a price factor to estimate the physical quantity of the input used, often called a top down approach. The 2012 report uses a bottom up approach by which the estimate is built one piece at a time, e.g. using energy values for tractor operations, irrigation water pumping, grain drying and hauling, etc.

Several data sources are used to build these bottom-up estimates including the ARMs survey, the Farm and Ranch Irrigation Survey, and the Agricultural Census. These reports were used to establish levels of factors such as irrigation water applied, system pressure, and pumping water depth; all these factors allow for the creation of an estimate for pumping energy for irrigation. In the case of equipment operation, a combination of ARMs data on tillage practices as well as national level data for tillage practices from the Conservation Technology Information Center (CTIC) were used with data on energy consumption from NRCS and ERS. Energy and carbon dioxide (CO_2) emissions levels by crop by tillage system (no-till, ridge-till, mulch till, and conservation till) are estimated from the study by West and Marland.[52] Given that specific data for cotton and rice energy by tillage system were not provided in the West and Marland (2002) study, it was assumed the tillage contribution to be the same for cotton as for corn for a given system, e.g., no-till.

In the case of rice, USDA NRCS estimates for fuel consumption[53] for rice versus corn were used to calibrate the West and Marland estimates to rice; corn was chosen because the USDA NRCS calculator includes estimates for corn in all states that also produce rice and is also found in the West and Marland study.

The national average rice tillage energy for a conventional tillage program was 54% that of corn among rice producing states. The portion of planted acreage managed using each of the defined tillage systems comes from the ARMS data and CTIC and is available for all crops with the exception of potatoes which are assumed constant over time.

Ideally, data would exist to allow quantification of fuel efficiency and emissions changes over time; however, our scan of the U.S. agriculture landscape did not find such data and consequently fuel efficiency over time is considered constant. We acknowledge that while not reflected in this analysis, equipment technology such as advanced transmissions and performance optimization have improved fuel efficiency per acre and per unit production.

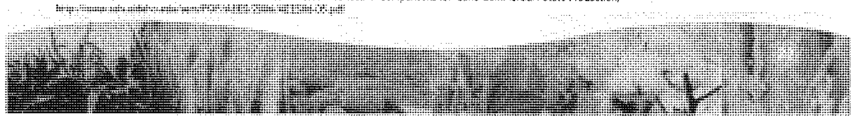
Fuel use data are not available through ARMS for potatoes, and consequently placeholder values were used based on typical levels provided in a detailed, 2006 University of Idaho study of production costs for Idaho potatoes:[54]

- Fuel for custom fertilizer applications (2), and custom aerial sprays (3) – 1.7 gallons of diesel/planted acre/year (set value for all years)
- Fuel for custom soil fumigation operations at 4.78 gallons of diesel/acre corrected by the percent of acres fumigated in "program states" each year
- Fuel use for other tractor operations (such as land prep, tillage, harvest) at a set value of 27.23 gallons of diesel/acre/year and 3.19 gallons of gasoline/acre/year
- Custom hauling was calculated at 0.07 gallons of diesel/cwt using production volume from each year

52 West, TO and G Marland. 2002. A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: Comparing tillage practices in the United States. Agriculture, Ecosystems, and Environment 91:217-232

53 USDA NRCS Energy Estimator. Energy Consumption Awareness Tool: Tillage. http://ecat.sc.egov.usda.gov/

54 Patterson, PE and RL Smathers. 2006. 2006 Cost of Potato Production Comparisons for Idaho Commercial Potato Production, [illegible]



The 2012 report also makes an estimate of the energy associated with manure application by crop: the report uses ARMS data for application rate, incidence of application and animal species to estimate the loading and application energy used for manure. A factor of 0.0862 gallons of diesel fuel per ton of manure (wet basis) applied is used to estimate the loading and application energy for manure.

2.6.2 Agricultural Chemicals (Crop Protectants)

Data on the quantity of agricultural chemicals used by crop type are available from USDA's ARMs survey and its Agricultural Chemical Usage reports.[55] USDA ARMS data utilizes four categories for pesticides: herbicides, insecticides, fungicides, and "all other." All data are reported as total pounds of active ingredient applied. Values for embedded energy in pesticides are provided in a report titled "Estimation of the greenhouse gas emissions from agricultural pesticide manufacturing" (Cranfield University, United Kingdom); the Cranfield study provides factors for energy and greenhouse gas emissions for the three named USDA pesticide categories (herbicides, insecticides, fungicides).[56] Fumigant, Plant Growth Regulators, Defoliants and other pesticide greenhouse gas (GHG) and energy values are not available in the Cranfield report; given their chemical nature these products are included in the herbicide category. For each category, the average energy per unit of active ingredient was multiplied by application rates by crop over time.

Product average values used for all crops/all years were as follows, as derived from the Cranfield study:[57]

- BTU per Pound Herbicides: 113,715
- BTU per Pound Insecticides: 92,175
- BTU per Pound Fungicides: 74,377
- BTU per Pound for products in USDA's "All Other" Category 113, 715

2.6.3 Chemical Fertilizer

USDA's Economic Research Service (ERS) provides national level data on the acreage and percentage of acreage of major crops that use chemical fertilizers, as well as the rate of fertilizer application.[58] Years without data on application rates from USDA were estimated by linear interpolation between years on the basis of rate (pounds/acre). By multiplying the percentage of acres fertilized by the application rate, one can calculate fertilizer per planted acre. Dividing by USDA's yield data results in the amount of fertilizer per bushel or pound of crop. Fertilizer application rates for N,P_2O_5, and K_2O basis are multiplied by energy conversion factors provided in the GREET 1.8d model; these factors include embedded energy and transport energy for fertilizer. Values used for all crops are as follows:[59]

- BTU per Pound N: 23,646
- BTU per Pound P_2O_5: 5,945
- BTU per Pound K_2O: 3,722

Note: Corn, cotton, potatoes, rice and wheat all require fertilizer nitrogen for economically viable yields. When properly inoculated, soybeans do not require nitrogen fertilizer. However, diammonium phosphate (DAP) is one of the most common forms of phosphorus fertilizer and it contains nitrogen. Thus, any DAP applied to soybeans will include nitrogen. It is this portion of nitrogen that is included in the soybean calculations.

[55] USDA National Agricultural Statistics Service (NASS). 2011. Agricultural Chemical Usage – Field Crops and Potatoes. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560

[56] Audsley, E, Stacey, K, Parsons, DJ and AG Williams, AG. 2009. Estimation of the greenhouse gas emissions from agricultural pesticide manufacture and use. https://dspace.lib.cranfield.ac.uk/bitstream/1826/3913/1/Estimation_of_the_greenhouse_gas_emissions_from_agricultural_pesticide_manufacture_and_use-2009.pdf

[57] Ibid.

[58] USDA ERS. 2008. Nitrogen used on cotton, rate per fertilized acre receiving nitrogen, selected States. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/Data/FertilizerUse/Tables/Table16.xls.

[59] U.S. Department of Energy Argonne National Laboratory, http://greet.es.anl.gov/publications

2.6.4 Planting Seed Energy

Seed energy, or more specifically, energy in seed used for crop establishment, is estimated as a proportion of the crop that would need to be used to create the seed used to establish the crop. Using corn as an example and given its relatively high yield and relatively low seed planting rate per acre, the impact of planting seed energy on total energy is very minimal. Also included in the seed calculation are 2 factors that are held constant across all crops which are the seed production yield factor (0.66) and the seed production energy intensity factor (1.5). These factors are used to correct for the fact that seed yields are typically lower than the crop yield for grain and also that more inputs are typically in the production of seed versus the general crop. In effect the factors imply that seed yields are 66% that of production for the general market and that input usage (fertilizer, tillage, etc.) is 150% that of commercial production. No official source exists for these seed factors so they were derived through discussions with industry experts. The seed factors were also developed to be a conservative (high) estimate of the likely energy used to produce seed. The impact of this approach likely creating a high estimate is minimized by the fact that seed usually accounts for less than 2 or 3 percent of the total energy to produce the crop.

Corn Seed Calculation		
Grain Yield	150	Bushel per Acre
Seed Yield Factor	0.66	Percent of Grain
Seed Yield	99	Bushels per Acre
Seed Input Intensity Factor	150	Percent
Seed Use Rate	25895	Kernels
Seed Conversation	80000	Kernels/Bushel
Seed Energy Share	0.49	Percent

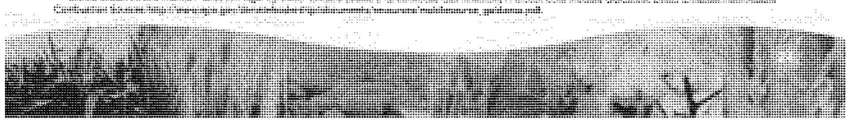
2.6.5 Drying and Crop Transport

Drying and crop transport energy was estimated by drawing estimates of grain drying activity from USDA reports, and in some cases extension specialists, and applying formulas available from extension literature.[60] The amount of moisture removed from grain and cotton were considered to be constant over time (does not change from year to year) as were the thermal efficiencies of drying equipment, this assumption was used with recognition that newer, more energy efficient grain dryers are being installed but that there is a lack of publicly available data to account for these improvements over time. Estimated distances from farm to point of sale were used in conjunction with EPA data on fuel consumption of heavy trucks to develop the transportation estimate.[61] Estimated distances are provided in the table below and are based on expert judgment regarding the crops analyzed; actual data are not available through the published ARMS surveys. EPA reports average one-way heavy truck mileage at 6.5 miles per gallon of diesel and provides no guidance on energy efficiency or emissions changes over time. Consequently this value is held constant over time. Literature on the amount of moisture removed from crops and the average distance transported is not routinely reported in the ARMs data or elsewhere. Given the lack of publicly available data at this time, both drying and transport energy levels are held constant on a per unit of production basis.

	Points of Moisture Removed	One-Way Distance Transported-Miles
Corn	2.9	30
Soybeans	1.4	45
Wheat	1.4	45
Rice	5.0	30

60 Sanford, S. 2005. Wisconsin Focus on Energy/Rural Energy Issues, University of Wisconsin, Biological Systems Engineering. Reduce Grain Drying Costs this Fall. http://extension.missouri.edu/seregion/Farm_Managenment/Wisconsin_Grin_Drying_Ecoonomics.pdf

61 [illegible]



2.6.6 Transport and Storage Energy Use (Potato)

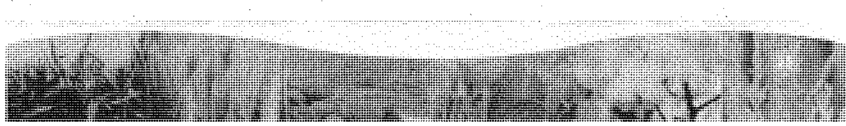
Depending on the sales arrangement a grower has with his/her buyer, potatoes may be sold as delivered to the buyer's location or the burden of hauling may be the responsibility of the buyer. In our analysis we don't include any transport energy from the farm or farm storage to the buyers' location.

Much of the fall potato crop is stored after harvest. This is to achieve year-long supply for the fresh market and to make efficient use of the capital investment in processing facilities. Storage energy is used for cooling and for air circulation to prevent excess build-up of humidity and/or CO_2. However, time in storage differs significantly, ranging from a few weeks to 10 months. In the case of potatoes, for this report, the crop was considered to have been stored for 120 days on farm and no transportation energy was assigned to the crop for purposes of this analysis.

Energy for ventilation in storage ranges from 7-13 kWh/1000cwt/day with conventional fans and from 3.7 to 7.2 Kwh/1000cwt/day with variable fan drives. For 120 days of storage, those ranges represent 2.7-5.1 KBTU/cwt and 1.5 to 2.9 KBTU/cwt respectively. These values are in the range of 2.8 to 9.7 percent of the total energy for production of the crop.

Energy use for cooling of stored potatoes varies greatly with the ambient temperature, which changes with the time of the year and with location. The efficiency of mechanical refrigeration systems also varies greatly with the age of the system. A substantial proportion of the cooling is also driven by evaporation – particularly at the beginning of the storage period.

Results are presented as total resource use (total Btu), average energy use per acre, and energy use per unit of production. Average trends for the entire study period are calculated using a least squares trends analysis. Efficiency data are indexed where the year 2000 equals 1 and displayed with other resource indicators on a summary spidergram by crop.



2.7. Greenhouse Gas Emissions Indicator

Climate change and its potential impact on agriculture is an important public policy topic. U.S. agriculture is a small but significant source of greenhouse gas, roughly 6.5% according to the US EPA.

This report measures the carbon dioxide equivalents (CO_2e) emitted both directly and indirectly in the production process. Whenever practical, the methods used in our greenhouse gas emission calculation utilize the US EPA inventory of emissions, including factors such as field burning and residue removal which were not included in the 2009 report.[62,63,64] This report also takes co-product/bi-products into consideration in the calculation of all metrics including energy and greenhouse gases. In the national context, cotton and wheat are the only two crops impacted by co-products in this analysis.

According to much of the current literature, energy use and tillage create sources of greenhouse gas emissions. However, some agricultural practices have the potential to sequester carbon dioxide in the soil.[65,66] For example, continuous no-tillage practices for some crops are documented as sources of carbon sequestration.[67,68] However, national scale datasets regarding continuous no-till practices do not exist, and the impact of intermittent no-till or other conservation tillage practices on soil organic matter remains poorly understood and are soil and climate specific. Some studies suggest that no-till may result in changes in the distribution of soil carbon—concentrating it into the upper-most soil layer— rather than a significant increase in total soil carbon measured over a larger soil profile.[69,70] We recognize these uncertainties in the current scientific understanding of the impacts of tillage practices as limitations to our greenhouse gas emissions methodology and for these reasons soil carbon change is not counted in our greenhouse gas emissions indicator for 2012; our previous work did include it as an offset against other emissions. The removal of soil carbon from our metric is not an indication of lack of importance but rather an acknowledgment of the complexity and uncertainty of its measurement.

62 U.S. Environmental Protection Agency. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. Chapter 6: Agriculture. Washington, D.C.: U.S. Environmental Protection Agency. http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

63 U.S. Environmental Protection Agency. 2011. Reactive Nitrogen in the United States: An Analysis of Inputs, Flows, Consequences, and Management Options. A Report of the EPA Science Advisory Board. Washington, D.C.: U.S. Environmental Protection Agency. http://yosemite.epa.gov/sab/SABPRODUCT.NSF/67057225CC780623852578F10059533D/$File/EPA-SAB-11-013-unsigned.pdf

64 Ibid.

65 Snyder, CS, Bruulsema, TW, Jensen, TL and PE Fixen. 2009. Review of greenhouse gas emissions from crop production systems and fertilizer management effects. Agric. Ecosyst. Environ. 133: 247–266.

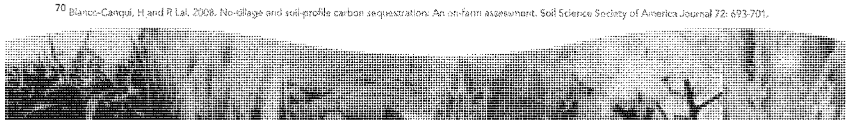
66 Paustian, K, Andren, O, Janzen, HH, Lal, R, Smith, P, Tian, G, Tiessen, H, Van Noordwijk, M and PL. Woomer. 2007. Agricultural soils as a sink to mitigate CO2 emissions. Soil Use and Management 13:s4:230-244.

67 For example, West, TO and W.M. Post. 2002. Soil organic carbon sequestration by tillage and crop rotation: A global data analysis. Soil Science Society of America Journal 66:1930-1946.

68 Ibid.

69 Omonode, RA, A Gal, E Stott, TS Abney and T J Vyn. 2006. Short-term versus continuous chisel and no-till effects on soil carbon and nitrogen. Soil Science Society of America Journal 70: 419-425.

70 Blanco-Canqui, H and R Lal. 2008. No-tillage and soil-profile carbon sequestration: An on-farm assessment. Soil Science Society of America Journal 72: 693-701.



Another significant change in the 2012 report comes with the addition of rice as a crop. Methane emissions are associated with rice production. CH_4 emissions are the result of anaerobic conditions that occur in fields that need to be flooded for continuous periods of time during the growing season in order to produce a rice crop. Because the 2009 report did not include rice, it did not include methodology for estimating CH_4 emissions; this methodology is now incorporated in the case of rice.

Estimates for emissions from equipment operation and other operations such as irrigation pump operation were developed in the same manner as in the energy calculation and a factor of 22.3 pounds CO_2 per gallon of diesel combusted was used. It is expected that actual emissions associated with combustion of diesel through agricultural engines has improved over time but no time series data for these emissions exists at this time. It is our understanding that groups such as the Nebraska Tractor Testing Laboratory are starting to track emissions of new equipment entering the agriculture sector and in the future these data can be used to substantiate change over time.

2.7.1 Agricultural Inputs

Data from the USDA's Agricultural Chemical Usage report provided periodic benchmarks for both chemical usage and fertilizer use for all crops in the 2012 study.[71] These product application rates were interpolated between reference years on a rate per acre basis to fill in gaps in data. Emissions factors for product-embodied CO_2 were taken from the GREET model version 1.8d for fertilizer and from Cranfield for crop protection products.[72 73]

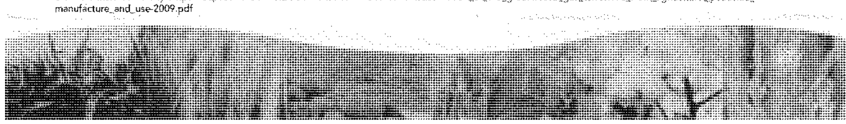
These emission factors were further adjusted to account for efficiency changes over time for natural gas to ammonia fertilizer conversion in the case of nitrogen fertilizer and for emissions changes on the electric grid over time for crop protection products. The electric grid correction factor was chosen for crop protection products because of the very high relative importance of electric power in the production of these products compared to other energy inputs according to Cranfield.

The embedded greenhouse gases in the seed used to produce the crop is estimated in the exact same manner as it is for energy, e.g, as a fraction of the total greenhouse gases to produce the crop. A simplistic example would be if it takes 1 bushel of seed to plant a crop that produces 100 bushels of grain, then the greenhouse gases are roughly 1/100 or 1%. Expansion factors were applied to this 1% to acknowledge that seed yields are typically less than grain yields and that input use on seed is likely somewhat higher than grain production alone. An estimate of the fraction of the crop used to create the seed is developed and the emissions are based on the emissions to produce the actual crop.

[72] U.S. Department of Energy Argonne National Laboratory, http://greet.es.anl.gov/publications

[71] USDA National Agricultural Statistics Service (NASS). 2011. Agricultural Chemical Usage – Field Crops and Potatoes. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1560

[73] Audsley, E, Stacey, K, Parsons, DJ and Williams, AG 2009. Estimation of the greenhouse gas emissions from agricultural pesticide manufacture and use. Bedfordshire, U.K.: Cranfield University. https://dspace.lib.cranfield.ac.uk/bitstream/1826/3913/1/Estimation_of_the_greenhouse_gas_emissions_from_agricultural_pesticide_manufacture_and_use-2009.pdf



2.7.2 Emissions from Machinery Operations

The carbon emissions due to equipment operation for alternative tillage systems were reported by West and Marland (2002) as follows:[74]

Carbon Emissions from Machinery Operation	Corn	Soybeans	Wheat
Conventional (Kg C per hectare)	72.02	67.45	67.45
Reduced Tillage (kg C per hectare)	45.27	40.70	40.70
No-Till (kg per hectare)	23.26	23.26	23.26

The three tillage systems are defined in the study as being consistent with the definitions used by the Conservation Technology Information Center (CTIC) and USDA's ARMS data: Conventional Till, Reduced Till, and No-Till. CTIC provides data over time of the percentage of each crop under the different tillage practices. The CTIC values are provided for corn, soybeans, wheat, and cotton.[75] USDA ARMS data are used for rice; conventional tillage is assumed for potatoes with the assumption of little or no change in tillage practices (and thus tillage energy and emissions) for potatoes over time.[76]

Conventional tillage uses the most energy for machinery, and hence produces the largest carbon emissions of the three practices (no-till, reduced tillage, and conventional tillage), with respect to machinery usage. No-Till uses the least amount of energy, and hence produces the least amount of carbon emissions (see Table 2.7). Given that specific data for cotton and rice emissions by tillage system were not provided in the West and Marland (2002) study, it was assumed the tillage contribution to be the same for cotton as for corn for a given system, e.g., no-till.

In the case of rice USDA NRCS[77] estimates for fuel consumption for rice versus corn were used to calibrate the West and Marland estimates to rice; corn was chosen because the USDA NRCS calculator includes estimates for corn in all states that also produce rice and is also found in the West and Marland study. The national average rice tillage energy for a conventional tillage program was 54% that of corn among rice producing states. The portion of planted acreage managed using each of the defined tillage systems comes from the ARMS data and CTIC and is available for all crops with the exception of potatoes which are assumed constant over time.

The analysis in this report assumes that these emissions factors by tillage system have not increased or decreased over time. According to researchers at the Nebraska Tractor Test, the focus of agricultural engine researchers has been to reduce emission and this focus has limited their progress in fuel consumption improvements over time. Other recently added performance improving attributes of farm tractors are not well captured in the data provided by USDA.[78] While the specific impact of this assumption is not known, the directional impact is likely an understatement of improvements in energy efficiency and associated emissions over time.

Changes over time in the national average emissions from machinery come only from the changing percentages of tillage practices over time. Efficiency gains due to changes in tillage practices are captured using the CTIC and ARMs data for the share of each crop under each tillage system. In the case of potatoes, no change in tillage-related energy was assumed over the study period. This assumption was made because no publicly available data could be found to substantiate change over time.

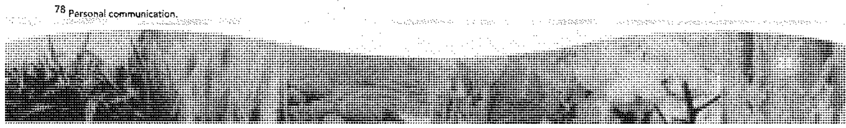
74 West, TO and G Marland. 2002. A synthesis of carbon sequestration, carbon emissions, and net carbon flux in agriculture: comparing tillage practices in the United States. Agriculture, Ecosystems, and Environment 91:217-232.

75 CTIC. 2006. 2006 Crop Residue Management Survey: A survey of tillage system usage by crops and acres planted. West Lafayette, IN: Purdue University Conservation Technology Information Center. http://www.conservationinformation.org/pdf/2006CRMSurveySummaryLoRes.pdf

76 Patterson, PE. 2004. Cost of Potato Production Comparisons for Idaho Commercial Potato Production. Moscow, Idaho: University of Idaho College of Agricultural and Life Sciences, Department of Agricultural Economics and Rural Sociology. http://www.ag.uidaho.edu/aers

77 USDA NRCS Energy Estimator. Energy Consumption Awareness Tool: Tillage. http://ecat.sc.egov.usda.gov/

78 Personal communication.



Emissions associated with changes in the level of soil carbon are considered to be neutral in this study so they neither add nor subtract from the total emissions of the crop.

Emissions from the pumping and distribution of irrigation water are estimated from the energy calculation. Given the prevalence of electric pumps used in irrigation, the improvements in emissions from the national grid are taken into consideration with regard to irrigation.

2.7.3. Soil Nitrous Oxide (N_2O) Emissions from Nitrogen Application

Nitrous oxide (N_2O) is a potent greenhouse gas (global warming potential 296 times CO_2),[79] and as such, N_2O released from soil microbial activity in association with fertilizer nitrogen application is an important source of carbon-equivalent emissions. However, the range of estimates for N_2O as a percent of N applied is very wide depending on the source of N, the method of application, and the soil conditions at the time of application. Data from the 2009 International Plant Nutrition Institute literature review reports that N_2O emissions as a percent of N applied can range from near zero to nearly 20 percent of applied N.[80] Bouwman et al (2002) report a global mean of 0.9% of nitrogen from fertilizer is released from soil as N_2O.[81]

For the purposes of our analysis we use a factor of 1.4 percent of all fertilizer N applied. This estimate is consistent with the current Intergovernmental Panel on Climate Change (IPCC) estimates.[82]

To estimate N_2O emissions from crop production the applied nitrogen from commercial/synthetic fertilizer and manure is multiplied by 1.4 percent to estimate the nitrogen that is emitted as nitrous oxide.

The 1.4 percent factor accounts for emissions from all sources, both direct and indirect. The IPCC assumes that 1% of applied nitrogen fertilizer (uncertainty range of 0.3-3.0%) is lost from direct emissions of N_2O at the field level due to nitrification/ denitrification. This assumption is based on analysis of all appropriate scientific publications that report these losses for specific crops and cropping systems (IPCC, 2007a). Indirect N_2O emissions result from denitrification of volatilized ammonia (NH_3) deposited elsewhere or from nitrate (NO^3) - lost to leaching and runoff as the reactive nitrogen (Nr) cascades through other ecosystems after leaving the field to which it was applied. The IPCC assessment protocol assumes that volatilization losses represent 10% of applied nitrogen, and that N_2O-N emissions for these losses are 1% of this amount; leaching losses are assumed to be 30% of applied nitrogen and N_2O-N emissions are 0.75% of that amount.[83] Therefore, the IPCC default value for total direct and indirect N_2O emissions represents about 1.4% of the applied N from fertilizer. While sophisticated models exist to more closely estimate N_2O emissions on a field scale (e.g., the DeNitrification-DeComposition, or DNDC model),[84] the execution and aggregation of this model to the national scale is beyond the scope of this report, and for the purposes of estimating trends in national average emissions, the use of the single factor is deemed appropriate.

[79] IPCC. 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, JT,Ding, Y, Griggs, DG, Noguer, M, van der Linden, PJ, Dai, X, Maskell, K and CA Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881 pp.

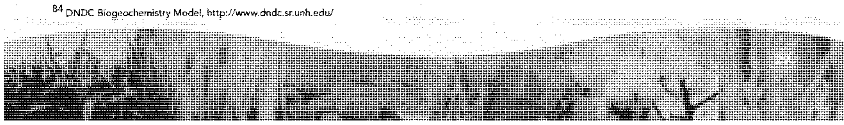
[80] Snyder, CS, Bruulsema, TW, Jensen, TL and PE Fixen. 2009. Review of greenhouse gas emissions from crop production systems and fertilizer management effects. Agric. Ecosyst. Environ. 133: 247–266.

[81] Bouwman, AF, Boumans, LJM and NH Batjes. 2002. Modeling global annual N2O and NO emissions from fertilized fields. Global Biogeochemical Cycles 16:4:1080.

[82] IPCC. 2001. IPCC Third Assessment Report: Climate Change 2001. Geneva: United Nations Environmental Program Intergovernmental Panel on Climate Change. http://www.grida.no/climate/ipcc_tar/wg1/

[83] IPCC. 2007a. Intergovernmental Panel on Climate Change: Fourth Assessment Report: Climate Change 2007 (AR4). www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1

[84] DNDC Biogeochemistry Model, http://www.dndc.sr.unh.edu/



Data on U.S. mean annual fertilizer nitrogen applied per crop by year is provided by USDA and manure application data were taken from USDA's ARMS data concerning tons applied and manure source by crop over time. Data for non-reported years are interpolated on a rate per acre basis and held constant prior to the data beginning and after the last data point. It is noted that management factors such as split application on nitrogen as well as application method and timing can have a significant impacts on the ultimate emissions level from applied nitrogen. The approach we have taken does not capture these differences or their potential to have changed over time.

To convert the emissions from applied nitrogen into carbon dioxide equivalents (CO_2e), we have accounted for the ratio of the molecular weight of nitrous oxide to nitrogen (44/28) and the CO_2e factor for nitrous oxide (296). Using these factors, 100 pounds of applied N results in emission of 651 pounds CO_2e.

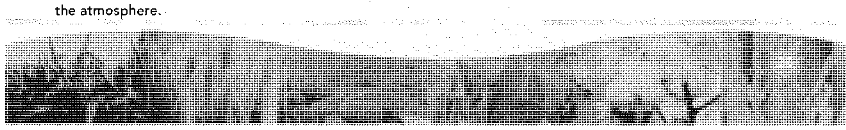
- *Emissions from 100 pounds applied N = 100 X 1.4% X (44/28) X 296 = 651* pounds CO_2e.

2.7.4 Emissions from Field Burning and Residue Removal

Emissions from field burning of surface residue are a relatively small share of total emissions from agricultural production but in cases where residue is burnt the impact can be significant. Field burning emissions are calculated for all crops in the study except potatoes due to the fact that potatoes typically have no surface residue that would warrant burning; while we have algorithms to estimate emissions from burning for soybeans and cotton and these are utilized in this report, from a practical standpoint little or no field burning is performed for these crops. National incidence levels of residue burning are taken directly from the EPA reporting of greenhouse gases from agriculture. The quantity of surface residue available to be burned is calculated as a proportion of the crops' yield; crop specific factors are available for every crop. The final calculation determines the amount of CH_4 and N_2O released into the atmosphere.

The release of CO_2 is not counted as it is expected to be released over time independent of burning; burning just changes the timing. At the national level, field burning of sugarcane is a much larger contributor than any of the crops considered in our analysis. Among the crops in our analysis burning of rice residue is the most prevalent with 10% of acres being burnt according to EPA data. When you apply the factors to calculate emissions from residue burning of rice overall it accounts for about 0.5 percent of total emissions for rice.

Among the crops in this analysis, wheat is the only crop for which a measurable share of the acres have residue removed following the primary crop harvest. A value of 0.21 pound N from residue per bushel of grain harvested times the amount of acres harvested for straw of wheat harvested is subtracted from the greenhouse gas accounting. According to 1998 USDA ERS data, 13% of all wheat acres experience straw removal; the nitrogen factor is based on an expectation of 50% of the surface residue being removed. At the national level wheat straw removal reduces greenhouse gas emissions for the crop by between 0.5 to 0.75 percent.



2.7.5 Methane (CH_4) Emissions from Rice Fields

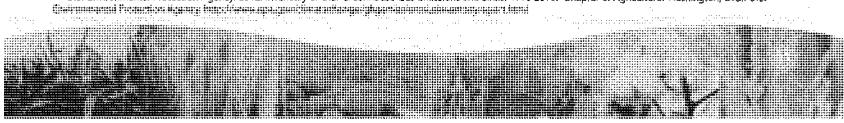
Emissions for rice are based on the levels reported in the EPA's annual inventory of greenhouse gases.[85] EPA data were scaled to a per planted acre basis for the period 1990 through 2010. Years prior to 1990 were set to the 1990 level while years after 2010 were held constant at the 2010 level, again on a per planted acre basis. Consistent with EPA's reporting of the data, CH_4 emissions have trended lower over time on both a per acre and per unit of production basis. It should be noted that CH_4 emissions from other crops due to flood irrigation are considered to be insignificant due to the relatively limited number of acres flooded and the short duration of flooding.

2.7.6 Emissions from Grain Drying and Transport

The emissions from grain drying, crop storage (potatoes), and transport are calculated in a consistent manner with the energy used for these activities. Largely the amount of fuel energy combusted and electricity consumed are used to estimate greenhouse gas emissions. Propane is assumed as the fuel for drying while diesel is assumed as the fuel used for transport. Electricity values are assumed as average emissions from the national grid including improvements in emissions over time.

Results are presented as total greenhouse gas emissions (carbon dioxide equivalents), average emissions per acre, and average emissions per unit of production. Average trends for the entire study period are calculated using a least squares trends analysis. Efficiency data are indexed where the year 2000 equals 1 and displayed with other resource indicators on a summary spidergram by crop.

[85] U.S. Environmental Protection Agency. 2012. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2010. Chapter 6: Agriculture. Washington, D.C.: U.S. Environmental Protection Agency. [illegible]



2.8. Discussion of Progress on Water Quality and Biodiversity Indicators

Introduction

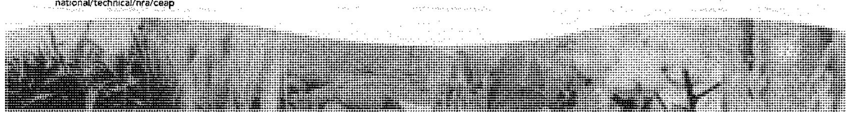
In its 2009 environmental indicators report, Field to Market recognized the need to develop methodologies for measuring environmental outcomes of water quality and biodiversity. Field to Market has been working actively since that first report to develop metrics for these outstanding indicators. Each has posed unique challenges and greater difficulty as compared to the indicators detailed in the first report, raising important questions, in particular, about what trends can be reported at the national or regional scale that are meaningful, measurable, and can be correlated back to practices and decisions within the control of agricultural producers.

Below we describe our progress in developing metrics for water quality and biodiversity at the national and regional scale. Field to Market plans to report on an analysis of watershed-scale trends in water quality and aquatic biodiversity (currently under review) in the future. Field to Market is also currently actively developing and evaluating potential field and farm-scale metrics for water quality and biodiversity and will release information about these processes and products as appropriate in the future.

In the past several years, the USDA Conservation Effects Assessment Project (CEAP) has provided important analyses of regional and national water quality and biodiversity trends. CEAP is a multi-agency effort to quantify the environmental effects of conservation practices and provides the science and education base needed to enrich conservation planning, implementation, management decisions, and policy.

Recent CEAP Cropland National Assessment reports for specific river basins have provided findings regarding trends in implementation of conservation practices for soil erosion control and nutrient management; the modeled or estimated impacts of these practices in reducing sediment and nutrient losses; and the predicted benefit of additional implementation. The CEAP Wildlife National Assessment similarly seeks to quantify fish and wildlife benefits of conservation practices. [86]

[86] USDA Natural Resources Conservation Conservation Service. 2012. Conservation Effects Assessment Project. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap



Water Quality

Water quality is recognized as a primary concern for all agricultural stakeholders – including producers, the supply chain, consumers, conservation organizations, and regulatory agencies. The impacts of agriculture on water quality and aquatic ecosystems have been extensively studied and discussed. At the broad scale, Field to Market's effort to contribute to existing analyses and dialogues has focused on evaluating correlations between agricultural land use, water quality, and aquatic biodiversity at the watershed scale using publicly available monitoring datasets. This has proven no easy task, especially given the complexity of environmental and anthropogenic processes within a watershed. The work has been conducted under the leadership of University of Arkansas, with technical support, peer review, and directional guidance from the USGS as well as from water quality experts within Field to Market's diverse membership. The analysis is currently under review and information will be shared when final results are available.

Field to Market is also currently actively exploring potential field and farm-scale metrics for water quality to be implemented in the Fieldprint Calculator.

Biodiversity

Field to Market continues to explore indicators for biodiversity as related to agricultural sustainability. According to 2007 land use data from the USDA, the United States composes 2.3 billion acres in total; 17.7% of these are cropland, or 406 million acres.[87 88] In addition to working croplands, farmers also own and manage non-working lands including pastures and forests. Together, these working and non-working agricultural lands provide important ecosystem services including food production, habitat, soil health and prevention of soil erosion, and maintenance of water quantity and quality (which can also provide positive benefits for aquatic biodiversity). Private lands account for one quarter of the total populations of imperiled and endangered species in the U.S.[89] As the supply chain and consumers become more interested in the footprints of their food, including its impacts on biodiversity and the ecosystem services provided by agriculture, numerous efforts have emerged to develop biodiversity metrics and life cycle assessments for agricultural production.

A first path toward meeting production and biodiversity goals is in maintaining and increasing productivity of existing agricultural lands rather than expanding to/converting lands not already in production, thus decreasing pressure on existing habitat for wildlife and biodiversity of all forms.[90] Field to Market's existing land use metric tracks progress in increasing productivity with respect to land use by calculating the amount of land needed to produce a unit of production (e.g., a bushel of corn).

[87] Lubowski, RN, Vesterby, M, Bucholtz, S, Baez, A and M.J. Roberts. 2006. Major Uses of Land in the United States, 2002. United States Department of Agriculture, Economic Research Service; Report nr EIB-14.

[88] United States Department of Agriculture, National Agricultural Statistics Service (NASS), Research and Development Division, Geospatial Information Branch, Spatial Analysis Research Section. 2009. 2007 Census of Agriculture, United States Summary and State Data. Washington, D.C.: United States Department of Agriculture.

[89] Stein, BA, Kutner, LS, Adams, JS. 2000. Precious Heritage: Status of Biodiversity in the United States. Oxford University Press.

[90] Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Washington D.C.: Island Press. http://www.millenniumassessment.org/documents/document.356.aspx.pdf

Within a relatively mature agricultural system, a key question posed by Field to Market has been how to maintain and increase productivity on agricultural lands while also maximizing opportunities for biodiversity. Specifically, for working lands, are there measurable mechanisms for promoting biodiversity that are also consistent with sustained production? In addition, are there mechanisms and practices that can be applied to marginal agricultural lands that also meet these objectives?

Field to Market recognizes that on the one hand, farms have demonstrated that they are compatible with many forms of biodiversity and ecosystem services, and many farmers actively manage for these services, for economic reasons or otherwise. On the other hand, management for biodiversity and wildlife can be inconsistent with production goals, especially when this management attracts potential pests or otherwise leads to decreased productivity.

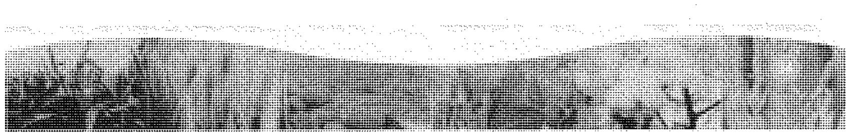
Field to Market seeks to develop metrics and tools intended to help understand the overall progress of agriculture with respect to biodiversity and to enable individual growers to understand their own performance in this area and identify potential mechanisms for maximizing biodiversity while maintaining or improving productivity.

Since the fall of 2008, Field to Market has explored possible outcomes-based, science-based approaches to both tracking the overall progress of agriculture with respect to biodiversity and enabling individual growers to track and improve their own progress in this area.

Several challenges have consistently presented themselves, including:

- Identifying the appropriate scales to meaningfully measure biodiversity so that producers can use information in their day-to-day management and stakeholders can assess overall biodiversity conservation performance.
- Identifying long-term, large-scale, outcomes-based datasets. While remote sensing can provide habitat data, few large-scale, outcomes-based species datasets exist.
- Identifying a suite of indicators, based on biodiversity goals.
- Defining "sustainability" for biodiversity can be context specific, with competing definitions depending on biodiversity goals. For example, high species richness may be favorable in some contexts but not in others; actions favoring one species may help or harm another species; species to be explored can include indicator species, keystone species, umbrella species, flagship species, and vulnerable species.
- Linking broader impacts to farm-scale practices can be problematic due to "noise" created by other influences on biodiversity (e.g., population trends for wide-ranging species such as birds are impacted by non-agricultural land uses).

In light of these challenges, Field to Market has explored various mechanisms for measuring biodiversity outcomes that are meaningful, measurable, and within the individual farmer's ability to control. We have considered approaches focused on species richness and abundance, land cover type and quality, conservation practices, and ecosystem services.



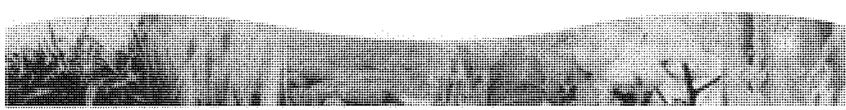
Examples of approaches that Field to Market has explored or is currently exploring:

Broad Scale Trends:

- Regional trends in aquatic macroinvertebrates are being explored through Field to Market's work in water quality metrics. Using USGS NAWQA data and US EPA wadeable streams data, Field to Market is exploring trends in observed versus expected (O/E) ratios for aquatic macroinvertebrates in watersheds that are dominated by agricultural land use. Field to Market plans to share results of these studies in the future once they are finalized.
- Agricultural land use trends are reported through Field to Market's current Land Use indicator, which tracks trends over time for total land use and land use efficiency for many commodity crops. The efficiency measure reflects trends in increasing productivity that can reduce pressure to convert new habitat.
- Field to Market also has explored the efficacy of measuring broad-scale trends over time for terrestrial species. These investigations have been challenged by the availability of large-scale, long-term, comprehensive datasets. The Breeding Bird Survey provides a good example of such a dataset, but analyses of this data are limited by many of the challenges noted above, including the challenge of analyzing large scale trends in migratory bird patterns with respect to agricultural vs. other land use patterns.

Field and Farm-Scale Tools:

- Field to Market has been working with North Carolina State University to develop a field-scale proof of concept model that predicts the relationship between management actions and vertebrate species richness. Field to Market is currently evaluating the proof of concept results to determine next steps.
- Field to Market is also exploring the potential to develop a farm-scale index for land quality and conservation potential that would evaluate farm land types and the quality or conservation value of these lands.



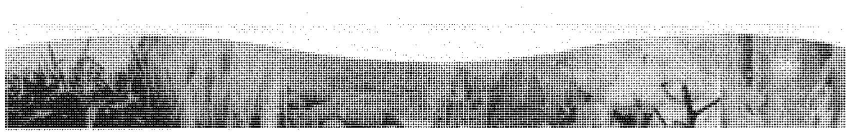
3. Results

3.1. Results Overview

This section provides an overview of results for all crops followed by more detailed summaries for each crop. For each crop, each resource indicator is presented in three ways – resource use/impact per unit of production ("efficiency"), resource use/impact per acre, and total resource use/impact. Each provides important information with respect to sustainability, and the interpretation of each should be accompanied by certain caveats, as described below:

1. "Efficiency" indicators showing resource indicator (use or impact) per unit of production. "Efficiency" measures show change in use or impact over time relative to our ability to meet productivity demands and normalizes the metrics to a common unit of comparison for producers and stakeholder. Field to Market has highlighted these efficiency indicators as a unique and important piece of the sustainability conversation, especially to the extent that sustainability, as we have defined it, includes meeting both productivity and environmental goals. However, it should be noted increased efficiencies may still be accompanied by increased demand and increased production, and a complete conversation on sustainability requires an understanding of efficiency along with total resource constraints, uses, and impacts. Furthermore, other "efficiency" metrics, beyond units of production, may be desirable; for example, resources per calorie or other nutritional measure.

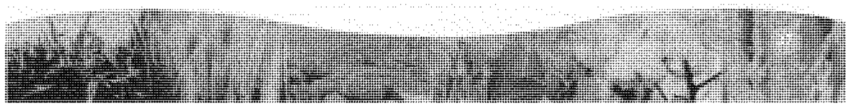
2. Per acre resource use or impact. Per acre resource use similarly normalizes the metrics to a common unit of comparison. For several resource indicators (e.g., land use, soil erosion, and irrigation water applied), resource use per acre is perhaps the most commonly encountered format. It should be noted however, that an equal amount of resources may be used per acre with varying production levels achieved, and thus the acre is itself a resource rather than an outcome. "Efficiency" indicators are an important mechanism of comparing resource use against the production outcome associated with acreage rather than the acreage itself.



3. Total use indicators show the annual use or impact per acre multiplied by total acres harvested. Total resource use or impact indicators are essential for informing conversations regarding total resource restraints or limits, however it should be noted that at the national level, important caveats should be placed around interpretation of total use metrics. First, total use does not necessarily equal total impact, as impact is created through interaction of resource use, resource constraints, and other factors. Second, resource limitations or constraints and thus impacts for many indicators are often more appropriately defined at the regional or local scale (e.g., soil erosion relative to soil regeneration rates, or irrigation water applied relative to aquifer recharge rates or streamflow), and thus total use values, particularly for some indicators such as water and soil, may have less meaning at a national level. Third, total use analysis for an individual crop may be impacted by changes in land use patterns for that particular crop and thus an aggregated understanding of total use across all crops may be a more meaningful metric for total use. Finally, lacking meaningful context of actual resource constraints against which to compare and normalize interpretations, total use data may be particularly misleading – for example, because total use for one crop is offset by another, or because an improving trend at a national level does not reflect real and significant challenges and impacts at a more local level. For these reasons, while total use data and results are presented in this report, the reader is cautioned that further analysis and context –which is currently beyond the scope of this report – is necessary to better understand the true impacts of total resource impacts in any given region or locale.

As discussed earlier in the methods section, results are expressed graphically in three forms:

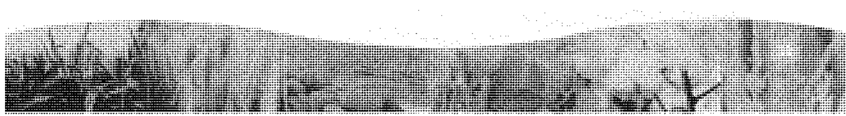
1. A **summary table of percent change** over the full study period (based on a least squares trend analyses from 1980-2011) for each crop, indicator, and unit of analysis, found in the summary of results for each crop. Average trends for the entire study period are calculated using a least squares trends analysis.
2. A **summary spidergram for "efficiency" indicators over time**, found in the summary of results for each crop. The spidergram visually demonstrates the change in the overall efficiency footprint or "Fieldprint" over time and summarizes all indicators on one graph. In order to facilitate comparison and evaluate relative changes over time across multiple indicators with differing units of measure (e.g., Btu for energy vs. CO_2e), each efficiency indicator is indexed where actual values observed in the year 2000 are set equal to 1. Therefore, a 0.1 unit change in the index value of an individual indicator is equal to a 10% percent change relative to the actual value in the year 2000. Trends that demonstrate movement toward the center of the spidergram (toward a value of zero, or a shrinking of the "Fieldprint") represent an improvement of efficiency, or resource use/impact per unit of production, over time.



3. **Individual line graphs** for each crop, indicator, and unit of analysis (production, acre, and total) are also found in each crop summary section. The graphs chart actual resource values (e.g., actual Btu per bushel) by year for the entire study period (1980-2011). The line graphs provide additional resolution regarding changes over time and the conformity of those changes with average trend line for the full study period. The summary narratives also note where the data demonstrate a more recent deviation from the average trend line for the full study period. Note: The regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.

Results are also highlighted and discussed in text for each crop and indicator. It should be noted that in both the results and conclusions sections, we have purposefully avoided speculation regarding the practice, contexts and drivers that influence the outcomes estimated through this analysis. Field to Market recognizes that management decisions by U.S. agricultural producers are guided by many factors, including availability of science and technology, price signals and other economic conditions, Farm Bill policies and programs including incentive programs such as the Conservation Reserve Program, and biofuel policies and incentives. Where the data that were utilized to construct the metric can explain changes over time, some interpretation is given. However thorough interpretation, including at the more geographically-specific scale needed to understand some trends, is beyond the scope of this report. Please see the Discussion and Conclusions section for suggestions and considerations for future analyses and evaluations.

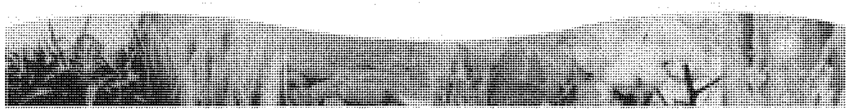
It should also be emphasized that average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted in the text. The national average trends, of course, may obscure local or regional variability on any given indicator. Finally, where actual numeric values are cited for each crop and indicator – for example, acres of land, acre inches of water, tons of soil erosion, Btu of energy, and CO_2e of greenhouse gas emissions – it should be noted that Field to Market has attempted to estimate values with the highest degree of accuracy possible given the national scope of the exercise, the availability of appropriate datasets, and the current state of scientific research and consensus. However, national scale data availability and/or current scientific knowledge may limit the accuracy of the actual values to some degree. Given the overarching objective of this analysis in examining changes in trends over time, the reader is encouraged to interpret the actual values as best approximations while understanding that the application of consistent methodology over time ensures the appropriate comparison of trends.



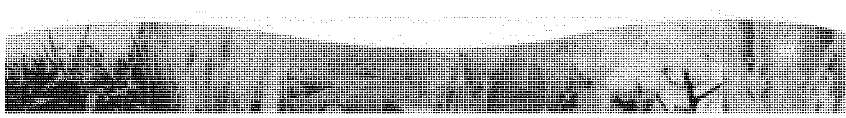
Environmental Indicators: Results Overview

Over the study period (1980-2011), on average at the national scale in the United States, the following trends were observed. Percent change is relative to single crop and based on the average trend line for the entire study period:

- **Production and Yield**
  - o Total production increased for corn (+101%), cotton (+55%), potatoes (+30%), rice (+53%), and soybeans (+96%); total wheat production decreased (-16%).
  - o Yield per planted acre increased for all crops: corn (+64%), cotton (+43%), potatoes (+58%), rice (+53%), soybeans (+55%), and wheat (+25%).
- **Land use**
  - o Land use per unit of production (e.g., bushels, cwt and pounds) has improved (decreased) for all six crops because of increased yields: corn (-30%), cotton (-30%), potatoes (-37%), rice (-35%), soybeans (-35%), and wheat (-18%).
  - o Total land use (planted acres) has increased for corn (+21%), cotton (+11%), rice (+9%) and soybeans (+24%) but decreased for potatoes (-15%) and wheat (-33%).
- **Soil Erosion**
  - o Soil erosion per unit of production has improved (decreased) for all six crops: corn (-67%), cotton (-68%), potatoes (-60%), rice (-34%), soybeans (-66%), and wheat (-47%).
  - o Per acre soil erosion has improved (decreased) for corn (-43%), cotton (-50%), potatoes (-34%), soybeans (-41%), and wheat (-34%) and remained constant for rice (rice has historically had low rates of soil erosion). However, improvements in per acre soil erosion for corn, cotton, soybeans, and wheat occurred primarily in the earlier part of the study period; per acre soil erosion has remained relatively constant for these crops in recent years.
  - o Total soil erosion has improved (decreased) for corn (-31%), cotton (-42%), potatoes (-42%), soybeans (-28%), and wheat (-57%) and increased for rice (+9%) (rice has historically had low levels of total soil erosion and increases are likely associated with increased acreage). However, improvements (decreases) in total soil erosion for corn and soybeans occurred primarily in the first half of the study period, with increases occurring in more recent years associated with increased production.
- **Irrigation Water Applied**
  - o Irrigation water applied per unit of production has improved (decreased) for all six crops: corn (-53%), cotton (-75%), potatoes (-38%), rice (-53%), soybeans (-42%), and wheat (-12%).
  - o Per acre irrigation water applied has improved (decreased) for corn (-28%), cotton (-46%), rice (-25%), and soybeans (-9%) and decreased slightly for potatoes (-2%); per acre irrigation water applied increased for wheat (+6%).
  - o Total irrigation water applied decreased for cotton (-35%), rice (-18%), and wheat (-12%) and increased for corn (+27%), potatoes (+31%), and soybeans (+271%).
- **Energy use**
  - o Energy use per unit of production has improved (decreased) for all six crops: corn (-44%), cotton (-31%), potatoes (-15%), rice (-38%), soybeans (-48%), and wheat (-12%).
  - o Per acre energy use improved (decreased) for corn (-6%), cotton (-2%), rice (-3%), and soybeans (-17%), and increased for potatoes (+33%) and wheat (+9%).
  - o Total energy use decreased for wheat (-26%), and increased for corn (+14%), cotton (+9%), potatoes (+11%), rice (+6%), and slightly for soybeans (+3%).



- **Greenhouse gas emissions**
  - Greenhouse gas emissions per unit of production have improved (decreased) for all six crops: corn (-36%), cotton (-22%), potatoes (-22%), rice (-38%), soybeans (-49%), and wheat (-2%).
  - Per acre greenhouse gas emissions improved (decreased) for rice (-4%) and soybeans (-18%), and increased for corn (+8%), cotton (+9%), potatoes (+23%), and wheat (+21%).
  - Total greenhouse gas emissions decreased for wheat (-17%), increased slightly for potatoes (+3%) and soybeans (+1%), and increased for corn (+31%), cotton (+20%), and rice (+5%).



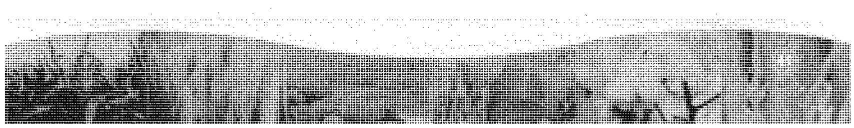
3.2. Corn for Grain Summary of Results

Overview (Corn for Grain)

Over the study period (1980-2011), trends in U.S. corn production were as follows:

- Yield: Corn increased in total production (+101%) and yield (bushels per acre) (+64%).
- Resource efficiency (per bushel): Corn improved on all measures of resource "efficiency," with decreases in per bushel land use (-30%), soil erosion (-67%), irrigation water applied (-53%), energy use (-44%), and greenhouse gas emission (-36%).
- Resource use/impact per acre: Corn improved (decreased) per acre soil erosion (-43%), irrigation water applied (-28%), and energy use (-6%) and increased per acre greenhouse gas emissions (+8%). Improvements in per acre soil erosion occurred primarily in the first half of the study period; per acre soil erosion has remained relative constant since the late-1990s.
- Total resource use/impact: Corn improved (decreased) total soil erosion (-31%) and increased total land use (+21%), irrigation water applied (+27%), energy use (+14%), and greenhouse gas emissions (+31%). Improvements in total soil erosion occurred primarily in the first half of the study period, with more recent trends indicating a slight increase in total annual erosion.

Please note: all results are for corn for grain; corn for grain includes corn for all purposes other than forage; corn for grain includes grain for ethanol. A summary of trends for specific indicators are provided in **Figure 1.1** and **Table 1.1** and in the text below. **Figures 1.2 through 1.16** demonstrate linear trends over the full study period for total, per acre, and per unit of production resource use/impacts. Average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted below.



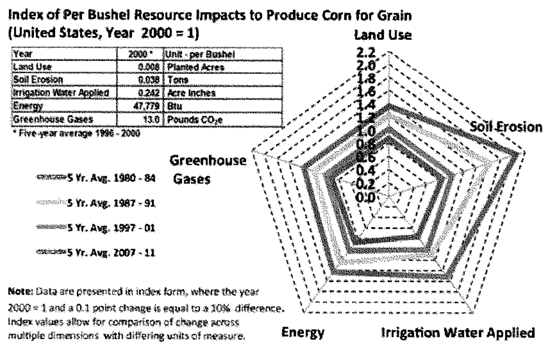


Figure 1.1 Index of Per Bushel Resource Impacts to Produce Corn for Grain, United States, 1980-2011

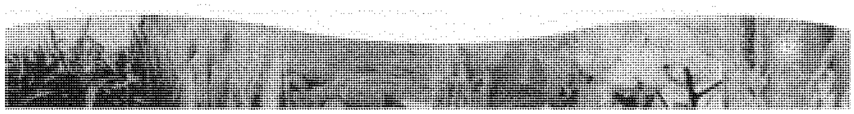


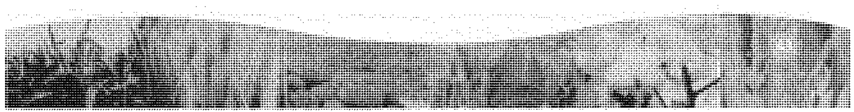
Table 1.1 Corn for Grain Summary of Results

Corn Summary of Results:
Trends in U.S. Production, Resource Use / Impact, 1980-2011

Resource Area	Indicator	Percent Change* 1980-2011		
		Trend Direction	Entire Period	Compound Annual
Crop Yield	Total Production	↑	101	2.3
	Bushels per Acre	↑	64	1.6
Land Use	Total Planted Acres	↑	21	0.6
	Acres per Bushel	↓	(30)	(1.1)
Soil Erosion	Total Tons	↓	(31)	(1.2)
	Tons per Acre	↓	(43)	(1.8)
	Tons per Bushel	↓	(67)	(3.5)
Irrigation Water Applied	Total Volume	↑	27	0.8
	Volume per Irrigated Acre	↓	(28)	(1.0)
	Volume per Bushel	↓	(53)	(2.4)
Energy Use	Total Btu	↑	14	0.4
	Btu per Acre	↓	(6)	(0.2)
	Btu per Bushel	↓	(44)	(1.9)
GHG Emissions (CO_2 Equivalents)	Total Pounds	↑	31	0.9
	Pounds per Acre	↑	8	0.2
	Pounds per Bushel	↓	(36)	(1.4)

*Percent change results are based on a least squares trends analyses from 1980 - 2011

Sources: Calculations are based on a number of data sources: 1. USDA, NASS, Census of Agriculture, Farm and Ranch Irrigation Survey, http://www.agcensus.usda.gov/Publications/index.php 2. USDA, Economic Research Service (ERS), Agricultural Resource Management Survey (ARMS) http://www.ers.usda.gov/Briefing/ARMS/Access.htm 3. USDA, National Resources Conservation Service (NRCS), National Resrouce inventory (NRI) Reports http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri



Total Production and Yield (Corn for Grain)

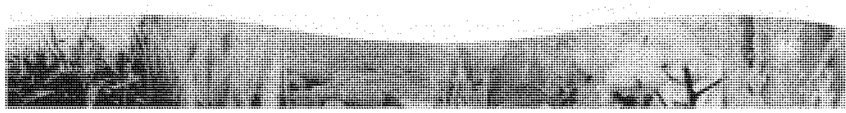
Total production and yield for corn for grain increased over the study period. Total production of corn increased by 101 percent, or 2.3 percent compound annually; 12.4 billion bushels of corn were produced in 2011 compared with 6.64 billion bushels in 1980. The increase in production corresponded with a 21 percent increase in total planted acreage over the study period (see land use, below). Bushels per planted acre increased 64 percent over the study period, or 1.6 percent compound annually; average planted area yield in 2011 was 145 bushels per planted acre, compared to 89.1 bushels per planted acre in 1980. The yield per harvested acre in 2011 was 147 bushels. Both planted and harvested yields for corn for grain were below expectations in 2011 and lower than in previous years; adverse conditions, particularly caused by flooding along the Mississippi and Missouri Rivers, drove increased abandonment (impacting planted acre yields) as well as poorer yields on acres that were harvested.

Land Use (Corn for Grain)

Total planted acreage of corn for grain increased over the study period while land use per bushel decreased. Total planted acreage increased by 21 percent, or 0.6 percent compound annually; 85.8 million acres of corn for grain were planted in 2011 as compared to 74.5 million acres planted in 1980. The harvested acre area of corn for grain in 2011 was 84.0 million acres, reflecting 1.8 million acres of abandonment in that year. 2011 abandonment was larger than normal due to adverse conditions. Over the study period, the land use "efficiency" metric (planted acres per bushel) improved (decreased) by 30 percent, or 1.1 percent compound annually.

Please note: all numbers are based on estimated planted area of corn for grain (which does not include corn for silage or forage, but does include corn grain for ethanol); the estimated percent abandonment for corn for silage and corn for grain are assumed to be equal and estimated corn for silage planted area has been subtracted from USDA's total planted area for corn for all purposes. For reference, in 2011, 93.4 percent of corn harvested for all purposes was for grain.

See **Figures 1.2, 1.3 and 1.4** for more detail regarding the annual land use, production, and yield values



Soil Erosion (Corn for Grain)

Soil erosion for corn for grain improved for all measures. Total tons of soil erosion for corn decreased 31 percent over the study period, or 1.2 percent compound annually; total erosion was 563 million tons in 1980 and 416 million tons in 2011. In absolute terms (not relative to a tolerance rate or T), per acre soil erosion decreased 43 percent (1.8 percent compound annually), to 4.85 tons per acre in 2011 compared with 7.56 tons per acre in 1980. (Note: Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre). Tons per bushel decreased 67 percent (3.5 percent compound annually).

While the trend since 1980 shows significant improvement in total and per acre soil erosion, these improvements occurred primarily before the mid-1990s, likely attributable in large part to implementation of conservation plans, particularly on highly erodible lands. Since the late-1990s, per acre erosion for corn has remained relatively constant (near 5 tons per acre). From the mid-1990s until 2006, total soil erosion remained relatively constant, but has increased in more recent years; for example, total soil erosion was 346 million tons in 1995, 350 million tons in 2006, and 416 million tons in 2011.

Please note: Due to the nature of the NRI datasets used for this soil erosion analysis, soil erosion rates for corn for grain and corn for silage were assumed to be equal; however, considering differences in harvest practices for silage and grain, it is expected that, on average, erosion from corn silage would be higher than that from corn grain, all other things being equal. Consequently, absolute levels of soil erosion for corn for grain may be slightly overestimated in this report.

See **Figures** 1.5, 1.6 and 1.7 for more detail regarding the annual soil erosion values

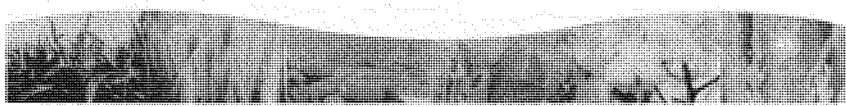
Irrigation Water Applied (Corn for Grain)

Over the study period, corn for grain decreased its volume per irrigated acre and volume per bushel and increased its total irrigation water applied. Volume per irrigated acre decreased 28 percent (1.0 percent compound annually). Volume per incremental bushel produced as a result of irrigation also improved (decreased) (53 percent, 2.4 percent compound annually). Average per acre water use (per irrigated acre) was 12.0 acre inches in 2011 compared with 16.8 acre inches in 1980. Per acre irrigation water applied decreased through the first half of the study period, increased after 1995, then decreased again in the early part of this century.

Total irrigation water applied for corn for grain increased 27 percent (0.8 compound annually) over the study period, from 120 million acre inches in 1980 compared with 144 million acre inches in 2011. This increase corresponds with a proportionate increase of irrigated acreage as compared to non-irrigated acreage for corn over time. For example, over the study period, there was an estimated 59 percent increase in total irrigated land acreage for corn for grain, as compared to the 21 percent increase in planted acreage of corn for grain reported in the land use section, above.

Please note: Due to the nature of the Ag Census Farm and Ranch Irrigation Survey datasets used for this irrigation analysis, it was assumed that the irrigation water applied rate for corn for grain and corn for silage are equal, although irrigated acres for corn for grain most likely increased more than irrigated acres of corn for silage.

See **Figures** 1.8, 1.9, and 1.10 for more detail regarding the annual irrigation water applied values.



Energy Use (Corn for Grain)

Over the study period, energy use per acre and per bushel decreased while total energy use increased for corn for grain. Energy use per acre decreased by 6 percent (0.2 percent compound annually); energy use was 6.3 million Btu per acre in 1980 compared with 6.1 million Btu per acre in 2011. Energy use per bushel of corn for grain production improved (decreased) 44 percent (1.9 percent compound annually) over the study period; energy use was 70.9 thousand Btu per bushel in 1980 and 42.1 thousand Btu per bushel in 2011. Total energy use for corn production increased an average of 14 percent (0.4 percent compound annually); total energy use was 471 trillion Btu in 1980 and 523 trillion Btu in 2011.

Decreases in energy use per acre are likely attributable to decreases in tillage energy over the full study period. Efficiency gains may be understated because our study does not capture efficiency gains from larger equipment use over time. Decreases in nitrogen application rates per acre were seen up to the mid-1990s, after which time application rates began to increase. Improvements in per bushel energy use are impacted by these factors but are largely driven by yield improvements.

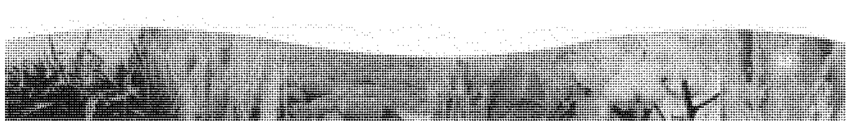
See **Figures 1.11, 1.12, and 1.13** for more detail regarding the annual energy use values.

Greenhouse Gas Emissions (Corn for Grain)

Over the study period, greenhouse gas emissions per bushel decreased while per acre and total emissions increased for corn for grain. Greenhouse gas emissions per bushel of corn for grain improved (decreased) 36 percent (1.4 percent compound annually) over the study period, from approximately 18.5 pounds CO2e per bushel in 1980 to approximately 12.7 pounds CO2e per bushel in 2011. Emissions per acre increased 8 percent (0.2 percent compound annually), from approximately 1,650 pounds CO2e per acre in 1980 to approximately 1,836 pounds CO2e per acre in 2011. Total greenhouse gas emissions for corn for grain production increased 31 percent (0.9 percent compound annually), from 123 billion pounds CO2e in 1980 to 158 billion pounds CO2e in 2011; this increase is largely attributable to increased planted acreage for corn.

See figures 1.14, 1.15, and 1.16 for more detail regarding the annual greenhouse gas emissions values.

Please note, in the following graphs, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



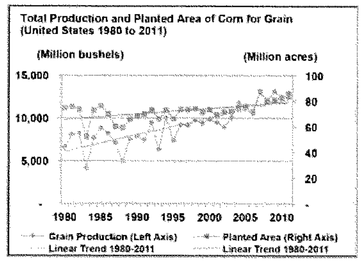


Figure 1.2 Total Production and Planted Area of Corn for Grain, U.S. 1980 to 2011

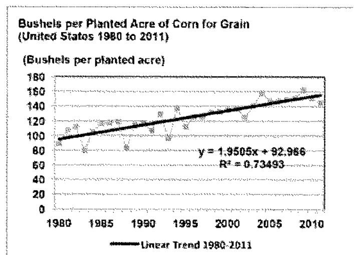


Figure 1.3 Bushels per Planted Acre of Corn for Grain, U.S. 1980 to 2011

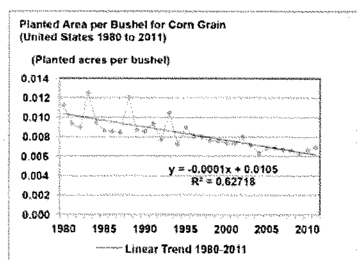
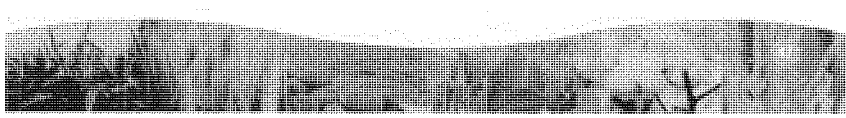


Figure 1.4 Planted Area per Bushel of Corn for Grain, U.S. 1980 to 2011



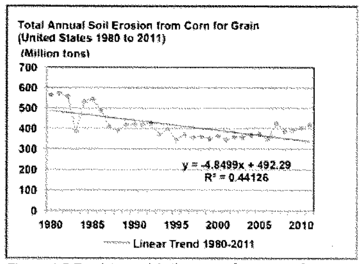


Figure 1.5 Total Annual Soil Erosion from Corn for Grain, U.S. 1980 to 2011

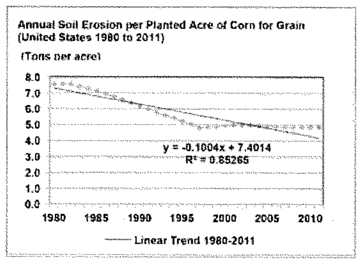


Figure 1.6 Annual Soil Erosion per Planted Acre of Corn for Grain, U.S. 1980 to 2011

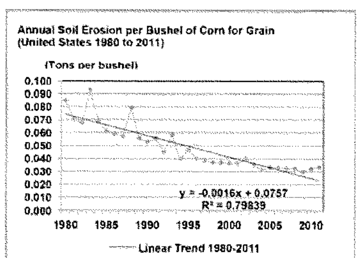
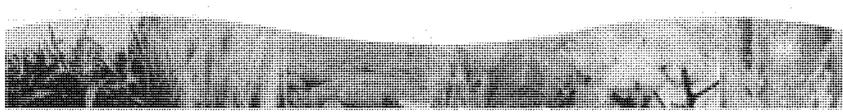


Figure 1.7 Annual Soil Erosion per Bushel of Corn for Grain, U.S. 1980 to 2011



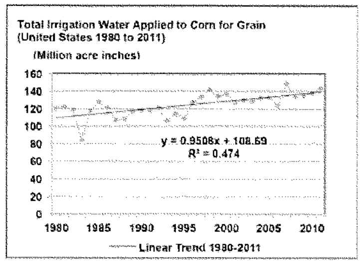


Figure 1.8 Total Irrigation Water Applied to Corn for Grain, U.S. 1980 to 2011

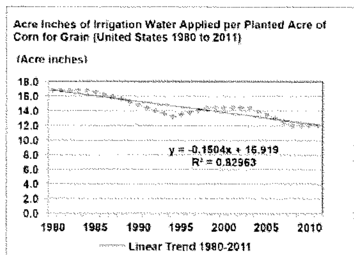


Figure 1.9 Acre Inches of Irrigation Water Applied per Planted Acre of Corn for Grain, U.S. 1980 to 2011

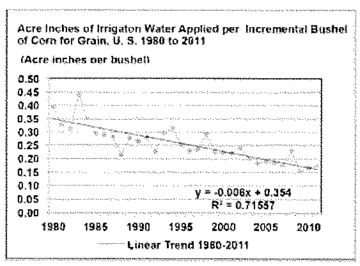
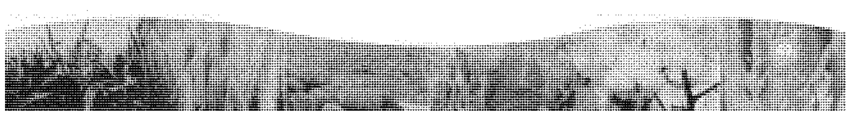


Figure 1.10 Acre Inches of Irrigation Water Applied per Incremental Bushel of Corn for Grain, U.S. 1980 to 2011



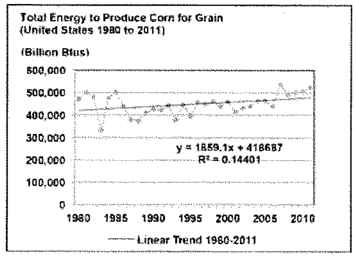


Figure 1.11 Total Energy to Produce Corn for Grain, U.S. 1980 to 2011

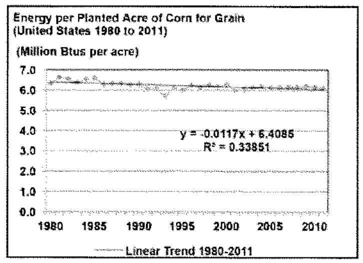


Figure 1.12 Energy per Planted Acre of Corn for Grain, U.S. 1980 to 2011

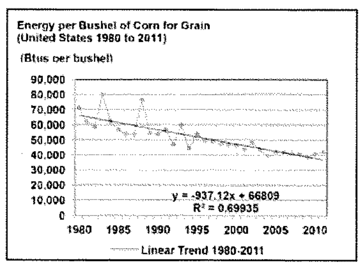
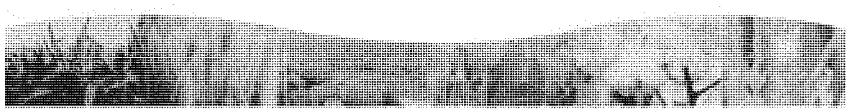


Figure 1.13 Energy per Bushel of Corn for Grain, U.S. 1980 to 2011



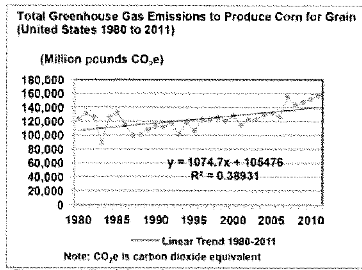


Figure 1.14 Total Greenhouse Gas Emissions to Produce Corn for Grain, U.S. 1980 to 2011

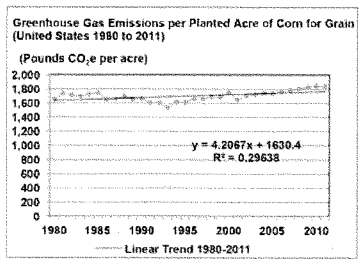


Figure 1.15 Greenhouse Gas Emissions per Planted Acre of Corn for Grain, U.S. 1980 to 2011

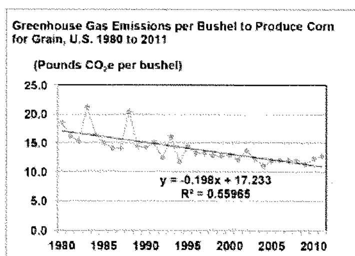
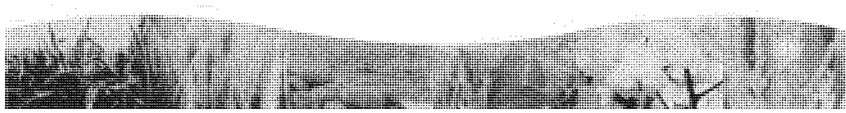


Figure 1.16 Greenhouse Gas Emissions per Bushel of Corn for Grain, U.S. 1980 to 2011



3.3. Cotton Summary of Results

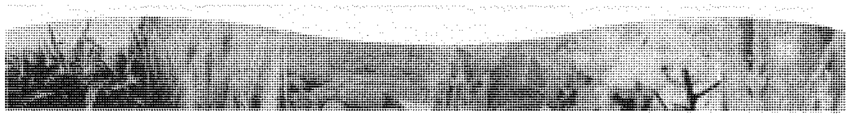
Overview

Over the study period (1980-2011), trends in U.S. cotton production were as follows:

- Yield: Cotton increased in total production (+55%) and yield (pounds lint per planted acre) (+43%).
- Resource efficiency (per pound of lint): Cotton improved on all measures of resource "efficiency," with decreases in per pound lint land use (-30%), soil erosion (-68%), irrigation water applied (-75%), energy use (-31%), and greenhouse gas emissions (-22%).
- Resource use/impact per acre: Cotton improved (decreased) per acre soil erosion (-50%) and irrigation water applied (-46%); per acre energy use decreased slightly (-2%) and greenhouse gas emissions per acre increased (9%) The most significant improvement in per acre soil erosion occurred in the first half of the study period.
- Total resource use/impact: Cotton improved (decreased) total soil erosion (-42%) and irrigation water applied (-35%); cotton increased total land use (+11%), energy use (+9%) and greenhouse gas emissions (20%).

Please note: cotton resource use/impact for soil, energy, irrigation water applied and greenhouse gas emissions are allocated between seed and lint using an economic allocation method, with 83 percent of use and resource impact values being attributed to lint and 17 percent to seed based on 2005-2009 economic data (land use acreage is not allocated). Values for cotton lint may be converted to values representing that required to produce both economic yield components, lint and seed, by multiplying lint values by 1.17.

Summary trends for specific indicators are provided in **Figure 1.17** and **Table 1.2** and in the text below. **Figures 1.18 through 1.32** demonstrate linear trends over the full study period for total, per acre, and per unit of production resource use/impacts. Average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted below.



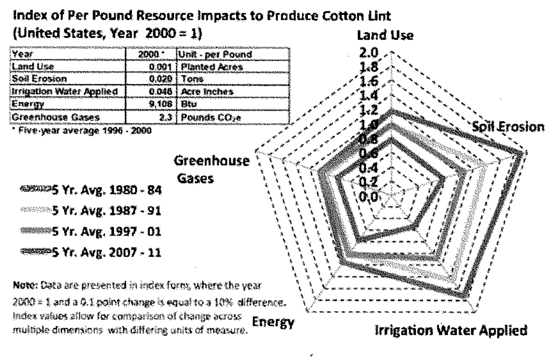


Figure 1.2 Index of Per Pound Resource Impacts to Produce Cotton Lint,United States, 1980-2011

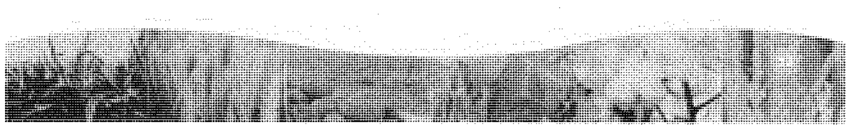


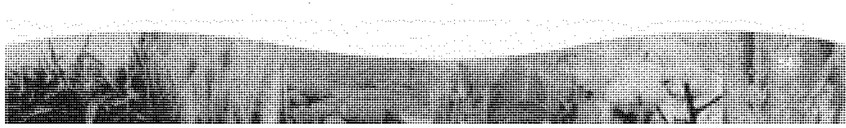
Table 1.2 Cotton Lint Summary of Results

Cotton Summary of Results:
Trends in U.S. Production, Resource Use / Impact, 1980-2011

Resource Area	Indicator	Percent Change* 1980-2011		
		Trend Direction	Entire Period	Compound Annual
Crop Yield	Total Production	↑	55	1.4
	Pounds per Acre	↑	43	1.2
Land Use	Total Planted Acres	↑	11	0.3
	Acres per Pound	↓	(30)	(1.2)
Soil Erosion	Total Tons	↓	(42)	(1.7)
	Tons per Acre	↓	(50)	(2.2)
	Tons per Pound	↓	(68)	(3.6)
Irrigated Water Applied	Total Volume	↓	(35)	(1.4)
	Volume per Irrigated Acre	↓	(46)	(2.0)
	Volume per Pound	↓	(75)	(4.4)
Energy Use	Total Btu	↑	9	0.3
	Btu per Acre	↓	(2)	(0.1)
	Btu per Pound	↓	(31)	(1.2)
GHG Emissions (CO_2 Equivalents)	Total Pounds	↑	20	0.6
	Pounds per Acre	↑	9	0.3
	Pounds per Pound	↓	(22)	(0.8)

*Percent change results are based on a least squares trends analyses from 1980 - 2011

Sources: Calculations are based on a number of data sources: 1. USDA, NASS, Census of Agriculture, Farm and Ranch Irrigation Survey, http://www.agcensus.usda.gov/Publications/index.php 2. USDA, Economic Research Service (ERS), Agricultural Resource Management Survey (ARMS) http://www.ers.usda.gov/Briefing/ARMS/Access.htm 3. USDA, National Resources Conservation Service (NRCS), National Resrouce Inventory (NRI) Reports http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri



Total Production and Yield (Cotton Lint)

Over the study period, total production and yield for cotton lint increased. Total production of cotton lint increased by 55 percent, or 1.4 percent compound annually; 7.53 billion pounds of cotton lint were produced in 2011 compared with 5.34 billion pounds in 1980. Yield (pounds lint per acre) increased 43 percent over the study period, or 1.2 percent compound annually; average planted acre yield in 2011 was 616 pounds per planted acre as compared with 443 pounds per planted acre in 1980. The yield per harvested acre in 2011 was 790 pounds. The gap between planted and harvested acre yields is driven by abandonment, which in the case of cotton can be highly variable.

Land Use (Cotton Lint)

Over the study period, total land use increased and land per pound lint decreased. Total planted acreage of cotton increased by 11 percent, or 0.3 percent compound annually; however, there was significant variability in planted acreage over the study period: 12.2 million acres of cotton were planted in 2011 compared with lows of 6.58 million and 7.59 million planted acres in 1983 and 2009, respectively, and a high of 14.1 million acres in 1995. The harvested acre area of cotton in 2011 was 9.5 million acres, reflecting 2.7 million acres of abandonment in that year. 2011 abandonment was dramatically larger than normal due to adverse conditions, particularly in Texas. The land use "efficiency" metric (acres per pound lint) improved (decreased) by 30 percent, or 1.2 percent compound annually.

See **Figures 1.18, 1.19, and 1.20** for more detail regarding the annual land use, production, and yield values.

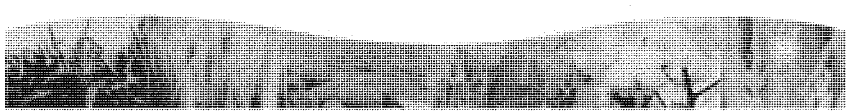
Soil Erosion (Cotton Lint)

Soil erosion for cotton improved for all measures. Total tons of soil erosion for cotton decreased 42 percent over the study period, or 1.7 percent compound annually; total soil erosion was 151 million tons in 2011 compared with 249 million tons in 1980. In absolute terms (not relative to a tolerance rate or T), per acre soil erosion improved (decreased) 50 percent (2.2 percent compound annually); per acre soil erosion was 10.3 tons in 2011 compared with 17.2 tons per acre in 1980. (Note: Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre). While the trend since 1980 shows significant improvement per acre soil erosion, the largest improvement occurred in the first half of the study period, and trends in per acre soil erosion have remained relatively constant since the early 2000's. Tons per pound of lint decreased 68 percent (3.6 percent compound annually).

See **Figures 1.21, 1.22, and 1.23** for more detail regarding the annual soil erosion values.

Irrigation Water Applied (Cotton Lint)

Irrigation water applied for cotton improved on all measures. Over the study period, total irrigation water applied for cotton decreased 35 percent (1.4 percent compound annually); total water use was 95.5 million acre inches in 1980 and 62.9 million acre inches in 2011. Cotton decreased its volume per irrigated acre (46 percent, 2.0 percent compound annually), from 20.9 acre inches per acre in 1980 to 13.0 acre inches per acre in 2011. Volume per incremental pound of lint produced as a result of irrigation also improved (decreased) (75 percent, 4.4 percent compound annually).



The proportion of irrigated cotton acreage (as compared to non-irrigated acreage) has remained relatively constant over the study period, at approximately 32 percent; total irrigated acreage has thus increased at a rate generally corresponding with overall trends in total land use for cotton use. On a per acre and per pound basis, irrigation technology has largely driven improvements in irrigated water use for cotton.

See **Figures 1.24, 1.25., and 1.26** for more detail regarding the annual irrigation water applied values.

Energy Use (Cotton Lint)

Over the study period, energy use decreased per acre and per bushel and total energy use increased for cotton lint. Energy use per acre decreased slightly by 2 percent (0.1 percent compound annually); energy use per acre was approximately 4.6 million Btu in 2011 compared with 4.7 million Btu in 1980. Energy use per pound of cotton lint produced improved (decreased) 31 percent (1.2 percent compound annually) over the study period; energy use per pound was 9,000 Btu in 2011 compared to 12,900 in 1980. Improvements in energy use efficiency per pound are driven in part by improvements in irrigation water efficiency resulting in decreased pumping energy.

Total energy use for cotton lint production increased 9 percent (0.3 percent compound annually), although the trend for total energy use varies considerably by year, with lower levels in the 1980s, followed by higher levels throughout the 1990s and early 2000s, and a decrease in the latter part of the study period that corresponds with a decrease in total planted acres and production. Total energy use for cotton lint was approximately 67.5 trillion Btu in 2011, compared to lows of 38.7 trillion Btu in 1983 and 44.0 trillion Btu in 2008, and a high of 86.8 trillion Btu in 1995.

See **Figures 1.27, 1.28, and 1.29** for more detail regarding the annual energy use values.

Greenhouse Gas Emissions (Cotton Lint)

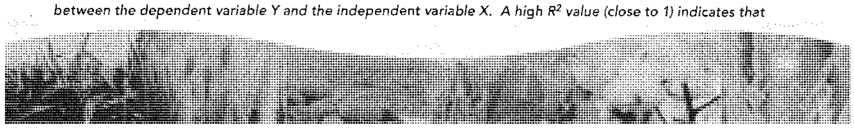
Over the study period, greenhouse gas emissions per pound decreased and emissions per acre and total emissions both increased for cotton lint. Greenhouse gas emissions per pound of cotton lint improved (decreased) 22 percent (0.8 percent compound annually) over the study period; emissions were approximately 2.1 pounds CO2e per pound lint in 1980 and 1.9 pounds CO2e per pound lint in 2011. Improvements in greenhouse gas efficiency per pound are driven in part by improvements in irrigation water efficiency resulting in decreased pumping energy and associated emissions.

Emissions per acre increased 9 percent over the study period, or 0.3 percent compound annually; however the last several years have seen emissions falling below the trend line, with emissions hovering near 1,000 pounds CO2e per acre throughout much of the study period but declining to 1,077 pounds CO2e per acre in 2011.

Total greenhouse gas emissions for cotton production increased 20 percent (0.6 percent compound annually), from approximately 11.2 billion pounds CO2e in 1980 to approximately 14.6 billion pounds CO2e in 2011. Although the average trend for total emissions for the full study period shows an increase, a decrease in the latter part of the study period (2007-2010) corresponds with the decrease in total planted acres and production.

See **Figures 1.30, 1.31, and 1.32** for more detail regarding the annual energy use values.

Please note, in the following graphs, the regression equations and R2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend. r bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that



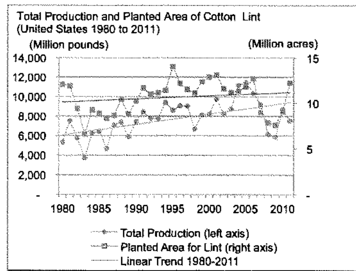


Figure 1.18 Total Production and Planted Area of Cotton Lint, U.S. 1980 to 2011

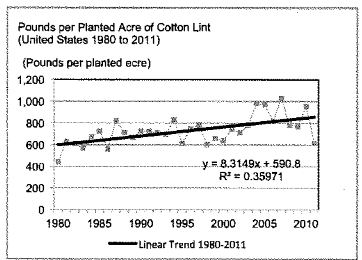


Figure 1.19 Pounds per Planted Acre of Cotton Lint, U.S. 1980 to 2011

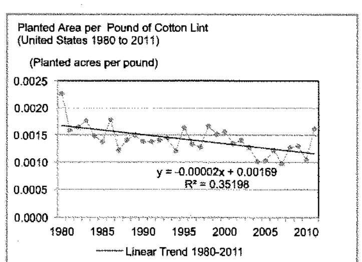


Figure 1.20 Planted Area per Pound of Cotton Lint, U.S. 1980 to 2011

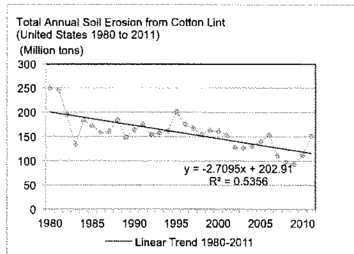


Figure 1.21 Total Annual Soil Erosion from Cotton Lint, U.S. 1980 to 2011

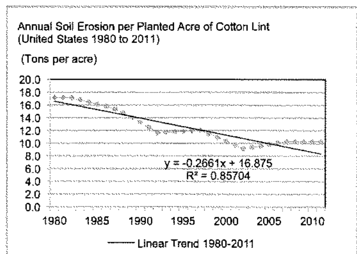


Figure 1.22 Annual Soil Erosion per Planted Acre of Cotton Lint, U.S. 1980 to 2011

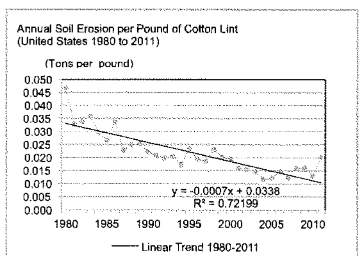
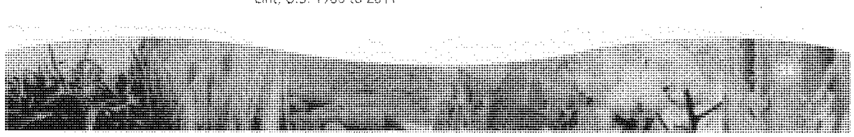


Figure 1.23 Annual Soil Erosion per Pound of Cotton Lint, U.S. 1980 to 2011



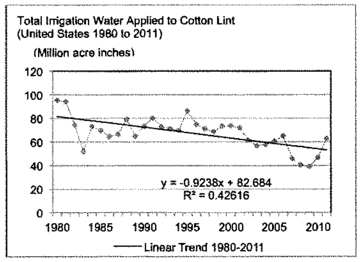


Figure 1.24 Total Irrigation Water Applied to Cotton Lint, U.S. 1980 to 2011

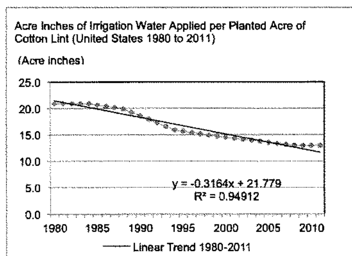


Figure 1.25 Acre Inches of Irrigation Water Applied per Planted Acre of Cotton Lint, U.S. 1980 to 2011

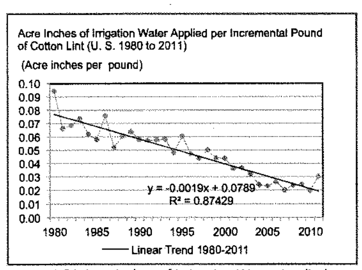
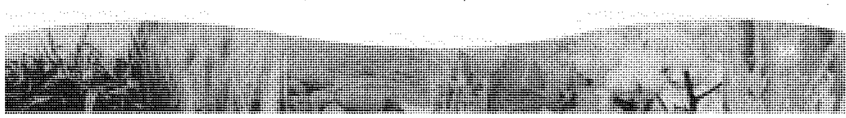


Figure 1.26 Acre Inches of Irrigation Water Applied per Incremental Pound of Cotton Lint, U.S. 1980 to 2011



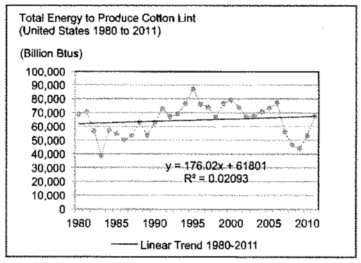


Figure 1.27 Total Energy to Produce Cotton Lint, U.S. 1980 to 2011

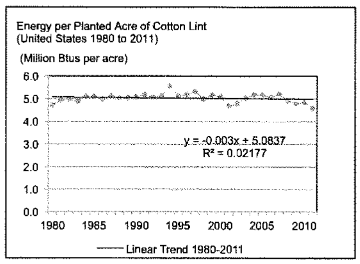


Figure 1.28 Energy per Planted Acre to Produce Cotton Lint, U.S. 1980 to 2011

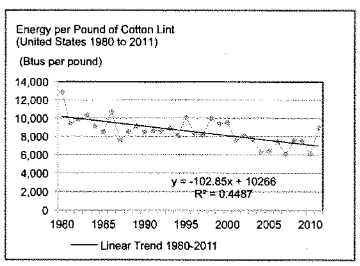


Figure 1.29 Energy per Pound of Cotton Lint, U.S. 1980 to 2011

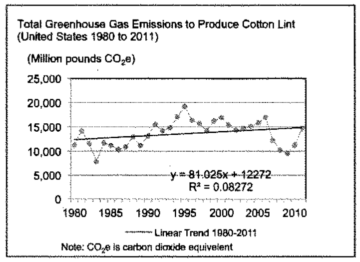


Figure 1.30 Total Greenhouse Gas Emissions to Produce Cotton Lint, U.S. 1980 to 2011

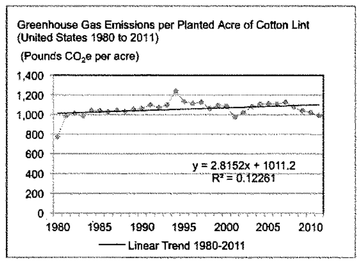


Figure 1.31 Greenhouse Gas Emissions per Planted Acre of Cotton Lint, U.S. 1980 to 2011

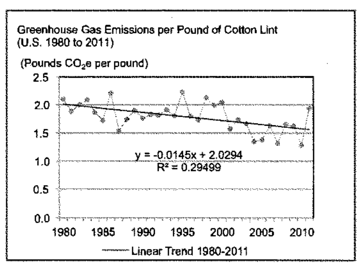


Figure 1.32 Greenhouse Gas Emissions per Pound of Cotton Lint, U.S. 1980 to 2011

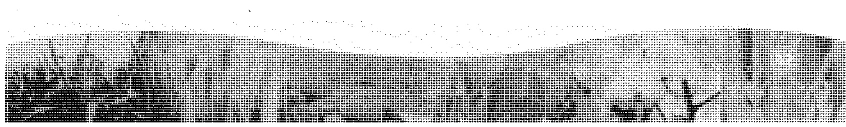
3.4. Potatoes Summary of Results

Overview

Over the study period (1980-2011), trends in U.S. potato production were as follows:

- **Yield:** Total potato production increased (+30%) and yield (cwts per planted acre) increased (+58%).
- **Resource efficiency (per cwt):** Potatoes improved on all measures of resource "efficiency," with decreases in land use (-37%), soil erosion (-60%), irrigated water use (-38%), energy use (-15%), and greenhouse gas emissions per cwt (-22%).
- **Resource use/impact per acre:** Potatoes improved (decreased) per acre soil erosion (-34%); irrigation water applied per acre remained nearly constant (-2%) while per acre energy use (+33%) and greenhouse gas emissions increased (+23%).
- **Total resource use/impact:** Potatoes improved (decreased) total soil erosion (-42%); total land use decreased (-15%), total greenhouse gas emissions increased slightly (+3%), and potatoes increased total irrigation water applied (+31%) and energy use (+11%).

For potatoes, the end point of this analysis is not point-of-sale but rather on-farm storage for 120 days. Due to the variability in on-farm storage length (ranging from no storage to as much as 10 months), this analysis assumes an average storage period of 120 days. Summary trends for specific indicators are provided in **Figure 1.33** and **Table 1.3** and in the text below. **Figures 1.34 through 1.48** demonstrate linear trends over the full study period for total, per acre, and per unit of production resource use/impacts. Average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted below.



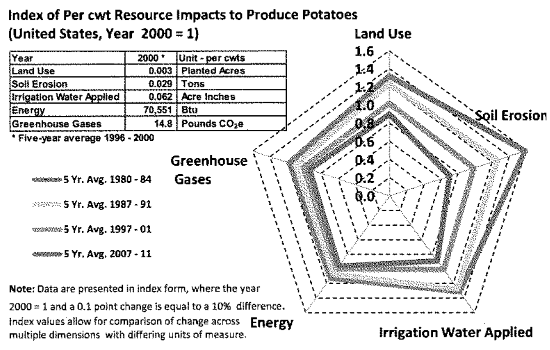


Figure 1.33 Index of Per cwt Resource Impacts to Produce Potatoes, United States, 1980-2011

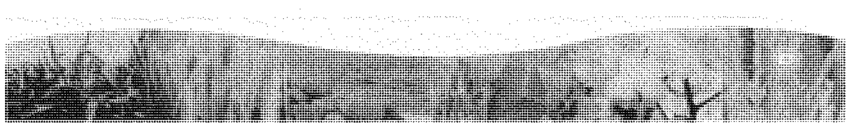


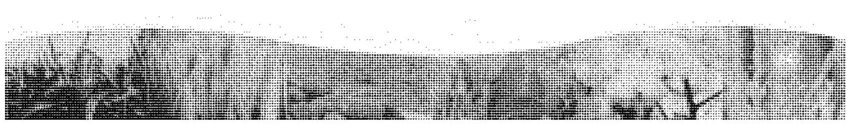
Table 1.3 Potatoes Summary of Results

Potatoes Summary of Results:
Trends in U.S. Production, Resource Use / Impact, 1980-2011

Resource Area	Indicator	Percent Change* 1980-2011		
		Trend Direction	Entire Period	Compound Annual
Crop Yield	Total Production	↑	30	0.8
	Cwt per Acre	↑	58	1.5
Land Use	Total Planted Acres	↓	(15)	(0.5)
	Acres per cwt	↓	(37)	(1.5)
Soil Erosion	Total Tons	↓	(42)	(1.8)
	Tons per Acre	↓	(34)	(1.3)
	Tons per cwt	↓	(60)	(2.9)
Irrigation Water Applied	Total Volume	↑	31	0.9
	Volume per Irrigated Acre	↓	(2)	(0.1)
	Volume per cwt	↓	(38)	(1.6)
Energy Use	Total Btu	↑	11	0.3
	Btu per Acre	↑	33	0.9
	Btu per cwt	↓	(15)	(0.5)
GHG Emissions (CO_2 Equivalents)	Total Pounds	↑	3	0.1
	Pounds per Acre	↑	23	0.7
	Pounds per cwt	↓	(22)	(0.8)

*Percent change results are based on a least squares trends analyses from 1980 - 2011

Sources: Calculations are based on a number of data sources, including: 1. USDA, NASS, Census of Agriculture, Farm and Ranch Irrigation Survey, http://www.agcensus.usda.gov/Publications/index.php; 2. USDA, Economic Research Service (ERS), Agricultural Resource Management Survey (ARMS) http://www.ers.usda.gov/Briefing/ARMS/Arcoss.htm; 3. USDA, National Resources Conservation Service (NRCS), National Resource Inventory (NRI) Reports http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri



Total Production and Yield (Potatoes)

Over the study period, total production and yield for potatoes both increased. Total production of potatoes increased over the study period by 30 percent, or 0.8 percent compound annually; 417 million cwt of potatoes were produced in 2011 as compared with 304 million cwt in 1980. Yield (cwt per planted acre) increased 58 percent over the study period, or 1.5 percent compound annually; average yield in 2011 was 380 cwt per planted acre as compared with 259 cwt per planted acre in 1980. The yield per harvested acre in 2011 was 397 cwt per harvested acre.

Two primary drivers in increased yield and increased production, despite decreased planted acreage (see below), have been increased irrigation and shifts in geographic patterns of potato growth toward higher producing areas.

Land Use (Potatoes)

Total land use and land use per cwt both decreased for potatoes over the study period. Total planted acreage of potatoes decreased over the study period by an average of 15 percent, or 0.5 percent compound annually; 1.03 million acres of potatoes were planted in 2011, as compared with 1.18 million acres in 1980. The harvested acre area of potatoes in 2011 was also 1.1 million acres; abandonment for potatoes is limited. Total land use and total production increased slightly through the middle of study period and then decreased more recently.

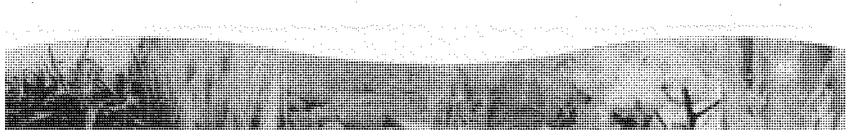
Over the study period, the land use "efficiency" metric (acres per cwt) improved (decreased) by 37 percent, or 1.5 percent compound annually.

See **Figures 1.34, 1.35,** and **1.36** for more detail regarding the annual land use, production, and yield values.

Soil Erosion (Potatoes)

Soil erosion for cotton improved for all measures. Total tons of soil erosion for cotton decreased 42 percent over the study period, or 1.7 percent compound annually; total soil erosion was 151 million tons in 2011 compared with 249 million tons in 1980. In absolute terms (not relative to a tolerance rate or T), per acre soil erosion improved (decreased) 50 percent (2.2 percent compound annually); per acre soil erosion was 10.3 tons in 2011 compared with 17.2 tons per acre in 1980. (Note: Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre). While the trend since 1980 shows significant improvement per acre soil erosion, the largest improvement occurred in the first half of the study period, and trends in per acre soil erosion have remained relatively constant since the early 2000's. Tons per pound of lint decreased 68 percent (3.6 percent compound annually).

Decreases in total soil erosion for potatoes, particularly in more recent years, are driven in part by a decrease in total planted acreage. However, decreases in per acre erosion and erosion per cwt have also been realized, driven in part by use of cover crops as well as less intensive tillage programs (a reduction in the number of tillage passes). See **Figures 1.37, 1.38,** and **1.39** for more detail regarding the annual soil erosion values.



Irrigation Water Applied (Potatoes)

Over the study period, potatoes improved irrigation water per applied cwt, slightly improved irrigation water applied per acre, and increased total irrigation water applied. Potatoes improved (decreased) irrigated volume per cwt by 38 percent, or 1.6 percent compound annually. Please note: because of data availability as well as the fact that the vast majority of potatoes are now irrigated, the irrigation water applied "efficiency" metric for potatoes (water applied per unit of production)– unlike for other crops but similar to rice – is based on the absolute yield rather than differential yield as a result of irrigation.

Volume per irrigated acre decreased slightly (2 percent, 0.1 percent compound annually); irrigation water applied averaged 21.6 acre inches per acre in 2011. Total irrigation water applied for potatoes increased 31 percent (0.9 percent compound annually) over the study period, from 14.6 million acre inches in 1980 to 21.6 million acre inches in 2011; a peak in total irrigation water applied occurred in the middle portion of the study period corresponding to a peak in overall production.

Over the study period, share of irrigated potato acreage increased from 58 percent 92 percent, driving the increase in total irrigation water applied despite decreases in total land use. Per cwt improvements have been driven primarily by improvements in yield.

See **Figures 1.40, 1.41, and 1.42** for more detail regarding the annual irrigation water applied values.

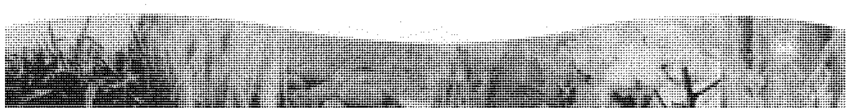
Energy Use (Potatoes)

Over the study period, energy use per cwt decreased while energy use per acre and total energy use increased for potatoes. Energy use per cwt of potatoes improved (decreased) 15 percent (0.5 percent compound annually) over the study period, from approximately 82,700 Btu per cwt in 1980 to 70,900 Btu per cwt in 2011. Energy use per acre increased 33 percent (0.9 percent compound annually), from 21.4 million Btu per acre in 1980 to 26.9 million Btu per acre in 2011. Total energy use for potatoes increased 11 percent (0.3 percent compound annually), from 25.1 trillion Btu in 1980 to 29.6 trillion Btu in 2011; a peak in total energy use occurred in the middle portion of the study period corresponding to a peak in overall production.

Storage energy for potatoes represents approximately 4 percent of total energy use; however, variations from the standard assumption of 120 days of storage that is used in this analysis could greatly impact energy use trends for potatoes.

In 2011, embedded energy in pesticides represented 12 percent of total energy use as compared to 5 percent in 1980. Embedded energy in fertilizers, on the other hand, has decreased in relative contribution to total energy use over the study period. For both embedded energy sources, however, particularly for pesticides, there is significant regional variability in application rates that would thus drive variability in regional energy use metrics.

See **Figures 1.43, 1.44, and 1.45** for more detail regarding the annual energy use values.



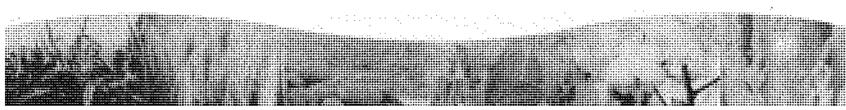
Greenhouse Gas Emissions (Potatoes)

Over the study period, potatoes decreased greenhouse gas emissions per cwt and increased per acre and total emissions. Greenhouse gas emissions per cwt of potatoes improved (decreased) 22 percent (0.8 percent compound annually) over the study period; emissions were 14.3 pounds of CO_2e per cwt in 2011 compared with 18.0 pounds of CO_2e per cwt in 1980. Emissions per acre increased 23 percent (0.7 percent compound annually), from approximately 4,650 pounds of CO_2e per acre in 1980 to 5,430 pounds of CO_2e per acre in 2011. Total greenhouse gas emissions for potato production increased slightly by 3 percent (0.1 percent compound annually); potato production resulted in approximately 5.96 billion pounds of CO_2e in 2011; a peak in total emissions occurred in the middle portion of the study period corresponding to a peak in overall production.

For all crops in this report, accounting of N_2O emissions from applied nitrogen assumes a flat 1.4 percent rate irrespective of practices. However, for potatoes, given the large proportion of nitrogen that is delivered through irrigation and incrementally throughout the season, the nitrous oxide estimates in this analysis are likely higher than would be produced using a more detailed nitrous oxide approach that accounts for such variability in timing of application and other practices.

See **Figures** 1.46, 1.47, and 1.48 for more detail regarding the annual greenhouse gas emission values.

Please note, in the following graphs, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



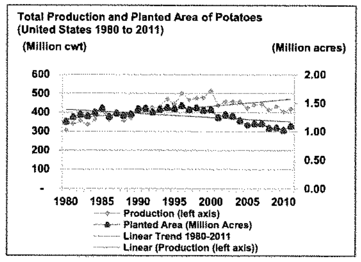


Figure 1.34 Total Production and Planted Area of Potatoes, U.S. 1980 to 2011

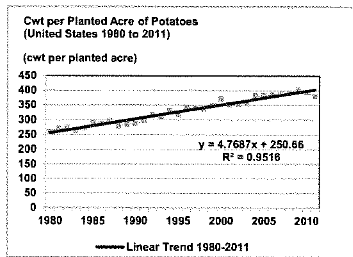


Figure 1.35 Cwt per Planted Acre of Potatoes, U.S. 1980 to 2011

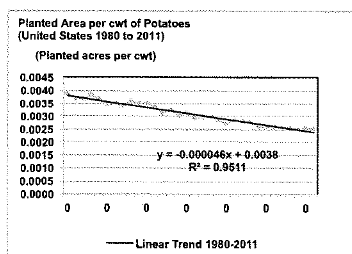
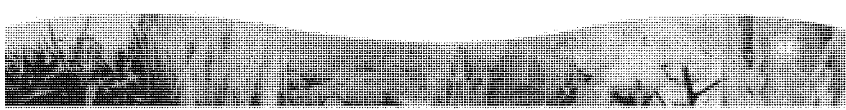


Figure 1.36 Planted Area per cwt of Potatoes, U.S. 1980 to 2011



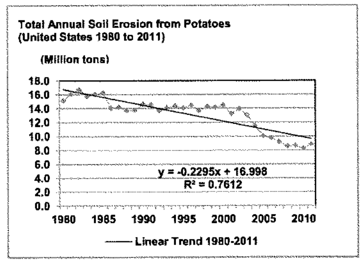


Figure 1.37 Total Annual Soil Erosion from Potatoes, U.S. 1980 to 2011

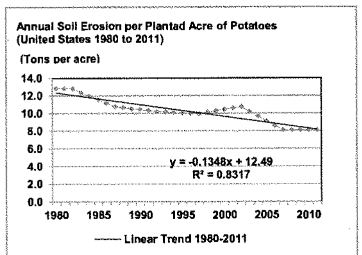


Figure 1.38 Annual Soil Erosion per Planted Acre of Potatoes, U.S. 1980 to 2011

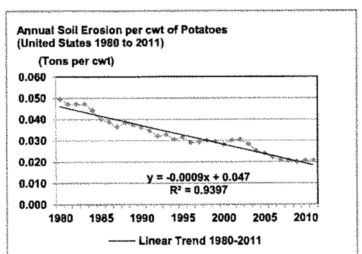


Figure 1.39 Annual Soil Erosion per cwt of Potatoes, U.S. 1980 to 2011

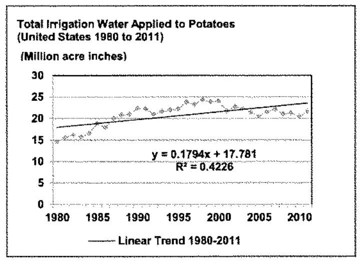


Figure 1.40 Total Irrigation Water Applied to Potatoes, U.S. 1980 to 2011

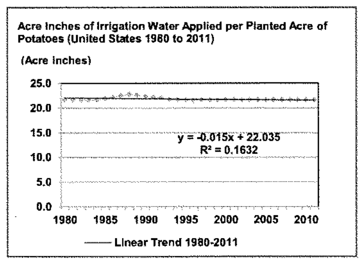


Figure 1.41 Acre Inches of Irrigation Water Applied per Planted Acre of Potatoes, U.S. 1980 to 2011

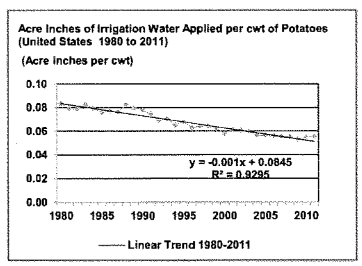


Figure 1.42 Acre Inches of Irrigation Water Applied per cwt of Potatoes, U.S. 1980 to 2011

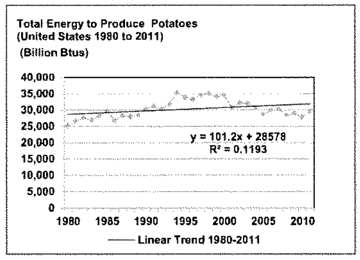


Figure 1.43 Total Energy to Produce Potatoes, U.S. 1980 to 2011

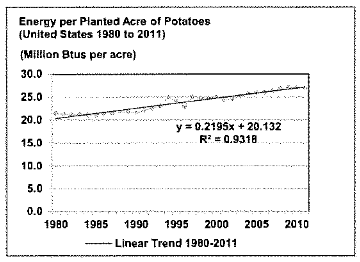


Figure 1.44 Energy per Planted Acre of Potatoes, U.S. 1980 to 2011

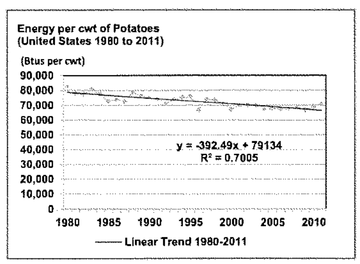


Figure 1.45 Energy per cwt of Potatoes, U.S. 1980 to 2011

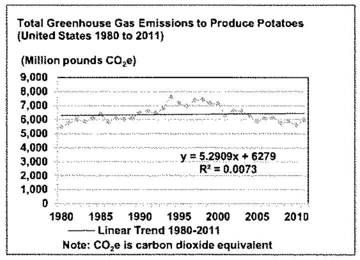


Figure 1.46 Total Greenhouse Gas Emissions to Produce Potatoes, U.S. 1980 to 2011

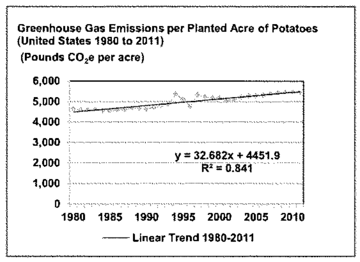


Figure 1.47 Greenhouse Gas Emissions per Planted Acre of Potatoes, U.S. 1980 to 2011

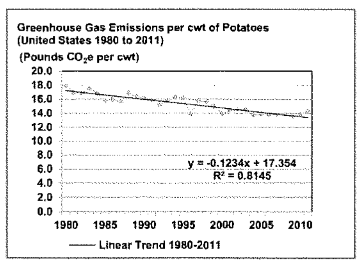
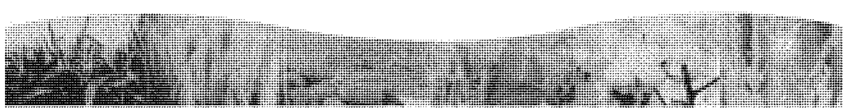


Figure 1.48 Greenhouse Gas Emissions per cwt of Potatoes, U.S. 1980 to 2011



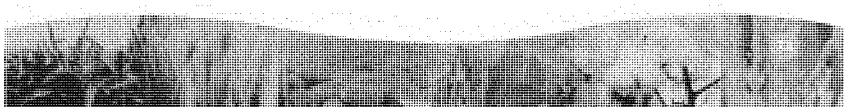
3.5. Rice Summary of Results

Overview

Over the study period (1980-2011), trends in U.S. rice production were as follows:

- **Yield:** Total rice production increased (+53%) and yield (cwt per planted acre) increased (+53%).
- **Resource efficiency (per cwt):** Rice improved on all measures of resource "efficiency," with decreases in per cwt land use (-35%), soil erosion (-34%), irrigation water applied (-53%), energy use (-38%), and greenhouse gas emissions (-38%).
- **Resource use/impact per acre:** Rice improved (decreased) per acre irrigation water applied (-25%) and slightly improved per acre energy use (-3%) and greenhouse gas emissions (-4%); per acre soil erosion remained constant (0%).
- **Total resource use/impact:** Rice improved (decreased) total irrigation water applied (-18%); rice increased total land use (+9%), soil erosion (+9%), energy use (+6%), and greenhouse gas emissions (+5%).

Summary trends for specific indicators are provided in **Figure 1.49** and **Table 1.4** and in the text below. **Figures 1.50 through 1.64** demonstrate linear trends over the full study period for total, per acre, and per unit of production resource use/impacts. Average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted below.



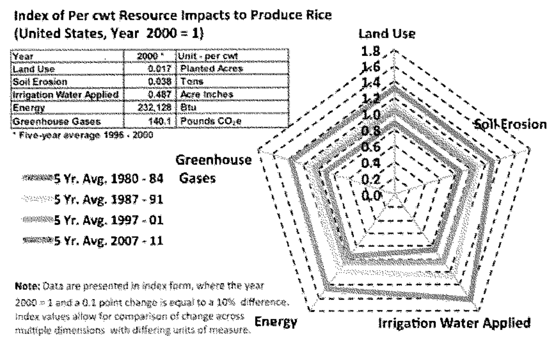


Figure 1.49 Index of Per cwt Resource Impacts to Produce Rice, United States, 1980-2011

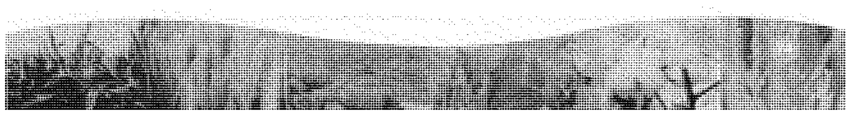
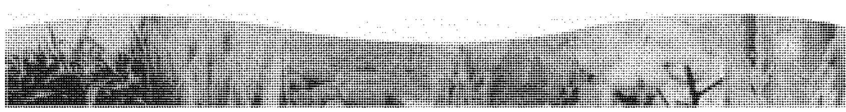


Table 1.4 Rice Summary of Results

Rice Summary of Results: Trends in U.S. Production, Resource Use / Impact, 1980-2011				
Resource Area	Indicator	Percent Change* 1980-2011		
		Trend Direction	Entire Period	Compound Annual
Crop Yield	Total Production	↑	53	1.4
	Cwt per Acre	↑	53	1.4
Land Use	Total Planted Acres	↑	9	0.3
	Acres per Cwt	↓	(35)	(1.4)
Soil Erosion	Total Tons	↑	9	0.3
	Tons per Acre	↓	(0)	(0.0)
	Tons per Cwt	↓	(34)	(1.3)
Irrigation Water Applied	Total Volume	↓	(18)	(0.6)
	Volume per Irrigated Acre	↓	(25)	(0.9)
	Volume per Cwt	↓	(53)	(2.4)
Energy Use	Total Btu	↑	6	0.2
	Btu per Acre	↓	(3)	(0.1)
	Btu per Cwt	↓	(38)	(1.5)
GHG Emissions (CO_2 Equivalents)	Total Pounds	↑	5	0.2
	Pounds per Acre	↓	(4)	(0.1)
	Pounds per Cwt	↓	(38)	(1.5)

*Percent change results are based on a least squares trends analyses from 1980 - 2011

Sources: Calculations are based on a number of data sources, including: 1. USDA, NASS, Census of Agriculture, Farm and Ranch Irrigation Survey, http://www.agcensus.usda.gov/Publications/index.php; 2. USDA, Economic Research Service (ERS), Agricultural Resource Management Survey (ARMS) http://www.ers.usda.gov/Briefing/ARMS/Access.htm; 3. USDA, National Resources Conservation Service (NRCS), National Resource Inventory (NRI) Reports http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri



Total Production and Yield (Rice)

Total production and yield for rice increased over the study period. Total production of rice increased by 53 percent, or 1.4 percent compound annually; 185 million cwt of rice were produced in 2011 as compared with 146 million cwt of rice produced in 1980. Yield (cwt per planted acre) increased 53 percent over the study period, or 1.4 percent compound annually; average planted acre yield in 2011 was 68.8 cwt per planted acre as compared with 43.2 cwt per planted acre in 1980. Harvested yield was 70.7 cwt per harvested acre in 2011.

Land Use (Rice)

Total planted acreage increased for rice and acres per cwt decreased over the study period. Total planted acreage of rice increased by an average trend of 9 percent, or 0.3 percent compound annually, with variability over time; 2.69 million acres of rice were planted in 2011, compared to highs of 3.83 million acres and 3.64 million acres in 1981 and 2010, respectively, and a low of 2.19 million acres in 1983. Harvested acreage in 2011 was 2.6 million acres; rice typically experiences minimal abandonment. Over the study period, the land use "efficiency" metric (planted acres per cwt) improved (decreased) by 35 percent, or 1.4 percent compound annually.

See **Figures** 1.50, 1.51, and 1.52 for more detail regarding the annual land use, production, and yield values.

Soil Erosion (Rice)

Soil erosion per acre remained constant, soil erosion per cwt decreased, and total soil erosion increased for rice over the study period. On a per acre basis, rice consistently demonstrates the lowest per acre soil erosion of all 6 crops examined (slightly above 2 tons/acre, not relative to T). (Note: Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre). This is due in part to the cultivation practices employed that are unique to rice, particularly flood irrigation and land leveling practices.

Per acre soil erosion remained constant over the study period. Soil erosion (tons) per cwt of rice improved (decreased) 34 percent over the study period (1.3 percent compound annually) due to increases in productivity. Total tons of soil erosion for rice increased 9 percent (0.3 percent compound annually), with variability over time in correlation with variability in planted acreage; total erosion was 5.9 million tons in 2011.

See **Figures 1.53, 1.54** and **1.55** for more detail regarding the annual soil erosion values.

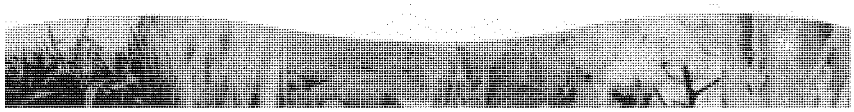
Irrigation Water Applied (Rice)

Irrigation water applied for rice improved on all measures. Over the study period, rice improved (decreased) its volume per cwt (53 percent, 2.4 percent compound annually), from 0.80 acre inches per cwt in 1980 to 0.40 acre inches per cwt in 2011. Rice improved its volume per acre (25 percent, 0.9 percent compound annually), from 34.8 acre inches in 1980 to 27.6 acre inches in 2011. Total irrigation water applied decreased (18 percent, 0.6 compound annually), from 118 million acre inches in 1980 to 74 million acre inches in 2011.

Please note: because all rice is irrigated, the irrigated water use "efficiency" metric for rice (water applied per unit of production) – unlike for other crops but similar to potatoes – is based on the absolute yield rather than differential yield as a result of irrigation.

Adoption of practices and infrastructure to use reclaimed and recycled water for rice production nationwide has also increased water use efficiency over the study period; however, because this study focuses on amount of water applied rather than source of water, and due to limitations of the data, these improvements are not reflected in our analysis.

See **Figures 1.56, 1.57,** and **1.58** for more detail regarding the annual irrigation water applied values.



Energy Use (Rice)

Energy use for rice decreased per cwt and per acre and total energy use increased over the study period. Energy use per cwt of rice production improved (decreased) 38 percent (1.5 percent compound annually) over the study period, primarily due to productivity gains; energy use was approximately 341,000 Btu per cwt in 1980 and 212,000 Btu per cwt in 2011. Energy use per acre decreased slightly, by 3 percent (0.1 percent compound annually); average energy use per acre was 14.6 million Btu in 2011. Total energy use for rice production increased an average of 6 percent (0.2 percent compound annually) over the study period, however, relative to the average trend line, there was variability throughout the study period and total energy use for rice was 39.3 trillion Btu in 2011 compared with a high of 56.4 trillion Btu in 1981 and a low of 33.7 trillion Btu in 1983.

See **Figures 1.59, 1.60 and 1.61** for more detail regarding the annual energy use values.

Greenhouse Gas Emissions (Rice)

Greenhouse gas emissions for rice decreased per cwt and per acre and total greenhouse gas emissions increased over the study period. Greenhouse gas emissions per cwt of rice improved (decreased) 38 percent (1.5 percent compound annually) over the study period, primarily due to improvements in productivity; emissions were approximately 193 pounds CO_2e per cwt in 1980 and 123 pounds CO_2e per cwt in 2011. Emissions per acre decreased by 4 percent (0.1 percent compound annually); emissions were approximately 8,450 pounds CO_2e per acre in 2011. Total greenhouse gas emissions for rice production increased by an average of 5 percent (0.2 percent compound annually), however, relative to the average trend line, there was variability through the study period; total emissions were approximate 22.7 billion pounds CO_2e in 2011 compared with a high of 32.4 billion pounds CO_2e in 1981 and a low of 18.8 billion pounds CO_2e in 1983.

See **Figures 1.62, 1.63 and 1.64** for more detail regarding the annual greenhouse gas emissions values.

Please note, in the following graphs, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.

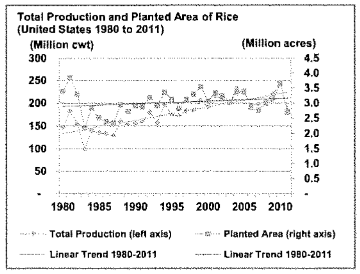


Figure 1.50 Total Production and Planted Area of Rice, U.S. 1980 to 2011

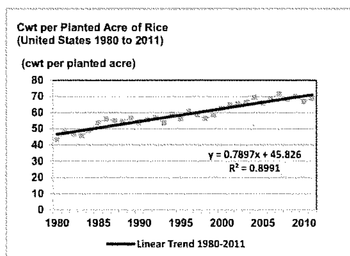


Figure 1.51 Cwt per Planted Acre of Rice, U.S. 1980 to 2011

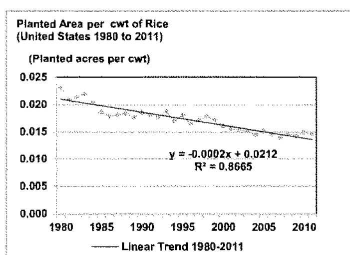


Figure 1.52 Planted Area per cwt of Rice, U.S. 1980 to 2011

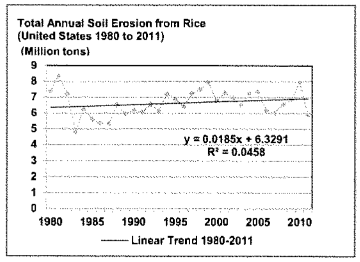


Figure 1.53 Total Annual Soil Erosion from Rice, U.S. 1980 to 2011

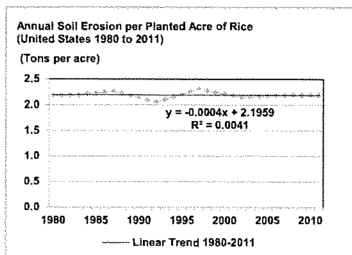


Figure 1.54 Annual Soil Erosion per Planted Acre of Rice, U.S. 1980 to 2011

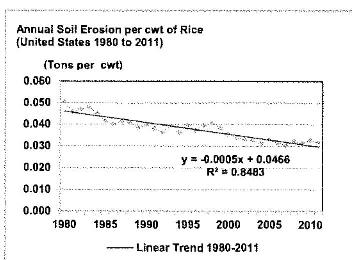
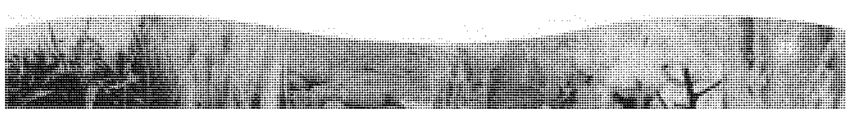


Figure 1.55 Annual Soil Erosion per cwt of Rice, U.S. 1980 to 2011



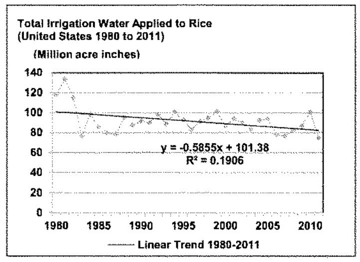


Figure 1.56 Total Irrigation Water Applied to Rice, U.S. 1980 to 2011

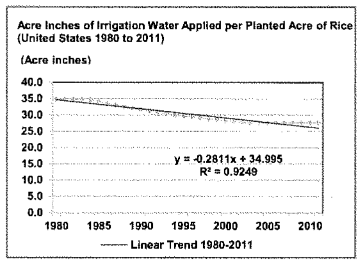


Figure 1.57 Acre Inches of Irrigation Water Applied per Planted Acre of Rice, U.S. 1980 to 2011

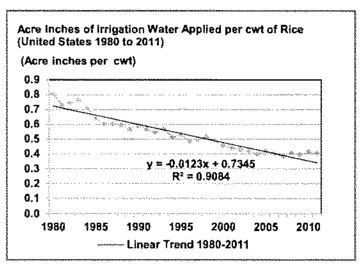


Figure 1.58 Acre Inches of Irrigation Water Applied per cwt of Rice, U.S. 1980 to 2011

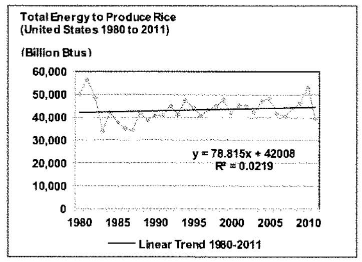


Figure 1.59 Total Energy to Produce Rice, U.S. 1980 to 2011

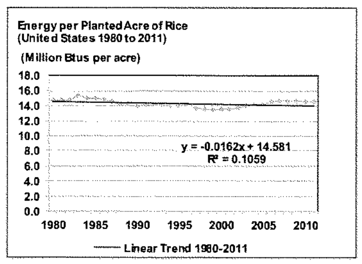


Figure 1.60 Energy per Planted Acre of Rice, U.S. 1980 to 2011

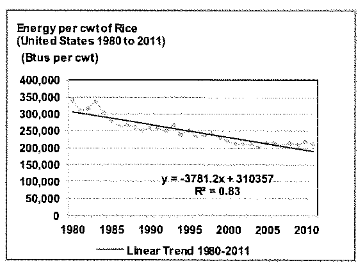


Figure 1.61 Energy per cwt of Rice, U.S. 1980 to 2011

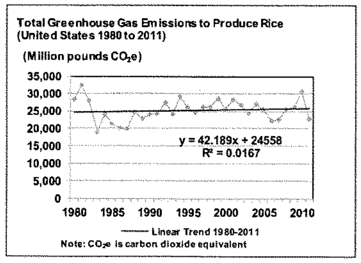


Figure 1.62 Total Greenhouse Gas Emissions to Produce Rice, U.S. 1980 to 2011

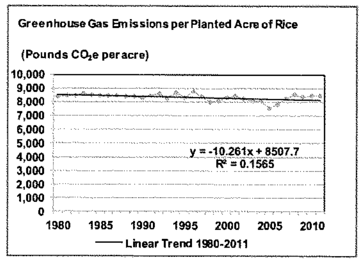


Figure 1.63 Greenhouse Gas Emissions per Planted Acre of Rice, U.S. 1980 to 2011

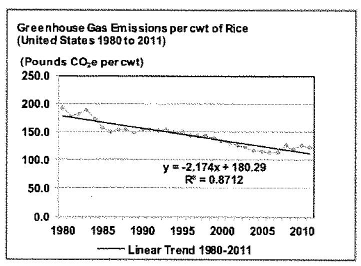
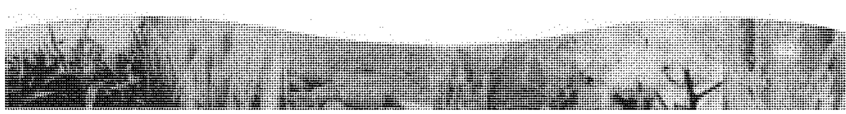


Figure 1.64 Greenhouse Gas Emissions per cwt of Rice, U.S. 1980 to 2011



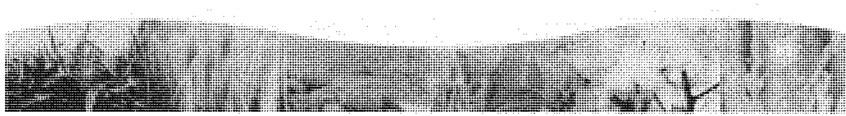
3.6. Soybeans Summary of Results

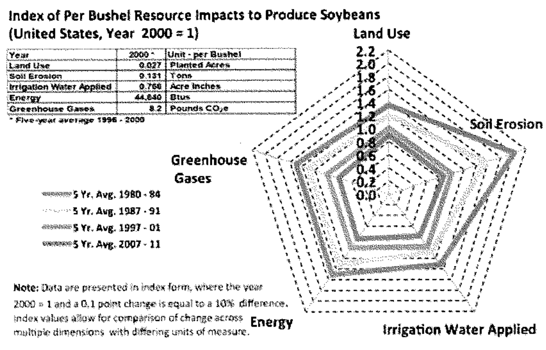
Overview

Over the study period (1980-2011), trends in U.S. soybean production were as follows:

- **Yield:** Total soybean production increased (+96%) and yield (bushels per planted acre) increased (+55%).
- **Resource efficiency (per bushel):** Soybeans improved on all measures of resource "efficiency," with decreases in per bushel land use (-35%), soil erosion (-66%), irrigation water applied (-42%) , energy use (-48%), and greenhouse gas emissions (-49%).
- **Resource use/impact per acre:**Soybeans improved (decreased) per acre soil erosion (-41%), irrigation water applied (-9%), energy use (-17%), and greenhouse gas emissions (-18%). Improvements in per acre soil erosion occurred primarily in the first half of the study period; per acre soil erosion has remained relative constant since the mid-1990s.
- **Total resource use/impact:** Soybeans improved (decreased) total soil erosion (-28%) and increased total land use (+24%) and irrigation water applied (+271%);soybeans experienced slight increases in total energy use (+3%) and greenhouse gas emissions (+1%). Improvements in total soil erosion occurred primarily in the first half of the study period, with more recent trends indicating a slight increase in total annual erosion.

Summary trends for specific indicators are provided in **Figure 1.65** and **Table 1.5** and in the text below. **Figures 1.66 through 1.80** demonstrate linear trends over the full study period for total, per acre, and per unit of production resource use/impacts. Average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted below.





Year	2000 *	Unit - per Bushel
Land Use	0.027	Planted Acres
Soil Erosion	0.131	Tons
Irrigation Water Applied	0.766	Acre Inches
Energy	44,840	Btus
Greenhouse Gases	8.2	Pounds CO_2e

* Five-year average 1996 - 2000

Figure 1.65 Index of Per Bushel Resource Impacts to Produce Soybeans, United States, 1980-2011

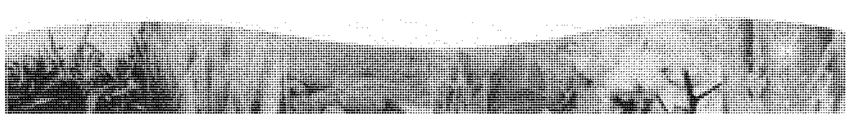


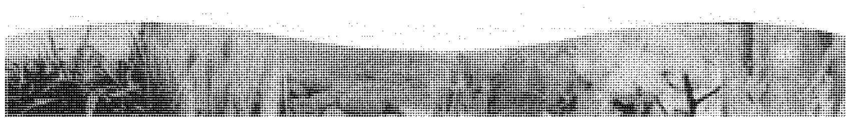
Table 1.5 Soybeans Summary of Results

Soybeans Summary of Results:
Trends in U.S. Production, Resource Use / Impact, 1980-2011

Resource Area	Indicator	Percent Change* 1980-2011		
		Trend Direction	Entire Period	Compound Annual
Crop Yield	Total Production	↑	96	2.2
	Bushels per Acre	↑	55	1.4
Land Use	Total Planted Acres	↑	24	0.7
	Acres per Bushel	↓	(35)	(1.4)
Soil Erosion	Total Tons	↓	(28)	(1.0)
	Tons per Acre	↓	(41)	(1.7)
	Tons per Bushel	↓	(66)	(3.5)
Irrigation Water Applied	Total Volume	↑	271	4.3
	Volume per Irrigated Acre	↓	(9)	(0.3)
	Volume per Bushel	↓	(42)	(1.8)
Energy Use	Total Btu	↑	3	0.1
	Btu per Acre	↓	(17)	(0.6)
	Btu per Bushel	↓	(48)	(2.1)
GHG Emissions (CO_2 Equivalents)	Total Pounds	↑	1	0.0
	Pounds per Acre	↓	(18)	(0.6)
	Pounds per Bushel	↓	(49)	(2.1)

*Percent change results are based on a least squares trends analyses from 1980 - 2011

Sources: Calculations are based on a number of data sources: 1. USDA, NASS, Census of Agriculture, Farm and Ranch Irrigation Survey, http://www.agcensus.usda.gov/Publications/index.php 2. USDA, Economic Research Service (ERS), Agricultural Resource Management Survey (ARMS) http://www.ers.usda.gov/Briefing/ARMS/Access.htm 3. USDA, National Resources Conservation Service (NRCS), National Resrouce inventory (NRI) Reports http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri



Total Production and Yield (Soybeans)

Total production and yield of soybeans increased over the study period. Total production of soybeans increased over the study period by 96 percent, or 2.2 percent compound annually; 3.06 billion bushels of soybean were produced in 2011 as compared with 1.80 billion bushels in 1980. Yield (bushels per planted acre) increased 55 percent over the study period, or 1.4 percent compound annually; average planted yield in 2011 was 40.8 bushels per planted acre as compared with 25.7 bushels per planted acre in 1980. Harvested yield was 41.5 bushels per harvested acre in 2011.

Land Use (Soybeans)

Total planted acreage increased and acres per bushel decreased over the study period. Total planted acreage of soybeans increased over the study period by 24 percent, or 0.7 percent compound annually; 75.0 million acres of soybeans were planted in 2011 as compared with 69.9 million planted acres in 1980. Harvested acreage was 73.6 million acres for soybeans in 2011. Soybeans experience minimal abandonment. Over the study period, the land use "efficiency" metric (acres per bushel) improved (decreased) 35 percent, or 1.4 percent compound annually.

See Figures 1.66, 1.67 and 1.68 for more detail regarding the annual land use, production, and yield values.

Soil Erosion (Soybeans)

Soil erosion for soybeans improved for all measures. Total tons of soil erosion for soybeans decreased 28 percent over the study period, or 1.0 percent compound annually, from 519 million tons in 1980 to 360 million tons in 2010. In absolute terms (not relative to a tolerance rate or T), per acre soil erosion decreased from more than 7 tons per acre to 4.80 tons per acre, or 41 percent (1.7 percent compound annually). (Note: Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre). Tons per bushel decreased 66 percent (3.5 percent compound annually).

Adoption of no-till practices for soybeans has been more pervasive than for any other crop in the United States, helping to drive improvements in soil erosion. Much improvement was seen in the first half of the study period; trends in improvement in total and per acre soil loss have slowed since the mid-1990s.

While the average trend since 1980 shows significant improvement in total and per acre soil erosion, these improvements occurred primarily before the mid-1990s, likely attributable in large part to implementation of conservation plans, particularly on highly erodible lands. Since the mid-1990s, per acre erosion for soybeans has remained relatively constant; however, total soil erosion has increased in correlation with increases in total planted acreage.

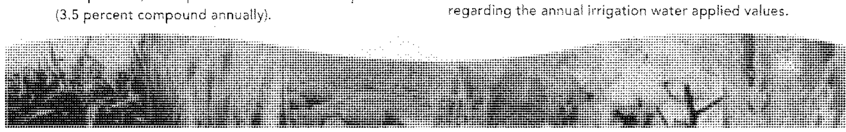
See Figures 1.69, 1.70 and 1.71 for more detail regarding the annual soil erosion values.

Irrigation Water Applied (Soybeans)

Irrigation water applied decreased per acre and per bushel and total irrigation water applied increased over the study period. Soybeans decreased volume of water applied per irrigated acre (9 percent, 0.3 percent compound annually), from approximately 9.6 acre inches in 1980 to 8.4 acre inches in 2011. Volume per incremental bushel produced as a result of irrigation also improved (decreased) (42 percent, 1.8 percent compound annually), from 1.09 acre inches per bushel in 1980 to 0.60 acre inches per bushel in 2011. Total irrigation water applied for soybeans increased 271 percent (4.3 compound annually) over the study period; from 24.2 million acre inches in 1980 to 58.6 million acre inches in 2011.

The incidence of irrigation water applied for soybeans has increased steadily over the study period; less than 4 percent of soybean acreage was irrigated in 1980 as compared to more than 9 percent in 2011; the increase in proportion of irrigated acres corresponds with an increase in total planted soybean acres, thus driving increases in total irrigation water applied. However, per acre irrigation water applied for those acres that are irrigated has remained relatively flat.

See Figures 1.72, 1.73 and 1.74 for more detail regarding the annual irrigation water applied values.



Energy Use (Soybeans)

Energy use decreased per bushel and per acre and total energy use increased slightly for soybeans over the study period. Energy use per bushel of soybeans improved (decreased) 48 percent (2.1 percent compound annually) over the study period, from 74,000 Btu per bushel in 1980 to 36,800 Btu per bushel in 2011. Energy use per acre decreased 17 percent (0.6 percent compound annually), from 1.9 million Btu per acre in 1980 to 1.5 million Btu per acre in 2011. Total energy use for soybeans increased 3 percent (0.1 percent compound annually). However, actual values for total energy use are less linear, punctuated by a decrease from 1980 to 1993 and a more rapid increase between ~1993 and 2004, followed by a more recent decrease. The 2011 value for total energy (113 trillion Btu) is actually less than the 1980 value (133 trillion Btu).

Energy use for crop chemicals (embedded energy) and irrigation for soybeans have increased over time, however these increases have been offset by decreases in tillage energy.

See **Figures 1.75, 1.76 and 1.77** for more detail regarding the annual energy use values.

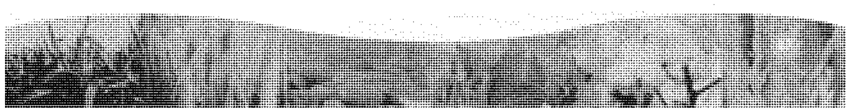
Greenhouse Gas Emissions (Soybeans)

Greenhouse gas emissions decreased per bushel and per acre over the study period while total emissions remained nearly constant. Emissions per bushel of soybeans improved (decreased) 49 percent (2.1 percent compound annually) over the study period, from 13.6 pounds CO2e per bushel in 1980 to 6.5 pounds CO2e per bushel in 2011. Emissions per acre decreased by 18 percent (0.6 percent compound annually), from 351 pounds CO2e per acre in 1980 to 267 pounds CO2e per acre in 2011. Total greenhouse gas emissions for soybean production remained nearly constant, increasing 1 percent (0.0 percent compound annually), however, similar to energy use, actual values for total emissions are less linear, punctuated by a decrease from 1980 to 1992 and a more rapid increase between ~1992 and 2004, followed by a more recent decrease. The 2011 value for total emissions (20.0 billion pounds CO2e) is actually less than the 1980 value (24.5 billion pounds CO2e); total emissions peaked at 25.0 billion pounds CO2e in 2004.

Greenhouse gas emissions associated with crop chemicals (embedded energy) and irrigation have increased over time. However these increases have been offset by decreases in emissions associated with tillage operations.

See **Figures 1.78, 1.79 and 1.80** for more detail regarding the annual greenhouse gas emissions values.

Please note, in the following graphs, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



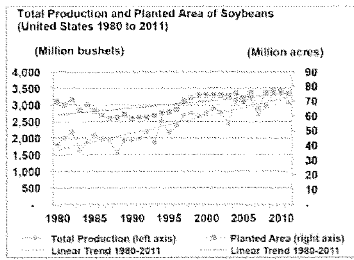


Figure 1.66 Total Production and Planted Area of Soybeans, U.S. 1980 to 2011

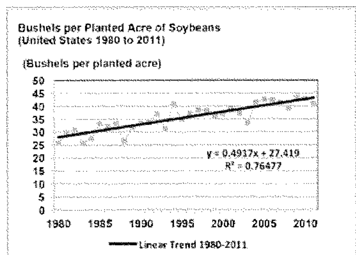


Figure 1.67 Bushels per Planted Acre of Soybeans, U.S. 1980 to 2011

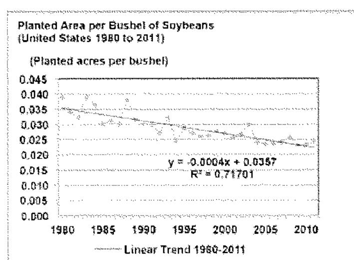
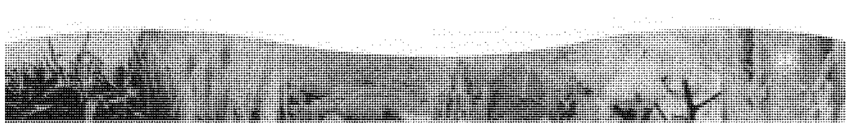


Figure 1.68 Planted Area per Bushel of Soybeans, U.S. 1980 to 2011



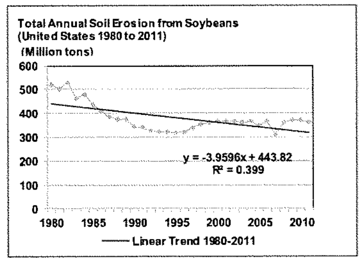


Figure 1.69 Total Annual Soil Erosion from Soybeans, U.S. 1980 to 2011

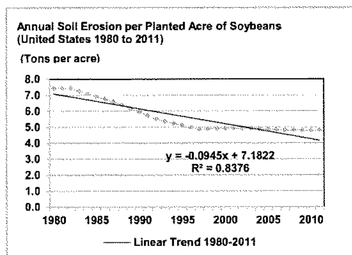


Figure 1.70 Annual Soil Erosion per Planted Acre of Soybeans, U.S. 1980 to 2011

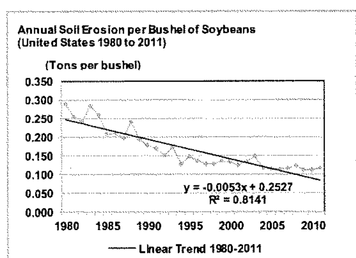
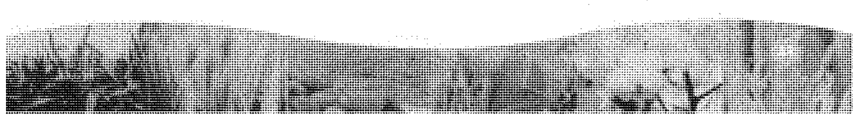


Figure 1.71 Annual Soil Erosion per Bushel of Soybeans, U.S. 1980 to 2011



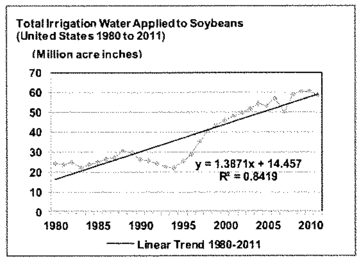


Figure 1.75 Total Energy to Produce Soybeans, U.S. 1980 to 2011

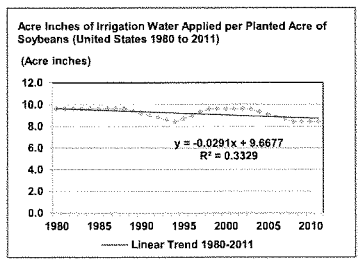


Figure 1.76 Energy per Planted Acre of Soybeans, U.S. 1980 to 2011

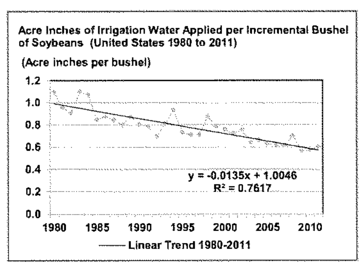
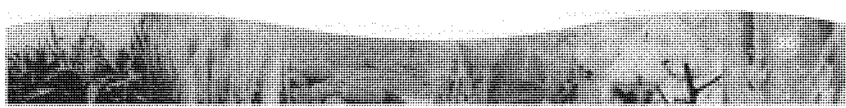


Figure 1.77 Energy per Bushel of Soybeans, U.S. 1980 to 2011



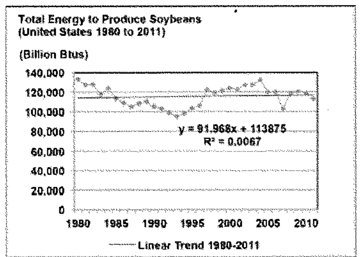


Figure 1.75 Total Energy to Produce Soybeans, U.S. 1980 to 2011

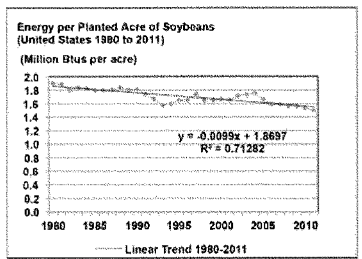


Figure 1.76 Energy per Planted Acre of Soybeans, U.S. 1980 to 2011

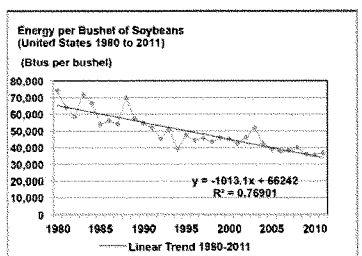
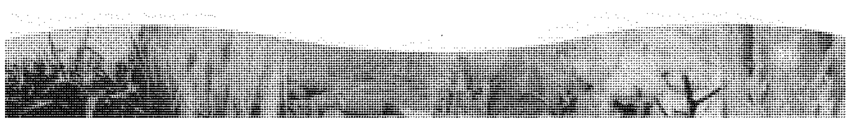


Figure 1.77 Energy per Bushel of Soybeans, U.S. 1980 to 2011



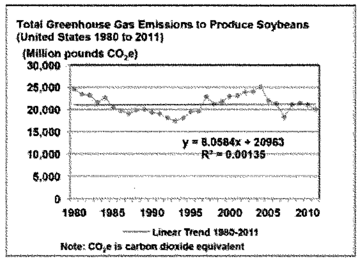


Figure 1.78 Total Greenhouse Gas Emissions to Produce Soybeans, U.S. 1980 to 2011

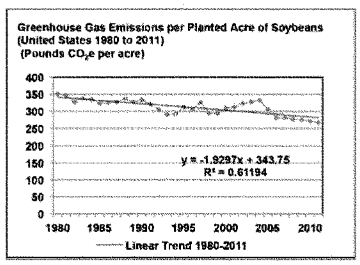


Figure 1.79 Greenhouse Gas Emissions per Planted Acre of Soybeans, U.S. 1980 to 2011

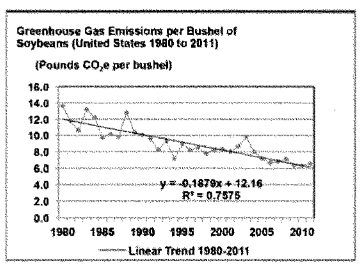


Figure 1.80 Greenhouse Gas Emissions per Bushel of Produce Soybeans, U.S. 1980 to 2011

3.7. Wheat Summary of Results

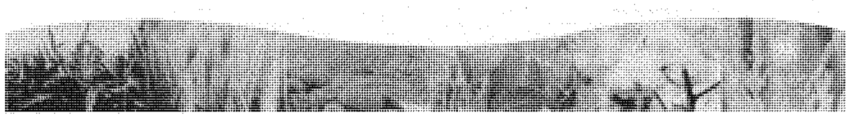
Overview

Over the study period (1980-2011), trends in U.S. wheat production were as follows:

- **Yield:** Total wheat production decreased (-16%) and yield per planted acre increased (+25%).
- **Resource efficiency (per bushel):** Wheat improved on all measures of resource "efficiency," with decreases in per bushel land use (-18%), soil erosion (-47%), irrigation water applied (-12%), energy use (-12%), and greenhouse gas emissions (-2%).
- **Resource use/impact per acre:** Wheat improved (decreased) per acre soil erosion (-34%); wheat increased per acre irrigation water applied (+6%), energy use (+9%) and greenhouse gas emissions (+21%). Per acre soil erosion improvements were realized primarily in the first half of the study period.
- **Total resource use/impact:** : Wheat decreased total land use (-33%), and correspondingly decreased total soil erosion (-57%), irrigation water applied (-12%), energy use (-26%), and greenhouse gas emissions (-17%).

Please note: wheat use/impact for soil, energy, irrigation water applied and greenhouse gas emissions are allocated between wheat and straw using an economic allocation method, with 96.6 percent of use and resource impact values being attributed to wheat and 3.4 percent to wheat straw based on 2005-2009 economic data (land use acreage is not allocated). Values for wheat may be converted to values representing that required to produce both economic yield components, wheat and straw, by multiplying wheat values by 1.034.

Summary trends for specific indicators are provided in **Figure 1.81 and Table 1.6** and in the text 5below. **Figures 1.82 through 1.96** demonstrate linear trends over the full study period for total, per acre, and per unit of production resource use/impacts. Average percent change values reported for the full study period are based on a least squares trend analyses from 1980-2011; significant variations from these average trends are noted below.



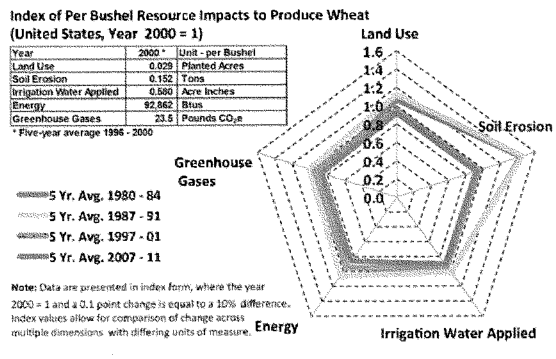


Figure 1.81 Index of Per Bushel Resource Impacts to Produce Wheat, United States, 1980-2011

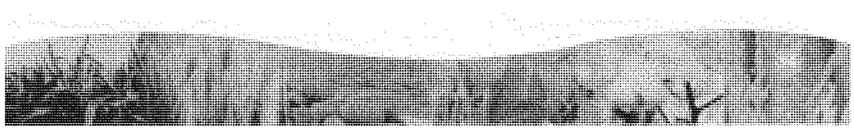


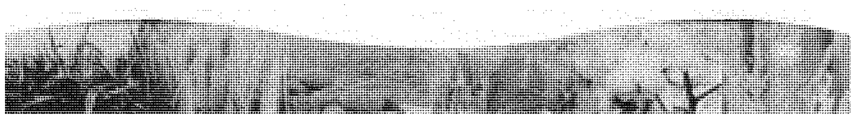
Table 1.6 Wheat Summary of Results

Wheat Summary of Results:
Trends in U.S. Production, Resource Use / Impact, 1980-2011

Resource Area	Indicator	Percent Change* 1980-2011		
		Trend Direction	Entire Period	Compound Annual
Crop Yield	Total Production	↓	(16)	(0.6)
	Bushels per Acre	↑	25	0.7
Land Use	Total Planted Acres	↓	(33)	(1.3)
	Acres per Bushel	↓	(18)	(0.7)
Soil Erosion	Total Tons	↓	(57)	(2.7)
	Tons per Acre	↓	(34)	(1.3)
	Tons per Bushel	↓	(47)	(2.1)
Irrigation Water Applied	Total Volume	↓	(12)	(0.4)
	Volume per Irrigated Acre	↑	6	0.2
	Volume per Bushel	↓	(12)	(0.4)
Energy Use	Total Btu	↓	(26)	(1.0)
	Btu per Acre	↑	9	0.3
	Btu per Bushel	↓	(12)	(0.4)
GHG Emissions (CO_2 Equivalents)	Total Pounds	↓	(17)	(0.6)
	Pounds per Acre	↑	21	0.6
	Pounds per Bushel	↓	(2)	(0.1)

*Percent change results are based on a least squares trends analyses from 1980 - 2011

Sources: Calculations are based on a number of data sources: 1. USDA, NASS, Census of Agriculture, Farm and Ranch Irrigation Survey, http://www.agcensus.usda.gov/Publications/index.php 2. USDA, Economic Research Service (ERS), Agricultural Resource Management Survey (ARMS) http://www.ers.usda.gov/Briefing/ARMS/Access.htm 3. USDA, National Resources Conservation Service (NRCS), National Resrouce Inventory (NRI) Reports http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri



Total Production and Yield (Wheat)

Total production decreased for wheat while yield increased over the study period. Total production of wheat decreased by 16 percent, or 0.6 percent compound annually; 2.0 billion bushels of wheat were produced in 2011 as compared with 2.3 billion bushels in 1980. Planted area yield (bushels per planted acre) increased 25 percent over the study period, or 0.7 percent compound annually; average planted yield in 2011 was 36.8 bushels per planted acre as compared with 29.5 bushels per planted acre in 1980. Harvested acre yield in 2011 was 43.7 bushels per acre. Wheat research over the study period has focused on quality and milling traits more so than on yield.

Land Use (Wheat)

Total land use and land use per bushel decreased for wheat over the study period. Total planted acreage of wheat decreased by 33 percent, or 1.3 percent compound annually; 54.4 million acres of wheat were planted in 2011 as compared with 80.8 million acres in 1980. Harvested acreage of wheat was 45.7 million acres in 2011. Over the study period, the land use "efficiency" metric (acres per bushel) improved (decreased) by 18 percent, or 0.7 percent compound annually.

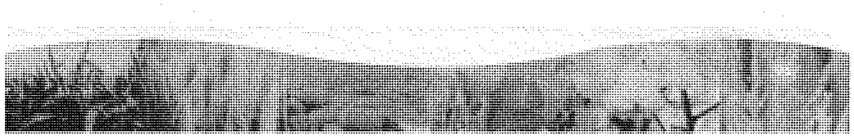
See **Figures** 1.82, 1.83 and 1.84 for more detail regarding the annual land use, production, and yield values.

Soil Erosion (Wheat)

Soil erosion for wheat improved for all measures. Total tons of soil erosion for wheat decreased 57 percent over the study period, or 2.7 percent compound annually, corresponding with a decrease in total planted acreage; total soil erosion was 291 million tons in 2011 compared with 585 tons in 1980. In absolute terms (not relative to a tolerance rate or T), per acre soil erosion decreased 34 percent (1.3 percent compound annually) from more than 7 tons per acre in 1980 to 5.35 tons per acre in 2011. (Note: Tolerable (T) soil loss levels vary by soil type across the country but range from 3.0 to 4.9 tons per acre per year – with a simple average of 4.3 tons per acre). Tons per bushel decreased 47 percent (2.1 percent compound annually).

While the average trend since 1980 shows significant improvement per acre soil erosion, these improvements occurred primarily before the mid-1990s. Adoption of conservation tillage practices for wheat has been lower than for other crops, however these and other practices – including the Conservation Reserve Program, which removed significant proportions of highly erodible wheat land from production – have helped to drive improvement on a per acre and per bushel basis.

See **Figures 1.85, 1.86** and **1.87** for more detail regarding the annual soil erosion values.



Irrigation Water Applied (Wheat)

Irrigation water applied per bushel and total irrigation water applied decreased over the study period while irrigation water per acre increased for wheat. Wheat improved (decreased) its volume per incremental bushel produced as a result of irrigation by 12 percent (0.4 percent compound annually). Wheat increased its volume per irrigated acre (6 percent, 0.2 percent compound annually); the average acre inches applied per irrigated acre was 16.8 acre inches in 2011. Total irrigation water applied for wheat improved (decreased) 12 percent (0.4 percent compound annually) over the study period; total irrigation water applied for wheat was 59.4 million acre inches in 2011.

Incidence of irrigation for wheat is relatively low and has not changed significantly over time; 4 percent of wheat acreage was irrigated in 1980 and 5 percent of wheat acreage was irrigated in 2011; a majority of irrigated wheat occurs in the Pacific Northwest.

See **Figures 1.88, 1.89** and **1.90** for more detail regarding the annual irrigation water applied values.

Energy Use (Wheat)

Per bushel and total energy use for wheat improved while per acre energy use increased. Energy use per bushel of wheat production improved (decreased) 12 percent (0.4 percent compound annually) over the study period, corresponding primarily with productivity gains; energy use per bushel was approximately 81,500 Btu per bushel in 2011 compared with 95,400 Btu per bushel in 1980. Energy use per acre increased by 9 percent (0.3 percent compound annually), from 2.8 million Btu per acre in 1980 to 3.0 million Btu per acre in 2011. Total energy use for wheat production decreased 26 percent (1.0 percent compound annually), corresponding with a decrease in total acreage; total energy use for wheat was approximately 163 trillion Btu in 2011, compared to 227 trillion Btu in 1980.

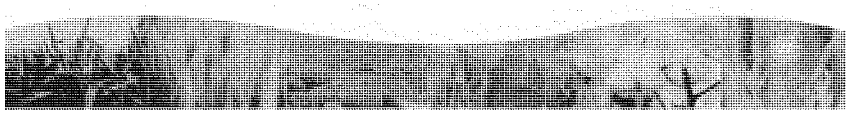
See **Figures 1.91, 1.92** and **1.93** for more detail regarding the annual energy use values.

Greenhouse Gas Emissions (Wheat)

Greenhouse gas emissions per bushel decreased slightly and total emissions decreased over the study period while emissions per acre increased for wheat. Per bushel greenhouse gas emissions for wheat improved (decreased) 2 percent (0.1 percent compound annually) over the study period, corresponding primarily with productivity gains; per bushel emissions were approximately 21.2 pounds of CO2e per bushel in 2011 compared with 22.1 pounds of CO2e per bushel in 1980. Emissions per acre increased by 21percent (0.6 percent compound annually), from 651 pounds of CO2e per acre in 1980 to 778 pounds of CO2e per acre in 2011. Total emissions decreased 17 percent (0.6 percent compound annually), corresponding with the decrease in total planted acreage; total emissions were approximately 42.3 billion pounds of CO2e in 2011, compared with 52.6 billion pounds CO2e in 1980.

See **Figures Figures 1.94, 1.95** and **1.96** for more detail regarding the annual greenhouse gas emissions values.

Please note, in the following graphs, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient will have the units of the indicators, e.g., tons of soil erosion per bushel per year. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



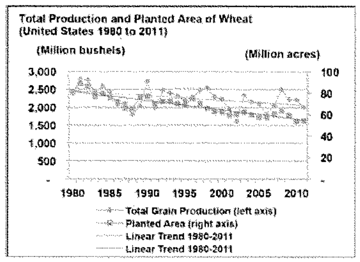


Figure 1.82 Total Production and Planted Area of Wheat, U.S. 1980 to 2011

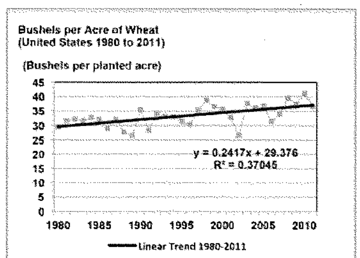


Figure 1.83 Bushels per Planted Acre of Wheat, U.S. 1980 to 2011

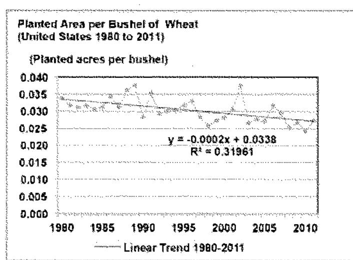


Figure 1.84 Planted Area per Bushel of Wheat, U.S. 1980 to 2011

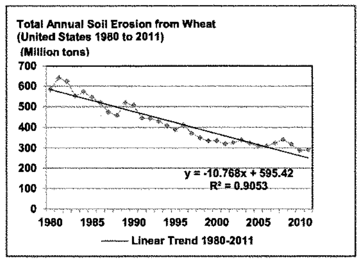


Figure 1.85 Total Annual Soil Erosion from Wheat, U.S. 1980 to 2011

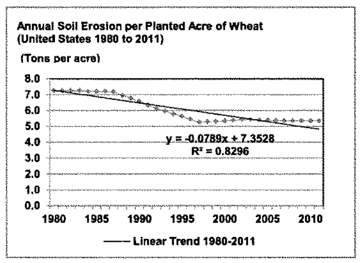


Figure 1.86 Annual Soil Erosion per Planted Acre of Wheat, U.S. 1980 to 2011

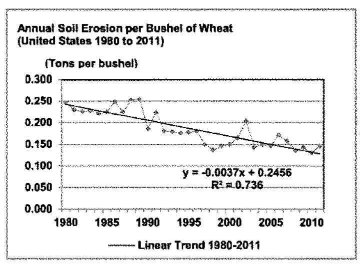


Figure 1.87 Annual Soil Erosion per Bushel of Wheat, U.S. 1980 to 2011

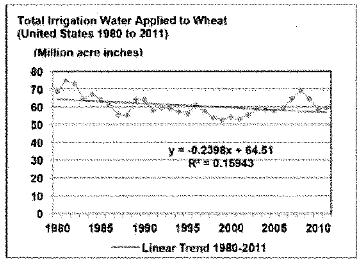


Figure 1.88 Total Irrigation Water Applied to Wheat, U.S. 1980 to 2011

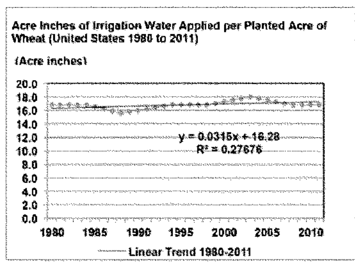


Figure 1.89 Acre Inches of Irrigation Water Applied per Planted Acre of Wheat, U.S. 1980 to 2011

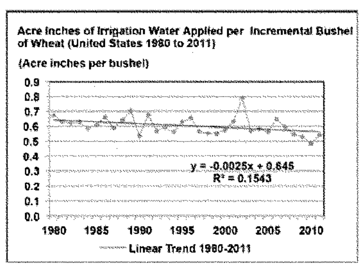
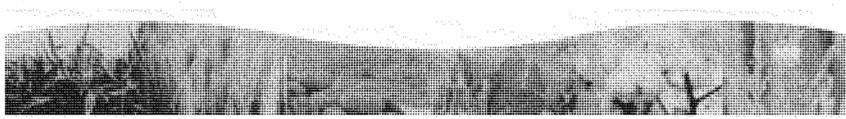


Figure 1.90 Acre Inches of Irrigation Water Applied per Incremental Bushel of Wheat, U.S. 1980 to 2011



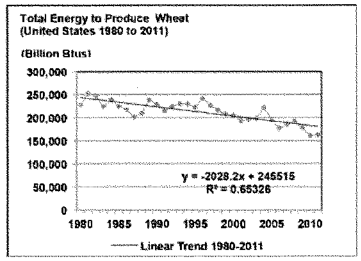


Figure 1.91 Total Energy to Produce Wheat, U.S. 1980 to 2011

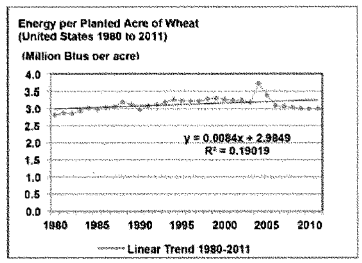


Figure 1.92 Energy per Planted Acre of Wheat, U.S. 1980 to 2011

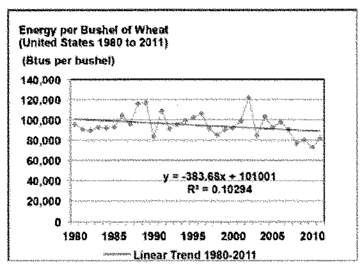
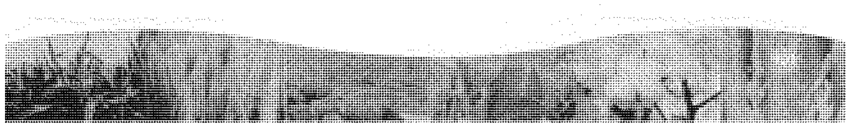


Figure 1.93 Energy per Bushel of Wheat, U.S. 1980 to 2011



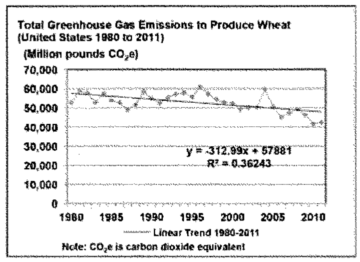


Figure 1.94 Total Greenhouse Gas Emissions to Produce Wheat, U.S. 1980 to 2011

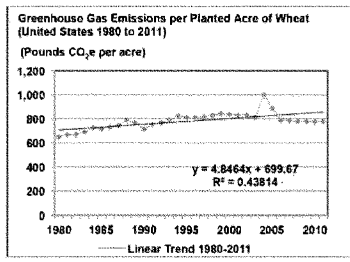


Figure 1.95 Greenhouse Gas Emissions per Planted Acre of Wheat, U.S. 1980 to 2011

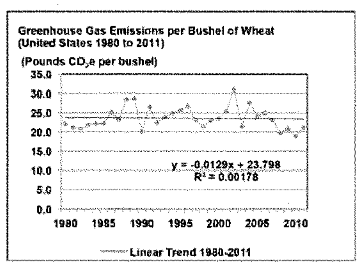
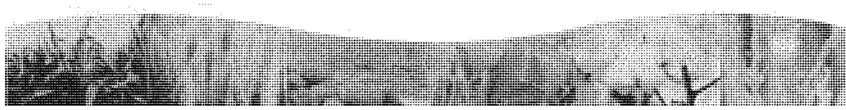


Figure 1.96 Greenhouse Gas Emissions per Bushel of Wheat, U.S. 1980 to 2011



4. Discussion and Conclusions

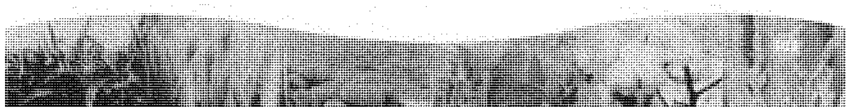
This report does not define a benchmark level for sustainability for environmental indicators. Rather, it explores broad-scale, commodity-level progress over time related to the major challenge facing agriculture in the twenty-first century: increasing demand and limited resources. By exploring three different metrics for each indicator – total use/impact, per acre, and per unit of production – the report offers an opportunity to better understand and contextualize outcomes of relevance to the challenge of increasing production and improving environmental outcomes. As described in the introduction to the results section, each data format provides unique perspective and also bears specific caveats.

As demonstrated by the results, over the study period of more than three decades, all six crops demonstrated progress in resource use/impact per unit of production on all five environmental indicators – an indication of continuous improvement toward producing crops more efficiently, with less resource use and impacts per unit of production. Improvements in efficiency were driven, at least in part, by improvements in yield for all crops. However, due in part to overall increases in production for five of the six crops (excluding wheat) and increases in total land use for four of the six crops (excluding potato and wheat), total resource use/impact increased for many crops on many indicators. These trends of increased efficiency, but also increased total resource use suggest that a challenge for the future will be to continue efficiency improvements such that overall resource limits (e.g., land, water, and energy) are not reached.

In general it should also be noted that while national trends may show improvement, specific local examples of continued challenges cannot be overlooked. Conversely, some national trends may show overall increases in total uses or decreases for efficiencies for a particular crop even while success stories may be occurring at more local levels. Further exploration of trends at more regional or local levels are outside the scope of this report and although they are important considerations for future study, the results for these types of analyses are not provided.

By advancing an outcomes and science-based approach to understanding and measuring sustainability indicators, this report represents a starting place for discussion and further research. Specific opportunities for continued refinement and extension of the work presented here include:

Expansion of indicators. The indicators presented in this report do not represent the full suite of sustainability indicators for agriculture. Expansion of the current indicator set to include additional crops as well as additional environmental indicators may occur given available methods and datasets. In particular, Field to Market continues to explore development of metrics for water quality and biodiversity. The next chapter of this report provides an analysis of national scale social and economic indicators for agricultural sustainability since social and economic dimensions are fundamental to all conversations regarding sustainability.

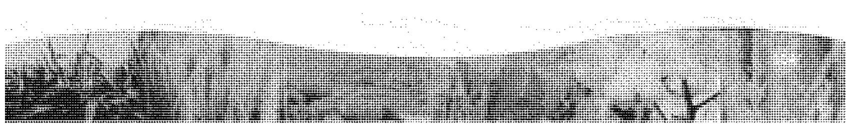


Refinement of methods and data. On a technical level, the updated approaches and results for the environmental indicators presented in this report represent continued and important progress towards evaluating agricultural sustainability and tracking progress over time. Refinements in methodology as compared with Field to Market's 2009 environmental indicators approach add robustness to results, and an expansion of data analyzed provides a longer-term and up-to-date analysis of trends for major commodity crops. Current methodology and results may be modified and improved as research, time and better and/or more recent data allow. Capacity to continue and enhance these kinds of analyses is dependent on the availability of the public data sources upon which it heavily relies. Public, national level datasets provide a transparent, accessible, and fundamental means of understanding sustainability trends. Examples of data and research that could improve future analyses include soil erosion data utilizing RUSLE2 rather than the USLE model, data for the quantification of fuel efficiency and emissions over time associated with equipment technology changes, and data and methods to better account for sequestration of carbon under various tillage systems, and improved data and coefficients for estimating rice methane emissions. Furthermore, while many datasets are currently available for the crops evaluated, the expansion of these methods to other crops would be limited by data availability, including ARMS data for crops such as alfalfa with smaller crop acreages.

Scaling of approaches. Downscaled analyses may require more sophisticated methodologies and datasets to allow for higher resolution, better interpretation of trends at local levels, and better understanding of how specific decisions affect specific resources and geographies. This report utilizes methods that strive for high scientific sophistication while also recognizing the limits of working with public data and at a broad-scale. More locally-scaled analyses may utilize and even require methods not feasible and data not available at the national scale, as local decisions will require more specific information to inform management and decision-making.

Exploration of impacts. Further analyses at all scales are needed to better understand the total impacts of crop production. For example, within our environmental indicators, efficiency and total use trends at the national scale do not capture the specific challenges associated with resource limitations and impact, including those at smaller scales. While many national trends show improvement for particular crops, whether for efficiency measures or total resource, overall national or even global resource limitations cannot be overlooked, nor can specific local examples of continued challenges. For example, sustainability can be impacted by nationally and globally available cropland and energy sources, as well as by groundwater availability for a particular regional or local aquifer. Conversely, some national trends may show overall increases in total uses for a particular crop even while success stories may be occurring at more local levels or may be occurring in consideration of all crops grown in a particular area.

Aggregation of results across all crops. Further analyses are needed to better understand the cumulative or aggregate impacts of all crop production. While crop-by-crop analyses provide important information for commodity sectors and supply chains, aggregation of data for all crops may provide further insight into directional changes in total uses. For example, increases or decreases in resource use for a single crop may actually be offset by decreases or increases for another crop, and aggregate results may in some cases be directionally different than by-crop results, both at the national and local scale. Aggregate total resource uses may also vary in direction at the local scale as compared to national scale; for example, due to land use change either away from agricultural production (e.g., conversion to urban land) or into production (e.g., release of Conservation Reserve Program land back into production). Similarly, for socioeconomic indicators, further analyses at additional scales and for the aggregate of agricultural production are needed, as are enhanced measures of impact on the farmer and farm community.



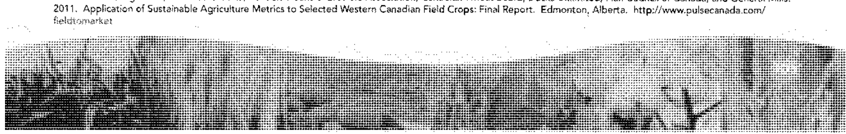
Evaluation of context and drivers. Further analyses are also needed to better understand both the context and drivers underlying the trends reported here. Context and drivers can include conditions both internal and external to agricultural systems – such as resource limitations and conditions (at a variety of scales), individual farmer choices, availability of new science and technology, profitability needs, supply chain and economic conditions, price signals, consumer behaviors, demographic changes, governance, and policy, including Farm Bill policies and programs such as the Conservation Reserve Program and ethanol mandates associated with energy policies. Because agriculture is an incredibly complex system and analysis of context and drivers equally complex, Field to Market does not attempt in this report to analyze nor speculate on them unless they are explicitly evident in the datasets used to build the metrics themselves.

Examination of recent trends versus historical trends. Further analyses are also particularly needed to better understand the most recent trends, drivers, and contexts for sustainability. This report highlights results in summary form – for example, percent change over the full 30-year study period – and also includes data demonstrating the full time series of trend lines for each crop and indicator. There are many more stories to be further explored and explained within the data provided in this report, including and especially those for which more recent trends may represent accelerations, decelerations, or reversals of the overarching 30-year trend-lines. The longer time period provides important historical context; the most recent trends may signal important considerations for the future. In particular, the soil erosion metric for many crops demonstrates more recent slow-downs and in some cases reversals in progress.

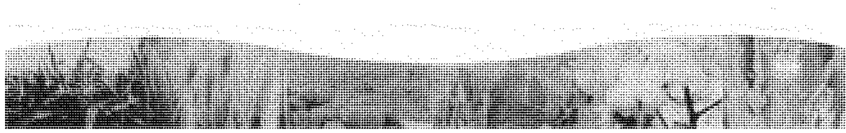
Expansion to additional crops and geographies. Field to Market's primary focus is currently on commodity agricultural production in the United States; however, the Alliance seeks to inform efforts focused on other crops and geographies by facilitating information-sharing, coordination, and collaboration regarding methodologies and approaches. As an example, Field to Market's 2009 report was recently adapted for Canadian field crops.[91] Field to Market continues exploration of opportunities to leverage and adapt the current work to new contexts, both within and beyond the United States.

Connecting trends to individual grower education and action. Field to Market's analysis of broad-scale trends provides a mechanism to measure overall progress. Yet what moves the "needle" of sustainability outcomes at the broad scale are individual practices and outcomes at the field and farm scale. Complementing its efforts to analyze broad-scale trends, Field to Market has also developed the Fieldprint Calculator, a free, online educational and awareness tool that allows individual growers to analyze the outcomes of their own management practices at the field level and compare them to broader-scale benchmarks as well as to trends within their own peer or pilot groups (www.fieldtomarket.org). Field to Market is actively engaged in piloting these tools and methodologies with farmers to identify future improvements and understand the utility of these tools in informing management actions and driving continuous improvements.

[91] Serecon Management, for Pulse Canada, Canadian Canola Growers Association, Canadian Wheat Board, Ducks Unlimited, Flax Council of Canada, and General Mills. 2011. Application of Sustainable Agriculture Metrics to Selected Western Canadian Field Crops: Final Report. Edmonton, Alberta. http://www.pulsecanada.com/fieldtomarket



The above-recommended future investigations represent significant opportunities for which this report is intended as a starting place. Through this report and Field to Market's advancement of agricultural sustainability metrics and tools that quantify the impacts of cropping practices at a variety of scales, the Alliance seeks to enable an outcomes-based, science-based discussion on the definition, measurement, and advancement of sustainability. The hope and intent is that such approaches will ultimately inform mechanisms to promote continuous improvements at the field level that aggregate, in turn, to continued, significant, and broad-scale progress toward meeting sustainability challenges for production, resource use and impacts, and social and economic well-being.



Part II: Socioeconomic Indicators Report

1. Introduction

Field to Market, The Keystone Alliance for Sustainable Agriculture is a collaborative stakeholder group involving producers, agribusinesses, food and retail companies, conservation and non-profit organizations, and university and agency partners working together to promote, define and measure the sustainability of food and fiber production.

Consistent with the Brundtland Report's definition of sustainable development, Field to Market has defined sustainable agriculture as meeting the needs of the present while improving the ability of future generations to meet their own needs by focusing on these specific, critical outcomes:

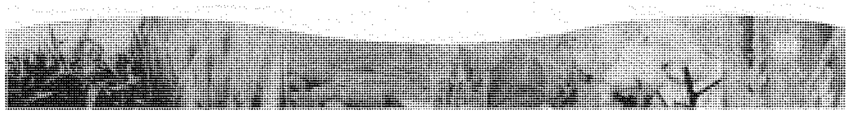
- Increasing agricultural productivity to meet future nutritional needs
- Improving the environment, including water, soil, and habitat
- Improving human health through access to safe, nutritious food
- Improving the social and economic well-being of agricultural communities

It is within this context that Field to Market is developing and refining metrics to measure the environmental and socioeconomic outcomes of commodity agriculture in the United States. These metrics will facilitate quantification and identification of key impact areas and trends over time, foster productive industry-wide dialogue and promote continuous improvement along the path toward sustainability.

This section, Part II: Socioeconomic Indicators, represents a new set of indicators as compared with the original 2009 Field to Market report. Social and economic sustainability are critical pillars of total sustainability, and Field to Market is pleased to take a first step, through this report, in introducing analyses for these indicators at the national and regional scale. While global demand, production, and sustainability trends are influenced by a myriad of complex drivers and conditions at a variety of scales, Field to Market's exploration of sustainability metrics has focused on United States agriculture and the science-based measurement of outcomes associated with the production of commodity crops. This focus provides important insights for sustainability of U.S. commodities, which represent a significant proportion of the cropland in the United States and are often associated with complex supply chains that require innovative approaches to measurement and data sharing. This current focus provides a starting point for further analysis and for the development of methodologies and approaches that could be further adapted and applied to other contexts.

Crop production is a complex operation and depends on environmental, political, and socioeconomic factors. Crop production efficiency and effectiveness evolves with the increased knowledge and sophistication of the agricultural community. Training, experience, and knowledge combined with favorable macro- and micro-economic climates can provide incremental improvements and/or innovation in farming techniques and technologies.

In order to address the social and economic concerns of sustainable agriculture, this section, Socioeconomic Indicators, identifies and discusses a limited number of social and economic indicators that contribute to the success and wellbeing of the farmer and farming community.



This report provides the national perspective on the annual changes in the socioeconomics of production agriculture, with some regional perspectives where possible and applicable, to describe a picture of the economic and social implications of producing commodity crops. This discussion of socioeconomic characteristics of sustainable land management includes the structure and financial status and performance of U.S. farm operators, their households, and farm businesses. Some examples of this structure include demographics, labor, various financial metrics, injury, productivity, and education levels.

Consistent with the 2009 Field to Market report and with the criteria for environmental indicators, criteria for development and inclusion of Field to Market socioeconomic indicators in the 2012 report are as follows:

1. **National scale** – Analyzes national level sustainability performance of crop production. National scale indicators can provide perspective and prompt industry-wide dialogue that is ultimately relevant to more localized investigations and efforts.
2. **Trends over time** – Metrics that allow comparison of trends over time rather than a static snapshot of farm activity.
3. **Science-based** – Utilizes best available science and transparent methodologies.
4. **Outcomes-based** – Provides an inclusive mechanism for considering the impacts and sustainability of diverse agricultural products and practices.
5. **Public dataset availability** – Utilizes publicly available data. Public, national-level datasets provide a transparent, accessible, and fundamental means to understand sustainability trends.
6. **On-farm** –Focuses on outcomes resulting from agricultural production within the farm-gate.
7. **Grower direct control** – Focuses on impacts over which a producer has direct influence through his or her management practice choices.

Numerous domestic and international initiatives have investigated and developed outcomes-based socioeconomic metrics for agriculture. Field to Market evaluated these methodologies and data for their consistency with the criteria described above. Among those reviewed were: Australia's Natural Heritage Trust, Australian Bureau for Agricultural and Resource Economics (ABARE),[92] Sustainable Agriculture Initiative (SAI) Platform Dairy Working Group's Principles & Practices for the Sustainable Dairy Farming,[93] UNEP's Guidelines for Social Life Cycle Assessment of Products,[94] the Response-Inducing Sustainability Evaluation (RISE) model, and the USDA's Economic Research Service (ERS) and Agricultural Resource Management Survey (ARMS).[95]

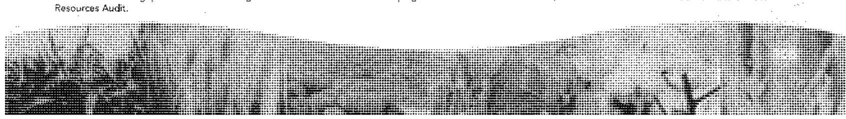
[92] ABARE. 2005. Signposts for Australian Agriculture: A framework for developing economic and social indicators, October 2005. Canberra: National Land & Water Resources Audit.

[93] SAI Platform Dairy Working Group. 2009. Principles & Practices for Sustainable Dairy Farming. Sustainable Agriculture Institute Platform. http://www.saiplatform.org/library

[94] UNEP. 2009. Guidelines for Social Lifecycle Assessment of Products. United Nations Environment Programme. http://www.unep.fr/scp/publications/details.asp?id=DTI/1164/PA

[95] USDA ERS. 2011. Agricultural Resources Management Survey. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/briefing/ARMS

[96] ABARE. 2005. Signposts for Australian Agriculture: A framework for developing economic and social indicators, October 2005. Canberra: National Land & Water Resources Audit.



Australia's Natural Heritage Trust's The National Land and Water Resources Audit's project Signposts for Australian Agriculture: A Framework For Developing Economic and Social Indicators, October 2005, defined eight criteria for identifying indicators (defined below). According to the report, indicators should be:

1. Related to identifiable policies or actions.
2. Directly related to the impacts of agriculture on outcomes.
3. Influences of factors other than agriculture on the indicator should be minimal.
4. Unambiguous, clearly indicating movement toward (or away) from desirable outcomes.
5. Able to be interpreted in context of appropriate scales and coverage.
6. Not be difficult or costly to measure using data of appropriate quality, availability and reliability.
7. Sensitive to measuring change across appropriate time dimensions and should be able to monitor change across locations and industries.
8. Amenable to predicting outcomes.

This study also discusses the concern for ambiguous interpretation of data when selecting socioeconomic indicators where data are liable to more than one interpretation, explanation or meaning. For example, the number of farm accidents can be used as a direct measure of agriculture's contribution to a community's health, whereas the number of visits to a doctor cannot be directly ascribed to agriculture. Indicators should also be unambiguous in defining whether outcomes are desirable at different scales. For example, a decline in local population may not be desirable at a regional level, but when viewed at a state or national level it might reflect a reallocation to employment opportunities elsewhere.

The RISE model incorporates social security, working conditions, local economy and economic stability and efficiency along with natural resources and management indicators into its output to demonstrate opportunities for improvement.

The indicators and their parameters were selected in a way to allow the farm manager (or other relevant entities) to exert an influence over their own particular sustainability situation and development.[97]

ERS data and ARMS survey data were consulted to understand the types of data that are collected regularly for the agronomic sector in the U.S. and are thus deemed relevant to socioeconomic indicators. Social facets include poverty status, access to health care including health insurance coverage, workplace fatalities, and labor allocations of farm households to farm and off-farm work. Economic facets include the income and economic well-being of the households of the principal operators of family farms, contribution to the national economy, and the economics of production practices used across commodity enterprises.

For this study, data has been retrieved and assembled across five primary crops in the United States:

1. Corn
2. Cotton
3. Rice
4. Soybeans
5. Wheat

These crops were selected for their consistency with the environmental indicators report. Together, the production of these crops has comprised a vast majority of the acres of agricultural cropland use in the United States for the past several decades.

Table 2.1 lists the components considered and explored in creating a socioeconomic index. Indicators included in the report are discussed in detail, and information on data and methodologies are accompanied by relevant data and analysis. Indicators that were explored but not included in the report for various reasons are discussed but no data are shown. Please see Chapter 2 Data and Methods for further explanation concerning reasons for not providing data on indicators explored but not included.

97 University of Applied Sciences Swiss College of Agriculture, 2009. RISE Model. Zolikofen, Switzerland.

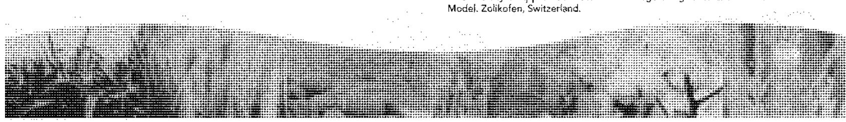
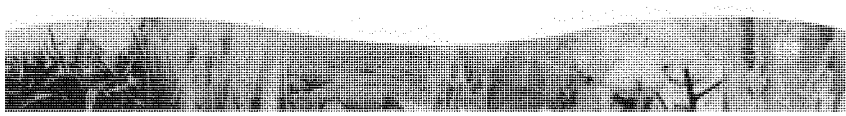


Table 2.1 Socioeconomic Indicators Included and Explored

Socioeconomic Indicators Included			
Type	**Indicator**	**National**	**Regional/State**
Economic	Debt/Asset Ratio	X	
	Return Above Variable Costs	X	
	GDP/Tax Base Contribution	X	X
Social	Non Fatality Illness and Injury	X	
	Fatalities	X	
	Labor Hours	X	X

Socioeconomic Indicators Explored But Not Included	
Type	**Indicator**
Economic	Real Gross Revenue per Acre
	Cropland Value
	Total Factor Productivity
	Cash Flow
	Input Costs
	Costs of Funds
	Household income
Social	Farmer Education
	Community Education
	Succession Planning
	Land Ownership and Tenure
	Poverty Rate
	Health Care Insurance
	Farm Labor Practices/Child Labor Practices
	Incidence Levels of Food-Borne Illness
	Biosecurity Protection Against Transmission of Zoonotic Diseases

X=Geographic representation



2. Data and Methods

2.1. Data and Methods Overview

The benchmark data for this report comes from the USDA and is an outcome of its Farm Cost and Returns data and the ARMS (Agricultural Resource Management Survey) dataset. Other higher frequency, monthly, data are collected for the prices paid for farm inputs such as fuel, seed, fertilizer, etc. These monthly data are published in the Agricultural Prices report from NASS (National Agricultural Statistics Service). The ARMS data provide information about the quantity of inputs being used and the mix of technology employed in the production of a given crop. Major field and row crops are surveyed approximately every 5 years. Data for prices paid by farmers for inputs to their production process are collected annually and published in the Agricultural Prices report. The most recent ARMS surveys for the crops we cover are wheat (2009), cotton (2007), soybeans (2006), rice (2007), and corn (2010).[98]

ERS U.S. Farm Resource Regions

In order to identify regional patterns in U.S. farming that might further the understanding of differences in financial performance of farms and the economic well-being of farm households, the USDA's Economic Research Service (ERS) constructed Farm Resource Regions that depict geographic specialization in production of U.S. farm commodities. In **Figure 2.1**, regions are defined by like farming characteristics rather than state lines.[99]

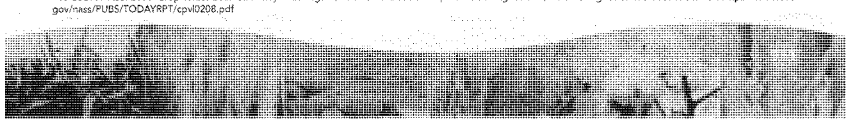
National, regional and state data have been considered where possible. Definitions of farming regions are described by the ERS U.S. Farm Resource Regions (see methodology) where regions are defined by like farming characteristics rather than state groupings. Varying time periods were selected such that the data used for a particular indicator are reported in a consistent format.

The data analyzed in this report have been retrieved from numerous sources – all are within the public domain. Data and methods for each socioeconomic indicator are further explained below. Data analysis and summary have been completed by IHS Global Insight, an economic, financial analysis, forecasting and consulting firm with more than 40 years of experience.

98 USDA ERS. 2011. Commodity Costs and Returns. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/Data/CostsAndReturns

99 USDA ERS. 2011. U.S. Farm Resource Regions. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/Briefing/ARMS/ResourceRegions/ResourceRegions.htm

100 USDA NASS. 2008. Crop Values 2007 Summary. Washington, D.C.: United States Department of Agriculture, National Agricultural Statistics Service. http://www.usda.gov/nass/PUBS/TODAYRPT/cpvl0208.pdf



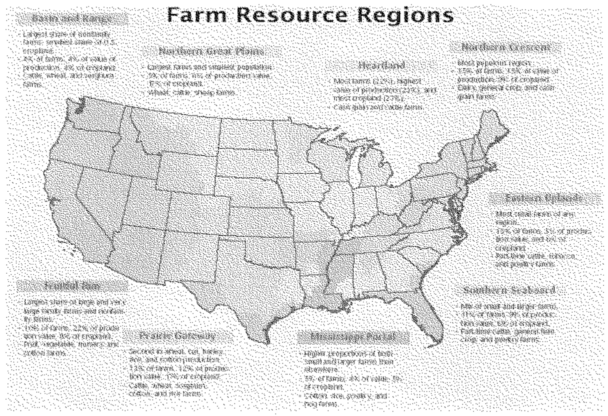
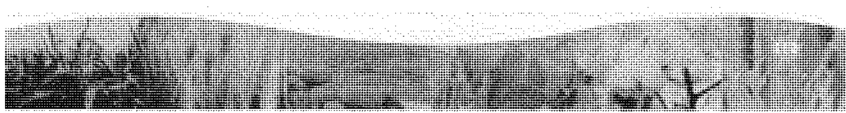


Figure 2.1 USDA Farm Resource Regions



For this study, data has been retrieved and assembled across five primary crops in the United States:

	Crop	Yield Unit	Description
1	Corn	bu.	Bushel, 56lbs. of corn grain per bushel
2	Cotton	lb. of lint	Pounds (lbs.) of lint
3	Rice	cwt	Hundred weight, (100 lbs.)
4	Soybeans	bu.	Bushel, 60 lbs. of soybean seed per bushel
5	Wheat	bu.	Bushel, 60 lbs. of wheat grain per bushel

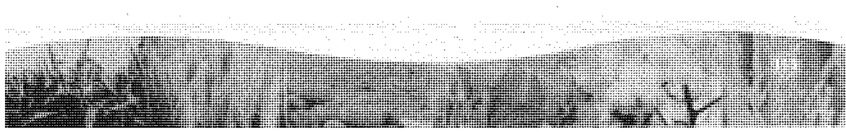
Together, the production of these five crops plus potatoes has comprised approximately 73 percent of the acres of agricultural cropland use in the United States for the past several decades. In 2011, the six crops comprised 73.9 percent of the 293.4 million acres of U.S. agricultural crops harvested and had combined crop value of $119 billion.[100] It is our intention that the methods used could be applied to a full range of technology choices and to other crops produced in the United States or elsewhere assuming sufficient data and, perhaps, with some modification. A comprehensive set of metrics were considered and six were identified as relevant and possible according to the criteria discussed in the introduction. The complete set of metrics considered is described in Table 2.1.

In selecting resource indicators, the group has chosen to focus on six important indicator areas. The six areas are:

1. Debt/Asset Ratio
2. Returns Above Variable Costs
3. GDP
4. Non-Fatality Illness and Injury
5. Fatalities
6. Labor Hours

Data Concerns for Metrics Investigated but Not Included

The importance and relevance of metrics that were considered but not included are discussed in the section 4.0 Socioeconomics Metrics Investigated But Not Included. The main issues contributing to the exclusion of the investigated metrics are definitional or directional ambiguity, sporadic data, and/or relevance to commodity crop farming. In many instances, available data are not crop specific or the metric is not sufficiently within direct control of the farm operator and meaningful conclusions cannot be derived. While many indicators are not solely within the control of a grower to influence, our intent is to focus on those that can be attributable in some significant way to actions taken by the farmer. In some instances, data were deemed inappropriate for this study due to categorization by geography rather than crop type. In addition, USDA ARMS classifies farm types as those having a value of production of 50% or more from a particular activity and therefore may skew data by crop type. Finally, cotton is typically reported with tobacco and peanuts data, and cannot be broken out by specific crop type.



2.2 Debt/Asset Ratio

The debt to asset ratio indicates what portion of the farm's assets is being financed through debt. Farms with high ratios are highly leveraged and may be at risk for foreclosure if creditors demand repayment of debt.

Data for this indicator were provided by the USDA ERS Farm Business and Household Survey Data's Farm Business Financial Ratio Report of Farm Finances Survey for all farms from 1996 to 2011.[101] Rather than specific crop data, general cash grains were used due to the ERS parameters of data collection. ERS defines a farm as being crop specific if 50% of its income is received from a specific crop.[102] As most commodity crop farms plant a differing ratio of crops each year, the data do not provide specific enough data pertaining to each crop to provide meaningful results.

101 USDA ERS. 2011. Agricultural Resources Management Survey. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/briefing/ARMS

102 USDA ERS. 2009. Farm Business and Household Survey Data- Farm Business Financial Ratio Report of Farm Finances Survey for all farms from 1996 to 2008.

2.3 Returns Above Variable Costs

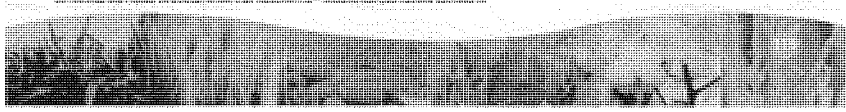
Returns above variable costs assist in gauging the potential profitability of a farming operation and helps growers evaluate alternative strategies for making the most out of their land, capital and labor. Variable costs are the out-of-pocket cash expenses paid for inputs unique to the commodity being produced. Variable expenses depend on production practices and on quantities and prices of inputs. These include inputs such as seed, fertilizer, feed, chemicals, and hired labor. These costs do not include land costs such as rent or taxes. Fixed costs such as equipment were not considered in this report due to accounting methodology for various costs including depreciation that may not accurately represent true farm cost structures and actual depreciation levels.

The benchmark data for these figures come from USDA and are an outcome of its Farm Cost and Returns data and the ARMs dataset (Agricultural Resource Management Survey).[103] Other higher frequency, monthly, data are collected for the prices paid for farm inputs such as fuel, seed, fertilizer, etc. These monthly data are published in the Agricultural Prices report from the National Agricultural Statistics Service, NASS.[104] The ARMS data provide information about the quantity of inputs being used and the mix of technology employed in the production of a given crop. Major field and row crops are surveyed approximately every 5 years. Data for prices paid by farmers for inputs to their production process are collected annually and published in the Agricultural Prices report. The most recent ARMS surveys for the crops covered in this report are wheat (2009), cotton (2007), soybeans (2006), rice (2007), and corn (2010).

The measure we are presenting as an indication of net returns for producing crops above variable costs is calculated on a planted acre basis so if any abandonment occurs, it is amortized across the crop that was produced. As a starting point, gross income is calculated as the sum of the values of production from primary and secondary products (for example wheat grain and straw) plus any government payments that are provided that are dependent on the act of producing the crop (for example loan deficiency payments). While loan deficiency payments have significantly declined in recent years, they remain a factor in legacy USDA accounting principles. Payments that are made irrespective of whether or not a crop is planted (fixed payments) are not included.

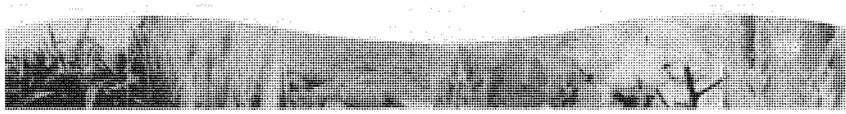
[103] USDA ERS. 2011. Commodity Costs and Returns: Data. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/Data/CostsAndReturns/testpick.htm

[104] USDA NASS. 2011. Agricultural Prices 2011. Washington, D.C.: United States Department of Agriculture, National Agricultural Statistics Service. [illegible]



From a cost perspective, all costs, such as fertilizer, seed, fuel, chemicals, repairs, paid labor and more, are included. Fixed costs such as land and land rental, equipment depreciation, and payments to management are not included. Variable costs are subtracted from gross income and the resulting number is deflated by the Consumer Price Index (CPI), providing a measure of returns above cost on an inflation-adjusted basis. The net-returns above variable cost for each crop are deflated by the consumer price index (CPI) so that the change over time in the resulting numbers is a representation of how well a crop farmer could provide for his or her family, i.e. inflation corrected income. The rationale for this approach is that net returns already have most of the farm expenses netted out such as fertilizer, fuel, chemicals, etc. and the result is representative of their income to be used for living expenses. Over time the concept is meant to reflect whether the returns from growing a certain crop are keeping up with inflation or not.

The Real Returns Above Variable Costs indicator normalizes data by using the year 2000 real dollars to adjust for inflation. Beyond the adjustment for inflation, the measure is presented as a 5 year moving average where, for example, the year 2000 value is the average of the years 1996 through 2000. The 5-year average is presented so that the volatility from single-year fluctuations is muted and the value represents the average over a longer period of years. The measure is presented in two ways, on a per planted acre basis and also on a per unit of output (bushel, pound, cwt.) basis.



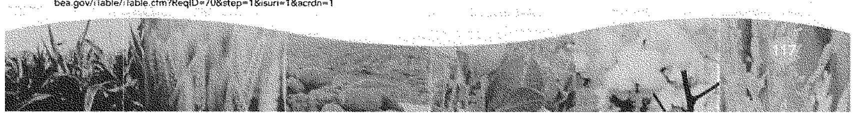
2.4 Agricultural Contribution to National and State GDP

GDP by state is the value added in production by the labor and capital located in a state. GDP for a state is derived as the sum of the gross domestic product by state originating in all industries in a state. In concept, an industry's GDP by state, referred to as its "value added," is equivalent to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other U.S. industries or imported). Thus, GDP by state is the state counterpart of the nation's gross domestic product.

GDP by state differs from national GDP for the following reasons: GDP by state excludes and national GDP includes the compensation of federal civilian and military personnel stationed abroad; government consumption of fixed capital for military structures located abroad; and military equipment. GDP by state and national GDP also have different revision schedules.

The U.S. Bureau of Economic Analysis (BEA) defines agriculture as including both crops and livestock and does not provide further data categorizations.[106]

[106] U.S. Department of Commerce BEA. (2011). GDP and Personal Income. Washington, D.C.: U.S. Department of Commerce Bureau of Economic Analysis. http://www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1&isuri=1&acrdn=1



2.5 Non-Fatality Illness and Injury

Workplace safety is captured in data collected by the Bureau of Labor Statistics (BLS). Data for fatalities by industry classification are available from 1993 through 2010; data prior to 2008 are based on the 2002 National American Industry Classification System (NAICS) while data for 2008 through 2010 are based on the 2007 NAICS.[107] From the documentation the changes between the two classifications should not stop users from comparing data across years; the changes are relatively minor. Data on workplace fatalities are reported by industry for companies of all sizes including single employee workplaces.

Data for non-fatal injuries are also sourced from the BLS but have one significant difference: mandatory reporting of injury data starts with firms having more than 10 employees. In the case of farms this reporting threshold excludes the majority of all farms. At the national level the employee threshold excludes roughly 90% of all farms but does capture 57% of all farm labor. Distribution of this coverage is not uniform. For example, the portion of farms in California with greater than 10 employees is 25% and the share of their labor covered is 85%. While in Iowa the share of farms represented is 1% while the share of farm labor is about 26%.

Despite the lack of representation of small farms in the non-fatal injury data, we use the data as an indication of trends in the farm workplace. The data include statistics on the type of injury and cause of death but these data for agriculture were thinly populated and were not easy to draw conclusions from, particularly in the context of a time series analysis. The data for non-fatal injury were analyzed both in terms of incidence of one or more lost work days as well as an attempt to estimate the cumulative number of lost work days for the year.[108] Ultimately we are presenting the incidence of one or more lost work days as the data seemed to be highly variable when approximating the total days lost.[109]

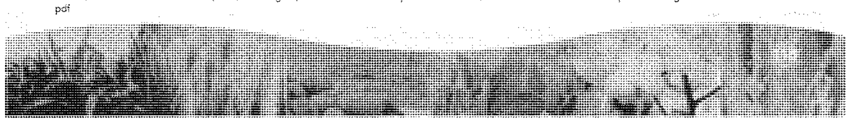
The NAICS classifications allow for analysis of crop farms by specialization but these data also seemed to have areas of very thin recording if at all. For that reason we created a single category defined as all crop farms less those that grow vegetables, fruits and nuts, greenhouse crops, or horticultural specialties. The expectation is that the farms that fall into this classification are largely crop farms growing field and row crops.

The data are presented in absolute terms rather than incidence levels per 1000 employed or any measure of output. Human lives and significant injuries are not something that should be considered as a tradeoff to productivity or output. Any amount of injury or loss of life is too much and the target should be zero.

[107] U.S. Bureau of Labor Statistics. (2010). Washington, DC: United Sates Bureau of Labor Statistics. http://www.bls.gov/iif/oshwc/cfoi/cftb0243.pdf

[108] US Bureau of Labor. (2010). Number and percent distribution of nonfatal occupational injuries and illnesses involving days away from work by industry and number of days away from work, private industry, 2009. Washington, DC: United Sates Bureau of Labor. http://www.bls.gov/iif/oshwc/osh/case/ostb2511.pdf

[109] U.S. Bureau of Labor Statistics. (2011). Washington, D.C.: United States Department of Labor, Bureau of Labor Statistics. http://www.bls.gov/iif/oshwc/cfoi/cftb0243.pdf



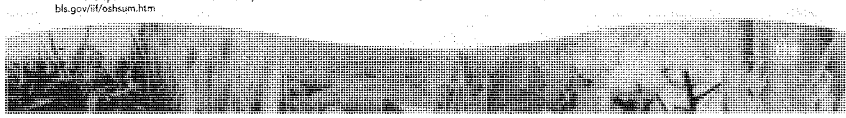
2.6 Fatalities

Workplace safety is captured in data collected by the Bureau of Labor Statistics (BLS).[110] Data for fatalities by industry classification are available from 1993 through 2010; data prior to 2008 are based on the 2002 National American Industry Classification System (NAICS) while data for 2008 through 2010 are based on the 2007 NAICS. From the documentation the changes between the two classifications should not stop users from comparing data across years; the changes are relatively minor. Data on workplace fatalities are reported by industry for companies of all sizes including single employee workplaces.

The NAICS classifications allow for analysis of crop farms by specialization but these data also seemed to have areas of very thin recording if at all. For that reason we created a single category defined as all crop farms less those that grow vegetables, fruits and nuts, greenhouse crops, or horticultural specialties. The expectation is that the farms that fall into this classification are largely crop farms growing field and row crops.

The data are presented in absolute terms rather than incidence levels per 1000 employed or any measure of output. Human lives and significant injuries are not something that should be considered as a tradeoff to productivity or output, and any amount of injury or loss of life is too much and the target should be zero.

[110] U.S. Department of Labor BLS. (2011). Injuries, Illnesses, and Fatalities. Washington, D.C.: United States Department of Labor, Bureau of Labor Statistics. http://www.bls.gov/iif/oshsum.htm



2.7 Labor Hours

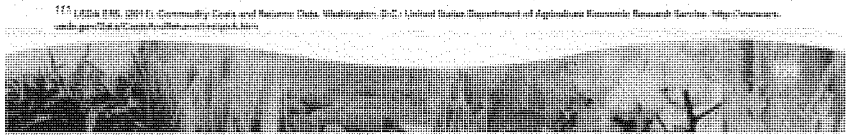
The data for labor hours were derived from the USDA Economic Research Service (ERS) Commodities Cost and Returns data.[111] The data are broken out by farm enterprise and consist of hired labor cost per acre and unpaid labor opportunity cost per acre from 1975 to 2009. Data were also used from the USDA National Agricultural Statistics Service (NASS) and include farm labor wage rate in each quarter from 1975 to 2009.

Labor hours per acre for each crop were derived from:

- (Hired labor cost per planted acre) + (Unpaid labor cost per planted acre)/(Wage rate)

A 3-year centered moving average was used to smooth the influence of single data point.

[111] USDA ERS. (2011). Commodity Costs and Returns Data. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://www.ers.usda.gov/[illegible]



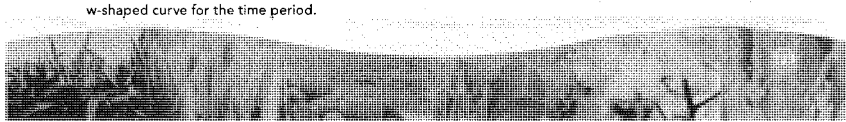
3. Results

3.1 Results overview

This section provides an overview of results followed by more detailed summaries for each socioeconomic indicator. Data for each indicator are presented in either a line graph or table format. Line graphs for Debt to Asset Ratio, Agriculture Contribution to National GDP, Non-Fatality Injury, Fatalities, and Labor Hours are presented with regression equations and R2 values. The line graphs provide additional resolution regarding changes over time and the conformity of those changes with average trend line for the full study period.

Results are also highlighted and discussed in text for each crop and indicator. It should be noted that in both the results and conclusions sections, we have purposefully avoided speculation regarding the practice, contexts and drivers that influence the outcomes estimated through this analysis. Field to Market recognizes that management decisions by U.S. agricultural producers are guided by many factors, including international price signals, Farm Bill policies and programs including incentive programs such as the Conservation Reserve Program, and biofuel policies and incentives. Where the data that were utilized to construct the metric can explain changes over time, some interpretation is given, however thorough interpretation, including at the more geographically-specific scale needed to understand some trends, is beyond the scope of this report.

- **Debt to asset ratio** (1996-2010)
  - The debt to asset ratio decreased (improved) (-37%) for general cash grain farms.
- **Returns over variable costs** (1980–2011)
  - Returns over variable costs for corn, rice, soybeans and wheat decreased during the 1980s, increased in the early to mid-1990s with a slight decrease in the late 1990s and an increase beginning in approximately 2002, providing a w-shaped curve for the time period.
  - Returns over variable costs for cotton decreased in the early 1980s, maintained flat growth with some variability from the late 1980s to approximately 1998, and then decreased again until the early 2000s when returns stabilized. There has been an increase in returns over variable costs for cotton since approximately 2009.
- **National and state gross domestic product** (GDP)(1997–2009)
  - The national growth rate trend has increased (69%) for the agricultural sector contribution to the national GDP.
- **Non-fatality injury** (1995–2010)
  - The number of work related injuries decreased (-55%) for all crop-producing farms with eleven or more employees.
  - The number of lost work days (-76%) and the incidence of one or more work days lost (-49%) due to injury both decreased for crop farms (excluding fruit, vegetable, and other specialty crops).
- **Fatality** (1993–2010)
  - Fatalities decreased (-32%) for crop farms (excluding fruit, vegetable, and horticulture farms).
- **Labor hours** (1990–2011)
  - The implied time to produce corn (-59%, -75%), cotton (-69%, -75%), rice (-43%, -58%), and soybeans (-66%, -74%) decreased both per acre and per unit of production, respectively.
  - The implied time to produce wheat decreased (-12%) per bushel but remained relatively flat (-1%) per planted acre.



In summary, the indicators for debt to asset ratio, fatalities, and non-fatality injury decreased (improved) over their respective time periods and farm classification. Returns over variable costs have been inconsistent over the indicator's respective time period, but have been increasing for all crops, excluding cotton, since approximately 2002, and for cotton since 2009. Labor hours have decreased for all crops per unit of production and, excluding wheat, per planted acre. Overall, the agricultural sector's contribution to national GDP has increased over the explored time period in absolute terms but decreased as a share of total.

Results for the individual indicators are detailed in the sections below. Tables 2.2 and 2.3 summarize data for all socioeconomic indicators.

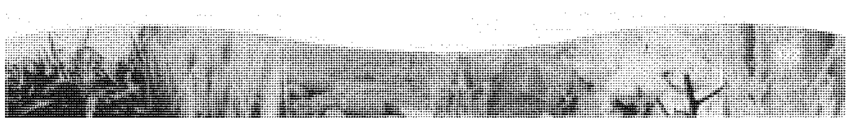


Table 2.2 Socioeconomic Summary of Results 1

Socioeconomics Summary of Results 1: United States Trends						
Indicator	Crop	Measurement	Time Period	Percent Change* 1980-2011		
				Trend Direction	Entire Period	Compound Annual
Debt/Asset Ratio	Cash Grain Farms	Percent	1996-2010	↓	(37)	(3.2)
Contribution to National GDP - Crops and Livestock	Total Crops and Livestock	Billions - Nominal	1997-2010	↑	69	4.1
		Share of Total	1997-2010	↓	(11)	(0.9)
Non Fatal Injury	U.S. Crop Farms excluding Fruit, Vegetables and Horticulture Farms	Non-fatal Injuries - Number	1994-2010	↓	(55)	(4.8)
		Workdays Lost	1995-2010	↓	(76)	(9.2)
		One or More Days Lost	1995-2010	↓	(49)	(4.3)
Fatalities		Number of Fatalities	1993-2010	↓	(32)	(2.2)
Labor Hours	Corn	Hours/Planted Acre	1990-2011	↓	(59)	(4.1)
		Hours/Bushel	1990-2011	↓	(75)	(6.3)
	Cotton	Hours/Planted Acre	1990-2011	↓	(69)	(5.5)
		Hours/lb Lint	1990-2011	↓	(75)	(6.5)
	Rice	Hours/Planted Acre	1990-2011	↓	(43)	(2.7)
		Hours/cwt	1990-2011	↓	(58)	(4.0)
	Soybeans	Hours/Planted Acre	1993-2011	↓	(66)	(5.8)
		Hours/Bushel	1993-2011	↓	(74)	(7.1)
	Wheat	Hours/Planted Acre	1993-2011	↓	(1)	(0.1)
		Hours/Bushel	1993-2011	↓	(12)	(0.7)

*Percent change results are based on a least squares trends analyses for the time period indicated.

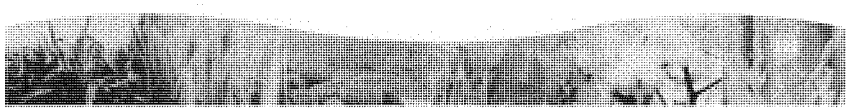
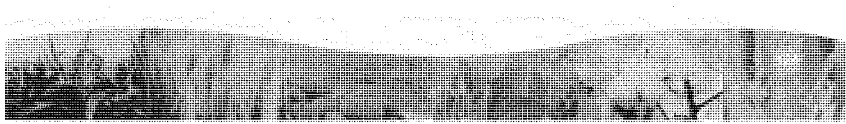


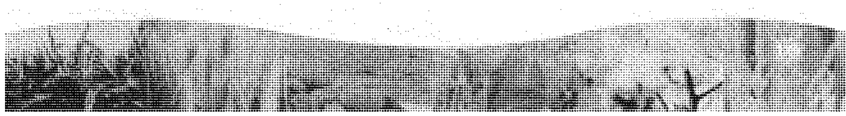
Table 2.3 Socioeconomic Summary of Results 2

Socioeconomics Summary of Results 2: United States Trends							
Indicator	Crop	Measurement	Time Period	Real Dollar Value (1980 to 2010)			
				2010 Level	Mean	Min	Max
Net Returns Above Variable Costs (Real year 2000 dollars)	Corn	$/Acre	1980-2010	258.3	151.6	106.0	299.3
		$/Bushel	1980-2010	2.1	1.1	0.7	2.5
	Cotton	$/Acre	1980-2010	112.1	149.5	99.7	196.2
		$/lb Lint	1980-2010	0.2	0.2	0.1	0.4
	Rice	$/Acre	1980-2010	380.0	208.4	126.7	396.3
		$/cwt	1980-2010	5.5	3.5	2.3	6.7
	Soybeans	$/Acre	1980-2010	228.1	173.2	129.0	255.4
		$/Bushel	1980-2010	5.5	5.0	3.4	8.0
	Wheat	$/Acre	1980-2010	93.3	68.1	48.1	108.3
		$/Bushel	1980-2010	2.5	2.1	1.4	3.5



3.2 National Debt to Asset Ratio

Data from the USDA's Economic Research Service for the years 1996 through 2010 indicate continued strengthening of the financial position (measured by the debt-to-asset ratio) for U.S. farms that specialize in the production of cash grains (**Figure 2.2**). By 2010, the most current year that data are available, the ratio was at 11.4 compared with 16.6 in 1996. The strong performance of this measure is driven by two main factors, strength in land values and reluctance by farmers to increase debt. The financial measure did see an upward spike in 2002 due to a drop in property asset values and crop inventories while experiencing an upward movement in borrowing. Grain producers have seen record income levels over the past several years that have caused land values to increase and producers to pay cash for purchases that might otherwise have been financed. In contrast, farms that specialize in pork, poultry, or dairy have tended to operate at debt to asset ratios nearly double of that of their cash grain counterparts. The recent decline in the financial position of livestock farms can be explained in part by the sustained increase in feed cost experienced in the past 5 years. The livestock sector cannot adjust to these factors quickly.



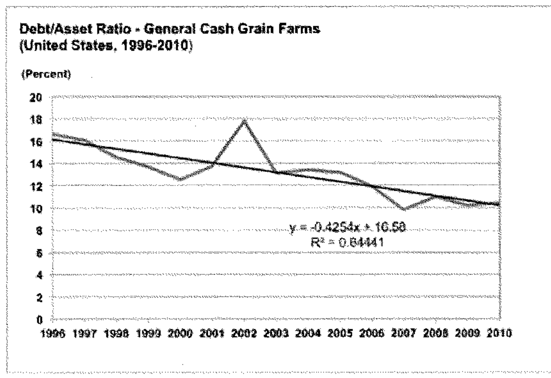
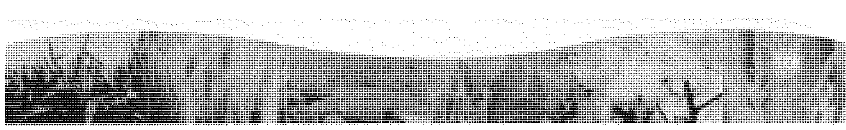


Figure 2.2 Debt/Asset Ratio, General Cash Grain Farms, United States 1996-2010

Please note, in the graph above, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient has the unit of percent. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



3.3 Real Returns Above Variable Costs

Several factors can impact the returns above variable costs for crop producers. Over a long period of time, sustained increases in the growth rate for purchased inputs can reduce the net margin if output prices do not move at the same rate. Also over the long run, increase in yield or productivity can increase the returns on a per acre basis and potentially reduce the costs on a per unit basis; for example if yields increase but the same amount of fuel is burnt to establish the crop and care for it. In the very short term, a given growing season, the most significant factor impacting net returns will be output price changes and yield variation due to weather. One contrast between the impacts of the two previously mentioned factors is that commodity prices from one region to another tend to move together, e.g., the corn price in the Midwest will not move dramatically in any direction without corn prices in other regions moving in the same direction. Variation caused by yield, usually to the downside, is typically isolated to a single geographic area and may or may not have a significant impact on output prices. The price received that is used in the calculation of crop revenue is based on a harvest period price including the impact of quality adjustment and farmers' use of cash forward contracts. The estimates do not include the impact of farmers' use of futures markets to protect a net price level.

According to a recent USDA analysis of U.S. farm financial performance, total returns on farm business assets (from current income plus capital gains) are estimated at 8.6 percent in 2010 (with 2.1-percent growth in returns from current income and 6.5-percent growth in returns from capital gains). Given the continued strong farm income situation and growth in farmland values, the situation for 2011 appears to have continued to strengthen.[105]

The following figures by crop are all national data based on 5 year moving averages and include both the income and expense from crop insurance as well as the income from government programs for which payment is dependent on producing the crop, for example loan deficiency payments. While loan deficiency payments have decreased significantly in the past few years due to stronger market prices, they are a legacy factor in USDA Return above Variable Costs calculations.

Corn

Measured in year 2000 currency, real net returns from corn production averaged $167 per acre (not including land costs) over the period 1980 to 2011, sank to a low of $60 in 1986, and rose to a peak of $382 in 2010. On a per bushel basis, corn net returns above variable costs (not including land costs) averaged $1.20 and experienced a low in 1986 of $0.33 and a high of $3.44 per bushel in 2011. During the period 1980 to 2011, corn returns have seen sustained periods of strength during the early years (through the middle 1980s) and more recently since 2006 to present. The largest determinant in the years of strong commodity prices was high corn prices. Charted averages are 5 year moving averages (**Figure 2.3**).

[105] USDA ERS. 2011).Agricultural Income and Finance Outlook. Washington, D.C.: United States Department of Agriculture Economic Research Service. http://usda01.library.cornell.edu/usda/current/AIS/AIS-12-14-2011.pdf

Cotton Lint

Cotton yields have experienced relatively consistent growth over time with a long-run trend of about 1% annually over the past 30 years. Yield on a planted acre basis reached a record high driven by very favorable weather across most regions, particularly Texas. These strong yields and, more recently, a near doubling in the season average price have caused real net returns above variable cost to begin to increase or at least stabilize (**Figure 2.4**). The farm level cotton price has increased from $0.42 per pound in 2004 and is anticipated to increase to approximately $0.92 per pound in 2011/2012 marketing year. The run up in cotton prices was a few years behind that which occurred in most grain and oilseed crops and consequently caused a significant drop in area devoted to cotton production. Cotton has seen considerable increases in its cost over time as have many crops. Crop insurance is a widely used program and production challenges in recent years have caused crop insurance payouts to be considerable.

Rice

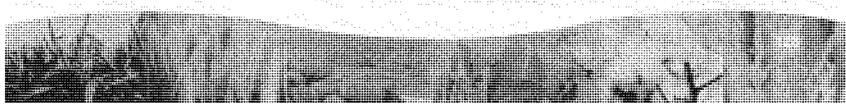
Similar to other grain crops, rice in the early 1980s experienced high prices on an inflation adjusted basis and 5 year average net returns reached a high $303 per acre and $6.66 per cwt. in 1984 (Figure 2.5). Through the late 1980s and all of the 1990s, rice per acre real returns hovered around $150 to $200 per acre and around $3.00 per cwt. High crop output prices in recent years and strong yields have allowed per acre net returns to rise above the past highs and reached nearly $400 in real dollars (year 2000). Rice returns per cwt continued to rise in recent years, reaching $5.71 in 2011. Rice production in the United States is fully irrigated, thus reducing yield variation due to weather; this likely explains why the year-to-year variation in returns is less than for other crops, however a full analysis of drivers that is beyond the scope of this report would be necessary to confirm this.

Soybeans

Over the period 1980 through 2011 soybeans real net returns above variable costs averaged $5.31 per bushel with a high of $11.06 in 1980 and a low of $3.06 in 2006. Returns in 2011 are projected to have been approximately $7.00 per bushel. On a real year 2000 basis, the low for per acre net returns was $126 in 1999 and the high is projected for 2011 at $286. The average for the period is $183, year 2000 dollars, per planted acre. Charted averages are 5 year moving averages (**Figure 2.6**).

Wheat

Wheat returns adjusted for inflation (real 2000 dollars) peaked in the early 1980s due to high real crop prices and generally favorable yields in the United States. In 1984 the 5-year average per acre real returns hit $108 and fell to a low $48 in 2005. The sustained rise in grain price over the last several years has pushed real returns back up to $106 in 2011. The average for the period was $68 per acre. On a per bushel basis, high and low wheat returns coincided with the same years as the per acre measure. The 5 year average per bushel returns for the period 1989 through 2011 were $2.07 with a low of $1.42 in 2005 and $3.46 in 1984 (**Figure 2.7**).



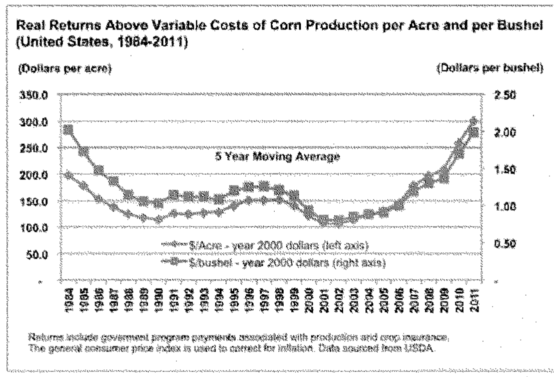


Figure 2.3 Real Returns Above Variable Costs of Corn Production per Acre and per Bushel, United States 1984-2011

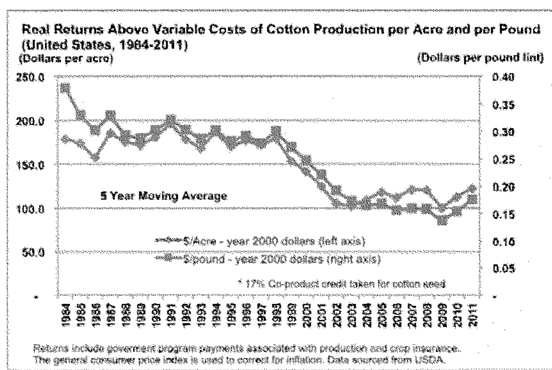
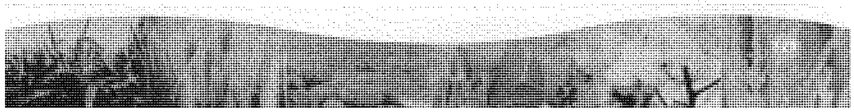


Figure 2.4 Real Returns Above Variable Costs of Cotton Production per Acre and per Pound, United States 1984-2011



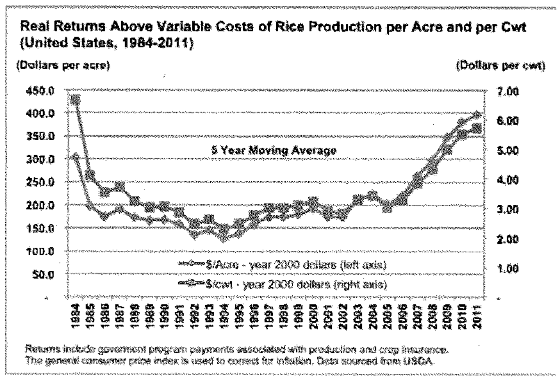


Figure 2.5 Real Returns Above Variable Costs of Rice Production per Acre and per Cwt, United States 1984-2011

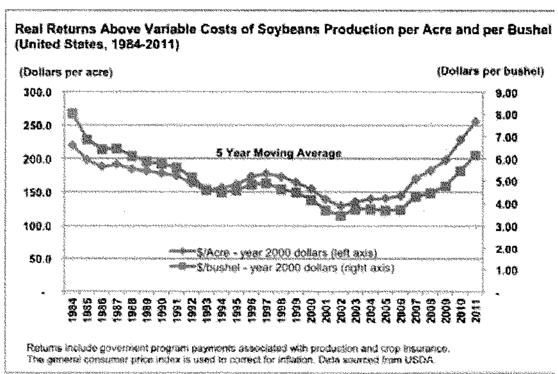
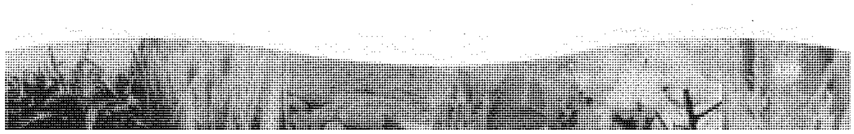


Figure 2.6 Real Returns Above Variable Costs of Soybeans Production per Acre and per Bushel, United States 1984-2011



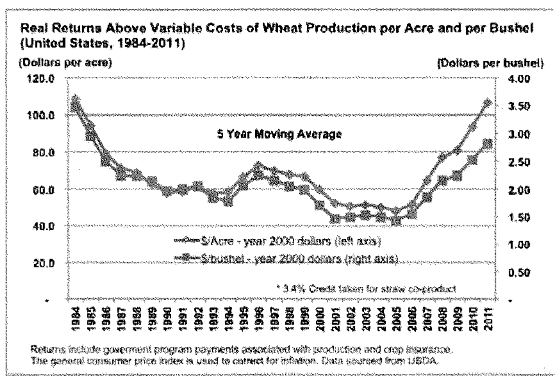
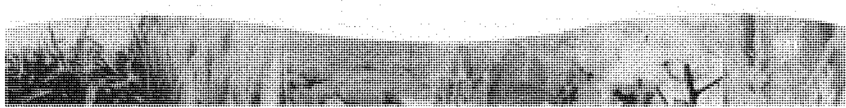


Figure 2.7 Real Returns Above Variable Costs of Wheat Production per Acre and per Bushel, United States 1984-2011



Regional Real Returns Over Variable Costs

Corn

Regional data for corn net returns are presented for the years 1996 through 2010. While the regional returns have a pattern of better profits in the early years as well as the most recent years some regional dispersion does occur during the period. In 1998 the Southern Seaboard region saw a dramatic dip in corn yields in 1998 to 64 bushels per planted acre while many other regions saw favorable growing conditions. During 2008 and 2009 the Southern seaboard and the Northern Crescent saw relatively poor productivity levels while other regions saw favorable levels causing these regions to significantly underperform the other regions.

See **Figures 2.8, 2.9** and **2.18** for more detail regarding corn regional real returns over variables costs results.

Cotton Lint

Real net returns for cotton lint by region are considerably variable over time with those for the Prairie Gateway (largely Texas) being the most variable and averaging the lowest over the period of 7 cents per pound over the 1997 to 2010 time period. With respect to the Prairie gateway region most all crops experience considerable production variation due to moisture stress and yield variability. Please note that for cotton lint production, the Heartland region includes Missouri only.

See **Figures 2.10, 2.11** and **2.19** for more detail regarding cotton lint regional real returns over variables costs results.

Rice

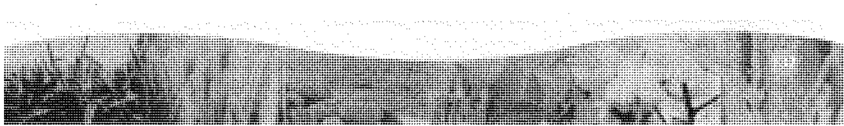
The Mid-South and Gulf Coast rice-growing regions primarily produce long-grain rice, while California produces primarily medium and short-grain rice. Long-grain rice has a significantly different price and market situation, with recently lower prices, on average, than medium and short-grain rice prices. Part of this is due to the uses of the different types of rice, and because some of the export-market demand for U.S. medium-grain rice is the result of previously-negotiated trade agreements that require certain levels of U.S.-rice imports.

See **Figures 2.12, 2.13** and **2.20** for more detail regarding rice regional real returns over variables costs results.

Soybeans

Regional soybeans cost and returns data for the period 1997 through 2010 are available from USDA. Over that period the Eastern Upland and Southern Seaboard regions saw significant declines in real returns in 1999 due to low yields. In 1999 per acre net returns in the Eastern Uplands dropped to $15 dollars per acre due to a significant yield decline to only 22 bushels per acre.

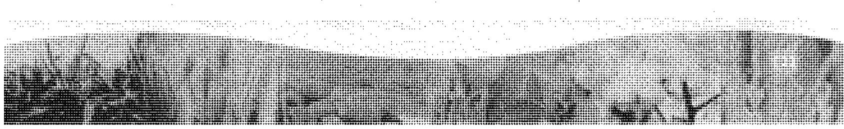
See **Figures 2.14, 2.15 and 2.21** for more detail regarding soybeans regional real returns over variables costs results.



Wheat

On a regional basis the dominant wheat growing areas (Northern Great Plains and the Prairie Gateway) experience the greatest range of net returns while less significant growing areas (many of which are East of the Mississippi) experience much less variation in returns. For both Prairie Gateway and Northern Great Plains, annual rainfall is relatively low, wheat is not irrigated and wheat is grown on a very large acreage. All of these factors could contribute to variability in returns (as well as abandonment of land). While the dominate wheat growing areas see the greatest variation in net returns from one year to the next they tend to be the regions that have seen the highest peaks in net returns. The Southern Seaboard was near zero (0) for returns, while returns were positive for other regions.

See Figures **2.16**, **2.17** and **2.22** for more detail regarding wheat regional real returns over variables costs results.



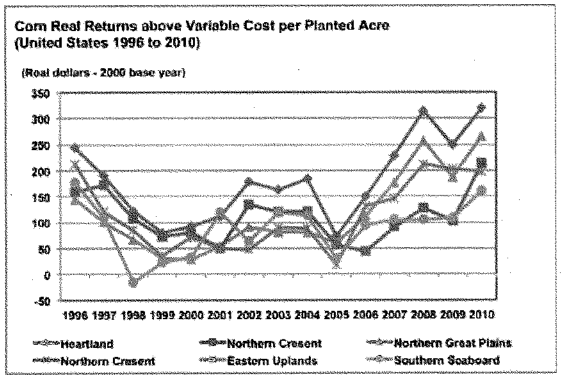


Figure 2.8 Corn Real Returns above Variable Costs per Planted Acre, United States 1996-2010

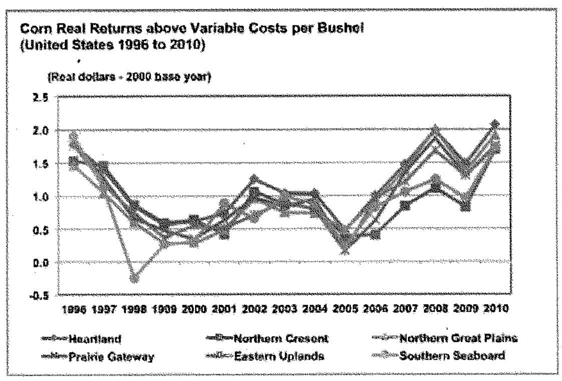
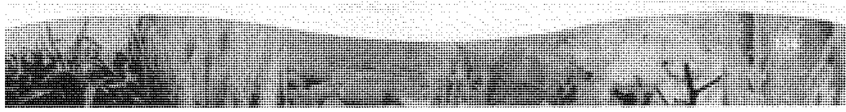


Figure 2.9 Corn Real Returns above Variable Costs per Bushel, United States 1996-2010



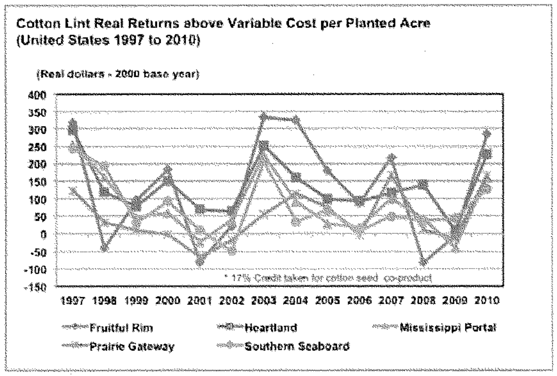


Figure 2.10 Cotton Lint Real Returns above Variable Costs per Planted Acre, United States 1997-2010

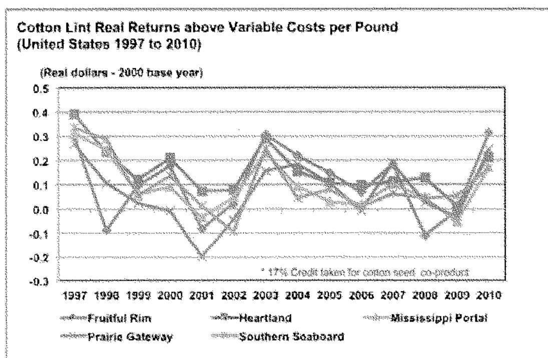


Figure 2.11 Cotton Lint Real Returns above Variable Costs per Pound, United States 1997-2010

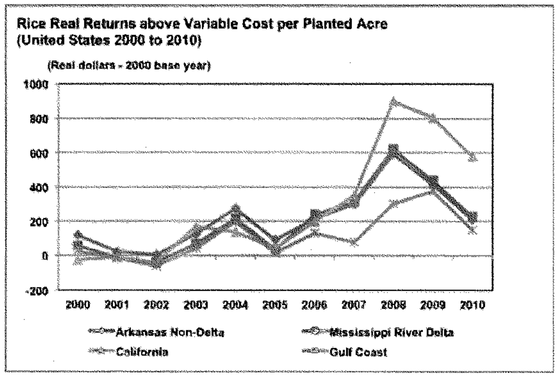


Figure 2.12 Rice Real Returns above Variable Costs per Planted Acre, United States 2000-2010

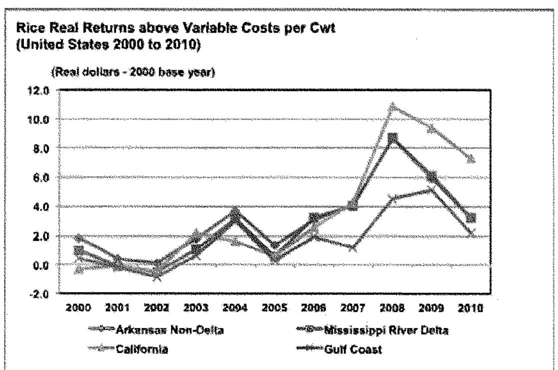
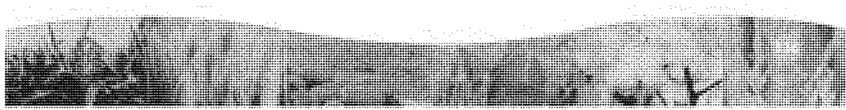


Figure 2.13 Rice Real Returns above Variable Costs per Cwt, United States 2000-2010



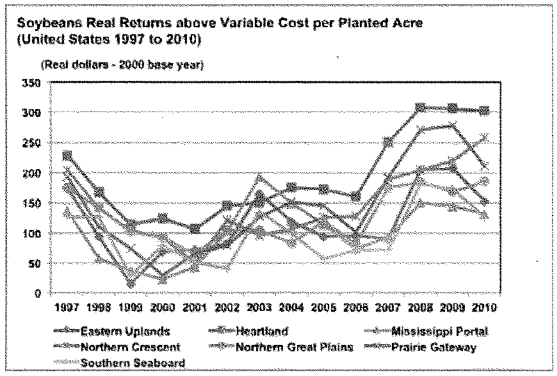


Figure 2.14 Soybeans Real Returns above Variable Costs per Planted Acre, United States 1997-2010

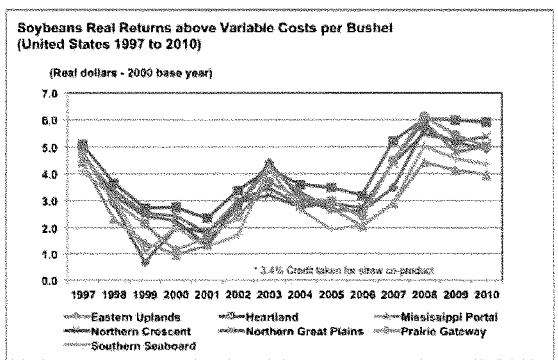
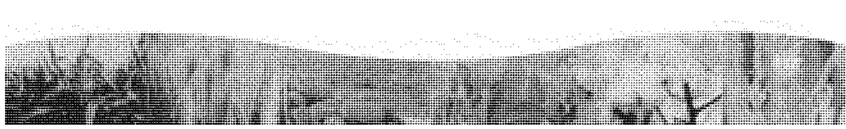


Figure 2.15 Soybeans Real Returns above Variable Costs per Bushel, United States 1997-2010



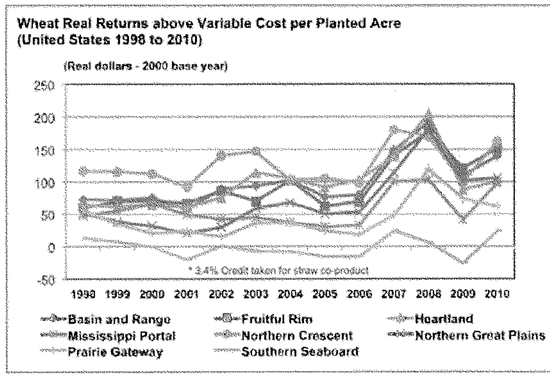


Figure 2.16 Wheat Real Returns above Variable Costs per Planted Acre, United States 1998-2010

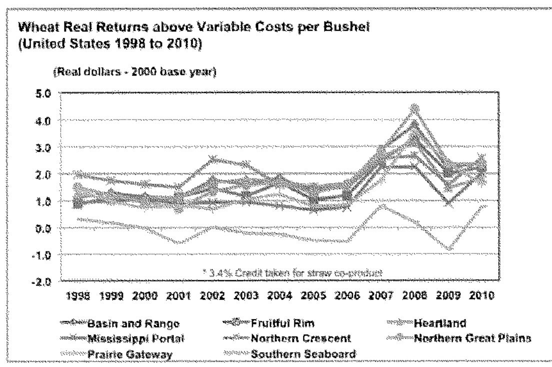
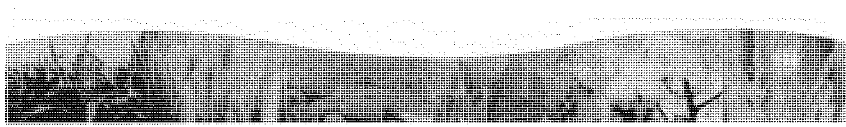


Figure 2.17 Wheat Real Returns above Variable Costs per Bushel, United States 1998-2010



Regional Real Returns above Variable Costs: Mean, Minimum, Maximum

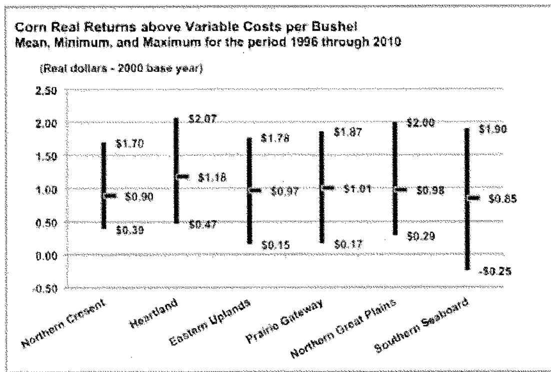


Figure 2.18 Corn Real Returns above Variable Costs per Bushel: Mean, Minimum, Maximum, United States 1996-2010

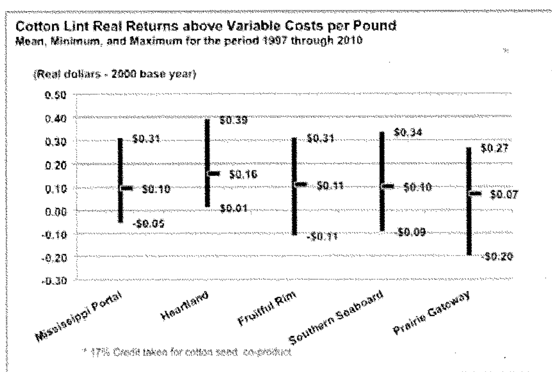


Figure 2.19 Cotton Lint Real Returns above Variable Costs per Pound: Mean, Minimum, Maximum, United States 1997-2010

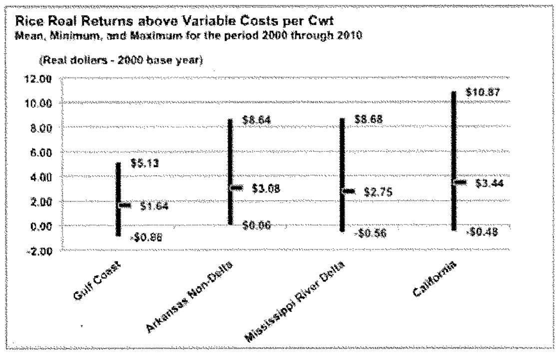


Figure 2.20 Rice Real Returns above Variable Costs per Cwt: Mean, Minimum, Maximum, United States 2000-2010

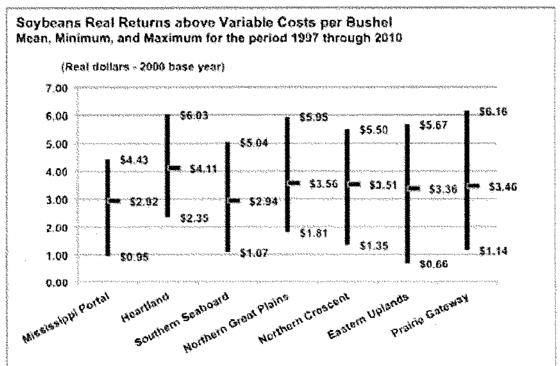
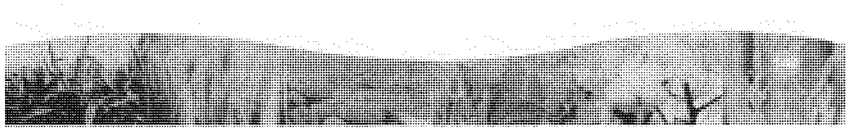


Figure 2.21 Soybeans Real Returns above Variable Costs per Bushel: Mean, Minimum, Maximum, United States 1997-2010



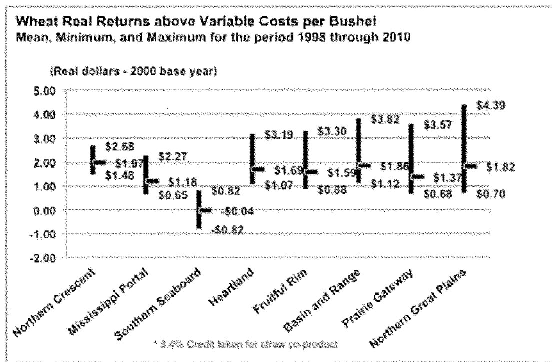
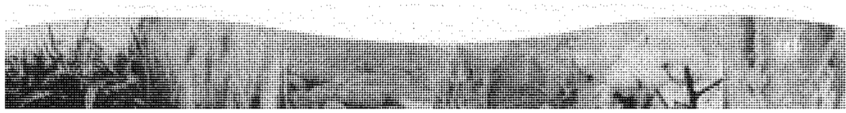


Figure 2.22 Wheat Real Returns above Variable Costs per Bushel: Mean, Minimum, Maximum, United States 1998-2010



3.4 Agricultural Contribution to National and State GDP

The value of production from the crop and livestock sectors of U.S. agriculture has increased roughly \$3.8 billion per year over the period 1997 through 2009. While its absolute level has been rising, as a share of the national economy the crop and livestock sectors have been basically flat (**Figure 2.23**).

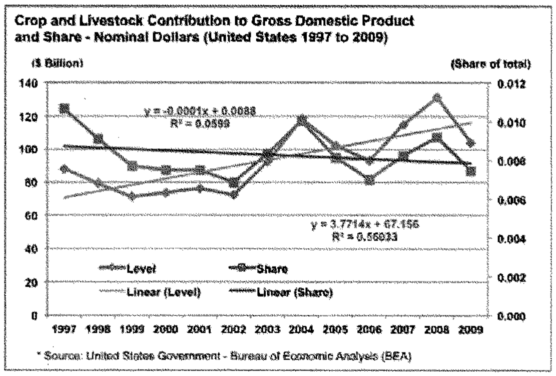
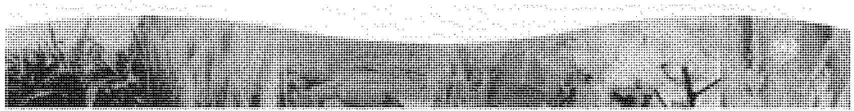


Figure 2.23 Crop and Livestock Contribution to Gross Domestic Product and Share – Nominal Dollars, United States 1997-2009

Please note, in the graph above, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient has the unit of the appropriate Y axis. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



The top 30 state agricultural contributions to National Gross Domestic Product (GDP) and their respective contribution to their State GDP are shown in **Table 2.4.** Agricultural contribution as defined by the USDA for available data includes all crops and livestock. In addition the table shows growth rate trends (1997-2009) and impact of agriculture on the state economy.

The top five states with the largest growth in agricultural contribution (crop and livestock) to state GDP are North Dakota, Nebraska, Iowa, Minnesota, and Missouri. North Dakota's agricultural contribution (crop and livestock) to state GDP is growing at a rate of 9.8 percent.

The top five states that contributed the largest agricultural (crop and livestock) share to their respective state GDP are North Dakota, South Dakota, Nebraska, Iowa, and Idaho.

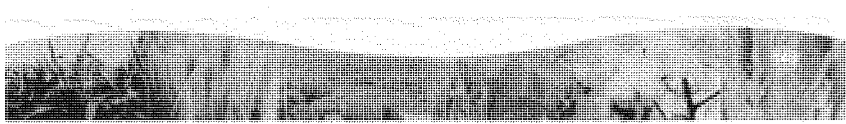
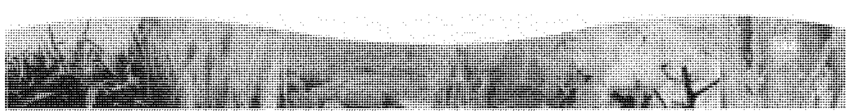


Table 2.4 State Agricultural Contribution to National and Local GDP

	2005 to 2009 Average (Billion dollars)	Rank	Share of Nation	Cummulative Share	2005 - 2009 Trend Growth Rate	Share of the local economy
United States	109.01	1	100.0%		4.0%	0.8%
California	17.91	2	16.4%	16.4%	3.7%	1.0%
Texas	6.13	3	5.6%	22.1%	1.4%	0.6%
Iowa	5.93	4	5.4%	27.5%	7.3%	4.6%
Minnesota	4.62	5	4.2%	31.7%	8.3%	1.8%
Nebraska	4.34	6	4.0%	35.7%	6.9%	5.4%
Illinois	4.30	7	3.9%	39.7%	8.1%	0.7%
Florida	4.01	8	3.7%	43.3%	-0.2%	0.5%
Washington	3.62	9	3.3%	46.7%	4.8%	1.2%
North Carolina	3.26	10	3.0%	49.7%	0.6%	0.8%
Wisconsin	3.22	11	3.0%	52.6%	3.6%	1.4%
Kansas	3.17	12	2.9%	55.5%	5.5%	2.7%
Indiana	2.73	13	2.5%	58.0%	7.9%	1.1%
Missouri	2.72	14	2.5%	60.5%	7.5%	1.2%
Georgia	2.70	15	2.5%	63.0%	1.5%	0.7%
Ohio	2.52	16	2.3%	65.3%	3.8%	0.5%
South Dakota	2.46	17	2.3%	67.6%	6.8%	7.0%
Arkansas	2.40	18	2.2%	69.8%	2.5%	2.5%
Pennsylvania	2.35	19	2.2%	71.9%	3.1%	0.5%
Michigan	2.29	20	2.1%	74.0%	6.1%	0.6%
North Dakota	2.19	21	2.0%	76.0%	9.8%	7.7%
Idaho	2.13	22	2.0%	78.0%	5.2%	4.1%
Oregon	2.12	23	1.9%	79.9%	3.5%	1.3%
Colorado	1.96	24	1.8%	81.7%	4.0%	0.8%
Kentucky	1.86	25	1.7%	83.4%	1.5%	1.2%
New York	1.85	26	1.7%	85.1%	4.2%	0.2%
Oklahoma	1.69	27	1.5%	86.7%	2.0%	1.2%
Alabama	1.67	28	1.5%	88.2%	1.6%	1.0%
Mississippi	1.43	29	1.3%	89.5%	2.1%	1.6%
Arizona	1.31	30	1.2%	90.7%	1.0%	0.5%



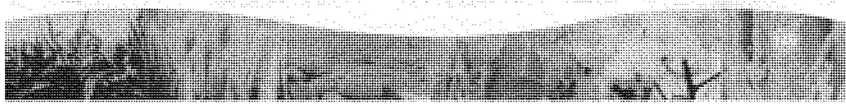
3.5 Non-Fatality Injury

The US Bureau of Labor Statistics (BLS) reports detailed data on workplace injuries and fatalities by employment type as well as by the cause of the injury or death. The data have limitations given the reporting criteria for injuries are for firms with 10 or 11 or more employees. Given the reporting criteria, these data should be looked at more as an indication of trend and direction and not a measure of absolute magnitude. To put this reporting criterion in perspective, only 9 percent of all US farms in 2007 had eleven or more workers but farms with eleven or more workers represented about 57 percent of all farm labor. This indicator has significant regional variation with many more farms in California and Florida likely to meet the reporting criteria than farms in the Midwest.

Both crop farms and all of private industry have seen a considerable reduction in the incidence of injuries declining more than 50% since 1994. Labor employed in crop production experience an injury incidence of 4.4% compared with an overall industry level of 3.4%.

While recognizing the data limitations, crop-producing farms (excluding those producing fruits, vegetables, and other horticultural specialty crops) experienced considerable reductions from 1994 to 2010 in the number of reported injuries and the incidence of injury. The number of injuries declined from 31,000 to 16,000 cases and the incidence declined from nearly 9 percent to 4.4 percent (**Figure 2.24**). Data for the number of days lost per incidence implies that lost work days has decreased from roughly 32,000 workdays to about 11,000 days (**Figure 2.25**).

Please note, in the graphs below, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient has the unit of the appropriate Y axis. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.



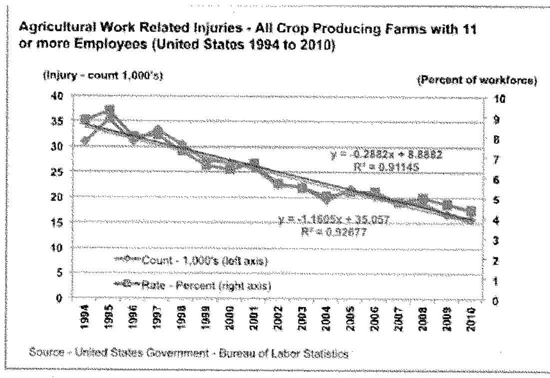


Figure 2.24 Agricultural Work Related Injuries – All Crops Producing Farms with 11 or more Employees, United States 1994-2010

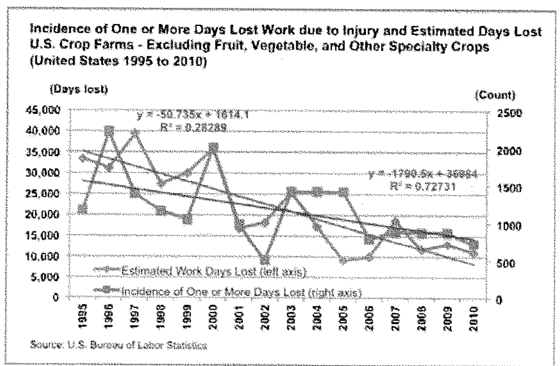
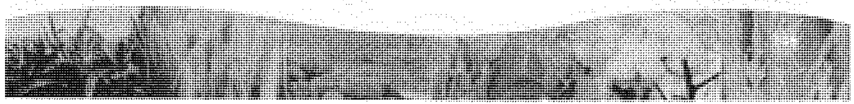


Figure 2.25 Incidence of One or More Days Lost Work due to Injury and Estimated Days Lost, U.S. Crop Farms – Excluding Fruit, Vegetable, and Other Specialty Crops, United States 1995-2010



3.6 National Fatalities

The US Bureau of Labor Statistics (BLS) reports detailed data on workplace injuries and fatalities by employment type as well as by the cause of the injury or death. Unlike injury data, in the case of fatality data there is no size threshold so all data are reported and categorized irrespective of number of employees.

U.S. Agriculture remains among the most dangerous industries to work in when measured by incidence of fatal injuries. Data for the period 2006 through 2010 indicates an average fatality incidence of 28.7 occurrences per 100,000 employees while the private sector industry average is roughly 4 for the same period.

Agricultural employees suffer from a fatal injury incidence of roughly 7 times the industry average, The fatality incidence for the construction sector is nearly double the industry average but still one-third that of agriculture. While agriculture's fatality incidence level remains very high it needs to be noted that the trend is downward.

The number of fatal injuries on crop-producing farms (exclude those that specialize in vegetable, fruit, or other horticultural specialty crops such as tree-nuts) declined from 350 in 1994 to 264 in 2010 (Figure 2.26). The largest portion of fatal farm accidents occur in two areas: vehicle-related and contact with equipment or objects.

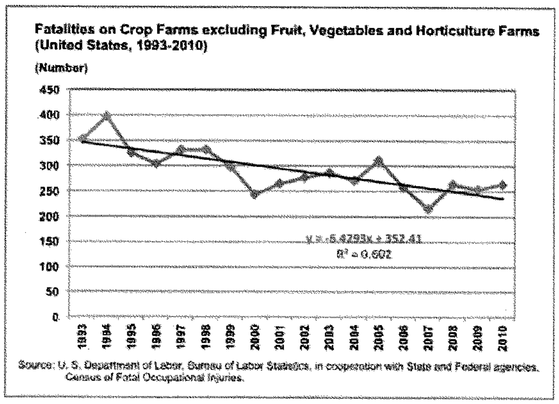
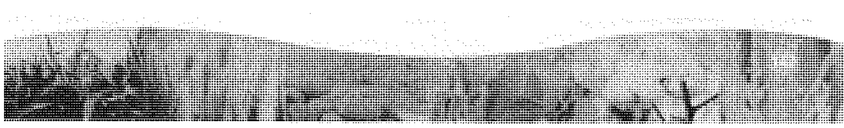


Figure 2.26 Fatalities on Crop Farms excluding Fruit, Vegetables and Horticulture Farms, United States 1993-2010



3.7 Implied Labor Hours

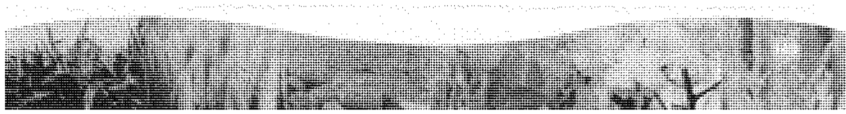
USDA data for the period 1990 through 2011 is presented to describe the implied amount of labor that is used to produce an acre and unit of output (e.g., labor hours per bushel of soybeans). A five-year moving average of the data is used to reduce the impact of year-to-year yield volatility, thus reducing the time period for the data to 1993 through 2011. The time period was selected because it appears data during this period is reported in a consistent format. The data used to assess the labor involved in crop production are the paid labor and value of unpaid labor divided by the labor rate for agricultural labor for crop production.

Agriculture has a strong trend toward increased efficiency in its use of both product inputs such as fuel and fertilizer as well as labor which can be from both paid and unpaid sources. When you measure the number of hours invested to produce an acre of a crop there are several technologies that have come to bear to make agriculture more productive over time. When measured in terms of hours per unit of production, positive trends in crop productivity make the efficiency gains even more pronounced. Among the technologies that agriculture is adopting that add to productivity are GPS navigation, auto-controlled equipment operation, and generally larger equipment overall. Most of these technologies have a compounding impact on efficiency change over time. There is good reason to believe that these trends will continue for quite some time given that their costs continue to decline allowing farmers of smaller scale to employee them.

Corn

The imputed hours to produce an acre and a bushel of corn have decreased considerably over the past 2 decades. Labor has been reduced from 6 hours per acre in 1993 to less than 3 hours in 2011 (**Figure 2.27**). This change is consistent with the changes in equipment size, tillage practices used, and productivity. Strong adoption of reduced tillage and no-till has reduced the trips across the field while larger tractors and combines have decreased the time to cover an acre. Improved yields have only added to these efficiency gains over time. Over the past 20 years corn farmers have reduced their investment in time to produce an acre of corn by roughly 11 minutes per year.

See **Figures 2.32 and 2.33** for more detail regarding corn implied labor hours results on a regional basis.



Cotton Lint

Cotton producers have seen considerable reductions in the amount of time it takes to produce cotton for many reasons. The adoption of insect and herbicide tolerant cotton varieties has reduced the time invested in both weed and insect control while at the same time a continual trend toward less intensive tillage has cut the hours spent tilling and planting. As with all crops the size and speed of harvesting equipment has led to reduced time in the field and recent technology of on-board modeling cotton harvesters stands to reduce the harvest time even more. The implied hours to produce an acre of cotton has decreased from about 11 hours per planted acre in 1990 to less than 4 hours in 2011.today (**Figure 2.28**).

See **Figures 2.34** and **2.35** for more detail regarding cotton lint implied labor hours results on a regional basis.

Rice

The implied labor to produce an acre of rice has decreased by roughly one-third, averaging about 6 hours per acre in 2011 (**Figure 2.29**). On a per unit production basis, the implied labor is 5.6 minutes per cwt. There is little if any abandonment of planted acreage given that all rice is irrigated and complete crop failure is rare. Improved application of irrigation water, along with increased equipment size over time, has helped continue the trend in labor efficiency, cutting per acre labor by 15 minutes per acre per year.

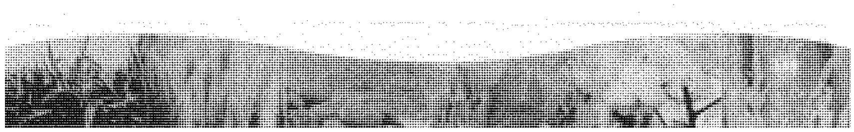
See **Figures 2.36** and **2.37** for more detail regarding rice implied labor hours results on a regional basis.

Soybeans

The implied labor to produce an acre of soybeans declined from 4.3 hours per acre in 1993 to 1.9 hours in 2011 (**Figure 2.30**). On a per bushel basis, soybeans labor dropped from 0.131 hours per bushel (7.4 minutes) to 0.046 hours (2.7 minutes). The trend for soybeans data prior to 1993 are counterintuitive to expectations and cannot be explained by actions being taken on the farm as they imply that the hours per planted acre increased by nearly 2 hours in the late 1980s. The shift appears to be a change in the categorization of the data but the USDA was not able to give an explanation and any attempt would be speculation.

USDA data on the paid and unpaid labor hours used to produce soybeans implies a continued upward trend in the time invested to produce soybeans in the Mississippi Portal region. The trend is not consistent with trends seen in soybean production in other growing regions of the U.S. A review of the underlying factors that would support this trend indicate that the region sees a greater incidence of tillage for establishment of their soybean crop than other regions, measured by tillage passes in the USDA ARMs data. The Mississippi Portal region also sees a somewhat higher incidence of cultivation for weed control than in other regions. These factors appear to explain at least part of the difference in the Mississippi Portal's labor investment but don't fully explain the upward trend in labor.

See **Figures 2.38** and **2.39** for more detail regarding soybeans implied labor hours results.

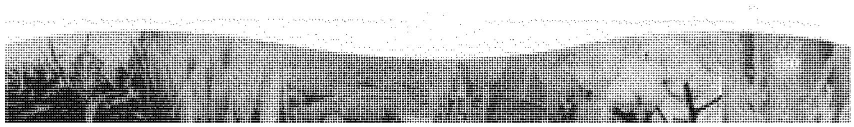


Wheat

The implied labor hours to produce an acre of wheat or a bushel of wheat have both declined over the period 1990 through 2011 (**Figure 2.31**). The hours per acre have declined from 2.7 hours to 2.0 hours, a 26% reduction, while the hours per bushel have declined from 0.085 hours (5 minutes) to 0.054 hours (3.24 minutes). The reduction in implied labor to produce a bushel or acre of wheat has not fallen as much over time as other crops such as corn, soybeans, or rice, but the absolute amount of labor used to produce wheat has historically been relatively low on a per acre basis. The primary cause of inherently low labor per acre for wheat growers is due to the very large equipment. Lack of progress on a per bushel basis is more attributed to relatively slow yield gains over time, averaging 0.85% per year. Wheat production technology and seed development seem to have had a greater focus on quality and milling characteristics than yield. Another factor that impacts the yield number on a planted acre basis is the relatively high implied abandonment level for wheat and has averaged 0.15 over the period compared with other grain crops with levels above 0.02. Several factors combine to cause the low ratio of harvested to planted area including wheat planted as a soil conserving cover, wheat planted for pasture, and wheat being traditionally grown in drought prone areas. Field to Market is not aware of any data that exist that would allow us to correct for these factors.

Please note, in the graphs below, the regression equations and R^2 values for each line graph are provided. In the regression equations for these analyses, X is always the coefficient with respect to time; the X values are 1 (year 1), 2 (year 2) and so on. The X coefficient has the unit of the appropriate Y axis. The R^2 value explains the degree of correlation between the dependent variable Y and the independent variable X. A high R^2 value (close to 1) indicates that there is a strong correlation with respect to time, e.g., a trend.

See **Figures 2.40** and **2.41** for more detail regarding wheat implied labor hours results on a regional basis.



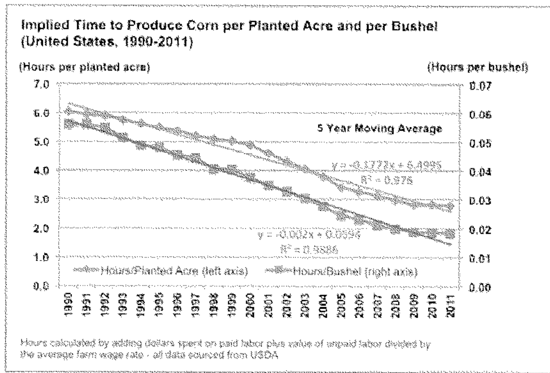


Figure 2.27 Implied Time to Produce Corn per Planted Acre and per Bushel, United States 1990-2011

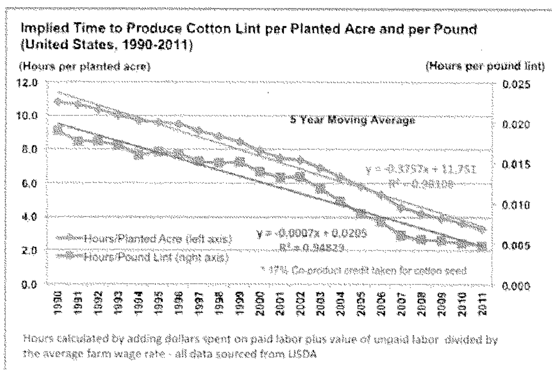
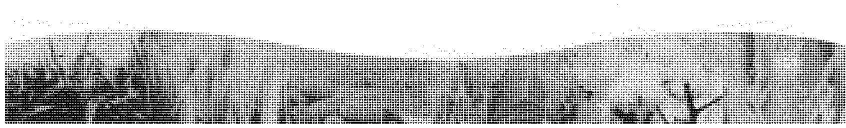


Figure 2.28 Implied Time to Produce Cotton Lint per Planted Acre and per Pound, United States 1990-2011



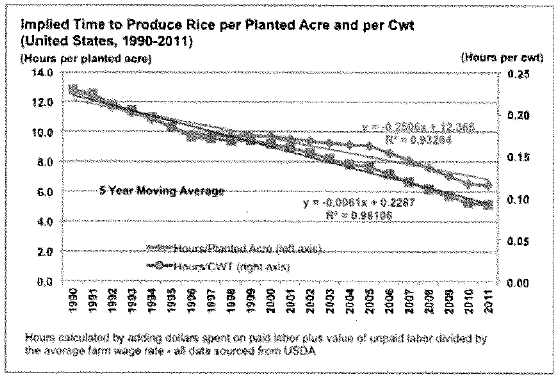


Figure 2.29 Implied Time to Produce Rice per Planted Acre and per Cwt, United States 1990-2011

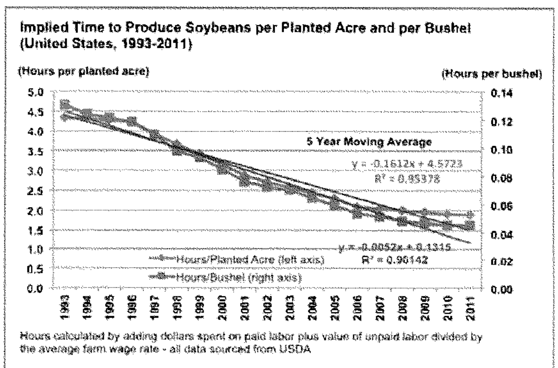
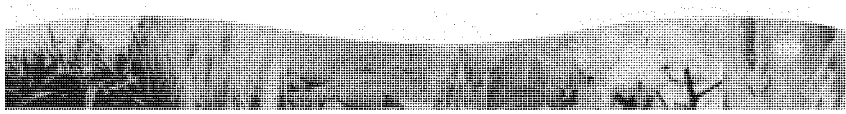


Figure 2.30 Implied Time to Produce Soybeans per Planted Acre and per Bushel, United States 1993-2011



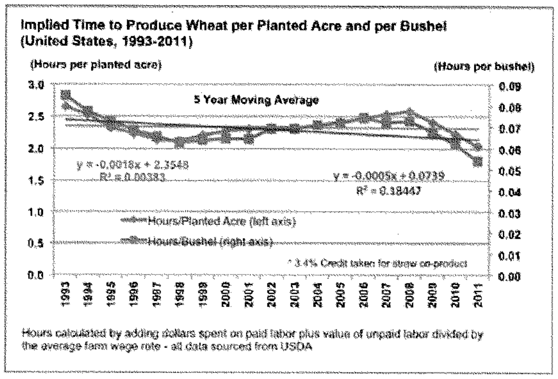


Figure 2.31 Implied Time to Produce Wheat per Planted Acre and per Bushel, United States 1993-2011

Regional Implied Labor Hours

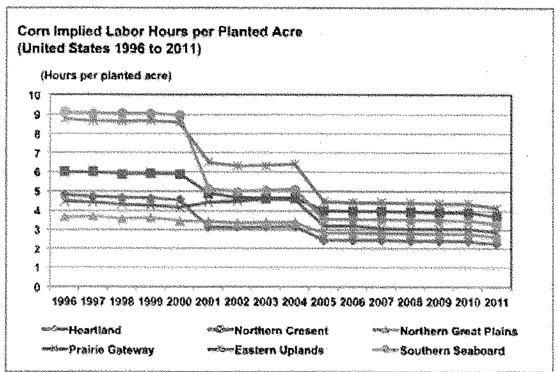


Figure 2.32 Corn Implied Labor Hours per Planted Acre by Region, United States 1996-2011

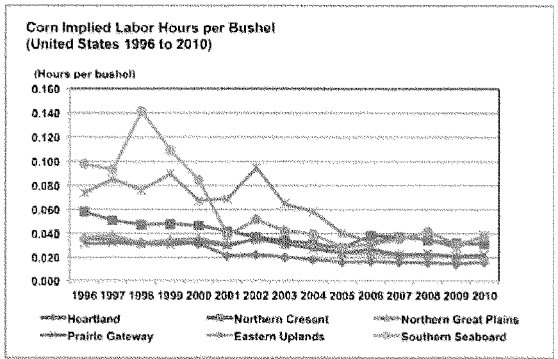


Figure 2.33 Corn Implied Labor Hours per Bushel by Region, United States 1996-2010

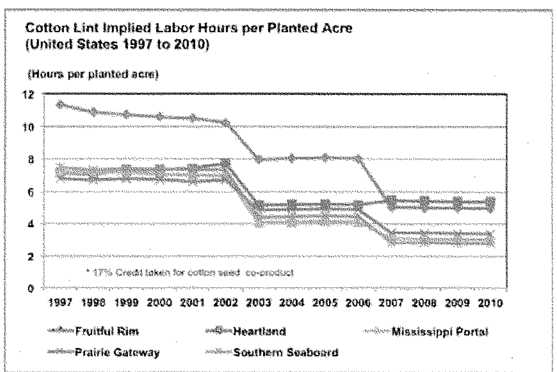
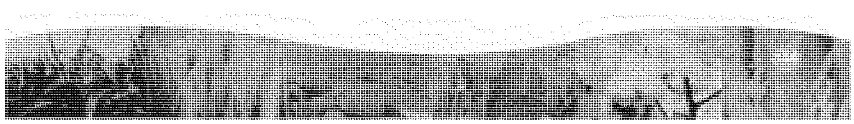


Figure 2.34 Cotton Lint Implied Labor Hours per Planted Acre by Region, United States 1997-2010



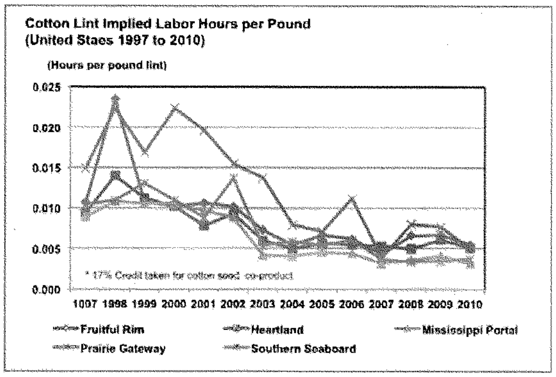


Figure 2.35 Cotton Lint Implied Labor Hours per Pound by Region, United States 1997-2010

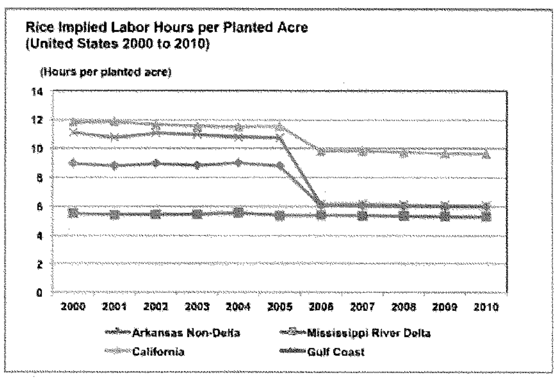
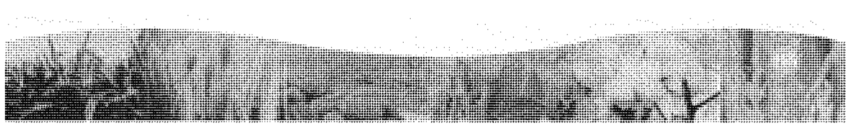


Figure 2.36 Rice Implied Labor Hours per Planted Acre by Region, United States 2000-2010



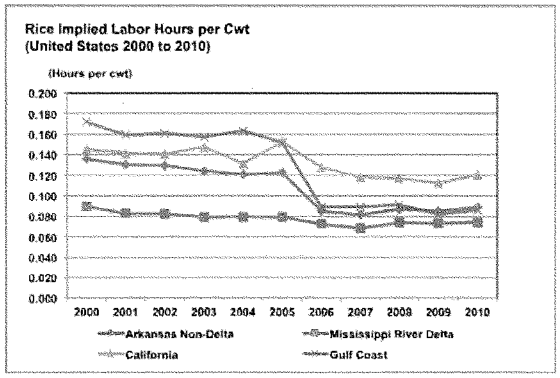


Figure 2.37 Rice Implied Labor Hours per Cwt by Region, United States 2000-2010

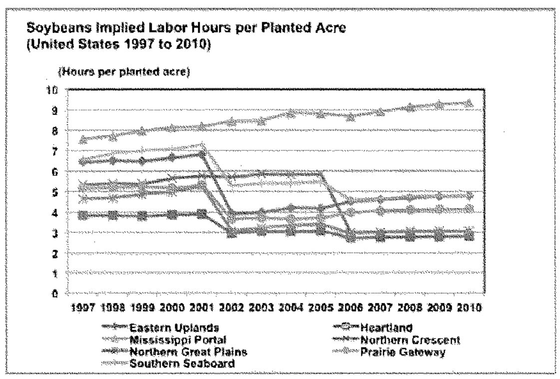
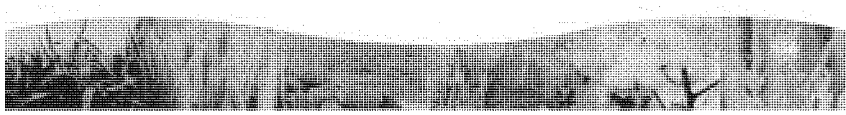


Figure 2.38 Soybeans Implied Labor Hours per Planted Acre by Region, United States 1997-2010



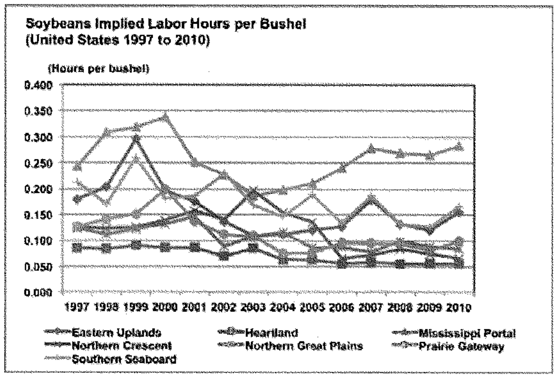


Figure 2.39 Soybeans Implied Labor Hours per Bushel by Region, United States 1997-2010

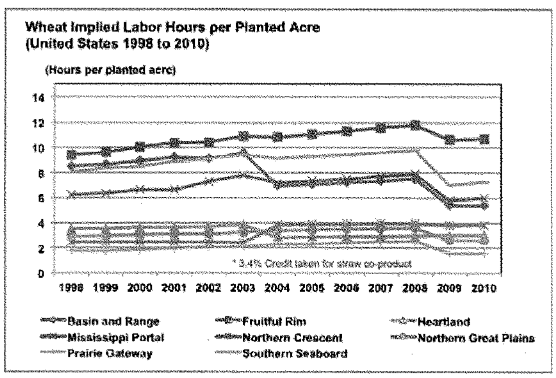
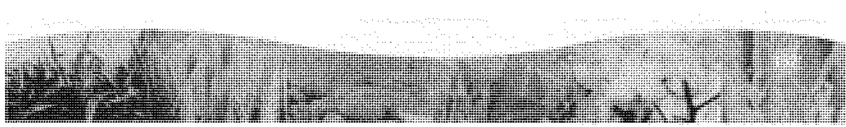


Figure 2.40 Wheat Implied Labor Hours per Planted Acre by Region, United States 1998-2010



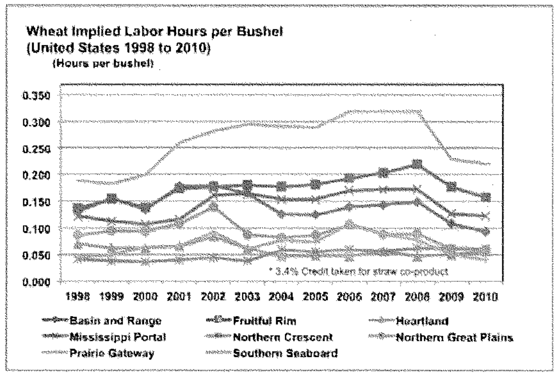
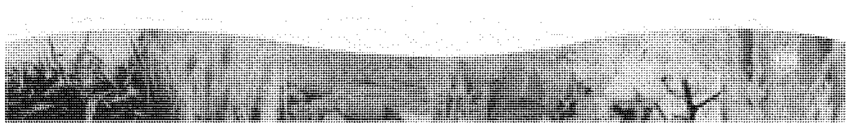


Figure 2.41 Wheat Implied Labor Hours per Bushel by Region, United States 1998-2010



4. Socioeconomic Indicators Investigated But Not Included

4.1 Introduction

The socioeconomic indicators contained in this section were explored but determined inappropriate for inclusion at this time for various reasons detailed in each indicator section, below. Many indicators were not selected because other indicators provided a better representation of the desired outcome. In other cases, national datasets were not available at all, or over an extended time period. Some were excluded due to definitional or directional ambiguity, or due to lack of significant correlation with actions being taken on the farm.

Other indicators were not included because of USDA ERS farm type classifications. For many surveys, farm types are determined by those having value of production of 50% or more from a particular activity and therefore skewed data by crop type. In addition, in these surveys, cotton is included with tobacco and peanut and cannot be broken out by specific crop type.

4.2 Household Income

The well-being of farm operator households is not equivalent to the financial performance of the farm sector or of farm businesses because there are other stakeholders in farming, such as landlords and contractors. In addition, farm operator households have non-farm investments, jobs, businesses, and other links to the nonfarm economy that are separate from their farming interests. Primarily for this reason, household income was not included as an indicator in this report. Crop type for this data is also determined by those having value of production of 50% or more from a particular activity, therefore providing a highly variable farm-type designation over time.

4.3 Real Gross Revenue per Acre

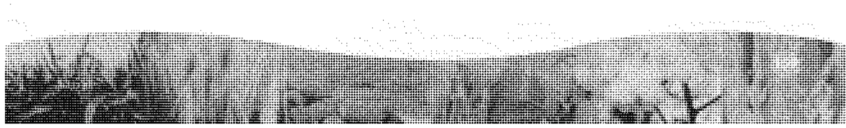
Gross revenue is revenue minus the costs of goods sold. The uncertainties of weather, yields, prices, government policies, global markets, and other factors can cause wide swings in farm income.

Data were investigated based on the USDA's Agricultural Resource Management Survey. This indicator was deemed to be a component of the recommended indicator "returns above variable costs" and therefore is not presented separately. In addition, price volatility could contribute to a false trend.

4.4 Cropland Value

Production value of land reflects its ability to provide consumers with goods and services through the extraction of minerals or organic goods as food and fiber. This value aligns with the notion that property value comes from the combination of land, labor, capital and management to produce something that people will pay for and generating income for the property owners. Value is used for the sale of the land and the calculation for capital gains.

Data were investigated based on the USDA's Agricultural Resource Management Survey, are only available at the state level and are not crop specific. This indicator was deemed to be a component of the recommended indicator "returns above variable costs" and therefore not needed for economic demonstration.



4.5 Total Factor Productivity

Total factor productivity (TFP) is the portion of output not explained by inputs used in the production process. As such, it could be determined by technology growth, efficiency, weather, etc.

USDA data on agricultural TFP is estimated at national and state levels, not by farm enterprise type. It is difficult to identify the factors contributing to the TFP growth relevant to the USDA data provided and therefore the indicator was not included.

4.6 Cash Flow, Input Costs, and Costs of Funds

Data were investigated based on the USDA's Agricultural Resource Management Survey, are only available at the state level and are not crop specific. This indicator was deemed to be a component of the recommended indicator "returns above variable costs" and therefore not needed for economic demonstration.

4.7 Poverty Rate

Threshold for poverty in the general economy may not be appropriate for farm specific areas given the non-monetary benefits that may occur on a farm, including food and housing as part of worker compensation.

4.8 Education – Farmer

Farmers should have access to the most recent information on techniques and efficiencies of food production. Improving knowledge of new techniques and technologies – in addition to providing with any physical resources necessary for implementation – can dramatically increase the farmers' level of productivity.[112]

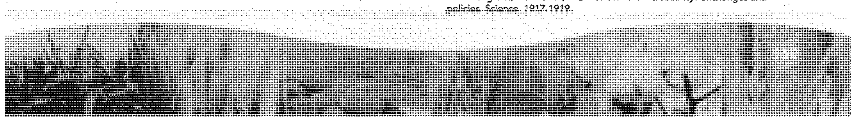
Data were investigated based on the USDA's Agricultural Resource Management Survey, which is subject to the 50% farm value designation described above. A primary reason for exclusion of this indicator is that education level is heavily influenced by geographic and larger community/demographic trends rather than by crop type or other factors specific to actions taken within the farm gate.

4.9 Education – Community

Education can be measured by the number of school years completed, number of persons completing high school and college, functional literacy rates, and participants in adult education. Education is important to the community as it provides members of a farm-based community improved chances for success in complex modern farming as well as in other types of professional career fields.

Data investigated on community-wide education level for agriculture communities wer based on the USDA's Agricultural Resource Management Survey, and were not presented for this report as data are geographic, not crop specific, and farmers do not directly control access to or participation in education by the community as a whole.

112 Rosegrant, M. & Cline, S. 2003. Global food security: Challenges and policies. Science, 1917-1919.



4.10 Succession Planning

Farm succession planning is the process of transferring the farm intact to the next generation of their family. Farm succession planning is crucial to the long term success of the farm because it unlocks cash from the organization for the exiting generation of owners and creates an atmosphere in which the next generation can begin taking over.

Data were investigated based on the USDA's Agricultural Resource Management Survey and were not as robust as needed for a complete analysis. However, this indicator is considered an important social indicator and may be included if better data become available in the future.

4.11 Land Ownership and Land Tenure

Farm tenure refers to the share of land of a farming operation that is owned by the operation. Each farming operation must have access to assets in order to produce crop and livestock products. This access may be obtained through renting rather than outright ownership.

Data were investigated based on the USDA's Agricultural Resource Management Survey. This indicator was not included because of a lack of directional context as renting or owning does not always have an impact on sustainable farm management practices and whether one is preferred over the other is largely a value judgment.

4.12 Healthcare Insurance

Healthcare insurance is insurance against the risk of incurring medical expenses among individuals.

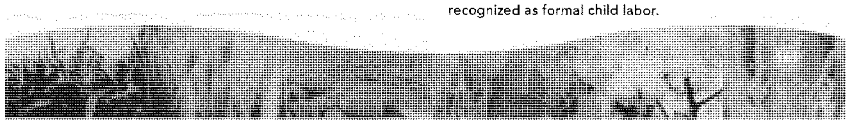
Data were investigated based on the USDA's Agricultural Resource Management Survey. This indicator was not included because of the differing ways healthcare insurance can be acquired that are not directly controlled by the farm operator. For example, spouses who work off-farm may insure the entire family through their workplace.

4.13 Farm Labor Practices/Child Labor Practices

Hired farmworkers make up less than one percent of all U.S. wage and salary workers, but they play an essential role in U.S. agriculture. Their wages and salaries represent roughly 17 percent of total variable farm costs, and as much as 40 percent of costs in labor intensive crops such as fruits, vegetables, and nursery products. Hired farmworkers continue to be one of the most economically disadvantaged groups in the United States.

Child labor refers to the employment of children at regular and sustained labor. This practice is considered exploitative by many international organizations and is illegal in many countries. Child labor laws in the United States set the minimum age to work in an establishment without restrictions and without parents' consent at age 16, except for the agricultural industry where children as young as 12 years of age can work in the fields for an unlimited number of non-school hours.

Both hired labor and child labor are recognized as important social issues; however, commodity crops, the focus of this study, have different labor characteristics than specialty crops, which are more aligned with migratory workers issues. Regarding child labor, many commodity farms are family farms that employ family members and are therefore not recognized as formal child labor.



4.14 Incidence Levels of Foodborne Illness

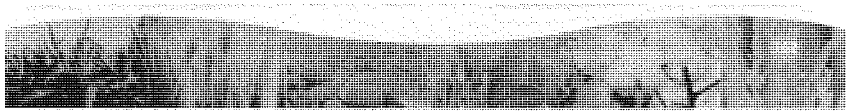
Foodborne illness is caused by consuming contaminated foods or beverages. Many different disease-causing microbes, or pathogens, can contaminate foods, so there are many different foodborne infections. In addition, poisonous chemicals, or other harmful substances can cause foodborne diseases if they are present in food.

Foodborne illness is recognized as a significant issue but is more common when discussing specialty crops rather than commodity crops, which are the focus of this study.

4.15 Biosecurity Protection Against Transmission of Zoonotic Diseases

Biosecurity is a strategic and integrated approach encompassing policies, regulations, tools, and activities to ensure food safety, as well as animal and plant life and health. Biosecurity concerns include: the introduction of plant pests, animal pests and diseases, zoonosis, threats to biodiversity, the introduction and management of invasive alien species and genotypes, and the protection of the environment.

Biosecurity protection against transmission of zoonotic diseases is recognized as a significant issue but is more common when discussing specialty crops rather than commodity crops, which are the focus of this study.



5. Conclusions and Discussion

This report does not define a benchmark level for socioeconomic indicators but rather explores broad-scale progress over time related to the major challenges facing agriculture in the twenty-first century: increasing demand, limited resources, and the need to maintain economically viable production systems that are consistent with the well-being of farmers and their communities. Such analyses of socioeconomic outcomes are needed in complement to analyses of environmental outcomes, especially as they may help us to better evaluate the sustainability implications of various trends in markets and production practices, e.g., larger yields, the substitution of chemical and mechanical inputs, volatile product prices, government support mechanisms, and the use of alternative business arrangements such as leasing and contracting.

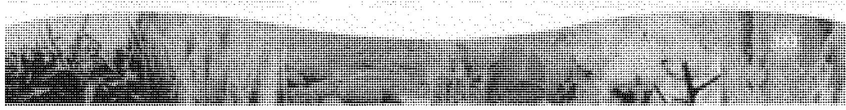
A review of a limited number of indicators is provided in this report in order to address the social and economic concerns of sustainable agriculture under the direct control of the farmer that contribute to the success and well-being of the farmer, farmer household, and farming community.

The social indicators show a decline in the number of labor hours, fatalities, and injuries on farm. Driven by productivity and harvesting efficiency gains, workers are spending less time in the field. These gains in return are driven by advances in farming equipment, technologies, and the adoption of conservation tillage practices that have all contributed to the reduced amount of tractor hours and therefore the reduced amount of operator labor hours needed. The incorporation and improvement of GPS equipment and precision agriculture technologies, including improved safety mechanisms for both old and new equipment, have also contributed to the decrease in worker injury due to operator fatigue.

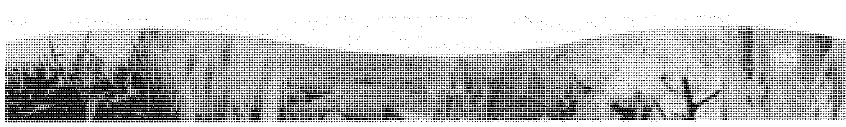
The economic indicators are driven in part by farming costs and revenues. While economics are affected by a multitude of variables in the agricultural industry – including food and nutrition and food safety policy, macro and micro economic trends, and federal support mechanisms –farmers have more direct control over their costs than revenues and continuously seek the optimal use of all inputs.

The main issues contributing to the omission of many socioeconomic metrics in this report are data availability challenges such as gaps in data continuity, definitional ambiguity, and data relevance to commodity crop farming. In many instances available data are not crop specific, the metric is not significantly under the control of the farm operator, and/or meaningful conclusions cannot be derived. In addition, USDA ARMS classifies farm types by criteria of a grower receiving over 50% of gross income coming from specific crop activity. Therefore the accounting of crop specific farms experiences volatility due to variations of product pricing. For example, many farmers switch between soybeans and corn production depending upon price fluctuations of those respective crops. Finally, cotton is typically included with tobacco and peanuts and cannot be broken out by specific crop type.

Capacity to continue and enhance these kinds of analyses is dependent on the availability of the public data sources upon which this report heavily relies. Public, national-level datasets provide a transparent, accessible, and fundamental means of understanding sustainability trends.



Through this report and Field to Market's advancement of agricultural sustainability metrics and tools at a variety of scales, the Alliance seeks to enable an outcomes-based, science-based discussion on the definition, measurement, and advancement of sustainability. The hope and intent is that such approaches will ultimately inform mechanisms to promote economically and socially viable improvements at the field level that contribute, in turn, to continued, significant, and broad-scale progress toward meeting sustainability challenges for production, resource use and impacts, and social and economic well-being.



Pasted below is a list of helpful links to programs and initiatives that are discussed in Chief Weller's testimony.

The following links will take you to our NRCS web pages for these topics:

Farm Bill – General http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/

EQIP – Environmental Quality Incentives Program
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Landscape Initiatives – General http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/initiatives/

NWQI – National Water Quality Initiative
http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1047761

GLRI – Great Lakes Restoration Initiative
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=nrcsdev11_023903

MRBI – Mississippi River Basin Initiative
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/initiatives/?cid=stelprdb1048200

RCPP – Regional Conservation Partnership Program
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/farmbill/rcpp/

CEAP - Conservation Effects Assessment Program
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/ceap/

FA – Financial Assistance http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/

TA – Technical Assistance
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/

Conservation Practice Standards
http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/

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UNITED STATES SENATE
THE COMMITTEE ON AGRICULTURE, NUTRITION AND FORESTRY

December 3, 2014

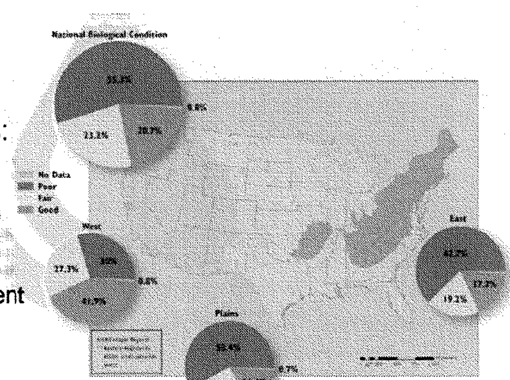
Jason Weller

Chief, Natural Resources Conservation Service

USDA
United States Department of Agriculture

National Water Quality Challenge

- Biological conditions of nation's rivers and streams
  - Poor: 55.3%
  - Fair: 23.3%
  - Good: 20.7%
  - Unknown: 0.8%
- Greatest stressors:
  - Phosphorous
  - Nitrogen
  - Riparian cover and disturbance
  - Streambed sediment



From National Rivers and Streams Assessment (2008–2009) (EPA, 2013)

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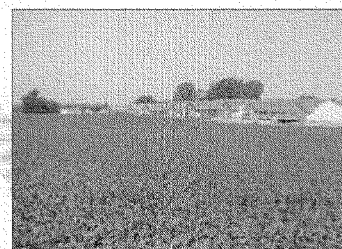
Private Lands and Conservation

- 70 percent of the land is privately owned
- 88 percent of all surface water occurs on private land
- The quality of our environment depends on the decisions private landowners make every day



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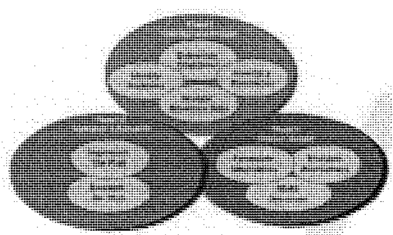
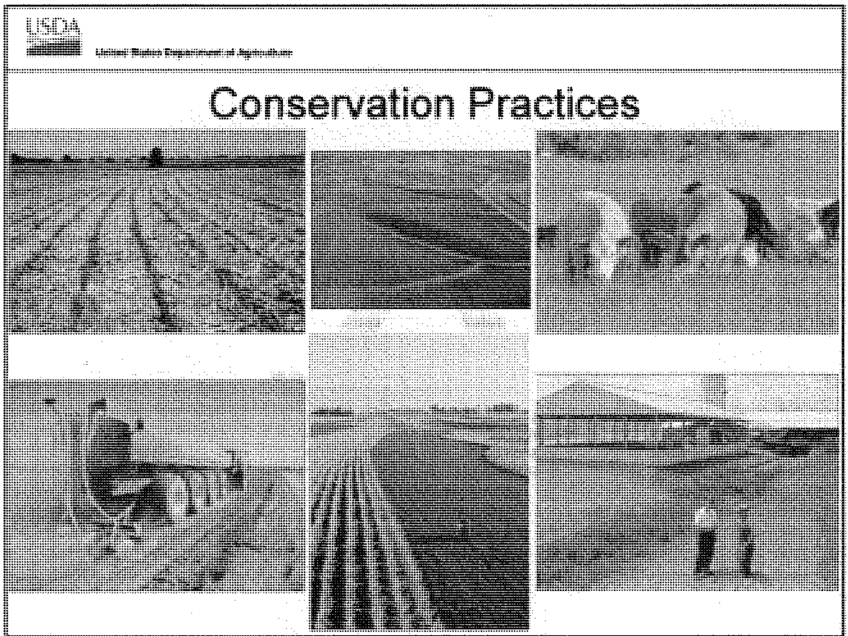
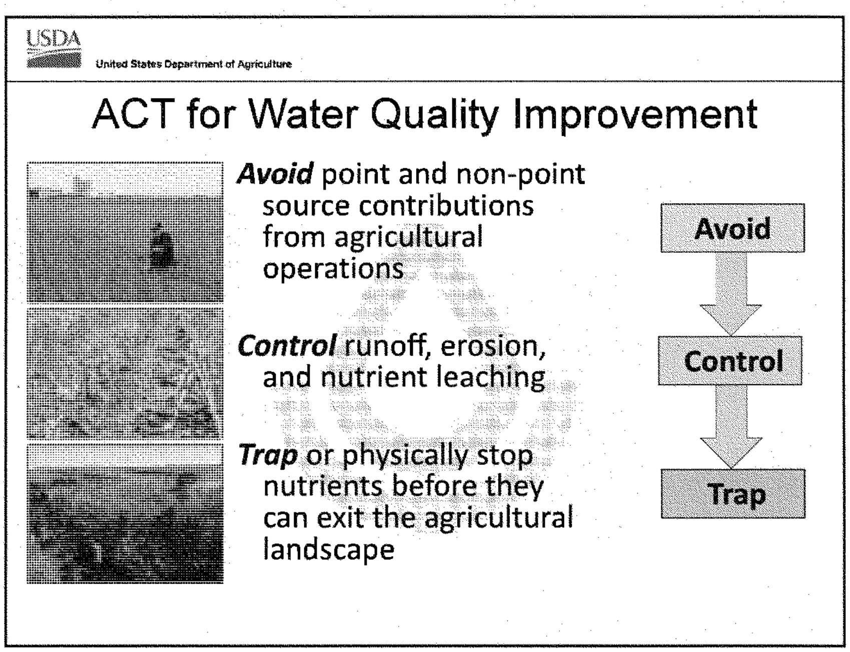
NRCS Conservation Planning




USDA
Conservation Practices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ACT for Water Quality Improvement
Avoid point and non-point source contributions from agricultural operations
Control runoff, erosion, and nutrient leaching
Trap or physically stop nutrients before they can exit the agricultural landscape
Avoid
Control
Trap

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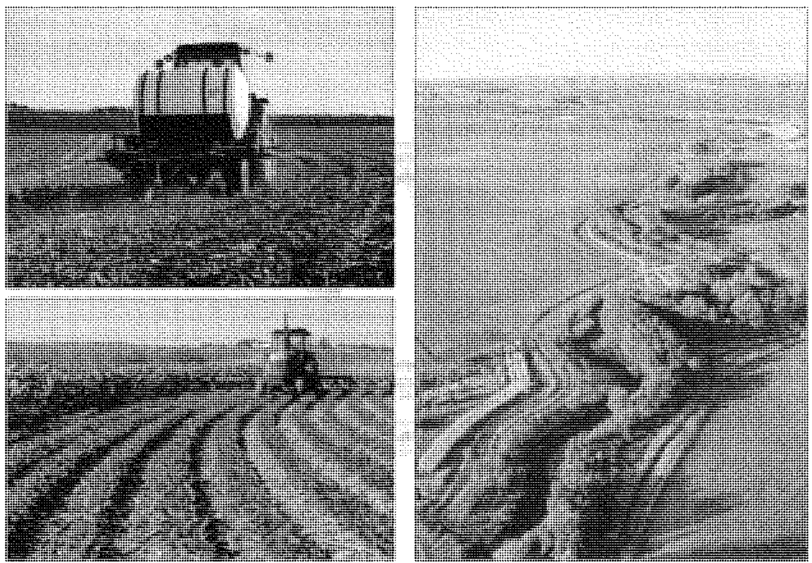
United States Department of Agriculture



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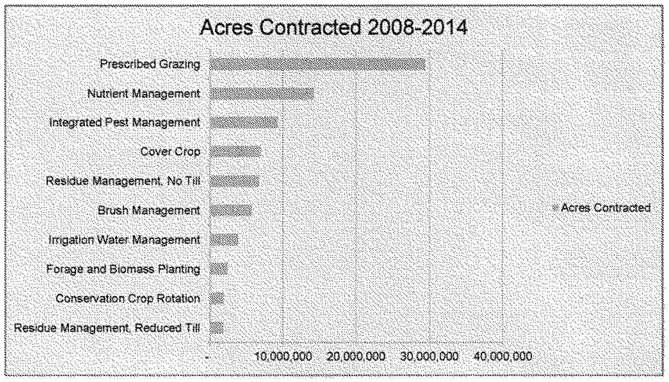
Investment in Conservation

During the period of 2008-2014:

- NRCS helped producers install **727,000** conservation practices for water quality.
- 86,000,000 acres of conservation practices implemented on private agricultural lands with specific water quality benefits.
- Represents an investment of **$3.4 B** in federal funding
- In addition producers invested **$1.7-$3.4 B** (estimate based on 25-50% of practice costs)

USDA
United States Department of Agriculture

Top Ten Practices by Acres Contracted



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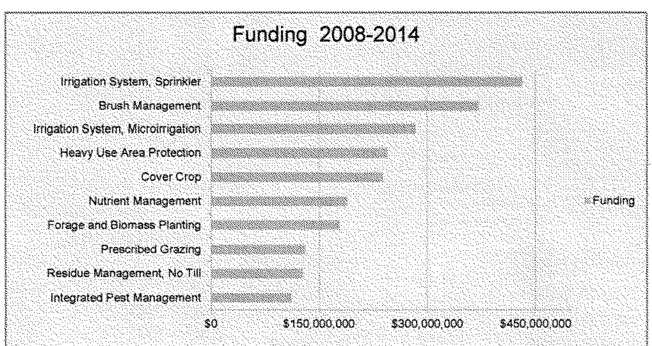
Top Ten Practices by Funding



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Investments Pay Dividends

- **Chesapeake Bay**: Conservation practices installed between 2006 and 2011 reduced:
  - » Sediment losses **by 62 percent**;
  - » Surface N losses **by 42 percent**;
  - » Subsurface N losses **by 16 percent**;
  - » Total P losses **by 49 percent**.

- Based on 2003-2006 and 2011 surveys conducted as part of the Conservation Effects Assessment Project and reflect edge of field impacts.

USDA United States Department of Agriculture

Targeted Approach is Best

NRCS Landscape Initiatives for Water Quality:

- Mississippi River Basin Initiative
- Great Lakes Restoration Initiative
- National Water Quality Initiative
- The Bay Delta Initiative
- Chesapeake Bay Watershed Initiative
- Driftless Area Landscape Conservation Initiative
- The Everglades Initiative
- Gulf of Mexico Initiative

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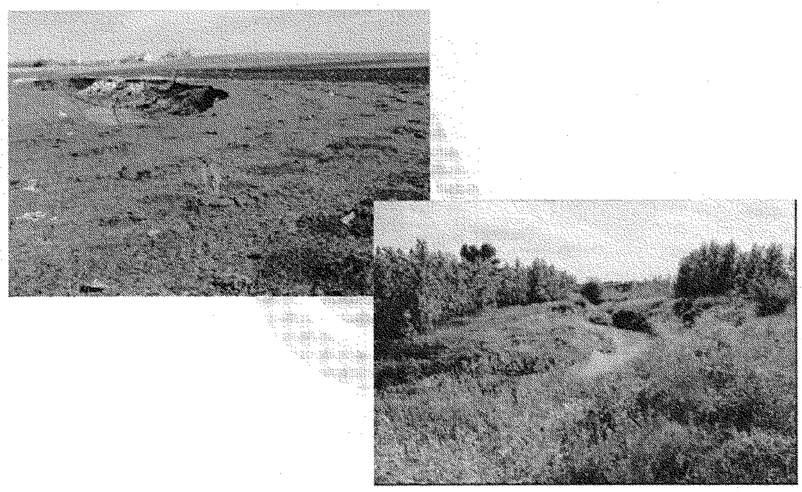
Before and After - Iowa



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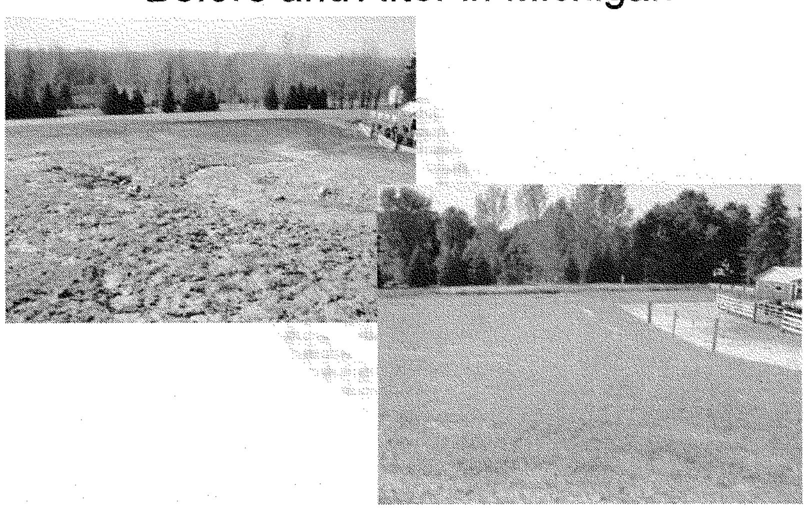
Before and After in Michigan



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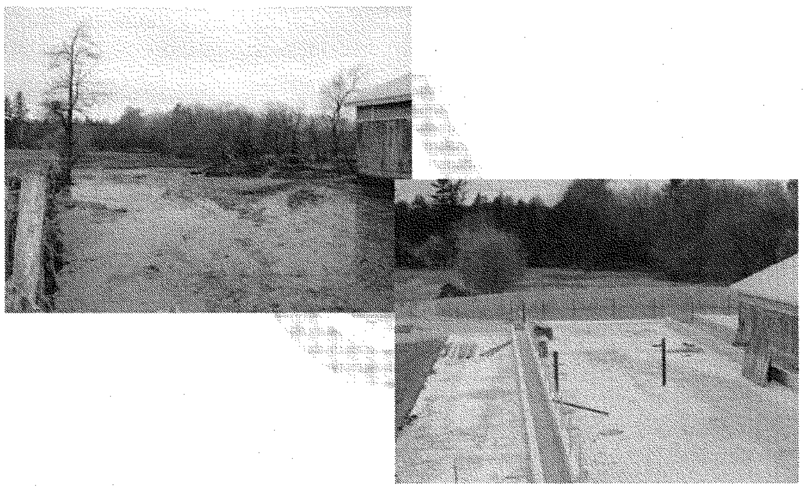
Before and After in Vermont



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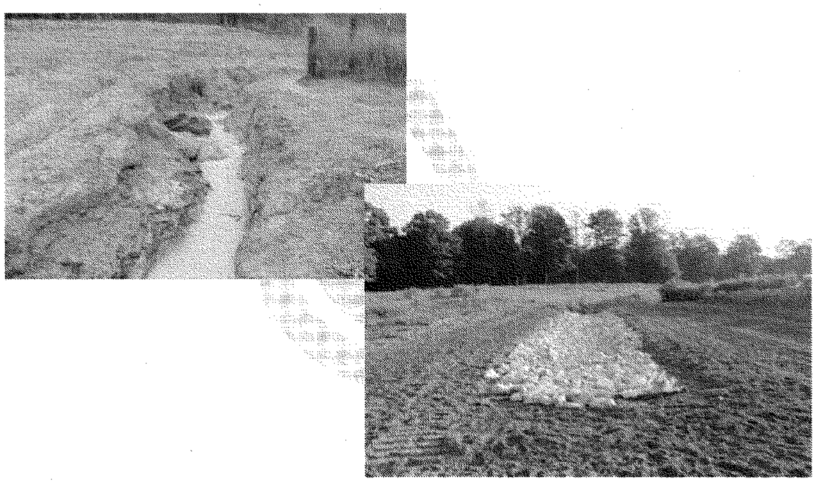
Before and After in Mississippi



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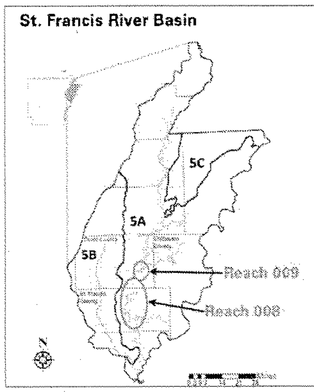
Arkansas Success Story



Agricultural runoff contributing sediment to the St. Francis River

Drop pipes used to discharge runoff into waterbody to avoid erosion

Map and photos courtesy of Arkansas Department of Environmental Quality

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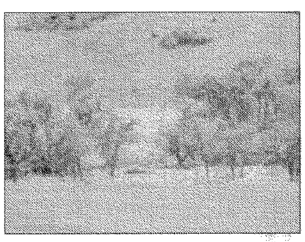
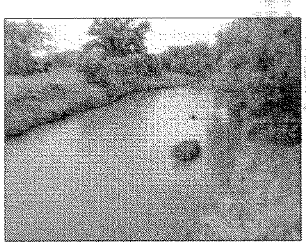
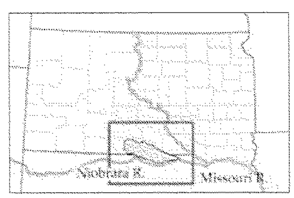
South Dakota Success Story

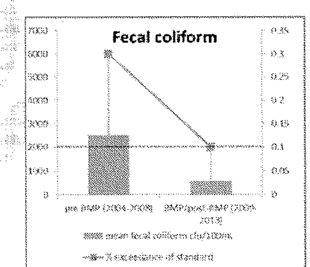


Fencing to exclude livestock



Second year of livestock exclusion on the Keya Paha River





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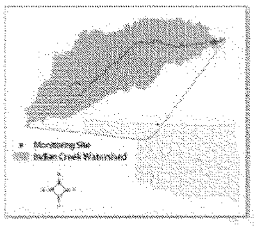
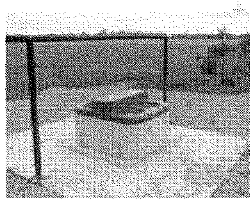
Oklahoma Success Story

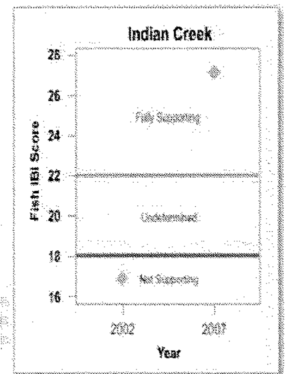




Grazing management restores "Biotic Integrity"

Program funding from NRCS plus 319, State and local programs.

Before and After monitoring by State WQ agency documents the results



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Demand for voluntary incentive based conservation remains extremely high!

The 2014-2015 signup for the new Regional Conservation Partnership Program resulted in 600 proposals and requests for $2.8 billion in program funding. About $400 million is available for this current round of selections.

QUESTIONS AND ANSWERS

DECEMBER 3, 2014

Senate Committee on Agriculture, Nutrition & Forestry
Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters
Wednesday, December 3, 2014 – 10:00am
328A Russell Senate Office Building
Ms. Kristin Weeks Duncanson

Chairwoman Debbie Stabenow

1. **Can producers make a measureable improvement in water quality by adopting voluntary conservation practices? If so, which suite of practices are most effective at improving water quality, for example combatting harmful algal blooms like the one we saw in Lake Erie this summer?**
   Yes, producers can make a measureable difference. Our experience tells us that as far back as the post –Dust Bowl era producers have worked together for good environmental outcomes. Producers working collaboratively at a watershed scale on nutrient management is one of the most effective approaches to prevent algal blooms like the one in Lake Erie. It is important to keep in mind that each watershed and its challenges and potential solutions are unique and agriculture production may not be the major contributor to the issue of concern. As producers and watershed groups use sound science to determine the practices and technologies necessary to achieve desired outcomes in their particular context, they can make informed decisions on how to move forward. Such practices may include improved nutrient management, cover crops, buffer strips, no or reduced tillage, drainage water management, and others which have proven effective. It is important to note that measurement can be expensive (though costs are coming down) and must be done regularly and at multiples scales in order to determine what kinds of impact changes in practice are having and to manage adaptively. This requires a significant investment.

2. **When discussing results and success stories for implementing conservation practices, often times the answer centers on participation numbers of producers, rather than measuring actual nutrient levels in receiving water bodies. How do you currently measure the results of implementing conservation practices in terms of nutrient runoff?**
   As mentioned above, measurement is challenging. There are several technological advances in measuring nutrient runoff as well as nutrient applications in production agriculture. Satellite systems such as Adapt N out of Cornell University and drain tile monitors are just a few. The trick is getting producers to use them and have confidence in them. Some producers have had great success and there are both public and private cost share dollars available to support their efforts. Advances in soil testing are widely used to help cut costs as well as runoff.

3. **Do you currently use on-farm monitoring to track nutrient losses from fields? What can be done to increase the use of this practice across the country?**
   We have been part of a pilot for the Adapt N program and use extensive soil testing at mid-field and field edge currently. To increase this practice across the country, government and other stakeholders can:

- Invest in research that demonstrates the environmental and economic benefits of tracking nutrient loss.
- Develop tools and provide technical assistance and monitoring infrastructure that will help producers capture those benefits on their operations.
- Ensure producers' proprietary information is protected.

4. **You mentioned in your testimony ideas on how to increase producer participation including "peer-pressure", but are there additional roles for the federal government to help build non-traditional models to increase outreach and ultimately participation?**
The federal government has been and will continue to be a key partner to help build non-traditional conservation models. Additional roles and contributions include:
   - Provisions in the new Farm Bill that lend themselves to funding with flexibility and watershed choice will help encourage producers to participate. Further shifts in funding to support innovative conservation approaches should be considered in future Farm Bills.
   - Extension services and sound technical advice regarding conservation aids producers working to adopt innovative practices on their own operations and determine strategies in collaboration with their neighbors to address conservation challenges at the watershed scale. There is a great need for additional extension capacity in many areas. Having technical experts skilled also in working directly with producers is critical – we need more and better technical people on the ground to assist producers with integrated natural resource management planning, practice adoption, and adaptive management.
   - Government agencies might consider providing safe harbor from future regulation to those who are willing to take voluntary action to achieve desired conservation outcomes or early adopters who achieve such outcomes in an innovative way.
   - Continued and in some cases increased investments in research and data integration that demonstrates the productivity and profitability benefits of conservation practices and technologies will be critical to engage producers in new approaches.

<u>Senator Amy Klobuchar</u>

1. **When crafting the Farm Bill, we designed the Regional Conservation Partnership Program (RCPP) to leverage private funding in order to maximize the impact of the federal funds allocated through the program. However, project agreements where a partner such as a state or local government, Indian tribe, non-profit business, or farmer cooperative can make a "significant contribution" are given priority. Have you experienced any issues with identifying and partnering with private funding sources in order to leverage federal investments?**
RCPP is a very solid concept for accomplishing conservation and increasing producers' productivity and resilience. We are just beginning to put together these partnerships and there are many organizations and entities that are applying for the funds, which indicates strong initial interest in leveraging federal investments through the program. As the program

progresses, further consideration can be given to whether this "significant contribution" provision presents any challenges to stakeholders working to achieve conservation outcomes.

Senate Committee on Agriculture, Nutrition & Forestry
Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters
Wednesday, December 3, 2014 – 10:00am
328A Russell Senate Office Building
Dr. Marty Matlock

Chairwoman Debbie Stabenow

1. Which suite of practices are most effective at improving water quality, for example combatting harmful algal blooms like the one we saw in Lake Erie this summer? Do the most effective practices differ depending on what type of nutrient a producer is trying to address or the type of soil that activities are conducted on; such as nitrogen verses phosphorus?

   Matlock Response: Harmful algal blooms are caused by a combination of conditions: increased nutrient (predominantly nitrogen and phosphorus) concentrations in water, warm water temperature, and reductions in water flow or circulation. For systems like Lake Erie, agricultural production does not affect temperature and circulation; those are influenced by larger urban and industrial impacts and climate change. Agricultural practices contribute to increased nutrient concentrations through loss of nitrogen and phosphorus from water and soil moving through and across agricultural fields, and through discharge from animal manure treatment systems. Nitrogen molecules used as fertilizers are more water-soluble than phosphorus molecules, so nitrogen moves more easily through the soil to streams, rivers, lakes, and estuaries dissolved in water (surface and ground water). Phosphorus typically moves from fields attached to soil particles, though it can move in water when in high concentrations on the land. Since algae need more than 10 times more nitrogen than phosphorus to grow, thus a little bit of phosphorus can have a big impact on algal growth. Practices that reduce erosion and runoff from fields can reduce nitrogen and phosphorus loss. These include adoption of conservation tillage practices, protection of streamside riparian buffer zones, collection and recirculation of tile drainage discharge (where appropriate), use of edge-of-field vegetative filter strips, constructed wetlands, and other landscape-scale treatment processes, and more intensive management of nutrient application using precision agriculture technologies. The technologies and practices exist today to achieve measurable reductions in nutrient losses from our Nation's agricultural fields. A systemic approach to managing nutrients at the field and watershed level is the most effective way to reduce risks of eutrophication from agricultural sources.

2. Is it important that we look at a combination of practices to most effectively reduce nutrients in our lakes, rivers and streams? If so, which practices are more effective than others?

   Matlock Response: Yes, a combination of practices must be available for producers to optimize their strategies for protecting water quality from agricultural activities. Not all soil conditions and cropping strategies are compatible with every nutrient reduction strategy. Every producer should have a nutrient management plan, developed with NRCS, to provide an education and management platform for comprehensive nutrient management within a watershed. NRCS should be coordinating and managing nutrients at the watershed level using this approach. The single most effective method of reducing runoff and soil erosion from fields in the past 40 years has been adoption of conservation tillage practices (ridge till, low till, no till, and others). We do not have high-resolution data (with respect to year or location) regarding implementation of conservation tillage practices, or any other conservation practice, for that matter. We only have anecdotal surveys from regions. We should be doing a better job of tracking, reporting, sharing which management practices are adopted, and where, so we can learn and improve together.

3. When discussing results and success stories for implementing conservation practices, often times the answer centers on participation numbers of producers, rather than measuring actual nutrient levels in receiving water bodies. What methods should producers be using to measure the effectiveness of implementing conservation practices?

   Matlock Response: Measuring effectiveness of conservation practices alone will not reduce nutrient loads to water bodies from agriculture; this requires a watershed approach where all the producers in a sensitive watershed are engaged in collaboratively implementing practices that improve water quality. The most common scale of water quality monitoring is the eight-digit hydrologic unit code (HUC8) scale, which are watersheds with areas of approximately 10,000 square miles. We have State-determined concerns regarding nutrients at this scale, and in some cases even at smaller watershed scales (HUC10, about 250 square miles), listed under CWA ss303(d) as non-compliant with water quality standards of the state. Each producer in a nutrient sensitive 303(d) listed watershed should have a nutrient management plan that is integrated within the context of the other producers in the watershed, and coordinated to reduce total nutrient loads. The nutrient management plan will identify potential nutrient hot spots in each producer's fields, so they can focus efforts and resources on reducing nutrient losses from those areas.

4. Are these methods currently widely used, and if not, what can be done to expand their usage?

   Matlock Response: Watershed-level strategies for nutrient reduction have been implemented in a number of watersheds across the US, but largely in response to local political or judicial pressure rather than systematic implementation of watershed-based strategies. Court-mandated total maximum daily load (TMDL) strategies usually are the drivers, but these legal remedies are most impactful on point sources, especially municipal and industrial wastewater treatment plants. The evidence of their effectiveness is compelling; watershed collaborative projects can improve water quality in a very short amount of time, if the appropriate metrics are measured at the appropriate locations, and the incentives for improvement are clearly defined.

5. In your testimony you mention the use of nutrient trading as a possible pathway to address water quality concerns at a larger scale. Can you further elaborate on steps that need to be taken to establish nutrient trading systems? Also, please explain how water trading links to measurability – does water trading require more than merely accounting for producers and acres signed up for conservation practices?

   Matlock Response: Nutrient trading is most often constructed as a contractual relationship between point source dischargers and non-point dischargers within the receiving stream watershed to engage in landscape-level practices that achieve a required reduction in nutrient (predominantly nitrogen and phosphorus) concentrations in the water body. The limits to implementation, in my experience, have been regulatory frameworks associated with National Pollutant Discharge Elimination System (NPDES) permits that regulate the point sources. The NPDES permits are generally issued by state environmental agencies and approved by regional EPA offices. The process of permitting approval is opaque; the negotiations and discussions between the state and regional EPA permit writers can take months, and many times the permit applicant is not engaged in those discussions. The added uncertainty regarding how a nutrient trading permit violation would be addressed creates an almost impenetrable barrier to implementation. A solution would be for USEPA to draft a national Nutrient Trading Permit strategy that provides clear policy authority in support of a trading strategy that is simple to understand and implement. The elements of this policy should be as clear as:

1) The NPDES permit only has jurisdictional and therefore penalty authority over the point source discharger.
2) Any relationship between the NPDES permitted discharger and nonpoint source dischargers to achieve a given water quality standard are outside the jurisdiction of the USEPA; these relationships are the sole responsibility of the permit holder.
3) The permit must have clear nutrient reduction and concentration goals for the water body, and the methods and frequency of measurement must be unambiguous.
4) Failure to achieve the nutrient reductions and concentration goals as defined in the permit will constitute a permit violation and be subject to the penalties associated with said violations.

This process will allow point sources maximum flexibility in developing risk management strategies for nutrient reductions that make sense in their watersheds. The other details (contractual criteria, load reduction multipliers, etc.) are the responsibility of the NPDES permit holder. They have to work with the other folks in their watershed to achieve common water quality goals.

<u>Senator Amy Klobuchar</u>

1. When we were debating the Farm Bill, one of my priorities was boosting funding for agricultural research. We managed to provide mandatory funding to establish the Foundation for Food and Agriculture Research, a non-profit corporation designed to supplement USDA's research activities. Do you view the collaborative public/private partnership model that's being used to leverage certain conservation funding as a model that can and should be expanded to other areas such as research?

Matlock Response: This model of public/private partnerships to solve complex agricultural problems created the most productive and innovative agricultural production system in the world in the mid-20th century. The erosion of that partnership beginning in the early 1980s has been detrimental to US agricultural producers, and in my opinion to our national food security. The creation of the FFAR in the 2014 Ag Bill is one of the most important steps we have taken in more than 40 years to support continued innovation in US agriculture. Public/private partnerships insure the scientific innovations move to the marketplace in a more timely and effective manner. I do believe this model should be expanded through other federally supported research initiatives such as NSF, DOE and NIH. The current model of using SBIR programs to spur the translation of invention to economic innovation has been effective, but can be enhanced with a framework for a more intimate corporate/academic partnership.

Senate Committee on Agriculture, Nutrition & Forestry
Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters
Wednesday, December 3, 2014 – 10:00am
328A Russell Senate Office Building
Mr. Sean McMahon

Please Note: Iowa State University professors Tom Isenhart and Matt Helmers assisted me in responding to Questions 1 and 2.

Chairwoman Debbie Stabenow

1. Which suite of practices are most effective at improving water quality, for example combatting harmful algal blooms like the one we saw in Lake Erie this summer?

It is important to determine what the primary water quality and resource concerns are in each watershed. My understanding of the harmful algal blooms in Lake Erie this summer and in recent years is that phosphorous is the primary resource concern and dissolved reactive phosphorous (DRP) represents a significant amount of the total phosphorous (TP) in the Western Lake Erie Basin. While point sources can represent a significant contribution to surface water nutrient loads during times of low flows, or where there are a larger number of permitted discharges, the following response pertains only to nonpoint source P loads.

Several recent and ongoing studies assessing the contribution of DRP to TP loads have highlighted the importance of DRP to total load, particularly in areas with artificial subsurface drainage, where DRP can represent a significant portion of TP.

When assessing the effectiveness of individual practices or a combination of practices to reduce nutrient flux (loads), it is always important to consider whether the practice will reduce the concentration (P concentration) or carrier (water). Practices listed within the Iowa Nutrient Reduction Strategy (INRS) as having the largest potential to reduce P load were based mainly on research addressing erosion and sediment-bound P. The literature related to effects of conservation practices on DRP is not as rich and that issue is not as well understood as conservation practices that address sediment-bound P.

There is published data that relates higher soil-test P to higher DRP concentrations within artificial subsurface drainage. So, as with TP loss, reducing soil-test P to optimal levels before application would likely reduce DRP loss to receiving waters.

Little data is available relating source and placement of P to DRP loss in drainage, though it is thought that they would have minimal impact. I believe that rate and timing of fertilizer application is more likely to effectively address DRP than source and placement.

Impacts of tillage would mainly be manifest in the sediment-bound component of TP. Conservation tillage, and no till and strip till in particular, is an effective set of practices for soil conservation. By limiting soil erosion through conservation tillage, the amount of sediment-bound P can be greatly reduced as well as TP.

Little data has been collected on the impacts of cover crops on DRP loss in drainage. However, due their impact on reducing soil-test P and total water loss, it could be expected that they may reduce DRP flux to receiving waters. Cover crops are known to effectively reduce nitrates, particularly nitrogen scavenging varieties like cereal ryes, annual rye grass and oats.

Most data on the effectiveness of riparian buffers has focused on total P in surface runoff. Their effectiveness at reducing DRP will be related to the extent that they increase infiltration of surface runoff. ISU has collected one year of data on DRP flux through saturated buffers. While the monitoring showed initial losses within the riparian soils, the long-term effectiveness would likely decline due to P saturation. Little data has been collected on P within bioreactors, though their long-term effectiveness would also likely decline due to P saturation. However, there are some ongoing studies in other states assessing the potential of adding iron or other P-binding substrates within the bioreactors to reduce DRP. These substrates would be replaced as needed.

2. Is it important that we look at a combination of practices to most effectively reduce nutrients? And do we know that certain practices are more effective than others?

   It is very important that we look at combinations of multiple practices to most effectively reduce N and P. Unfortunately there is no silver bullet for improving water quality, but we can hope to deliver silver buckshot by considering many different conservation practices, including which practices can improve water quality outcomes when used in combination. It is also important to consider what the primary resource concerns are as well as the goals we hope to achieve in each situation before selecting practices. Our understanding of the different transport mechanisms for N vs. P illustrates that multiple practices are needed to achieve significant reductions in concentration of N and P and multiple practices are also needed in reducing the carriers – sediment in the case of P and water in the case of N.

   Yes, it is understood that certain practices are more effective at reducing N and P than others. The following information on the effectiveness of various practices is excerpted from the Iowa Nutrient Reduction Strategy.

<u>Nitrogen Management Practices</u>

- Application (Timing, Rate, Placement, Source)
- Drainage Water Management
- Extended rotations
- Cover crops
- Alternative land uses (Energy Crops, Perennial Crops, Land Retirement)
- Buffers
- Targeted Wetlands
- Bioreactors[i]

	Practice	Comments	% Nitrate-N Reduction+	% Corn Yield Change++
			Average (SD*)	Average (SD*)
Nitrogen Management	Timing	Moving from fall to spring pre-plant application	6 (25)	4 (16)
		Spring pre-plant/sidedress 40-60 split Compared to fall-applied	5 (28)	10 (7)
		Sidedress – Compared to pre-plant application	7 (37)	0 (3)
		Sidedress – Soil test based compared to pre-plant	4 (20)	13 (22)**
	Source	Liquid swine manure compared to spring-applied fertilizer	4 (11)	0 (13)
		Poultry manure compared to spring-applied fertilizer	-3 (20)	-2 (14)
	Nitrogen Application Rate	Nitrogen rate at the MRTN (0.10 N:corn price ratio) compared to current estimated application rate. (ISU Corn Nitrogen Rate Calculator – http://extension.agron.iastate.edu/soilfertility/nrate.aspx can be used to estimate MRTN but this would change Nitrate-N concentration reduction)	10	-1
	Nitrification Inhibitor	Nitrapyrin in fall – Compared to fall-applied without Nitrapyrin	9 (19)	6 (22)
	Cover Crops	Rye	31 (29)	-6 (7)
		Oat	28 (2)	-5 (1)
	Living Mulches	e.g. Kura clover – Nitrate-N reduction from one site	41 (16)	-9 (32)
Land Use	Perennial	Energy Crops – Compared to spring-applied fertilizer	72 (23)	
		Land Retirement (CRP) – Compared to spring-applied fertilizer	85 (9)	
	Extended Rotations	At least 2 years of alfalfa in a 4 or 5 year rotation	42 (12)	7 (7)
	Grazed Pastures	No pertinent information from Iowa – assume similar to CRP	85	
Edge-of-Field	Drainage Water Mgmt.	No impact on concentration	33 (32)	
	Shallow Drainage	No impact on concentration	32 (15)	
	Wetlands	Targeted water quality	52	
	Bioreactors		43 (21)	
	Buffers	Only for water that interacts with the active zone below the buffer. This would only be a fraction of all water that makes it to a stream.	91 (20)	

Image courtesy of IDALS

Phosphorous Management Practices

- Cover Crops
- Alternative land uses (energy crops, perennial crops, land retirement)
- Extended rotations
- Application (rate, placement, source and timing)
- Tillage and residue management
- Buffers
- Erosion control practices and structures[ii]

	Practice	Comments	% P Load Reduction[a]	% Corn Yield Change[b]
			Average (SD[c])	Average (SD[c])
Phosphorus Management Practices	Phosphorus Application	Applying P based on crop removal – Assuming optimal STP level and P incorporation	0.6[d]	0
		Soil-Test P – No P applied until STP drops to optimum	17[e]	0
	Source of Phosphorus	Liquid swine, dairy, and poultry manure compared to commercial fertilizer – Runoff shortly after application	46 (45)	-1 (13)
		Beef manure compared to commercial fertilizer – Runoff shortly after application	46 (96)	
	Placement of Phosphorus	Broadcast incorporated within 1 week compared to no incorporation, same tillage	36 (27)	0
		With seed or knifed bands compared to surface application, no incorporation	24 (46)	0
	Cover Crops	Winter rye	29 (37	-6 (7)
	Tillage	Conservation till – chisel plowing compared to moldboard plowing	33 (49)	0 (6)
		No till compared to chisel plowing	90 (17)	-6 (8)
Land Use Change	Perennial Vegetation	Energy Crops	34 (34)	
		Land Retirement (CRP)	75	
		Grazed pastures	59 (42)	
Erosion Control and Edge-of-Field Practices	Terraces		77 (19)	
	Buffers		58 (32)	
	Control	Sedimentation basins or ponds	85	

Image courtesy of IDALS

3. When discussing results and success stories for implementing conservation practices, often times the answer centers on participation numbers of producers, rather than measuring actual nutrient levels in receiving water bodies. What improvements can be made to current conservation practices to improve water quality?

Conservation practices such as cover crops, conservation tillage, bioreactors and saturated buffers can have significant benefits on water quality within the first year of their establishment as measured at the edge of field scale. However, realizing water quality improvements at the watershed scale is a far longer process. Due to the legacy of nutrients and sediment that is already present within our agricultural watersheds, it's anticipated that it will take decades to improve water quality in large watersheds, such as at the HUC 6 watershed scale and larger.

4. Are there available, yet underutilized, practices that are effective at improving water quality? If so, what are they and what are the barriers to their implementation?

   Yes, I would consider saturated buffers, bioreactors and nutrient treatment wetlands to all be underutilized practices. All are known to effectively reduce nutrients.

   In the case of saturated buffers, there are policy barriers to implementing them within USDA. It would be most effective if we could install saturated buffers into existing Conservation Reserve Program (CRP) buffers. I understand that there is resistance to allowing that until a permanent standard for saturated buffers has been established. NRCS currently has an interim standard for saturated buffers.

   In the case of bioreactors and nutrient treatment wetlands, lack of sufficient funding is the biggest barrier for implementation. I understand that there have also been barriers related to permitting Conservation Reserve Enhancement Program (CREP) wetlands in Iowa. There is currently an interim NRCS standard for bioreactors. A permanent standard would make it easier to implement bioreactors in additional states.

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[i] Iowa Nutrient Reduction Strategy. 2013.
[ii] Iowa Nutrient Reduction Strategy. 2013.

Senate Committee on Agriculture, Nutrition & Forestry
Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters
Wednesday, December 3, 2014 – 10:00am
328A Russell Senate Office Building
Chief Jason Weller

Chairwoman Debbie Stabenow

1. When discussing results and success stories for implementing conservation practices, often times the answer centers on participation numbers of producers, rather than measuring actual nutrient levels in receiving water bodies. Is NRCS currently compiling measurable data on the reduction of nutrient runoff due to various conservation activities? If so, for how many water bodies? If not, are there plans to monitor nutrient levels? Is it feasible to implement these measuring practices on a large scale?

Response: NRCS has not historically collected data on the reduction in nutrient runoff; however, the agency is exploring ways to better leverage data that will more directly demonstrate the effectiveness of conservation activities. In the absence of routinely gathered data on nutrient loss reduction, NRCS has been building capacity through its Conservation Effects Assessment Project (CEAP) effort to model the effects of conservation practices on nutrient and sediment loss reductions as well as other natural resource benefits of conservation systems. CEAP is a product of the NRCS National Resources Inventory (NRI) and the farmer survey methodology of USDA NASS. The table below illustrates the estimated benefits in terms of reduced losses of soil and nutrients from runoff to water bodies nationwide as a result of the conservation that exists on cultivated cropland at the time of the first CEAP survey. This is the sum of conservation impacts and includes conservation practices that were adopted through federal, state, and local financial assistance and technical assistance programs, as well as farmer self-adopted conservation actions.

2003-06 Estimated benefit of conservation practices in place as compared to a no conservation practice condition.

Resource Concern	Annual Reduction	% Annual Reduction
Sediment	278 million tons	53%
Subsurface Loss of Nitrogen	2.1 billion pounds	31%
Surface loss of Nitrogen	1.7 billion pounds	41%
Phosphorus	584 million pounds	44%

At specific farm-field levels, NRCS also has a monitoring practice that landowners may participate in through the Environmental Quality Incentives Program (EQIP). About 80 producers in 15 states throughout the country have engaged with NRCS to do edge of field monitoring in an effort to measure directly the effects of agricultural conservation systems upon sediment and nutrient runoff. These measurements are made at the edge of the farm field, not in the downstream receiving water body. Measuring nutrient losses from farm fields is cost-prohibitive on a large scale, but these measurements along with other scientific inputs will be used to further develop, calibrate and improve the accuracy of simulation models, which can provide reliable estimates at regional and national scales.

NRCS also partners with other agencies to develop metrics and measures to evaluate results, and to align in-stream monitoring with edge-of-field monitoring. For example, through the National Water Quality Monitoring Initiative, NRCS works with the Environmental Protection Agency (EPA) to identify high priority watersheds to target our conservation funding. The EPA then funds states through their 319 program to monitor in-stream water quality. Over time, the aligned monitoring helps us assess water quality improvements in the whole watershed.

2. In your testimony, you discuss the 4-R approach as one component of a system of conservation practices that "avoid, control, or trap" excess nutrients. Can you elaborate on how 4-R fits together with other best management practices? Is the 4-R approach alone sufficient to reduce nitrogen and phosphorous loadings in the western basin of Lake Erie and other bodies of water that suffer from algae blooms?

Response: The 4-R approach pertains to the application of the Conservation Practice Standard, Nutrient Management (590). The 4-Rs refer to the Right Source of nutrients, the Right Timing of the application of nutrients, the Right Placement/Method for applying nutrients, and the Right Rate of nutrient application. Together the 4-Rs reduce nutrient loss via ground and surface water. However, the application of the 4-Rs alone is generally not sufficient to reduce nitrogen and phosphorus loadings to water bodies such as Lake Erie. Additional, site-specific practices are often needed to reduce soil erosion, control surface water runoff, and improve subsurface drainage water quality in order to limit the transport of nitrogen and phosphorus.

3. Given our current state of knowledge, what are the specific suite of conservation practices, either in combination or together as a system, that are known to reduce phosphorous levels in the western Lake Erie basin?

Response: Conservation planners use a systems approach for developing conservation plans that employ a suite of practices to address water quality needs based on site-specific conditions. Typically it is a combination of 3 or more practices applied on a given field, but the combination varies depending on site conditions and operation factors. The following are conservation practices commonly used to reduce the losses of sediment or nutrients:

Practice Name (units)

Drainage Water Management Plan (No.)
Waste Storage Facility (No.)
Conservation Cover (Ac.)
Conservation Crop Rotation (Ac.)
Residue and Tillage Management, No Till (Ac.)
Contour Farming (Ac.)
Contour Buffer Strips (Ac.)
Cover Crop (Ac.)
Critical Area Planting (Ac.)
Residue and Tillage Management, Reduced Till (Ac.)

Diversion
Windbreak/Shelter Establishment (Ft.)
Field Border (Ac.)
Riparian Herbaceous Cover (Ac.)
Riparian Forest Buffer (Ac.)
Filter Strip (Ac.)
Grassed Waterway (Ac.)
Forage and Biomass Planting (Ac.)
Prescribed Grazing (Ac.)
Drainage Water Management (Ac.)
Heavy Use Area Protection (Ft.)
Nutrient Management (Ac.)

Tree and Shrub Establishment (Ac.)
Waste Utilization
Restoration and Management of Rare and Declining Habitats (Ac.)
Wetland Restoration (Ac.)
Wetland Creation (Ac.)
Wetland Enhancement (Ac.)
Denitrifying Bioreactor (Ac.)
Phosphorus Removal System (No.)

4. NRCS has made significant investments in conservation practices that target the Western Lake Erie Basin, including over $46 million since 2009. However, according to NRCS statistics only 7% of producers in the region participate in conservation programs compared to the national average of 14%. Why is participation so low and what is NRCS doing to encourage producers to sign-up for conservation practices?

Response: The proportion of producers participating in conservation programs may not provide a complete picture of the level of conservation on the landscape because of variations in farm size and operation types. The total acreage with conservation applied can give a more complete view of the impact of conservation programs on the ground. The table below shows National Resource Inventory data on the percent of cultivated cropland acres in the Western Lake Erie (WLE) basin with structural practices or conservation tillage controlling erosion. This includes conservation applied with the assistance of NRCS as well as that applied by landowners on their own or through other state or local programs.

While these data show adoption of some level of conservation on nearly all acres, this does not indicate the job of conservation is complete. Complete comprehensive conservation planning is required on these acres to meet the water quality demands of the WLE basin.

Year	Total Cultivated Acres (millions)	% Acres with structural practices controlling erosion	% Acres with conservation tillage	% Acres with structural practices and/or conservation tillage or conservation tillage
1997	4.97	4%	63%	64%
2000	4.96	8%	65%	67%
2001	4.88	9%	65%	68%
2002	4.84	10%	68%	71%
2003	4.83	11%	69%	72%
2004	4.9	18%	79%	83%
2005	4.88	18%	79%	83%
2006	4.86	17%	81%	85%
2007	4.85	18%	81%	85%
2008	4.88	21%	83%	87%
2009	4.83	21%	85%	90%
2010	4.87	21%	85%	89%

5. You mention in your testimony that the new Regional Conservation Partnership Program will provide NRCS new tools to protect and restore our nation's waters. What impact do you expect that this new partnerships model will have on key outcomes such as excess nutrients in places like the Great Lakes?

Response: The Regional Conservation Partnership Program (RCPP) provides opportunities for broader partnerships to target regional resource concerns, significantly leveraging the federal investment of time, talent and funds. The Great Lakes Region was one of the eight Critical Conservation Areas designated by the Secretary for focused funding under RCPP to address water quality concerns. Partners proposed locally led projects that demonstrated innovation and collaboration, leveraged additional resources for conservation, and emphasized results. With partners in the driver's seat in RCPP, local commitment will drive positive outcomes, including: improved water quality of drinking water sources, expanded wildlife habitat and avoidance of listing species as threatened or endangered, reduced runoff and flooding with increased groundwater recharge, and reduced use of irrigation waters for improved water quantity management.

6. Though the Conservation Reserve Program (CRP) is our nation's largest conservation program, it is administered by the Farm Service Agency (FSA). How does NRCS coordinate with FSA on CRP in terms of developing specific practice standards, educating and working with producers, and targeting continuous sign-up and CREP programs so that we see the most effective conservation benefits for the money?

Response: The Natural Resources Conservation Service (NRCS) coordinates with the Farm Service Agency (FSA), at the local, state and national levels, to provide technical and programmatic support for the Conservation Reserve Program (CRP). NRCS works with FSA in developing practice standards through our technical assistance role. These standards are often the same or very similar between CRP and NRCS—for example, the standards for installing a riparian buffer or the seed mix for pollinators should be the same whether land is enrolled in an NRCS conservation program or under a CRP contract.

NRCS conservation planners actively promote CRP and the Conservation Reserve Enhancement Program (CREP) as program options when working with producers, to address their resource concerns. NRCS has also partnered with the National Fish and Wildlife Foundation to target CRP technical assistance in high CRP workload areas, while leveraging non-federal dollars for conservation. In addition, NRCS entered into an agreement with the University of Wisconsin Extension to develop and administer CRP technical assistance training to non-NRCS resource professionals. The agreement provided NRCS with a cadre of welled trained CRP planners that could assist with CRP technical assistance as needed.

7. Does NRCS audit its conservation practice standards to determine whether some practices can be improved? Can any be improved to improve the conservation of water quality, for example nutrient management standards?

Response: NRCS has a comprehensive system to review and update each conservation practice at least once every five years. A team of technical experts reviews the standards, incorporates results from recent peer-reviewed research, and provides draft updates as needed. Revisions are reviewed by all state NRCS offices and published in the Federal Register for public comment. Comments are addressed as appropriate, and the final practice standard version is incorporated into the NRCS Field Office Technical Guide.

8. One policy question: Is it possible that NRCS could complete its interim standards for bioreactors and saturated buffers by the end of 2015? It's commendable that NRCS has begun this process for two very promising activities, but it's our understanding that FSA will not use CRP to help pay the cost of such practices until the standards are complete.

Response: The Interim Conservation Practice Standard (CPS) 747, Denitrifying Bioreactors has been available since 2009. NRCS has completed a draft of the practice standard that will be included in the next Federal Register notice requesting public comment. Once comments are received and addressed, Denitrifying Bioreactors will become a National Practice Standard in the Handbook of Conservation Practices, which the ageney anticipates will oecur in the summer of 2015.

The interim CPS 739, Vegetated Subsurface Drain Outlet was issued in 2013, and has since received technical reports of efficacy from three states. Important parameters, such as loading rates for discharge areas and the interaction of soil type and land slope, need to be refined prior to conversion of this Interim Standard into a National CPS. Request for public comment through the Federal Register is expected in FY 16, with acceptance as a National CPS in summer, 2016.

9. What CRP practices and incentive payments are available to producers to improve water quality? Please provide a breakout of the total dollars and acres, by state, that were funded through the Conservation Reserve Program that contribute to improved water quality from the years 2008 through 2014. Please distinguish between acres and dollars provided through general sign-up versus continuous sign-up and CREP.

Response: NRCS coordinates with the Farm Service Agency (FSA), at the local, state and national levels, to provide technical and programmatic support for the Conservation Reserve Program (CRP). NRCS works with FSA to develop appropriate practice standards through our technical assistance role.

As of September 30, 2014, there are about 25.5 million acres of land in the Conservation Reserve Program, all of which provide some level of water quality benefits. There are incentives for continuous signup practices with water quality as a primary objective, such as a contract signing payment of $100 to $150 per acre, an additional incentive of 40% of the practice costs, and an annual incentive of 20% of the annual rental payment (Table 1, attached). The Conservation Reserve Enhancement Program, an offshoot of the CRP, also provides various incentives depending on each agreement. Of the 45 CREP projects, 37 have water quality as their primary purpose.

Other CRP benefits include wildlife habitat, soil conservation, carbon sequestration, pollination services, and diminishing down-stream flood damage. There is no precise method to calculate costs and benefits of CRP acres; for example, practice requirements for filter strips and riparian buffers require vegetative cover types that also provide wildlife habitat benefits and other substantial environmental benefits as well. For water quality, FSA estimates benefits from all CRP acres as follows:

Water Quality Benefits of CRP: Sediment and Nutrient Reductions (that are not leaving field or are being intercepted by buffers)*

		2008	2009	2010	2011	2012	2013	2014	Total 2008-2014
Sediment	*million tons*	219	220	220	226	221	209	201	**1,516**
Nitrogen	*million lbs.*	616	611	607	623	605	565	542	**4,169**
Phosphorus	*million lbs.*	123	123	122	124	121	113	108	**834**

* Total reductions have declined since 2011, and are a reflection of the overall decline in enrollment, especially in general signup acres - see Table 4A.

Also provided is enrollment information on selected water quality practices (Table 2), a breakdown of the water quality component of the environmental benefits index (EBI) relative to the other EBI components used in general signups (Table 3), and overall CRP enrollment and rental payments by general, continuous non-CREP, and CREP (Tables 4 and 5). State tables are attached.

Table 1. CRP Practices and Payment Provisions

Practice		Sign-up Type	Annual Rental Pmt.	Signing Incentive Pmt.	Practice Incentive Pmt.
CP1	Introduced grasses and legumes	General	SRR*	No	No
CP2	Native grasses	General	SRR	No	No
CP3	Softwood trees (not longleaf pine)	General	SRR	No	No
CP3A	Hardwood trees	General	SRR	No	No
CP3A	Longleaf pines (see also CP36)	General	SRR	No	No
CP4	Permanent wildlife habitat	General	SRR	No	No
CP5	Field windbreaks	Continuous	SRR+20%	Yes	Yes
CP6	Diversions	General	SRR	No	No
CP7	Erosion control structures	General	SRR	No	No
CP8	Grass waterways	Continuous	SRR+20%	Yes	Yes
CP9	Shallow water areas for wildlife	Continuous	SRR	No	Yes
CP10	Existing grasses and legumes	General	SRR	No	No
CP11	Existing trees	General	SRR	No	No
CP12	Wildlife food plots	General	SRR	No	No
CP15	Contour grass strips	Continuous	SRR	No	Yes
CP16	Shelterbelts	Continuous	SRR	Yes	Yes
CP17	Living snow fences	Continuous	SRR	Yes	Yes
CP18	Salinity reducing vegetation	Continuous	SRR	No	Yes
CP21	Filter strips (grass)	Continuous	SRR+20%	Yes	Yes
CP22	Riparian buffers (trees)	Continuous	SRR+20%	Yes	Yes
CP23	Wetland restoration	General	SRR	No	No
CP23	Wetland restoration - flood plain	Continuous	SRR+20%	Yes	Yes
CP23A	Wetland Restoration - Non-flood plain and playas	Continuous	SRR+20%	Yes	Yes
CP24	Cross wind trap strips	Continuous	SRR	No	Yes
CP25	Rare and declining habitats	General	SRR	No	No
CP27	Farmable wetland (wetland)	Continuous	SRR+20%	Yes	Yes
CP28	Farmable wetland (upland)	Continuous	SRR+20%	Yes	Yes

Practice		Sign-up Type	Annual Rental Pmt.	Signing Incentive Pmt.	Practice Incentive Pmt.
CP29	Wildlife habitat buffer on marginal pasture	Continuous	SRR+20%	Yes	Yes
CP30	Wetland buffer on marginal pasture	Continuous	SRR+20%	Yes	Yes
CP31	Bottomland hardwood trees	Continuous	SRR+20%	Yes	Yes
CP32	Hardwood trees (previously expired contracts)	General	SRR	No	No
CP33	Upland bird habitat (quail) buffers	Continuous	SRR	Yes	Yes
CP36	Longleaf pine	Continuous	SRR	Yes	Yes
CP37	Duck Nesting Habitat (Prairie Pothole area)	Continuous	SRR+20%	Yes	Yes
CP38	State acres for wildlife enhancement	Continuous	SRR	Yes	Yes
CP39	Constructed Wetlands	Continuous	SRR+20%	Yes	Yes
CP40	Aquaculture Wetlands	Continuous	SRR+20%	Yes	Yes
CP41	Flooded Prairie Wetlands	Continuous	SRR+20%	Yes	Yes
CP42	Pollinator Habitat	General	SRR	No	No
CP42	Pollinator Habitat	Continuous	SRR	Yes	No
--	Wellhead protection areas	Continuous	SRR+10%	Yes	Yes

* SRR = Soil Rental Rate, which is based on an estimate of the county average dryland cropland cash rental rate adjusted for each individual soil's productivity.

TABLE 2. SELECTED CRP WATER QUALITY PRACTICES ENROLLED AS OF SEPTEMBER 30, 2014 (ACRES)

STATE	CONSERVATION BUFFERS	WETLAND RESTORATION
ALABAMA	34,460	1,036
ALASKA	208	438
ARIZONA	0	0
ARKANSAS	67,297	48,331
CALIFORNIA	13,247	5,290
COLORADO	1,325	1,363
CONNECTICUT	60	0
DELAWARE	1,269	695
FLORIDA	64	0
GEORGIA	1,889	566
HAWAII	152	0
IDAHO	9,064	1,479
ILLINOIS	253,218	59,332
INDIANA	66,524	14,496
IOWA	312,254	172,031
KANSAS	35,412	12,038
KENTUCKY	130,888	3,479
LOUISIANA	6,029	86,110
MAINE	267	12
MARYLAND	55,013	3,883
MASSACHUSETTS	15	0
MICHIGAN	50,230	22,899
MINNESOTA	206,725	376,321
MISSISSIPPI	173,762	28,954
MISSOURI	71,331	17,330
MONTANA	2,650	5,001
NEBRASKA	25,699	17,904
NEVADA	0	0
NEW HAMPSHIRE	60	0
NEW JERSEY	572	6
NEW MEXICO	5,280	0
NEW YORK	16,238	1,008
NORTH CAROLINA	37,475	4,341
NORTH DAKOTA	10,244	703,045
OHIO	84,918	10,461
OKLAHOMA	2,273	2,857
OREGON	48,647	501
PENNSYLVANIA	27,791	1,512
PUERTO RICO	1,678	0
RHODE ISLAND	28	0

STATE	CONSERVATION BUFFERS	WETLAND RESTORATION
SOUTH CAROLINA	31,218	1,927
SOUTH DAKOTA	19,701	418,145
TENNESSEE	15,868	3,753
TEXAS	36,934	9,887
UTAH	274	0
VERMONT	2,584	3
VIRGINIA	29,386	326
WASHINGTON	72,094	3,437
WEST VIRGINIA	4,901	0
WISCONSIN	43,878	13,104
WYOMING	6,714	0
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TOTAL	2,017,811	2,053,306

TABLE 3. ENVIRONMENT COMPONENT OF EBI SCORE (EEBI)*
GENERAL SIGNUP UNDER CONTRACT AS OF SEPTEMBER 30, 2014

STATE	WATER QUALITY TERM	OTHER EEBI TERMS	TOTAL EEBI SCORE	PERCENT WATER QUALITY
ALABAMA	46	144	190	24
ALASKA	48	168	216	22
ARKANSAS	62	130	192	32
CALIFORNIA	52	150	202	26
COLORADO	21	139	159	13
CONNECTICUT	66	130	195	34
DELAWARE	67	120	187	36
FLORIDA	68	119	186	36
GEORGIA	53	150	202	26
IDAHO	40	139	179	22
ILLINOIS	63	146	210	30
INDIANA	67	138	204	33
IOWA	54	174	227	24
KANSAS	46	136	182	25
KENTUCKY	66	169	235	28
LOUISIANA	55	141	196	28
MAINE	34	128	162	21
MARYLAND	72	131	203	35
MICHIGAN	71	112	183	39
MINNESOTA	52	147	198	26
MISSISSIPPI	59	134	193	31
MISSOURI	61	152	213	29
MONTANA	25	140	165	15
NEBRASKA	46	151	197	23
NEVADA	6	134	140	4
NEW JERSEY	75	138	212	35
NEW MEXICO	41	166	208	20
NEW YORK	61	126	187	33
NORTH CAROLINA	63	126	189	33
NORTH DAKOTA	39	125	164	24
OHIO	67	134	200	33
OKLAHOMA	50	128	178	28
OREGON	54	142	196	27
PENNSYLVANIA	66	142	208	32
PUERTO RICO	53	165	218	24
SOUTH CAROLINA	49	124	174	28

STATE	WATER QUALITY TERM	OTHER EEBI TERMS	TOTAL EEBI SCORE	PERCENT WATER QUALITY
SOUTH DAKOTA	42	121	163	26
TENNESSEE	60	141	201	30
TEXAS	37	139	176	21
UTAH	51	104	155	33
VERMONT	66	131	196	33
VIRGINIA	61	126	187	33
WASHINGTON	54	150	204	27
WEST VIRGINIA	55	135	189	29
WISCONSIN	57	146	203	28
WYOMING	20	121	141	14
	==========	==========	==========	==========
TOTAL	43	141	184	23

* WITHOUT COST

The environmental benefit index (EBI) includes 5 environmental terms and a cost term, and is sued to rank and select offers made during CRP's general signup.

TABLE 4A. ACRES OF CRP GENERAL SIGNUP UNDER CONTRACT AT THE END OF EACH FISCAL YEAR (SEPTEMBER 30)

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ALABAMA	402,247	370,732	347,180	309,096	273,885	257,891
ALASKA	25,841	25,177	18,431	18,404	17,414	17,399
ARIZONA	0	0	0	0	0	0
ARKANSAS	142,619	135,054	121,557	115,166	97,486	89,929
CALIFORNIA	109,350	107,225	104,008	90,157	82,139	79,525
COLORADO	2,386,172	1,980,858	2,190,232	2,125,807	2,012,219	1,929,421
CONNECTICUT	105	105	105	96	67	57
DELAWARE	1,332	778	799	741	634	428
FLORIDA	65,303	61,384	55,392	50,478	45,324	42,031
GEORGIA	270,201	245,193	226,900	218,689	209,118	202,231
HAWAII	0	0	0	0	0	0
IDAHO	724,928	679,186	606,985	566,100	503,646	485,696
ILLINOIS	595,394	569,807	570,821	554,236	520,875	441,372
INDIANA	173,387	165,049	162,380	153,449	137,043	104,975
IOWA	1,132,364	1,039,339	1,040,561	1,029,846	933,903	836,100
KANSAS	2,989,950	2,659,235	2,585,257	2,351,502	2,176,854	2,088,881
KENTUCKY	226,646	215,888	192,800	169,290	142,101	119,358
LOUISIANA	216,535	209,072	197,945	191,111	165,554	146,998
MAINE	19,190	18,066	15,467	11,146	6,775	6,241
MARYLAND	7,935	6,637	6,037	5,830	5,477	5,102
MASSACHUSETTS	30	0	0	0	0	0
MICHIGAN	150,319	139,493	132,701	125,242	111,931	78,865
MINNESOTA	1,281,017	1,212,312	1,177,517	1,080,956	898,798	796,064
MISSISSIPPI	696,643	663,392	636,648	603,383	542,106	517,681
MISSOURI	1,256,536	1,222,132	1,185,619	1,107,119	947,731	842,392
MONTANA	3,083,687	2,945,440	2,722,029	2,360,605	1,854,731	1,602,843
NEBRASKA	1,042,080	920,745	897,103	816,109	705,960	651,648
NEVADA	146	146	0	146	146	146
NEW HAMPSHIRE	0	0	0	0	0	0
NEW JERSEY	1,633	1,612	1,378	1,081	843	674
NEW MEXICO	561,250	536,527	448,107	406,440	403,310	408,766
NEW YORK	33,386	32,022	30,624	28,148	25,348	21,961
NORTH CAROLINA	70,920	65,671	60,159	54,358	49,119	44,913
NORTH DAKOTA	2,646,627	2,451,383	2,324,488	2,037,064	1,350,333	1,132,647
OHIO	188,062	177,823	168,577	160,107	143,557	99,986
OKLAHOMA	950,499	850,796	848,377	804,267	769,393	741,455
OREGON	512,893	498,960	499,085	493,490	490,954	496,391
PENNSYLVANIA	19,529	14,853	13,255	12,447	11,415	10,384

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
PUERTO RICO	341	365	345	345	195	341
RHODE ISLAND	0	0	0	0	0	0
SOUTH CAROLINA	147,733	129,672	112,317	97,416	77,637	72,946
SOUTH DAKOTA	999,684	805,596	758,663	671,568	495,437	405,460
TENNESSEE	199,935	190,126	175,505	160,461	147,599	119,906
TEXAS	3,794,317	3,247,144	3,357,858	3,223,201	3,094,459	3,018,651
UTAH	194,518	145,057	167,228	178,105	176,663	176,664
VERMONT	94	94	94	52	52	52
VIRGINIA	33,516	31,137	30,251	28,285	26,282	24,035
WASHINGTON	1,402,849	1,331,175	1,318,887	1,318,597	1,278,898	1,218,074
WEST VIRGINIA	732	612	611	509	413	325
WISCONSIN	391,052	359,142	328,047	297,334	247,592	187,324
WYOMING	264,133	201,793	217,038	196,577	178,971	180,753
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TOTAL	29,413,661	26,664,009	26,055,374	24,224,562	21,360,393	19,704,983

TABLE 4B. ACRES OF CRP CONTINUOUS NON-CREP UNDER CONTRACT AT THE END OF EACH FISCAL YEAR (SEPTEMBER 30)

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ALABAMA	43,606	46,781	49,431	51,188	50,866	49,881
ALASKA	646	646	606	578	578	578
ARIZONA	4	4	4	0	0	0
ARKANSAS	97,743	107,505	120,900	129,043	135,183	139,172
CALIFORNIA	14,181	14,156	13,462	6,799	2,397	2,030
COLORADO	12,086	19,428	26,630	27,996	32,153	33,470
CONNECTICUT	107	71	59	31	1	1
DELAWARE	446	401	367	307	143	122
FLORIDA	670	741	906	968	946	973
GEORGIA	64,030	76,008	92,820	98,616	100,846	102,822
HAWAII	19	19	19	19	19	19
IDAHO	12,952	19,954	40,484	65,507	93,879	101,662
ILLINOIS	314,612	326,657	336,599	335,610	327,239	338,014
INDIANA	112,817	116,933	117,208	119,347	117,963	125,677
IOWA	570,161	596,017	619,815	612,454	588,492	618,576
KANSAS	100,066	113,804	135,813	157,579	163,982	166,818
KENTUCKY	64,688	65,783	64,587	62,599	59,815	58,673
LOUISIANA	40,174	59,308	80,036	84,691	97,686	111,331
MAINE	2,509	2,486	2,451	2,408	2,376	2,364
MARYLAND	2,536	2,336	2,265	2,320	2,100	2,071
MASSACHUSE TTS	20	15	15	10	10	10
MICHIGAN	23,384	23,544	23,868	23,599	22,749	21,786
MINNESOTA	323,434	339,430	367,484	384,587	391,330	414,770
MISSISSIPPI	187,914	199,210	212,848	224,428	235,036	241,436
MISSOURI	124,230	130,672	136,607	138,052	140,025	160,484
MONTANA	108,000	120,952	120,762	120,412	123,342	141,022
NEBRASKA	91,381	100,629	102,330	106,616	110,650	124,791
NEVADA	0	0	0	0	0	0
NEW HAMPSHIRE	60	60	58	13	13	13
NEW JERSEY	201	280	517	665	680	690
NEW MEXICO	5,280	5,280	6,104	7,880	13,154	25,969
NEW YORK	8,987	9,051	9,357	9,323	8,866	8,741
NORTH CAROLINA	24,855	24,268	23,873	23,197	23,478	23,305
NORTH DAKOTA	204,407	266,572	321,772	348,565	428,954	485,054
OHIO	59,800	60,834	65,393	63,749	60,191	63,257
OKLAHOMA	8,344	9,337	9,308	14,161	14,507	14,860
OREGON	12,048	11,978	12,569	12,249	13,249	12,740

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
PENNSYLVANIA	1,087	982	948	822	701	608
PUERTO RICO	1,687	1,687	1,687	854	914	902
RHODE ISLAND	28	28	28	28	28	28
SOUTH CAROLINA	41,192	43,298	46,482	45,825	44,035	39,314
SOUTH DAKOTA	249,210	296,795	353,910	373,023	402,728	446,260
TENNESSEE	25,352	27,404	29,360	29,713	28,696	28,325
TEXAS	52,491	58,107	98,071	130,970	158,394	157,963
UTAH	288	292	292	335	313	255
VERMONT	336	298	288	283	267	257
VIRGINIA	3,991	4,174	4,256	4,331	4,126	3,865
WASHINGTON	99,387	101,013	126,458	157,113	162,245	164,097
WEST VIRGINIA	246	237	232	210	194	166
WISCONSIN	28,723	28,763	29,566	29,579	27,945	33,015
WYOMING	6,626	7,026	6,956	16,444	16,499	16,095
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TOTAL	3,147,046	3,441,257	3,815,864	4,025,097	4,209,983	4,484,330

TABLE 4C. ACRES OF CREP UNDER CONTRACT AT THE END OF EACH FISCAL YEAR (SEPTEMBER 30)

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ALABAMA	0	0	0	0	0	0
ALASKA	0	0	0	0	0	0
ARIZONA	0	0	0	0	0	0
ARKANSAS	6,614	6,904	6,964	6,957	6,924	6,957
CALIFORNIA	4,566	4,287	4,287	4,272	3,123	1,558
COLORADO	21,355	21,816	22,112	22,139	22,698	25,205
CONNECTICUT	0	0	0	0	0	0
DELAWARE	5,525	5,598	5,650	5,493	5,515	5,625
FLORIDA	0	0	0	0	0	0
GEORGIA	0	0	0	0	0	0
HAWAII	0	147	149	479	479	752
IDAHO	17,036	17,383	17,403	17,193	17,104	16,671
ILLINOIS	126,601	126,339	129,941	140,605	144,763	140,956
INDIANA	4,482	5,699	6,501	7,570	8,231	8,849
IOWA	1,394	1,808	1,975	2,128	2,617	2,842
KANSAS	8,164	10,104	11,016	13,807	15,100	15,770
KENTUCKY	98,505	100,960	100,767	100,364	98,788	98,868
LOUISIANA	49,792	49,763	49,386	49,622	49,263	50,062
MAINE	0	0	0	0	0	0
MARYLAND	70,320	70,636	70,755	70,613	67,455	62,962
MASSACHUSETTS	0	0	0	0	0	0
MICHIGAN	66,494	70,168	71,795	72,849	73,155	74,533
MINNESOTA	90,337	90,271	90,202	90,211	90,192	88,699
MISSISSIPPI	0	0	0	0	0	0
MISSOURI	39,581	39,275	38,469	37,614	36,932	36,781
MONTANA	10,663	10,757	10,784	11,444	11,484	11,099
NEBRASKA	70,655	71,411	71,981	71,200	70,838	67,263
NEVADA	0	0	0	0	0	0
NEW HAMPSHIRE	0	0	0	0	0	0
NEW JERSEY	595	623	679	699	698	722
NEW MEXICO	0	0	0	0	0	0
NEW YORK	12,027	12,566	12,939	13,187	13,353	13,906
NORTH CAROLINA	32,442	32,943	33,349	33,532	33,316	33,256
NORTH DAKOTA	1,672	1,708	1,704	1,616	1,623	1,616
OHIO	99,644	104,920	109,633	112,342	113,324	115,166
OKLAHOMA	133	239	471	542	578	624

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
OREGON	35,354	36,979	39,215	40,693	41,079	41,980
PENNSYLVANIA	202,006	205,765	205,907	192,281	174,027	163,675
PUERTO RICO	0	0	0	0	0	0
RHODE ISLAND	0	0	0	0	0	0
SOUTH CAROLINA	0	0	0	0	0	0
SOUTH DAKOTA	0	11,020	49,642	65,700	74,134	80,846
TENNESSEE	0	0	0	0	0	0
TEXAS	0	0	0	0	0	0
UTAH	0	0	0	0	0	0
VERMONT	2,038	2,310	2,438	2,492	2,508	2,574
VIRGINIA	26,977	27,697	28,492	28,555	28,401	28,242
WASHINGTON	11,802	12,263	12,617	12,912	13,373	13,553
WEST VIRGINIA	4,184	4,674	5,063	5,513	5,715	5,880
WISCONSIN	39,804	40,236	40,844	41,317	41,558	42,029
WYOMING	0	0	0	0	0	0
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TOTAL	1,160,765	1,197,272	1,253,132	1,275,941	1,268,352	1,259,523

TABLE 5A. RENTAL PAYMENTS FOR GENERAL SIGNUP ACREAGE ($1,000)

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ALABAMA	18,010	16,791	15,710	14,085	12,554	11,880
ALASKA	880	856	630	630	598	597
ARIZONA	0	0	0	0	0	0
ARKANSAS	6,319	6,023	5,810	5,679	5,370	5,191
CALIFORNIA	3,127	3,068	3,295	3,218	3,370	3,410
COLORADO	75,094	62,762	70,394	69,324	67,351	64,870
CONNECTICUT	6	7	7	6	5	4
DELAWARE	93	56	57	52	46	31
FLORIDA	2,545	2,399	2,212	2,075	1,949	1,890
GEORGIA	10,959	10,099	9,613	9,644	9,758	9,761
HAWAII	0	0	0	0	0	0
IDAHO	28,500	26,796	25,244	25,151	24,359	23,957
ILLINOIS	48,825	46,756	49,509	49,927	49,804	48,732
INDIANA	13,817	13,230	13,538	13,189	12,459	10,517
IOWA	111,580	103,656	111,992	114,158	113,343	108,136
KANSAS	115,691	103,394	101,105	92,683	86,678	84,941
KENTUCKY	15,981	15,222	14,562	13,506	12,342	11,437
LOUISIANA	10,019	9,734	9,365	9,174	8,294	7,511
MAINE	961	910	762	506	260	237
MARYLAND	561	476	441	430	412	394
MASSACHUSETTS	3	0	0	0	0	0
MICHIGAN	9,262	8,689	8,545	8,290	7,727	6,149
MINNESOTA	68,980	65,706	64,867	61,371	55,029	50,849
MISSISSIPPI	27,822	26,660	26,810	26,803	26,317	26,318
MISSOURI	84,494	82,346	84,190	84,733	84,452	81,634
MONTANA	100,604	95,159	87,250	75,017	57,819	48,820
NEBRASKA	54,004	49,092	48,551	44,910	40,240	38,094
NEVADA	2	2	0	1	1	1
NEW HAMPSHIRE	0	0	0	0	0	0
NEW JERSEY	69	69	59	44	34	28
NEW MEXICO	18,328	17,578	14,978	14,367	15,070	15,275
NEW YORK	1,392	1,332	1,282	1,192	1,092	965
NORTH CAROLINA	3,159	2,936	2,763	2,579	2,390	2,269
NORTH DAKOTA	87,614	81,156	78,270	69,755	47,882	40,858
OHIO	14,328	13,600	13,079	12,526	11,493	8,518
OKLAHOMA	31,219	27,989	28,367	27,089	26,369	25,385
OREGON	24,070	23,503	24,603	25,587	26,912	28,581

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
PENNSYLVANIA	902	706	636	602	558	511
PUERTO RICO	27	29	27	26	18	26
RHODE ISLAND	0	0	0	0	0	0
SOUTH CAROLINA	4,780	4,257	3,753	3,267	2,690	2,534
SOUTH DAKOTA	38,989	32,328	32,416	29,788	23,820	20,205
TENNESSEE	11,859	11,327	11,163	11,009	10,815	9,843
TEXAS	134,168	114,902	120,502	117,054	114,515	110,388
UTAH	5,900	4,452	5,178	5,732	5,903	5,916
VERMONT	6	6	6	4	4	4
VIRGINIA	1,388	1,302	1,261	1,191	1,119	1,021
WASHINGTON	73,369	70,399	70,680	71,141	70,173	67,857
WEST VIRGINIA	31	25	25	21	18	13
WISCONSIN	27,156	25,126	23,864	22,525	19,907	16,407
WYOMING	7,178	5,475	5,773	5,175	4,627	4,699
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TOTAL	1,294,072	1,188,387	1,193,144	1,145,234	1,065,940	1,006,664

TABLE 5B. RENTAL PAYMENTS FOR CONTINUOUS NON-CREP ACREAGE ($1,000)

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ALABAMA	2,206	2,357	2,488	2,570	2,553	2,510
ALASKA	43	43	41	39	39	38
ARIZONA	0	0	0	0	0	0
ARKANSAS	6,542	7,359	8,382	9,131	9,678	10,094
CALIFORNIA	867	865	821	448	190	154
COLORADO	503	802	1,078	1,129	1,285	1,331
CONNECTICUT	11	8	6	2	0	0
DELAWARE	35	32	29	25	12	11
FLORIDA	34	39	47	51	50	52
GEORGIA	3,578	4,313	5,422	5,784	5,936	6,105
HAWAII	2	2	2	2	2	2
IDAHO	690	991	1,920	3,219	4,668	5,097
ILLINOIS	42,436	45,243	48,247	49,976	50,465	54,836
INDIANA	14,900	15,820	16,320	17,314	17,743	19,609
IOWA	85,505	92,523	100,494	101,713	100,427	112,503
KANSAS	5,883	6,480	7,325	8,163	8,373	8,621
KENTUCKY	6,535	6,817	6,872	6,773	6,641	6,878
LOUISIANA	2,488	4,341	6,900	7,476	8,837	10,278
MAINE	174	172	168	165	163	162
MARYLAND	235	221	216	222	203	202
MASSACHUSETTS	3	3	3	2	2	2
MICHIGAN	2,303	2,345	2,382	2,374	2,326	2,288
MINNESOTA	29,543	31,684	35,058	36,951	39,297	43,595
MISSISSIPPI	11,797	12,761	14,098	15,436	16,705	17,779
MISSOURI	11,259	12,141	12,962	13,285	13,753	16,952
MONTANA	3,184	3,542	3,533	3,521	3,619	4,227
NEBRASKA	7,518	8,365	8,566	9,090	9,702	12,146
NEVADA	0	0	0	0	0	0
NEW HAMPSHIRE	3	3	3	1	1	1
NEW JERSEY	13	17	30	40	41	41
NEW MEXICO	223	223	262	341	563	971
NEW YORK	473	476	493	491	468	463
NORTH CAROLINA	1,654	1,627	1,639	1,603	1,643	1,640
NORTH DAKOTA	9,450	13,819	17,615	20,005	25,470	28,709
OHIO	6,533	6,724	7,330	7,220	6,903	7,511
OKLAHOMA	360	393	395	591	608	618

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
OREGON	719	724	764	743	810	777
PENNSYLVANIA	59	52	50	45	38	34
PUERTO RICO	103	103	103	53	57	56
RHODE ISLAND	2	2	2	2	2	2
SOUTH CAROLINA	2,143	2,232	2,344	2,303	2,167	1,946
SOUTH DAKOTA	18,405	22,733	27,711	29,838	32,818	38,414
TENNESSEE	2,158	2,361	2,595	2,653	2,564	2,579
TEXAS	1,997	2,244	4,028	5,524	6,441	6,426
UTAH	13	14	14	15	15	12
VERMONT	18	16	16	16	14	14
VIRGINIA	211	224	229	235	226	215
WASHINGTON	7,007	7,097	8,522	10,188	10,516	10,722
WEST VIRGINIA	12	11	11	10	10	8
WISCONSIN	2,832	2,881	3,000	3,046	2,935	4,147
WYOMING	300	318	314	550	543	530
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TOTAL	292,964	323,565	360,852	380,376	397,521	441,307

TABLE 5C. RENTAL PAYMENTS FOR CREP ACREAGE ($1,000)

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ALABAMA	0	0	0	0	0	0
ALASKA	0	0	0	0	0	0
ARIZONA	0	0	0	0	0	0
ARKANSAS	671	702	707	706	704	706
CALIFORNIA	546	500	500	498	358	175
COLORADO	2,360	2,403	2,430	2,421	2,488	2,891
CONNECTICUT	0	0	0	0	0	0
DELAWARE	647	656	664	651	654	669
FLORIDA	0	0	0	0	0	0
GEORGIA	0	0	0	0	0	0
HAWAII	0	8	8	24	24	37
IDAHO	2,263	2,309	2,311	2,283	2,271	2,213
ILLINOIS	20,430	20,390	21,352	24,166	25,321	26,569
INDIANA	885	1,162	1,355	1,591	1,746	1,909
IOWA	300	403	452	494	633	721
KANSAS	945	1,168	1,270	1,607	1,766	1,845
KENTUCKY	17,890	18,430	18,396	18,319	18,092	18,230
LOUISIANA	3,942	3,940	3,909	3,929	3,879	3,946
MAINE	0	0	0	0	0	0
MARYLAND	9,581	10,013	10,271	10,440	10,312	10,268
MASSACHUSETTS	0	0	0	0	0	0
MICHIGAN	8,356	8,940	9,234	9,406	9,518	9,807
MINNESOTA	10,362	10,353	10,346	10,348	10,344	10,179
MISSISSIPPI	0	0	0	0	0	0
MISSOURI	3,813	3,787	3,712	3,631	3,564	3,551
MONTANA	972	976	962	991	993	868
NEBRASKA	7,868	7,975	8,079	8,007	7,984	7,635
NEVADA	0	0	0	0	0	0
NEW HAMPSHIRE	0	0	0	0	0	0
NEW JERSEY	80	84	92	95	95	99
NEW MEXICO	0	0	0	0	0	0
NEW YORK	1,859	1,909	1,929	1,925	1,931	1,981
NORTH CAROLINA	3,550	3,618	3,669	3,692	3,665	3,662
NORTH DAKOTA	59	62	62	57	58	57
OHIO	18,328	19,536	20,664	21,290	21,510	22,065
OKLAHOMA	9	15	30	34	36	39
OREGON	2,955	3,123	3,344	3,492	3,537	3,643
PENNSYLVANIA	21,401	21,935	21,995	20,800	19,549	18,903

STATE	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
PUERTO RICO	0	0	0	0	0	0
RHODE ISLAND	0	0	0	0	0	0
SOUTH CAROLINA	0	0	0	0	0	0
SOUTH DAKOTA	0	1,052	5,225	6,896	7,735	8,658
TENNESSEE	0	0	0	0	0	0
TEXAS	0	0	0	0	0	0
UTAH	0	0	0	0	0	0
VERMONT	213	245	260	268	272	279
VIRGINIA	2,125	2,186	2,254	2,273	2,265	2,255
WASHINGTON	1,997	2,124	2,218	2,324	2,474	2,547
WEST VIRGINIA	324	364	399	432	449	471
WISCONSIN	4,747	4,849	5,006	5,128	5,207	5,317
WYOMING	0	0	0	0	0	0
	=========	=========	=========	=========	=========	=========
TOTAL	149,478	155,219	163,105	168,218	169,432	172,197

10. What NRCS specific practices and programs are available to producers to improve water quality? Can you provide a breakout of the total dollars and acres, by state, and by program, that were funded by NRCS that contribute to improved water quality from the years 2008 through 2014.

Response: Water quality improvements can be realized through a variety of NRCS programs, including Conservation Technical Assistance (CTA), the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), Wetlands Reserve Easements, and the Regional Conservation Partnership Program (RCPP). Conservation planners use a systems approach for developing conservation plans that employ a suite on practices to address water quality needs based on site-specific conditions. Typically it is a combination of 3 or more practices applied on a given field, but the combination varies depending on site conditions and operation factors (list of typical practices at Question 3). Since 2008, NRCS has provided nearly $3.5 billion in farm bill funding to assist producers in implementing conservation practices that can help address water quality concerns on over 700,000 acres of their lands.

11. Our nation's farmers are often bombarded with mixed messages, complex programs, and several options to manage their natural resources all coming from several sources including county, state, federal governments as well as the private sector and cooperative extension. With all the options and suite of conservation practices that producers can use to improve water quality what is NRCS doing or can NRCS do to improve education and outreach to producers so they are aware of the best practices to choose from.

Response: NRCS routinely conducts outreach to producers on conservation programs and opportunities through technical sessions, public meetings, and public notices, among other approaches to inform producers on the array of resources available to assist them with their operational and water quality objectives. Following the enactment of the 2014 Farm Bill, NRCS used a number of traditional and digital communications tools to share information on opportunities for assistance through Farm Bill programs, including a suite of Farm Bill webpages, brochures and other communications resources that were available in English (www.nrcs.usda.gov/FarmBill) and Spanish (www.nrcs.usda.gov/enespanol).

NRCS gave special focus to the new conservation compliance provisions to ensure those who receive crop insurance subsidies know the new requirements. NRCS worked with FSA and RMA to create outreach materials specifically for specialty crop producers, conducted interactive training through webinars, hosted specific outreach sessions, met multiple times with producer stakeholder groups, and sent direct producer letters with information about the new provisions.

One new resource for our customers included a *Get Started with NRCS* webpage and brochure (available in English and Spanish) and a video that walks customers and potential customers through how to get technical and financial assistance from NRCS.

The agency encouraged state, area and field offices to host outreach meetings, providing information to communities on assistance available through Farm Bill conservation programs. Meetings were especially prevalent in the 20 states in the StrikeForce for Rural Growth and Opportunity Initiative, where meetings were hosted in nearly all counties classified as persistently impoverished. These meetings provided historically underserved landowners with opportunities to learn about Farm Bill assistance.

In addition, for Fiscal Year (FY) 2015, NRCS, at the national level, is partnering with 12 community-based organizations, through cooperative partnership agreements, to assist new immigrant farmers, specialty crop farmers, and limited resource and socially-disadvantaged farmers and ranchers with technical assistance, on-site demonstrations, program awareness, inner-city urban agriculture, land loss prevention, and training opportunities. NRCS is also partnering with three tribal entities to conduct face-to-face educational meetings and workshops with tribes and their members, to further explain the 2014 Farm Bill programs.

Senator Patrick Leahy

1. Payment Limits & edge of field monitoring. Vermonters are increasingly demanding to know that the dollars being spent on conservation measures are going to where there will be the greatest improvement in water quality. We also know that the EPA will require much greater accountability when it issues the new phosphorus rule for Lake Champlain. Unfortunately there is very little data from which we can estimate the effect of even the most standard practices, such as cover crops. The NRCS in Vermont is doing great work to try to quantify the conservation benefits of various practices through an initiative started by your predecessor Chief White. Your staff and conservation partners have been able to demonstrate the environmental benefits of specific practice implementation through this "edge of field" monitoring of runoff in paired

watersheds studies that will be able to document nutrient reduction value of specific on-farm practices. This monitoring is leading to increased farmer willingness to take on the risk of new ideas or conservation practices and enable conservation partners and farmers to fine tune various practices.

But there are significant costs to get the results of a full five year study of edge of field monitoring. There is the installation of costly monitoring equipment and ongoing site maintenance, data collection, and analysis costs every year. Those costs can easily reach as high as nearly $150,000 in Vermont since our winter maintenance costs can run higher, although I understand that your national payment rates often only cover $110,000. I raise these figures, Chief Weller, because those payments for this edge of field monitoring, basically an on-farm research project that in the long run is going to help you at NRCS better understand where and how to implement these conservation practices, those payments count against the farmers USDA payment limits for conservation payments, specifically EQIP. So if we have a farmer who is participating in this monitoring he is handcuffed when it comes to completing other conservation practices on the farm. This simply is not right. That a farmer's work to help USDA better use these practices, in the end will limit that farmers ability to implement voluntary conservation projects on his farm and their ability to achieve meaningful water quality improvements where they are greatly needed. This must be addressed.
My question for you Chief Weller, is this, will the NRCS classify the Edge of Field Water Quality Installation (202) and Edge of Field Water Quality Monitoring and Evaluation (201) in a way that allows all of the work to be competed without impacting the farmers payment limitations to carry out other conservation practices on his or her farm?

<u>Response</u>: The Edge of Field Water Quality Installation (202) and Edge of Field Water Quality Monitoring and Evaluation (201) practices are currently being implemented through EQIP contracts with producers. Because this is a financially assisted EQIP practice, the payments must by statute and regulation count toward a producer's payment limitation. While many producers are willing to do so for the benefits that monitoring activities provide, the Agency recognizes that it may affect the ability of producers to access financial assistance for other conservation practices.

NRCS is exploring other monitoring opportunities to reduce the impact of the practice cost on producer payment limitations. For example, implementing edge of field monitoring activities through contribution agreements with local partners. NRCS is also expanding partnerships with agencies with monitoring and research missions in order to increase the availability of edge of field monitoring for interested producers implementing conservation practices where performance information would be most important. For example, in the Great Lakes basin, NRCS is working closely with USGS to identify locations where farmers would be interested in cooperating to install edge of field water quality monitoring stations; the resulting data will benefit the producers as well as both agencies. In addition, the Regional Conservation Partnership Program may offer another opportunity for NRCS to encourage more partners to leverage the cost of water quality monitoring and reduce or eliminate the cost to farmers.

Edge of field water quality monitoring and evaluation is an expensive and time-intensive activity that requires a long-term commitment from all involved (landowners, scientists, and partnering agencies and organizations). To be effective, monitoring needs to be conducted over a number of years in the context of a targeted plan for building data and information to further our understanding about the efficacy of conservation practices. NRCS has a long history of working within established partnerships to address natural resource challenges and is committed to the use of edge of field water quality monitoring and evaluation in locations and site conditions where evidence and data are needed to demonstrate results.

2. Increasing Use of Tile drainage

Chief Weller, you mentioned in your testimony the work by NRCS on best management for areas of the country that are heavily tiled and the importance of finding ways for crops to access the valuable nutrients when they need them and not just having the tile system carry them downstream. In recent years we have seen a growing interest in Vermont from farmers that want to install tile drainage to help them to better lower groundwater levels quickly in the spring so they can get access to their fields. With new inexpensive technology becoming more readily available we are seeing miles of new tile being installed in Vermont each year. Although the state of Vermont has no official records to quantify these installations, it has mostly been anecdotal as we see the giant equipment rolling through town. As we work so hard on reducing agricultural water quality impacts in Vermont we know very little about the water quality outcomes of this massive change to drainage patterns on landscape. However, we have seen research from the Midwest that has said that tiled farm fields are often the largest contributors of nitrate and phosphorus pollution to rivers, lakes and streams. I am very concerned that this rush by farmers to install new tile in Vermont will result in extremely high levels of dissolved phosphorus making its way to our waterways.

Will the NRCS be able to help the state of Vermont to undertake further monitoring of existing tile drainage systems in Vermont to assess their impact on water quality? Will the NRCS consider funding conservation practices that may reduce nutrient levels in the discharge from tile drains?

Response: NRCS allows use of financial assistance for edge-of-field monitoring activities to monitor surface runoff from farm fields and from tile outlets draining those fields. To date, NRCS has seen greater interest from producers wanting to employ edge-of-field surface runoff monitoring than tile drain monitoring. NRCS will continue to offer these monitoring practices in tile drainage situations in Vermont and across our nation.

NRCS currently has multiple practices that can be employed to "avoid, control and trap" nutrients in a systems approach to reduce nutrient levels in the discharge from tile drains. One of the most important conservation practices is Nutrient Management, which aims to optimize nutrient recovery by the crop. Control of nutrient losses can be assisted with practices such as Cover Crops, the planting of grasses, legumes, and forbs for seasonal vegetative cover to absorb soil nutrients when cash crops are unavailable to do such. Off-site measures such as Riparian Forest Buffers and Created Wetlands are practices that can trap nutrients that have made it out of the field and through the tile drain system. These and other practices are available for producer use while NRCS continues to evaluate new conservation technologies. In Vermont, NRCS is currently evaluating a Phosphorus Removal System conservation practice that could be located at the end of a tile drain, and in Ohio and Indiana, NRCS is beginning to use gypsum as a soil amendment for its potential to bind with phosphorus. NRCS plans to have this technology available nationwide beginning in 2016.

3. FPP-ALE concerned about dramatic reduction in farmland conservation - Even before I worked in the 1996 Farm Bill to create the Farmland Protection Program, which was based off of Vermont's own Farms for the Future Program, I have been a strong supporter of conserving farmland. FPP was a very important USDA farm program, it was in fact our only federal program focused solely on preserving farmland in this country. I should add that according to USDA's own research and the National Resources Inventory we know that in the 25-year period between 1982 and 2007, over 23 million acres of America's agricultural land were lost to development. Even more alarming is that our most fertile and productive land was developed at a disproportionately higher rate.

From a water quality perspective this is deeply concerning because our well-managed agricultural lands supply important services for our environment by providing food and cover for wildlife, help control flooding, protecting wetlands and watersheds, and maintaining air quality. These farmlands not only absorb and filter wastewater but they also provide important groundwater recharge. This is why our farmland conservation programs must be a top priority.

In the 2014 Farm Bill we combined the three separate easement programs into a single program, Agricultural Conservation Easement Program (ACEP), with two different branches, one for wetland easements and the other for Agricultural Lands Easements (ALE). I was very concerned when the funding allocations for Fiscal Year 2014 were released and we saw such a dramatic drop in the funding available for our working lands preservation through ALE. This is the only federal program available to preserve important working agricultural lands that are under severe threat to development, but we do have other resources available to help conserve wetlands. I hope that you will commit to working with me to find a more equitable balance of the funds for ACEP.

Will you agree to follow up with my staff about the process for Fiscal Year 2015 and finding a suitable balance between the funds available for Agricultural Lands Easements and Wetlands?

Can you also assure me that your new rules for ACEP, and how NRCS works with states like Vermont and conservation partners, will allow for the much needed flexibility that states require in order to implement ALE and work with farmers on the ground?

Lastly, I am was greatly concerned when I learned recently that NRCS may move to rank all easement projects nationally, wetlands and working lands, together in a single list. I am troubled that the Department would try to compare what is "apples to oranges" actually more like "apples to asteroids" because these easements have such different goals and needs. I hope you will reconsider this proposal so that the two types of easements are not compared in that way.

Response: Funding for the Agricultural Conservation Easement Program (ACEP) established by the 2014 Farm Bill is less than one-half of that previously available under the Wetlands Reserve Program (WRP), the Grassland Reserve Program (GRP), and the Farm and Ranch Lands

Protection Program (FRPP), the repealed programs. NRCS is implementing this program to respond to demand on an annual basis and is not establishing a funding split between the Agricultural Lands Easements and Wetlands Reserve Easements over the life of the Farm Bill. We anticipate that the funding proportion will fluctuate reflecting partner demand and the dynamic nature of agricultural lands.

In 2014, a total of approximately 90,000 acres of farm and ranch lands were protected through new ACEP-Agricultural Land Easement (ALE) enrollments, and 55,000 acres of wetlands were restored and protected through new ACEP-Wetlands Reserve Easement enrollments. While the reduced funding resulted in reduced enrollments across the entire program compared to its predecessors, in FY 2014 ACEP-ALE enrollment was 46 percent of the historic average acres under FRPP/GRP, while ACEP-WRE enrollment was 31 percent of the historic average acres under WRP. NRCS worked diligently to provide an equitable allocation of acres and funds across states and will continue to do so in FY 2015.

NRCS recognizes the importance of balancing consistency and flexibility in ACEP, and worked closely with stakeholders to ensure that perspectives were heard. Throughout FY 2014, NRCS participated in numerous listening sessions, meetings, conference calls, and other fora with partners and interested landowners in regard to the transition from FRPP to ACEP-ALE. NRCS has incorporated the feedback received into the draft regulations and associated policy in an effort to improve the efficiency and equitability of ACEP-ALE program delivery. NRCS will also be requesting input on the regulations through the public comment process when the interim final regulations are published in the Federal Register.

Lastly, NRCS is not making any move to rank all easement projects nationally and did not do so in FY2014. The ranking and selection of individual projects is and will continue to be conducted at the State level.

Senator Amy Klobuchar

1. No one has done more work to plan for the types of projects supported by the Regional Conservation Partnership Program (RCPP) than producers and stakeholders in the Red River Valley. What sort of considerations have USDA and NRCS made during the application process to work with early actors to ensure that their well-planned and high-quality projects are reflected in the final announcement? When can we expect those final announcements to be made?

Response: The Natural Resources Conservation Service (NRCS) review of the applications identified that a variety of partners are poised to utilize the Regional Conservation Partnership Program (RCPP). Partners with early interest and new partners both submitted excellent, well-planned proposals, and NRCS did not provide priority upon proposals based simply upon early interest. NRCS staff held over 65 small group sessions, four large public sessions, two webinars, and web page updates to provide information to applicants. NRCS conducted an intensive technical and programmatic evaluation of full proposals for potential funding. Final awards were announced in January 2015.

2. For producers in the Red River Valley, water retention and flood mitigation are especially important. We crafted RCPP to expand eligibility to include water quality and quantity issues specifically to allow local landowners to address, through USDA conservation programs, the consistent flooding they experience. The Farm Bill authorized mandatory funding of $100 million annually through FY2018 for RCPP. Are these investments in line with producer demand? Has the number of worthwhile proposals significantly outstripped total funding?

Response: The Natural Resources Conservation Service (NRCS) announced the availability of Regional Conservation Partnership Program (RCPP) funding in May 2014. Final full proposals were received from 210 applicants, with funding requests that exceeded $1.3 billion; over 4 times the available funding. In January 2015, 115 proposals were identified for award of the available $372 million in RCPP funding, with partner contributions estimated at nearly $400 million.

Senator Michael Bennet

1. Can you please speak about the importance of the EQIP program to improving irrigation efficiency in the arid West? Can you give us a few examples of success stories using EQIP from that region of the country?

Response: On-farm irrigation efficiency--the share of applied water that is beneficially used by the crop--has increased in recent decades. These water-use efficiency gains provide not only farm-level benefits through production gains and more efficient water use, but also contribute to off-farm benefits, such as improved fish and wildlife habitat. The efficiency of irrigation systems is particularly important in the arid western States. In these States, over half of the farms receiving public assistance for irrigation investments made use of the Environmental Quality Incentives Program (EQIP). Since the 2008 Farm Bill, The Natural Resources Conservation Service (NRCS) has invested over $540 million in contracts with producers to improve irrigation efficiency on over 4.1 million in the western region of the United States.

Success Stories Using EQIP to Address Irrigation Efficiency:

- California – Water savings/Conservation Planning. In California's Central Valley, conserving irrigation water is priority number one. With the help of NRCS programs and a conservation plan that almond grower Sacramento Aguilar developed in 2010, Aguilar cut his irrigation usage from seven acre feet to three acre feet. With micro-irrigation and cover crop plantings between rows through the Environmental Quality Incentives Program (EQIP), his 13-acre property can be considered a model of conservation in California's Central Valley. In addition, Aguilar's cover crop seed mix included phacelia and common vetch to attract pollinators to the property. Considering pollinators are essential to almond production, adding cover crops was an easy decision to make.

- California –Water savings/Conservation Planning. For Simon Sihota, an almond and wine grape grower in Fresno County, conservation is the key ingredient to ensuring a productive farming season especially during drought conditions. Sihota converted a majority of his 500 acres from flood irrigation to a mix of micro irrigation and drip with the help of NRCS. Moisture sensors were installed to provide more accurate data on when to apply water and how much water is really needed. Sihota participated in the NRCS EQIP, over a period of three years, to complete the work. Since the conversion, he not only saved 50 percent of his typical water use but he is also able to now use off-peak water rates, pay approximately 20 percent less in energy costs when running his irrigation pumps, fight fewer weeds in his planting rows and has cut down on his fertilizer use.

- Kansas – Ogallala Aquifer Initiative (OAI) - Loving Farms is owned and operated by Marty Loving of Pawnee Rock, Kansas. He had been concerned about the efficiency of his flood irrigation systems for several years; his combine, equipped with a yield monitor, was showing him 220 bushels per acre corn on the top end of the field and 140 bushels per acre corn on the bottom end of the field. In 2011, Marty began working with NRCS to use EQIP assistance to install Sub-Surface Drip Irrigation (SDI) on 80 acres of flood-irrigated land. After the installation of the SDI system, Marty now sees a consistent 220 bushels per acre reading on his yield monitor throughout the 80-acre field. The water savings has proved to be tremendous; his average water use was 18.6 acre inches (ac/in) per year with flood irrigation and now with SDI, he averages 10.5 ac/in water use per year. This is a savings of 17,595,792 gallons of water per year. In 2012, Loving replaced another 65 acres of flood irrigation with SDI. Previously, he used 16.1 ac/in of water per year. Now he uses 10 ac/in per year. His corn yield increased from an average of 180 bushels per acre using flood irrigation to 240 bushels per acre using SDI. His electricity usage has decreased 30-40 percent on both new SDI systems due to less pumping time and variable frequency drives installed on the electric motors. With SDI, Marty can deliver enough water to his crop to keep up with its daily water use, even during peak water use days in the summer. He can get irrigation water to every acre in these fields every day, whereas with flood irrigation, it took him 10 days to get water on every acre. SDI has proven to be at least 93 percent efficient with water use.

2. We've seen a lot of enthusiasm for the Regional Conservation Partnerships Program (RCPP) in Colorado. As you know, quite a bit of our state was designated as a Critical Conservation Area (CCA) under the program because we're a water-stressed region of the country facing regulatory challenges. As you also know, our water is vital in Colorado. We are the headwaters state, delivering water downstream to 19 other states and Mexico. Can you talk about where USDA is in the process for making awards under the RCPP?

Response: The Natural Resources Conservation Service (NRCS) announced the availability of Regional Conservation Partnership Program (RCPP) funding in May 2014. Final full proposals were received from 210 applicants, with funding requests that exceeded $1.3 billion; over 4 times the available funding. In January 2015, 115 proposals were identified for award of the available $372 million in RCPP funding, with partner contributions estimated at nearly $400 million. NRCS is in the process of finalizing agreements with partners currently.

3. The application of the Endangered Species Act (ESA) has become a top-of-mind issue for a lot of people in Colorado. And let me say for the record that I'm a strong supporter of the ESA. It's a statute that's protected a lot of the wildlife that make the West such a special place

to live. We've appreciated NRCS' efforts to facilitate habitat conservation for the Greater sage grouse. Can you discuss the Agency's ongoing work in this arena in light of the certainty brought about by a 5-year Farm Bill?

Response: Through the Working Lands for Wildlife partnership, NRCS and the USFWS developed a creative approach to incentivize voluntary conservation, by addressing landowner concerns about regulation under the Endangered Species Act (ESA). Using traditional ESA tools (Conference Reports/Opinions and Biological Opinions), USFWS provided an "expanded" duration of regulatory coverage (exemption for incidental "take" of a species) that lasts for up to 30 years for implementation of select conservation practices. This approach was formalized in 2012 through an exchange of letters between former NRCS Chief Dave White and USFWS Director Dan Ashe. With the certainty provided by the 5-yr farm bill, NRCS is looking at additional opportunities to provide a commitment to voluntary wildlife conservation for the next 5 years, with the specific goal of resolving the threats for the identified Working Lands for Wildlife priority species.

4. From recent conversations with NRCS, we understand that the rules and the policy manual governing the Agricultural Land Easements (ALE) program will not be available until March or April, when 2015 project selection will already be underway. Since the ALE program was specifically designed with partner organizations to implement the work on the ground, can NRCS share the draft policy manual and segments of the rule that are of primary concern to the programs' partners? We think that a small group of program participants could review these and provide feedback that will ensure that the program runs smoothly going forward.

Response: NRCS greatly encouraged input into its policy deliberations and engaged stakeholders in several listening sessions and other venues to gain input. The agency also has welcomed feedback on the policy used in FY 2014 from interest groups. In December 2014, the Office of Management and Budget (OMB) held a listening session to obtain stakeholder input into the rulemaking process, and these views also will be considered in the finalization of the ACEP rule. Additionally, the interim ACEP rule will include a request for comments. ACEP project selection will not occur until after the interim regulations and new ACEP policy are published, so that partners will have ample opportunity to review the rule and provide additional comments.

5. We are deeply concerned about the much smaller ALE program allocations in 2014 and what we are warned may be coming in 2015. These allocations are lower than we had seen in previous years under the FRPP Program. We understand that the new ACEP program has less funding overall than in the previous Farm Bill and that there were effects from sequestration, but two additional components of the 2014 funding allocations are of concern.

First, it appears that through new allocations to "Program Implementation costs" and NRCS Technical Assistance, that one third of all funding allocated to the program is not making it to landowners for on the ground conservation. Instead, we fear that this went to NRCS overhead and administrative expenses, something that did not occur under the FRPP program. Why is so much money being spent internally and not reaching the ground as intended?

Second, when we took a look at the 2014 allocation, almost 80% of those funds are going to the Wetlands program and related Technical Assistance within NRCS. This is much different than the historic 60/40 split of funds between Wetlands and the FRPP program. Does NRCS plan to even out funding between the two program components in order to be closer to the 60/40 split over the life of the 2014 Farm Bill?

Response: Shared costs (program implementation costs) cover the infrastructure, equipment, and administrative components necessary to deliver conservation programs. In FY2014, the contribution methodology for the shared costs was adjusted to ensure that all programs that depend on those shared services contribute appropriately, including ACEP. While WRP had previously contributed to these shared costs, fiscal year (FY 2014) was the first year that the Agricultural Land Easements (ALE) (FRPP and GRP) contributed. The contribution to shared costs for ACEP is calculated across the technical assistance (TA) available for the entire program, not by program component. The proportion of ACEP funds going to TA is about 31 percent. While about 10 percent ACEP funds are going to shared costs, this investment is what makes it possible to deliver the program to partners and the public.

The historic split between WRP and FRPP/GRP was 73 percent and 27 percent respectively. The average annual funding available under the new ACEP program will be approximately $368 million annually, about 47 percent of the amount previously available under the repealed programs. In FY2014, the ACEP funding split was approximately 66 percent ACEP-WRE and 34 percent ACEP-ALE. While the reduced funding resulted in reduced enrollments across the entire program compared to its predecessors, in FY2014, ACEP-ALE enrollments were 46 percent of the historic average acres under FRPP/GRP while ACEP-WRE enrollments were 31 percent of the historic average acres under WRP. Similarly, ACEP-ALE received a larger relative proportion of funds than historically were received under the predecessor programs. NRCS is implementing ACEP to respond to demand on an annual basis and is not establishing a funding split between the Agricultural Lands Easements and Wetlands Reserve Easements over the life of the Farm Bill. We anticipate that the funding proportion will fluctuate reflecting partner demand and the dynamic nature of agricultural lands.

Senator Joe Donnelly

1. There are a great number of Hoosier farmers who have been implementing conservation practices like cover crops on their farms, and one of the complaints that I have heard from producers is that frequently different USDA agencies and services, like NRCS, FSA, or RMA, may have different policies regarding cover crop management and termination policies. I suspect that making farmers navigate that extra layer of bureaucracy can be a disincentive to implementing this conservation practice.

Can you commit to me that you will work with your peers within USDA to ensure that we have harmonized policies for practices like cover crops?

Response: NRCS, RMA, and FSA have all worked together to develop NRCS Cover Crop Guidelines that address producers' concerns, while still providing them the flexibility they need for their specific growing conditions. The same three agencies and several partners have worked together to update the NRCS Cover Crop Guidelines three times over the last 3 years, primarily to address the unique challenges faced in the drier climates of the U.S. We will continue collaborate and to remain responsive to issues and opportunities for improvement.

Senator Thad Cochran

1. Your testimony covered many of the voluntary partnerships and initiatives currently carried out through USDA's Natural Resource Conservation Service (NRCS) that offer financial incentives to producers for implementing best management practices on their operations resulting in positive environmental outcomes for water quality. How do the Farm Service Agency (FSA) conservation programs, including the Conservation Reserve Enhancement Program (CREP) contribute to these partnerships and initiatives for water quality? Please provide some examples.

Response: Although CREP is administered at the state level while NRCS's landscape conservation initiatives are developed to be regional in nature, there are examples of the alignment of CREP with initiatives. In the Oklahoma portion of the Illinois River Sub-basin and Eucha-Spavinaw Lake Initiative (a two-state effort with Arkansas), for example, NRCS's work built on existing efforts to protect riparian areas through both CREP and a 319 riparian program. All partnering agencies in the area conducted outreach to educate producers on opportunities to improve water quality through both in-field and edge-of-field practices. Because the participating programs—CREP, 319, and EQIP—have different requirements and offer different management activities, producers have several options to address water quality run-off from their fields. The combined efforts of these programs are achieving results, with significant declines in bacteria in several water bodies within the watershed. For example, the Oklahoma Conservation Commission identified a 41 percent reduction in expected instantaneous *E. coli* loading in Flint Creek in their Illinois River Watershed Implementation Report as a result of agricultural conservation efforts.

2. In June, NRCS announced that $5 million was available in financial assistance through the Environmental Quality Incentives Program (EQIP) for the Mississippi Water Conservation Management Project. There has been significant producer interest in this announcement throughout the Mississippi Delta. When should producers expect to be notified of selection and when should producers expect to receive contract awards?

Response: In early June 2014, Mississippi NRCS announced the Mississippi Water Conservation Management Project with the application period ending on June 30, 2014. There was significant interest in the project and Mississippi NRCS started pre-approving applications in August 2014, with pre-approval notification letters being sent during the months of August and early September. All funds were obligated by the end of September.

Mississippi Water Conservation Management Project (MWCMP) for 2014:

	Applied	Enrolled
Applications/Contracts	1,422	415
Acres	196,373.7	84,030.6
Funds Requested	$7,081,661	$4,851,567

3. The Conservation title of the 2014 Farm Bill underwent a significant overhaul with the consolidation of several programs with common goals and purposes. With the creation of the new Regional Conservation Partnership Program (RCPP), which has the primary goal of addressing water quality and quantity issues, what is NRCS's plan moving forward with landscape initiatives that typically have been delivered through programs like EQIP and other conservation programs? In subsequent years, which initiatives should we expect to see continued investment in? What programmatic investments and plans does NRCS have for the Lower Mississippi River Valley to deal with environmental and natural resource priorities like water quality?

Response: Landscape conservation initiatives enhance the locally led process to better address regionally important conservation goals across boundaries. Through landscape initiatives, NRCS is able to coordinate its conservation program implementation efforts with other potential efforts in the region. Since establishing the initiatives under the 2008 Farm Bill, NRCS has used successes and lessons learned to enhance the delivery of landscape conservation initiatives. With tools like the Regional Conservation Partnership Program, the 2014 Farm Bill further emphasizes the focus on building effective partnerships and obtaining meaningful results for key natural resource concerns.

NRCS will continue to work with partners to improve outcomes through landscape conservation initiatives. For FY 2015, NRCS intends to continue implementation of the following named initiatives through dedicated EQIP, CSP, and/or ACEP funding: Bay Delta Initiative, Driftless Area Conservation Initiative, Great Lakes Restoration Initiative, Gulf of Mexico Initiative, Illinois River/Eucha-Spavinaw Watershed Initiative, Mississippi River Basin Healthy Watersheds Initiative, National Water Quality Initiative, Ogallala Aquifer Initiative, Red River Basin Initiative, Lesser Prairie Chicken Initiative, Sage Grouse Initiative, and Longleaf Pine Initiative. These initiatives are partner- and results-driven, and, based on annual reviews and existing initiative plans, NRCS intends to continue many of the initiatives if there is significant partner interest and progress in achieving results. Mississippi partners have and continue to be very active in initiatives, particularly the Mississippi River Basin Healthy Watersheds and Gulf of Mexico Initiatives. Going forward, as some initiatives are closed out, NRCS may invest in new ones as partner interest and regional need is demonstrated. At the same time, NRCS limits overall investment in these targeted efforts in order to maintain broadly available program funding.

4. Some States have passed legislation or entered into MOUs with Federal and state agencies to adopt regulatory certainty programs. Under these programs, a producer or landowner receives regulatory assurances from future regulations if he or she agrees to implement best management practices. What is USDA's role in these types of existing relationships or agreements to date? Has USDA led any efforts to promote this type of approach for water quality through any program grants or pilots? Are there currently any interagency discussions for advancing this type of approach for regulatory certainty?

Response: States are pursuing a range of approaches, collectively referred to by USDA as Certainty programs, to incentivize the voluntary adoption of systems of conservation practices to achieve specific environmental objectives, such as water quality improvements. These programs, also called "certification" or "assurance" programs, recognize producers for meeting a baseline level of natural resource stewardship.

USDA does not lead the development or administration of State Certainty programs, but has supported States in two major ways:

- Providing technical assistance and consultation to States and stakeholders interested in developing programs
- Prioritizing financial and technical assistance for producers participating in Certainty programs, consistent with USDA authorities.

USDA has worked with States at varying stages of developing and implementing Certainty programs. In some cases, the Department has simply provided information and served as an advisor to States exploring the concept. In other instances, USDA has played a more visible role. For example, in January 2012, Secretary Vilsack signed an MOU demonstrating USDA's support for the State of Minnesota's work in developing a Water Quality Certification Program. NRCS subsequently has provided dedicated EQIP financial assistance to producers participating in the program pilot.

In 2012, an NRCS Conservation Innovation Grant (CIG) was awarded to the Maryland Department of Agriculture to support development of the State's Agricultural Certainty Program. Regulations for the program were published in October 2014. NRCS Maryland has developed EQIP ranking criteria to prioritize participants in this Certainty program once it is made available to producers.

5. The Agriculture IR took effect upon publication last spring with the opportunity for the public to provide comments. That comment period closed on July 7, 2014. How many comments did USDA receive on the interpretive rule? Was USDA involved with other Federal agencies in reviewing these comments? If no, why not? Was there any discussion or consideration about how to address the comments through an amendment or withdrawal of the rule? The FY15 Omnibus spending package includes language directing the U.S. Environmental Protection Agency and the U.S. Department of the Army Corps to withdraw the agricultural interpretative rule. In the event of the passage of the FY15 omnibus spending package, please provide a detailed explanation of what steps the agency will take in order to accomplish the congressional directive? How long will it take the agency to do this?

Response: The U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) published the Interpretive Rule (IR) in April 2014 with the intent to clarify exemptions for certain agricultural conservation practices that might be implemented in waters subject to the jurisdiction of the Clean Water Act. Because the IR is under the jurisdiction of EPA, the U.S. Department of Agriculture (USDA) was not a party receiving or reviewing comments received through that public process. On December 16, 2014, President Obama signed the Consolidated and Further Continuing Appropriations Act, 2015, which instructs the EPA and the Department of the Army to withdraw the agencies' interpretive rule. Consistent with the statutory directive, the EPA and the Army have withdrawn the interpretive rule.

6. In the Memorandum of Understanding (MOU) between USDA, the Army Corps, and EPA related to the Agriculture Interpretive Rule, there is specific reference that NRCS is using statutory authority under the Soil Conservation and Domestic Allotment Act in order to enter into the MOU. Please provide an explanation of why and how NRCS used this authority to enter into the MOU. Please provide a detailed breakdown of the resources USDA considered using to implement the MOU by program account that would be used to fund these activities?

Response: The Natural Resources Conservation Service (NRCS) enters into Memoranda of Understanding (MOUs) with many different partners in order to accomplish its mission. The Agency's organic legislation, the Soil Conservation and Domestic Allotment Act provides the Secretary with broad authority to cooperate or enter agreements to leverage resources and accelerate opportunities to preserve soil, water, and related resources and promote soil and water quality, among other purposes. See 16 U.S.C. 590a(3). This authority was used as the basis for NRCS' role in the MOU because the Agency was cooperating with EPA and USACE with the goal of accelerating opportunities for producers to conserve soil, water, and related resources. NRCS' activities under the MOU were limited to coordination with EPA and USACE to discuss appropriate changes to the list of conservation practice standards exempt from permitting at a frequency agreed upon by the agencies. With the withdrawal of the IR, there are no expenses to report for such a coordination activity.

Senate Committee on Agriculture, Nutrition & Forestry
Farmers and Fresh Water: Voluntary Conservation to Protect our Land and Waters
Wednesday, December 3, 2014 – 10:00am
328A Russell Senate Office Building
The Fertilizer Institute

Chairwoman Debbie Stabenow

1. This industry-lead initiative around 4-Rs is commendable. Can you describe more about the goals of 4-R and the methods of outreach being used? Does the Fertilizer Institute have goals for the number of producers that it can reach in key watersheds?

   - The goals of the fertilizer industry's 4R efforts are to 1) promote the 4Rs as a recognizable strategy for the economic, social and environmental elements of sustainability; 2) expand the implementation of the 4Rs by agricultural service providers on the farm; and 3) increase awareness of efforts to boost adoption of the 4Rs among the general public and policymakers worldwide.

   - TFI has not set specific goals related to the number of producers we can reach within key watersheds. While producers will certainly be a key to successful implementation of the 4R's, we currently leverage our education and outreach efforts through partnerships with local and state organizations and other key agricultural service providers. For example, we currently have over 100 4R Partners who help provide outreach on the 4Rs. In many cases, their contribution to outreach and education is the message they provide to their grower customers. Current 4R Partners include a wide range of entities including state agribusiness associations, fertilizer and agribusiness companies, conservation organizations, equipment and technology providers and analytical laboratories to name a few. To view the list of partners, please visit the following website. http://www.nutrientstewardship.com/partners

   - TFI is currently in the process of developing metrics for use in evaluating industry efforts to enable implementation of 4R nutrient stewardship.

2. What impacts have you seen in water quality as a result of producers implementing the 4R program? What tools are available to measure the efficacy of the 4-R for a given watershed?

   - Improved water quality and nutrient loss reduction is one of the key goals of the 4R program. Because the 4R's are a relatively new program, the industry is currently undertaking efforts to better understand the impacts of 4R implementation on water quality. Significant research efforts are needed to better understand the effect of fertilizer best management practices on nutrient loss reduction. In 2013, the industry established a 4R Research Fund (http://www.nutrientstewardship.com/funding), funded with contributions from the fertilizer industry, to assist in evaluating the economic, social and environmental impacts of 4R nutrient stewardship. In 2014, we awarded 5 meta-analysis projects to evaluate past research and literature related to 4R practices and 4 research and demonstration projects to evaluate known information gaps. Additionally, state efforts like Illinois's "Keep it for the Crop" (http://illinoiscbmp.org/KIC%202025/) effort are leading the way to better understand the impact of the 4Rs locally. In IL, the agricultural industry increased a fertilizer tonnage tax on itself to raise funds for research. Their research efforts are currently underway. However, the gap in knowledge around the impact of specific practices is great because there are many complex factors tied to the results. Complete data sets are spatially and temporally complex because of variables by geography and time based on soil, weather, cropping system, management, etc.

- TFI is also working with the International Plant Nutrition Institute (IPNI) to develop metrics for evaluation of 4R efforts within a given watershed or region.

3. Is your trade association or members currently measuring results in any watershed and if so are you compiling the data that you collect?

- There are some aggregated efforts are underway to collect 4R practice implementation data in specific watersheds to understand what practices are being implemented. For example, the 4R Research Fund has awarded funding for a project to "Evaluate the 4R Nutrient Stewardship Concept and Certification Program in the Western Lake Erie Basin (WLEB)." The goal of the project is to evaluate the specific impacts of the adoption of practices associated with 4R Nutrient Stewardship, and the impact of the WLEB 4R Certification Program itself, on crop productivity and profitability, water quality, and perceptions of growers, nutrient service providers, and residents in the WLEB.

  A longer term goal is to be able to relate those implemented practices to water quality impacts through current research efforts.