Building the Biocarbon Economy: How the Northwest Can Lead

Re-grounding Agriculture: Restoring the Soil

Farm practices to build soil carbon, fertility and moisture while cutting fuel and fertilizer costs

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ADVANCING CLIMATE-FRIENDLY FARMING

From the Willamette Valley to the Columbia and Snake River Basins to the high plains of Montana, the Northwest possesses some of the nation's most productive agricultural areas. **To regional mainstays such as potatoes, wheat and dairy, pioneering farmers and researchers envision adding new ecosystem services products that reduce greenhouse gas emissions and concentrations**.

One indication of regional potentials came in a report from the Agriculture Sector Carbon Market Workgroup, a group created by the Washington Legislature. In 2008 the group reported that state agricultural lands could sequester 6.96 million metric tons of carbon dioxide and equivalents ($MTCO_2e$) yearly. The estimate based on available data was described as conservative and covered only the most promising potentials.[1]

Many Northwest farmers are being economically driven to practices that save soils, improve water use, and reduce inputs of costly fertilizers, fuels and chemicals, all subject to volatile price swings over recent years. These new practices build soil health and fertility while soaking carbon at the same time.

Though some areas of the Northwest still retain a rich soil endowment despite generations of loss, other areas are reaching critical thresholds for loss of soil fertility.

"We've been really hard on our soils for a long time," says Chad Kruger, one of the lead scientists at Washington State University's Climate-Friendly Farming Project. . **The long-term consequence is increased input costs**. "A lot of producers are looking at how all these issues are packaged together. It starts with soil management."

[1] *Recommendations for the Development of Agricultural Sector Carbon Offsets in Washington State*, Agriculture Sector Carbon Market Workgroup, October 2008, p.4

David Sjoding, a WSU Energy Extension Program agriculture and biomass expert, quotes an Eastern Washington wheat grower. **"I've been mining the carbon out of my soil for 40 years. I used to get 100 bushels to the acre. Now I get 60."**

"There is a ferment going on, driven by the shock of the price of nitrogen fertilizer and diesel a couple of years back," Sjoding says. **"We're coming up on an opportunity to totally overhaul how we do agriculture in the Northwest.** If we do it right it is a very big deal, and incredibly helpful in the carbon sequestration side of the equation."

The Climate-Friendly Farming Project (CFF) is one of the nation's most ambitious efforts to understand the connection between agriculture and climate change. The project has three practical goals: reduce farming greenhouse gas (GHG) emissions, improve carbon sequestration, and replace fossil fuels with farm-based products. The project's national leadership was recognized in October 2009 with a USDA Cooperative State Research, Extension and Education (now the National Institutes for Food and Agriculture) Partnership Award for Innovative Program Models.

Kicked off in 2003 with $3.75 million in research funding from the Paul G. Allen Family Foundation, the project has since drawn around $11 million from other sources. This has given the region a strong base on which to mount larger biocarbon efforts in agriculture. Thus this briefing focuses heavily on the project's work and findings.

Agriculture is a major climate player – a significant source of GHGs including CO_2, methane and nitrogen. The Intergovernmental Panel on Climate Change says direct agriculture emissions account for 10-12 percent of human GHG releases. Taking into account other emissions, including fuel use, production of chemicals and fertilizers, and carbon released by opening new cropland, agricultural emissions can reach 26-35 percent of total human GHGs, the World Bank calculates.[2] So opportunities to GHGs in agriculture are huge.

CFF has developed the most comprehensive information to date on Northwest farm GHGs for key regions and crops including dryland wheat and irrigated potatoes. The project has modeled the results of different tillage systems in rainfed and irrigated regions. The project also supported development of Washington state's first commercial dairy manure biodigester, a critical contribution in a state and region with a major dairy industry.

The WSU research team overviewed a number of carbon-reducing practices and technologies and found several ready for use now or in the near future:

- **Conservation tillage**
- **Precision agriculture**
- **Improved cropping systems**
- **Anaerobic digestion**

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[2] *Climate-Friendly Farming Project Summary, ,* CSANR Research Report 2010-001, Washington State University, p.1

The first three will be covered below. Because anaerobic digestion is a biomass processing technology it will be covered in the *Recycling Carbon* briefing.

CONSERVATION TILLAGE: ACCUMULATING SOIL CARBON

Soils hold an estimated 2,250-2,500 billion metric tons of carbon, more than three times the amount in the atmosphere. Converting natural lands to agriculture has released between 40 and 100 billion metric tons. Recapturing that carbon with adoption of farm practices that sequester carbon in soils would remove the equivalent of 29-47 parts per million (ppm) CO_2 from the atmosphere.[3]

Conservation tillage is widely viewed as one of the most promising carbon soaking and reducing strategies. The practice is based on the general rule that the less soils are disturbed, the more carbon builds up in their surface layers. Conservation tillage (CT) either reduces or replaces tillage that turns over soils by directly planting seeds in soils. These practices are respectively known as reduced tillage and no-till. **By one estimate, converting all U.S. cropland to no-till could soak 47 million $MTCO_2e$ annually**.[4]

"Tillage-intensive agriculture of the past century has caused severe soil erosion and has depleted more than 50 percent of the native soil carbon in the dryland grain cropping region of the PNW (Pacific Northwest)," CFF notes. "Conservation tillage . . . reverses this trend; it reduces direct emissions of CO2 from decreased on-farm fuel use, reduces *direct* emissions of CO_2 to the atmosphere caused by oxidation of soil carbon, and can increase carbon accumulation in soils . . . While our drier climate leads us to expect more modest potential for sequestering soil C (carbon) than reported for the U.S. Midwest, widespread deployment of conservation tillage to protect the region's fragile soil resource (and the remaining C sink) is still an essential goal for future sustainability." [5]

"Many GHG emissions management strategies provide significant environmental and/or economic benefits to farmers, which will encourage their adoption," CFF notes.[6]

The prime drivers moving farmers toward CT are reduced erosion, improved water retention and lower costs. CT builds organic matter in and on farm soils, soaking water like a sponge and protecting soil from winds. Cutting tractor passes from the usual seven or more to four or less reduces fuel use 50-80 percent and labor 30-50 percent. Encouraged by USDA conservation programs, no-till adoption grew more than three

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[3] T.T. Brown and Huggins, D.R., "Dryland Agriculture's Impact on Soil Carbon Sequestration in the Pacific Northwest, " CSANR Research Report 2010-001, Washington State University, Ch. 14, p.4; 1 part per million = 2.12 billion metric tons from James Hansen, *Storms of My Grandchildren: The Truth About the Coming Climate Catastrophe and Our Last Chance to Save Humanity*, Bloomsbury USA, New York, 2009 p.117

[4] T.T. Brown, p.5

[5] *Climate-Friendly Farming Executive Summary*, Washington State University "CSANR Research Report 2010-001

[6] *Climate-Friendly Farming Project Summary,* p.14

times from 1990-2004 to 22 percent of U.S. cropland. This and CT in general had much to do with a 43 percent reduction in wind- and water-caused erosion of U.S. cropland from 1988-2003.[7]

"I don't think within 20 to 25 years there will be a whole lot of conventional tillage systems here (in the Northwest) due to factors such as fuel costs," Chad Kruger says. "Farmers are going to have to makes changes in order to stay in business. No-till has become more and more successful as time goes on, enabling them to mange more acres. If we can do something to shift the switch to five to 10 years, which I think is realistic, we can gain 15 years head start with the carbon."

CT provides ecosystem services beyond carbon. Reducing erosion improves air and water quality, while keeping residues on soils improves nesting conditions for birds. An Iowa study found 12 species living in no-till lands -- four times more than those conventionally farmed.[8] This is a prime illustration of a practice change enhancing several different ecosystem services at once, underscoring a key understanding needed to advance CT in the Northwest. **The practices that accumulate carbon serve other vital ends, so policies and economic tools to drive CT will be most effective when they recognize and reward multiple benefits**.

Means to support ecosystem services provided by agricultural lands, including USDA conservation programs, are covered in the *Working Lands Toolbox* briefing.

NORTHWEST CONSERVATION TILLAGE PERFORMANCE

CFF modeled soil and residue carbon accumulations at four eastern Washington locations, one irrigated and three dryland with varying annual precipitation. Over a 12-year period, CT improved sequestration in all locations – no-till more than reduced tillage. Results covered a wide span from near zero to 0.33 $MTCO_2e$/acre/year. Results averaged 0.22 for no-till and 0.07 for reduced tillage.[9] At that rate, converting one million dryland acres to no-till would absorb about 700,000 $MTCO_2e$ annually.[10] Dryland farming covers approximately nine million acres in Oregon, Washington and Idaho.[11]

Though these figures are substantial, they tend toward the lower bound of estimates for U.S. farm soil carbon accumulation. So **per-ton carbon payments alone are not likely to provide incentives for a shift.** In three of the four modeled locations, credits of $67-$123 per acre would be required, CFF estimates, adding these levels are "unlikely to

[7] Huggins and Reganold

[8] David R. Huggins and Reganold, John P, "No-Till: the Quiet Revolution," *Scientific American*, July 2008., p.70-77

[9] K. Painter, "An Economic Analysis of the Potential for Carbon Credits to Improve Profitability of Conservation Tillage Systems Across Washington State," Washington State University, CSANR Research Report 2010-001, Chapter 24, p.16

[10] *Recommendations for the Development of Agricultural Sector Carbon Offsets in Washington State*, Agriculture Sector Carbon Market Workgroup, October 2008, p.37

[11] T.T. Brown, p.1

occur in near future."[12] But crediting a fuller range of ecosystem services benefits could tip the balance. For example, USDA estimates that off-site erosion damages inflict costs of $37.6 billion on the nation annually.[13]

Widely varying modeling results carry two important messages about CT.

First, notes CFF, ". . . **not all research reports carbon benefits for all forms of conservation tillage**."[14] In some low-rainfall areas reduced tillage along with other cropping and fertilizer strategies can make more sense. They are covered below in a section on other climate-friendly farming practices.

Second, **high variability in soil carbon levels "makes it difficult to develop reliable carbon sequestration data for carbon markets,"[15]** CFF says. This points to the importance of continued research to develop better databases by soil, climate and cropping.

Another key insight is that **soil reaches a new carbon equilibrium**. The first 5-10 years of no-till yield the top carbon performance. Soils reach stable carbon levels after 20-50 years. Some studies show no-till sequesters carbon in top layers while regular tillage pushes carbon deeper. Other studies suggest that no-till with intermittent light tilling buries surface carbon and resets the surface accumulation process.

"Basically the situation in many continuous no-till scenarios, particularly when starting with degraded soils, is that carbon is stratified at the soil surface over time, not tilled in as with plowing," explains David Huggins, a USDA Agriculture Research Service soil scientist. "This can result in greater carbon in surface three to six inches or so, but sometimes less from six to 10 inches as this depth is not receiving as much carbon input as with tillage. Periodic tillage, once every 5-10 years, may lead to greater soil carbon storage as this transports carbon-rich material to deeper depths and starts the accumulation at the surface over again."[16]

An important no-till angle is pesticide use.

"No-till can, in some cases, result in an increase in the total amount of herbicide used over conventional, though not necessarily, particularly during the transition phase," Chad Kruger notes. "But the more important questions than the total amount of chemicals used are the eco-toxicity, fate and transport of chemicals used in no-till versus conventional tillage. Existing data indicates that **the total toxicity of chemicals used in conventional production systems may be higher** due to the type of chemicals used even though less total product is used. Also, **chemicals used in a no-till system are far**

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[12] K. Painter, p.19
[13] *Climate-Friendly Farming Project Summary*, p.19
[14] *Climate-Friendly Farming Project Summary*, p. 6
[15] *Climate-Friendly Farming Project Summary*, p. 27
[16] T.J. Purakayastha; Huggins, D.R..; Smith, J.L., "Carbon Sequestration in Native Prairie, Perennial Grass, No-Till, and Cultivates Palouse Silt Loam," *Soil & Water Management and Conservation*, Vol.72, (2), March-April 2008, p.534-40

more likely to stay where they are sprayed rather than run-off due to the fact that soil erosion is dramatically reduced."

Research indicates that the more advanced a cropping system is, the more likely it is that total herbicide use can be reduced, Kruger adds.

ADVANCING NO-TILL IN THE NORTHWEST

Northwest land grant colleges and growers associations have long worked collaboratively to advance no-till in the Northwest. In 1975, they came together as ***STEEP, Solutions To Environmental and Economic Problems***, to form "an innovative interdisciplinary research/education program focusing on developing profitable cropping systems technologies for controlling cropland soil erosion and protecting environmental quality." Joining in the effort were Oregon State University, University of Idaho, Washington State University, USDA-Agricultural Research Service, and the wheat growers associations of the three states. STEEP continues to refine conservation tillage for the Northwest and educate farmers in best practices.[17]

The first contract for farm soil carbon accumulation in North America, and one of the world's first, came to Northwest no-till farmers in 2002. A voluntary offset was purchased by southern utility Entergy from the Pacific Northwest Direct Seed Association. The utility paid $75,000 to soak 30,000 tons of CO_2 into 6,470 acres owned by 77 grower members of PNDSA.[18] That translated into 0.15 tons of carbon per acre each year over 10 years, delivering to farmers modest returns of around $1.10 per acre after administrative fees were deducted.[19]

"It isn't the money," a PNDSA presentation wryly noted.[20] Instead, the association's goal was to build a base of knowledge on the carbon performance of no-till farming in the interior Northwest. With this farmers could potentially find larger and more profitable markets for farm soil carbon accumulations.

"The carbon sequestration of no-till will someday have value," notes Russ Zenner, founding president of PNDSA.

Though the Northwest pioneered the no-till carbon market, adoption rates are actually lower than the national average. Among reasons given are costs of buying needed equipment – a no-till seed drill can cost $100,000 – and the challenges of a steep learning curve. No-till represents a sharp break with conventional practices. The Northwest saw no-till failures in the 1980s and '90s because a need for altered crop

[17] http://pnwsteep.wsu.edu/ viewed June 15, 2010
[18] PNDSA Soil Carbon Sequestration Lease History, http://www.directseed.org/carbonhistory.html#carbonhistory viewed April 23, 2010
[19] Carbon Sequestration Fact Sheet: PNDSA and Entergy, Pacific Northwest Direct Seed Association, Sept. 12, 2002
[20] Ibid

rotations was not understood as it is today. Farmers also have concerns about yield loss despite significant research and experience that indicates it can be overcome.

A CFF analysis shows that no-till is already more profitable in the Palouse around Pullman, increasing annual per acre profits by $5 to $37 for a winter-wheat-spring barley-pea rotation. But no-till adoption is still relatively low, indicating that simple profitability does not alone drive adoption.

"Farmers may be resistant to change from something that has proven profitable," CFF says. "These rich deep soils appeared to be endlessly fertile, but estimations of soil erosion suggest that the region has lost about 35-45 percent of its topsoil from erosion over the years."[21]

In other dryland areas with different conditions CFF finds a profitability gap of $13-15/acre/year between conventional- and no-till, assuming equal yields, largely due to greater herbicide costs. But 10 percent yield gains bring no-till nearly even with conventional tillage. "This result is not implausible, as **large yield increases have been achieved under NT** in the ongoing Direct Seed Mentoring project, in which direct seed farmers plant land for conventional farmers who are interested in no-till systems."[22] The mentoring project, run by Spokane Conservation District, University of Idaho and WSU Extension, demonstrated 50 percent higher spring wheat yields due to moisture retention.[23]

Such **mentoring efforts are one of the keys to unlock no-till potential**. Successfully employed in the Midwest, they join experienced no-till farmers with those using conventional tillage. The no-tiller generally plants several hundred acres on the conventional farmer's land, whose direct costs are limited to supplies.

Bill Warren, a Columbia County, Washington no-tiller, notes that conservation districts and county extension services have played a crucial role driving very high adoption rates in his county and Wasco County, Oregon. "It comes down to the people to pioneers and leadership." **Once farmers understand no-till advantages they will "never look back."**

"No-till spreads neighbor to neighbor," says David Brown, soil scientist and terrestrial lead for Big Sky Sequestration Partnership.

Pioneering farmers "are very important to show success and share experience with neighbors," Zenner says.

[21] *Climate-Friendly Farming Project Summary,* p. 20
[22] *Climate-Friendly Farming Project Summary,* p. 19
[23] K. Painter, p.3

MANAGING CARBON INPUTS

Conservation tillage prevents soil carbon releases. Taking active steps to reduce carbon losses and add carbon to the soil through changed cropping and land management practices is a natural complement. In many cases these practices can actually generate more carbon accumulation than changes in tillage. A number of land management practices that lock carbon in soils are covered in this section.

Adding organic amendments to the soil

Organic amendments including barnyard manures, compost and biochar also have potential to cut fossil fuel-based fertilizer inputs and have been shown to dramatically increase soil carbon sequestration. In one Northwest dryland farming location where municipal biosolids from waste treatment plants have been applied for 14 years, carbon has accumulated at rates as high as 1.4 $MTCO_2e$/acre/year. That compares to an 0.1 $MTCO_2e$/acre/year rate for conservation tillage at a similar location. So, in fact, organic amendments could become even more important that tillage changes for accumulating biocarbon.

Biosolids have long been applied to Northwest farms on a commercial basis. They improve soil quality, cut costs for fossil-fuel-based fertilizers, and reduce public waste disposal costs. Fossil fertilizers represent significant GHG emissions, as will be discussed in the nitrogen use efficiency section below. So reducing fertilizers with crops or amendments is a double-win for climate. WSU researchers are exploring other new organic crop amendments beyond biosolids. The huge potential to generate organic amendments from biomass streams is covered in the *Bioeconomy* briefing.

Rotating "green-manure" crops

Nitrogen-fixing crops such as alfalfa and sweetclover provide a cover crop benefit and reduce use of fertilizers. Though some studied cases show a carbon loss of as much as 1.79 $MTCO_2e$/acre/year, most results are positive, ranging up to 1.60 $MTCO_2e$/acre/year. "Rotations that include green manures, as compared with rotations that did not include a green manure crop, generally shows increases in SOC (soil organic carbon). . ." in the eastern Palouse, CFF reports.[24]

Reducing field burning

Some farmers burn fields to manage crop residues. Besides raising air pollution concerns this practice also releases soil carbon. Studies show Northwest farm losses ranging from 0.25-1.22 $MTCO_2e$/acre/year.[25] "Burning generally accelerates SOC (soil organic carbon) losses beyond that from cropland management practices that did not use burning for

[24] T.T. Brown, p.26
[25] T.T. Brown, p.45

residue management," CFF finds.[26] Systems which leave residues in place, such as no-till, or forms of CT which harrow residues into the soil, provide superior performance.

Replacing fallow with cover crops

Leaving fields fallow exposes soils to oxidation. Studies show Northwest fallow carbon losses range from 0.13-1.01 $MTCO_2e$/acre/year.[27] Cover crops protect the soil and legume cover crops can be a source of fertility. Oilseed crops such as camelina, canola and mustard provide additional benefits by adding a crop rotation and supplying biofuels feedstocks. At the same time, biofuel markets can provide an incentive to add this agronomically valuable rotation that does not exist now.

Growing perennial crops

Crops which grow year to year reduce soil disturbances to a minimum. Many Northwest farmers operate mixed perennial-annual systems using crops such as wheatgrass and alfalfa to restore soil fertility. CFF conservatively estimates such systems add an average of 0.82 $MTCO_2e$/acre/year in the eastern Palouse region [28] A full perennial switchgrass system field tested by USDA Agricultural Research Service in the irrigated Columbia Basin found carbon increases of 1.6 $MTCO_2e$/acre/year.[29] Demonstrating higher productivity than in other regions, Northwest switchgrass is a potential bioenergy crop.

Active grazing management

Continuous livestock grazing which turns animals loose over large pastures tends to erode soils and trample grasses. Active grazing management is a set of practices that rotate livestock around more frequently in order to reduce impacts on any one plot of turf. Pastures divided by fences are subjected to short, high-intensity grazing and then allowed to recover, maximizing plant growth and carbon storage in roots. Introducing active management on grazing lands could add 0.3-.0.7 $MTCO_2e$/acre/year. Washington Department of Natural Resources leased grazing lands hold potential to sequester 2.3 million $MTCO_2e$/year.[30]

IMPROVING NITROGEN USE EFFICIENCY

CFF cautions that **practices which bring new carbon to the soil involve inputs such as fertilizer which have the potential to wipe out the carbon benefits**. "Further evaluation of the life-cycle impacts of such practices is needed in order to more fully understand their impact on net GHG emissions."[31]

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[26] T.T. Brown, p.25
[27] T.T. Brown, p. 44-45
[28] *Climate-Friendly Farming Project Summary,* p.13
[29] *Climate-Friendly Farming Project Summary*, p.32
[30] Ibid
[31] *Climate-Friendly Farming Executive Summary,* p.2

Carbon gains could be cancelled by one practice alone, overuse of nitrogen fertilizers. They release nitrous oxide, N_20. Commonly known as "laughing gas," and used as a dental anesthetic before more sophisticated drugs, N_2O impacts on the atmosphere are no joke. Each pound of N_2O is the equal of 296 pounds of CO_2 in terms of its potential to warm the atmosphere. So small reductions in N_2O have a big climate impact.

U.S. N_2O emissions come mostly from the farm sector. In 2008 U.S. N_2O emissions were 300 million $MTCO_2e$. The agriculture share was 218 – 76 percent was from nitrogen fertilizer and 24 percent from animal waste. Since 1990, farm N_2O emissions have grown nine percent.[32]

No-till and reduced tillage release approximately the same N_2O as conventional tillage – around 0.1-0.2 $MTCO_2e$/acre/year – as far as can be measured by current technology.[33] But the shift to no-till offers a prime opportunity to implement a series of agricultural practices known as precision farming. GPS-based soils mapping and sensors tailor timing and amount of fertilizer applications to specific crop needs and conditions. **Precision nitrogen management increases efficiency and minimizes leakage into the atmosphere and waterways** where overabundance of nutrients endangers fish.

CFF conducted the first rigorous field tests of precision nitrogen application on Northwest dryland wheat. **Scientists found 18 percent reduction possible on winter wheat crops without impacts on yield or protein content**.[34]

Precisely managing irrigation water applications through techniques such as drip irrigation and center-pivot irrigation also controls N_2O emissions. These allow cuts in nitrogen application, while controlling moisture reduces emissions from fertilizers that are applied.

AGRICULTURAL RESEARCH NEEDS

Though this briefing has focused heavily on WSU's Climate Friendly Farming Project, other **Northwest universities also have significant agricultural research programs in related areas**. For example:

- **Oregon State University** is the western regional center coordinating nine states for Sun Grant, a national partnership focused on advanced bioenergy and bioproducts.
- **University of Idaho** is researching rotational oilseed crops such as canola and mustard that improve soil conditions while providing biofuel feedstocks.
- **Montana State University** research on camelina has generated a new industry focused on sustainable biofuels from the drought-resistant oilseed crop grown in rotation with wheat. In December 2009, 14 airlines signed an agreement with

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[32] U.S. Energy Information Administration, Emissions of Greenhouse Gases Report, http://www.eia.doe.gov/oiaf/1605/ggrpt/nitrous.html (viewed April 29, 2010)
[33] *Climate Friendly Farming Project Summary*, p.10
[34] *Climate-Friendly Farming Project Summary*, p.5

AltAir, a new company in Seattle, to deliver camelina-based jet fuel at Sea-Tac International Airport. Montana is expected to be a major source.

Other regional research assets include the **USDA Agricultural Research Service**, which does significant work across all four states, and two U.S. Department of Energy national biomass research centers: **Pacific Northwest National Laboratory** for processing, and **Idaho National Laboratory** collection and delivery. The universities and federal institutions already collaborate extensively, and are well positioned to usefully employ increased resources for biocarbon-related research and development. This is needed in a number of areas:

Irrigated agriculture – "We don't have the extensive research and experimental basis with irrigated that we have for dryland. We're getting a much later start on conservation in these systems and the industry is leading the way," Chad Kruger says. Improved cropping along with residue and nutrient management will play important roles. "We need more research that can validate grower experiences and we are starting to see it fairly significant change happening."

Grazing lands – There are strong indications and some early experience to indicate active management of livestock herds improves grass growth and carbon storage. Credits for these practices have already been sold on the Chicago Climate Exchange. But, says Kruger, "We don't have defensible datasets yet." Monitoring and measurement is needed to understand carbon performance in different sub-regions.

Orchards – Practices such as growing nitrogen-fixing crops between tree rows could reduce fertilizer use and costs. Innovative orchardists are beginning to experiment with such creative cropping, but more systemic research efforts are needed.

Nitrogen management – While CFF has done important research on nitrous oxide, more monitoring and field work needs to be done to minimize emissions of this powerful GHG from farm fields

No-till – "The next step is to enhance the inherent nutrient cycling of the soil," Russ Zenner says. This is accomplished through cropping practices discussed in the carbon inputs section above. "The ultimate would be organic no-till." Publicly-funded agricultural research has been losing out to research driven by chemical manufacturers over the past 10-15 years, so a new emphasis on soils research is crucial, Zenner says.