Workshop Proceedings

Carbon Markets: Expanding Opportunities/Valuing Co-Benefits

Organized by the National Wildlife Federation and the Soil and Water Conservation Society
July 21, 2010 | St. Louis, Missouri

Preface

How can more farmers access carbon markets? How can those markets value the diverse co-benefits of increased soil carbon? Policy makers, farmers, businesses, NGOs and scientists have become increasingly aware of carbon markets and the tremendous opportunity they provide to efficiently fund climate change mitigation. In order to address the cutting edge of concerns about these markets, the National Wildlife Federation (NWF) and Soil and Water Conservation Society (SWCS) convened relevant groups to participate in a day-long symposium on carbon markets.

The planning committee, which included representatives from NWF, SWCS, Ducks Unlimited, Center for Rural Affairs, Ohio State University, USDA ARS, and the Missouri Department of Conservation, envisioned that the event would provide a fresh, interdisciplinary perspective at a key moment in the evolution of carbon markets. While legislative prospects for a climate bill this year seem dim at the time of this writing, the event is no less relevant. Voluntary markets in the US and around the world are setting the stage for regulated markets. Processes to create regulatory state and regional markets span the United States from California to the Northeast. For example, recently, the Western Climate Initiative, consisting of seven US states and four Canadian provinces released the design for its cap and trade system. Yet there are barriers to continued expansion of carbon markets. Information is lacking on what practices ought to qualify for credits, and the benefits as well as negative impacts of those practices. Many are concerned about funding projects that lack integrity or holistic benefits, while many are uncertain about future regulation.

The carbon market symposium sought to identify innovative practices for offsets, and investigate how to maximize co-benefits from offsets. To begin this conversation,

Additional Online Resources: An abstract book, attendee list and presentations are available at: www.swcs.org/carbonworkshop

Bill Hohenstein, Director of USDA's Climate Change Program office, framed the discussion of markets for climate mitigation. Session one had two USDA researchers, Larry West and Jerry Hatfield, explain the current state of scientific research at USDA into soil carbon sequestration, climate benefits from agriculture and land management, and general environmental benefits from agriculture and land management. The USDA researchers highlighted two programs, the Rapid Soil Carbon Assessment and the GRACEnet evaluation of agriculture practices which are laying a scientific foundation for a future carbon market. Establishing a solid understanding of existing soil carbon stocks, and of the impact on soil carbon of diverse agricultural practices in diverse landscapes, will yield necessary data that will pay big dividends down the road in a carbon market. Finally, Kathryn Goldman of the Climate Action Reserve shared their perspectives on developing a leading, fully functioning, voluntary market. The Climate Action Reserve is seeking to establish market standards by using a transparent, peer reviewed process to write protocols. Standardization of science and market access will be crucial to a well functioning carbon market, and these speakers are leading efforts to create accurate, unified information. These broad presentations gave us a sense of the beginning of something very exciting.

In our planning for the event, we hoped to highlight diverse climate friendly land management strategies. There is already much scientific research and policy focus on no-till farming and afforestation, which create important carbon sinks with considerable co-benefits. This event sought to identify other practices and technologies that would enable even more farmers to access the market and even more diverse co-benefits for ecosystems. The morning concurrent session included speakers presenting on fresh ideas, including reduced emissions from rice, sequestration from cover crops and compost, mixed tree and crop systems called agroforestry, reduced manure emissions with aerobic digesters and improved forest management. These presenters often challenged established ways of thinking, and provoked important dialogues. From soil biology to the latest aerobic manure treatment, many compelling scientific questions came out of these presentations.

The lunch time speaker, Rattan Lal, gave an outstanding overview of the potential co-benefits from soil carbon, listing 17 and suggesting many more. He brought a powerful moral direction to the issue, in addition to providing deep scientific expertise.

The afternoon sessions were meant to highlight some innovative ways of achieving greenhouse gas benefits and co-benefits at the same time. One session focused on the ways that holistic thinking about agricultural systems could lead to greenhouse gas benefits. These talks showed aerobic digesters,

whole farm footprints and whole soil cores beginning to include previously excluded information. The other session explored the tools and calculators we could use to measure those benefits. Presenters showed how improved measurement technologies can enable markets to find and fund those co-benefits.

The final segment focused on co-benefits for water holding capacity, water quality, biodiverse wildlife habitat, soil stability and air pollution that had been identified throughout the day. Participants agreed on the tremendous potential of soil carbon to provide benefits to society, and raised challenging questions of how to achieve those benefits. What policy instruments could be nuanced enough to pay for carbon and co-benefits? What are the risks of focusing on carbon to the detriment of co-benefits? Is carbon itself just a co-benefit of all these other ecosystem services? Or, as one farmer suggested, do all good things in the world come from soil carbon?

These proceedings will document each presentation of this packed event. By publishing them, the conference planners hope to bring the valuable lessons learned to a wider audience. We also anticipate that careful review of the entire event, even by participants, will spark new ideas and understandings. Scientists should find here topics on climate impacts of agriculture that demand deep research. Policy makers should learn of new offset types and potential social benefits that they can include in carbon markets. And business people, including farmers, may start to see the shape of an emerging economic opportunity.

General Session: Introduction

Bill Hohenstein is director of the global climate office at USDA. Secretary Vilsack has set a strategic vision for the department of addressing adaptation and mitigation to global climate change. Cap and Trade is an economically efficient way to implement environmental regulation, and it makes sense in the specific case of climate change. The many issues of carbon offsets for agriculture include additionality, leakage, baselines, finding permanence in carbon sequestration, and establishing means for considering the other environmental impacts of carbon sequestration efforts. Each of these challenges has potential solutions. Agriculture and forestry have many opportunities to participate in carbon markets. Hohenstein reported that economic studies of climate legislation have found small increases in input and energy costs for farmers. These increased costs are outweighed by new income opportunities from markets in carbon offsets and renewable energy. In sum, climate legislation seems to have a positive

effect on American farms. USDA is working to create greenhouse gas inventory guideline that will enable farmers to understand their carbon footprints at the farm scale. In the absence of climate legislation, USDA conservation programs will incorporate the goals of climate adaptation and mitigation.

General Session: State Of Current Knowledge On Offsets:

Larry West is USDA Natural Resources Conservation Service National Leader for Soil Survey Research and Laboratory. He is leading the rapid soil carbon assessment, which will measure existing US soil carbon stocks. The goal of the project is to provide a very rough baseline to understand current stocks, which will enable us to understand if we are sequestering soil in the future. The assessment is drawing on 7,000 locations, where soil cores are being taken and analyzed, and these data are combined with existing databases to produce a soil map differentiated by land use of the country.

Jerry Hatfield is a research leader at USDA ARS. GRACEnet is the Greenhouse Gas Reduction Through Agricultural Carbon Enhancement Network. The current project plan is from 2005 to 2010 and has been peer reviewed. The study coordinates 32 locations across the US with common protocols for effective data sharing. The locations are investigating the impacts of various agricultural management systems on carbon sequestration, greenhouse gas emissions, and total environmental benefits. Looking at these different outcomes has sharpened their understanding, as has the collection of continuous data throughout the several years. Preliminary results on crop rotations, tillage, and nitrous oxide demonstrate the benefits of increased diversity, reduced tillage, and continuous observance.

Kathryn Goldman is senior policy advisor at the Climate Action Reserve (the Reserve). The Reserve is seeking to link climate mitigation and agriculture through the development of protocols for offset projects in agriculture. According to EPA, the estimated mitigation potential for agriculture at $30 per ton is 26 million tons in 2020. Offset projects are additionally valuable for climate mitigation because they give the capped sector flexibility in achieving emissions reductions and creates opportunity to reduce emissions in uncapped sectors. However, risks of offset projects done poorly include an increase of atmospheric emissions and a loss of environmental integrity of the carbon cap. Agriculture is a priority for offset projects because it has a potential for multiple co-benefits, for example to wildlife habitat improvement, water quality, and others. The voluntary market is an excellent opportunity to demonstrate how this can work. The Reserve is preparing to develop greenhouse gas offset protocols for the agriculture sector. Based on preliminary scoping, the Reserve has identified these priority

project types: cropland management to increase soil carbon sequestration, nutrient management to reduce nitrous oxide emissions, and rice cultivation management to reduce methane emissions. The priorities will be further explored in upcoming public workshops.

Breakout Session: Annual Commodities

Dr. Norman Uphoff, a professor of government and international agriculture at Cornell University reported on the System of Rice Intensification (SRI)and its potential to raise agricultural production while improving soil and water quality and enhancing soil carbon. The methodology was discovered in Madagascar in the 1980s. This methodology was developed in Madagascar in the 1980s to enable farmers there to raise their irrigated rice yields without relying on new varieties and external inputs. Both pictures and data were presented showing how changes in crop management, greatly reducing plant populations and stopping continuous flooding of fields, can give large increases in yield with reduced water requirements and lower costs of production. SRI has been adopted as an official government recommendation in India and many other nations, as well as by the World Bank. Active and passive soil aeration plus increases in soil organic matter are key factors raising productivity with SRI management, getting more productive phenotypes from practically all genotypes (http://sri.ciifad.cornell.edu). The methods have been adapted to upland rice production and extrapolated to a variety of other crops like wheat, sugar cane, even teff. The methods promote larger root systems with more root exudation and also larger, more biodiverse soil biota. These contribute to increased soil carbon. Preliminary results indicate that stopping flooding of rice paddies and organic fertilization reduce methane emissions without offsetting increases in nitrous oxide. SRI experience is consistent with recent research that demonstrates the contributions of beneficial bacteria, and fungi to plant productivity and health.

Dr. Paul Hepperly is an independent consultant and advisor with seven years experience as research director at Rodale Institute, following experience at Pioneer Hi-Bred. How can we reach the needed 80% of carbon dioxide emissions reductions? The most limiting factor in agriculture is water, and soil organic carbon holds water. No-till builds soil organic carbon, but cover cropping increases it more, and manure even more. These systems have been shown to have higher yields in droughts than conventional ones. Compost applications could achieve even more carbon sequestration. Biochar offers the potential to

give energy and a valuable soil amendment. By looking at holistic changes in agricultural systems we can head towards a greenhouse gas friendly agriculture.

Dr. Guilherme Del Nero Maia on behalf of Dr. Joseph Taraba at the University of Kentucky shared research on the Effects of Media Moisture on Ammonia Abatement and Nitrous Oxide and Methane Generation in Compost-Based Gas-Phase Biofilters. Biofilters can reduce trace gas emissions and other pollutants from animal agriculture facilities. Addressing such pollutants have become increasingly challenging as animal feeding operations must treat increasing volumes of air in larger structures. The material type altered the drying process, and it is a challenge to maximize reductions across all three greenhouse gases. Specific recommendations on the level of moisture appropriate for a biofilter to have maximum greenhouse gas benefits were presented.

Breakout Session: Forestry

Dr. Peter Becker is on the Eastern Ozarks Forestry Council. Improved forest management can double carbon sequestration rates. Oak-hickory forests in Missouri sequester on average 1 tonne CO2e per acre per year, but under proper management this can be doubled. Forests could serve as a source of feedstocks for biofuels that avoided fossil carbon emissions. Forests also provide long-lived wood products that continue to sequester carbon. The co-benefits of forest offset projects include avoided deforestation and degredation, sustainable forestry on private lands, clean water, clean air, wildlife habitat and biodiversity. Barriers to participating in a carbon market through improved forest management include uncertainty in laws and market requirements and upfront and ongoing costs of participation. High resolution remote sensing might cut these costs. A major challenge is establishing baselines from which to measure increased carbon sequestration—should maintaining existing stocks count?

Mathew Smith is VP of Field Operations at Finite Carbon. Finite Carbon has had success in coupling conservation easements with carbon credits. Some may ask if this poses a conflict? Smith contends the coupling is not only clearly legal, but improves participation in both environmental programs. Within the REDD program, risk of deforestation or degradation must be clearly present, or proof that improved forest management can increase carbon sequestration in order for a project to get accepted. There is a tremendous opportunity to make these comprehensive projects work. The many benefits from such

projects make it clear that private landowners ought to take advantage of such programs, using support from groups like Finite Carbon.

Michele Schoeneberger, with the USDA FS/NRCS National Agroforestry Center, discussed the roles agroforestry can play in carbon sequestration *while* simultaneously providing many other production and environmental services demanded by landowners and society from agricultural lands. Regardless of intent, agroforestry practices (alley cropping, silvopasture, forest farming, riparian forest buffers, and windbreaks) will sequester significant amounts of carbon within the woody biomass and soil as well as through the indirect carbon benefits realized through fuel savings, reduced emissions and natural gas savings from fertilizer manufacture. These carbon benefits are not currently well accounted for; limiting our ability to account for their current and future contributions to GHG mitigation and for their full inclusion in emerging carbon markets. Just by adding a few acres of trees to a farm for non-carbon purposes, for instance ~3% in windbreaks to enhance protection and production of crops and livestock, can significantly increase the carbon being sequestered within farm operations. Strategic design and placement of these C sequestering practices can also create critical habitat and travel corridors within the farm and larger landscape providing a tool whereby wildlife resources within the highly disturbed and fragmented agricultural matrix can also be enhanced. Research and technology efforts are providing better tools, including more accurate biomass equations and implicit incorporation of agroforestry into inventory efforts and reporting tools, like COMET-VR Ver. 2, that will improve our ability to estimate and report the carbon benefits of agroforestry.

Dr. Rattan Lal is a professor of soils at Ohio State University. Today has already seen a debate over many fundamental questions. We don't have the answer to all of them. What we do know is that "Farmers have custody of more environment that does any other group" (Paarlberg 1980) Including 60 percent of soil carbon. Over time we have depleted soil carbon through agriculture, but if we implement good agricultural practices we could return to the original soil organic carbon levels and even higher perhaps. This would be a good thing because soil organic carbon increases yield and provides 17+ ecosystem services. How can we pay farmers for this valuable service? The total potential carbon sink of world soils would equate to a 100 part per million reduction in atmospheric concentrations. This could bring down our atmospheric carbon concentrations from around 380 ppm to the pre-industrial levels of about 280 ppm. James Hansen, and many other scientists argue that we must lower concentrations below 350 ppm to avoid catastrophic impacts from climate change. Crop residue, Dr. Lal contends, is not

waste, as many have presumed, and should not be used for biofuels. Instead, Dr. Lal argued, residue should be returned to soil for carbon sequestration. Choices about soil carbon influence the planet's climate, food security and a whole host of other ecosystem services both now and for the future. This means that our management of soil has moral implications for how we treat each other, and how we are treating future generations. Dr. Lal argued that the societal value of soil carbon must be determined by just, fair, and transparent methods based on inherent characteristics of soil organic matter such as value of nutrient and water content in it

Breakout Session: Ag Systems

Bethany Reinholtz works with GDS Associates. GDS provides farm carbon footprinting as an extension of agriculture energy management. GDS will provide a carbon inventory of direct and indirect greenhouse gas emissions as part of their farm audits, and convert all emissions and energy audit information into carbon dioxide emissions equivalents. They examine three sources (on-site, purchased, caused,) plus any carbon sinks the farm provides. By establishing a baseline of energy use and then reducing that use, farmers can save money and increase profits. Profit is, most often, the biggest motivator for causing farmer action. For example, one farm paid $70,000 to reduce annual costs by $23,000annuallly. But the increased awareness of emissions and the potential for low cost reductions can also motivate.

Matias Vanotti is a research soil scientist at USDA-ARS. Using aerobic treatment technology can produce carbon offsets in swine manure. For example, in Chile, before 2000, anaerobic lagoons were the typical manure management system. The Chilean wine industry could not use the water for irrigation because vines could not handle the high ammonia content. In 2001, the Clean Development Mechanism offered the chance for projects around the world to sell carbon credits to developed countries. Certified emission reductions from improvements in manure management on Chilean farms were mainly sold to Canadian and Japanese utilities seeking carbon credits. From 1997 to 2007, Chile's central region went from 100% lagoons to 97% aerobic treatment. From 2000 to 2008, North Carolina, with a large swine industry, developed new aerobic technology to reduce the environmental impact of their facilities. This method does not destroy methane, as is typical of anaerobic digesters, rather it avoids the emissions to begin with by treating and storing manure in an aerobic state. The process splits solid and liquid waste, compost solids and treats liquids. The treated water with low salinity optimizes crop irrigation, the composted solids are used in soil amendments and potting soils. By implementing this technology, hog growth increased by 5.8% and mortality fell by 47%, all the while reducing greenhouse gas emissions by

97 percent. Thus, the use of aerobic technology for manure management could provide both significant greenhouse gas emission reductions and substantial environmental and animal production benefits. implemented requirements for the swine industry to use the technologies demonstrated in Chile.

Alan Franzluebbers is a research soil scientist at USDA in Georgia. Franzluebbers discussed the role conservation agriculture can have in increasing soil organic carbon and improving the environment. The three principles of conservation agriculture are minimal soil disturbance, diversity of plant and animal residues and permanent cover. One must look at the entire soil profile to understand no till versus conventional tillage. Carbon and other benefits come from perennial pasture and increasing rotations. No tillage may produce slightly reduced yield, for a few years, but will often produce progressively greater yields than with conventional tillage for many years after soil organic matter has improved. Adding a cover crop immediately addresses the short-term production fall. The co-benefits of increasing soil organic carbon include reduced erosion, water run-off, improved infiltration greater storage of nutrients, greater soil biodiversity, and improved soil quality.

Break Out Session: Models, Metrics and Measurement

Shaun McKinney, with USDA NRCS in Oregon, outlined NRCS efforts to combine their understandings of carbon measurement with nutrient measurement. They are bringing COMET-VR together with the Nutrient Trading Tool so that individual farmers can enter data about their farms in one place and see data on all ecosystem services in one place; providing a one-stop location for entering information and determining ecosystem services on their lands. A team has been assembled with a graphical user interface and business requirements. They are working to clean up models and combine them effectively.

David Diaz is at Forest Trends' Ecosystem Marketplace in Washington, DC. Ecosystem Marketplace is a non-profit provider of reports, articles, and news to support transparency in ecosystem service markets of all kinds, including carbon markets. They analytically divide carbon markets into compliance (i.e., regulatory) and voluntary markets, and then further subdivide voluntary markets into those with exchange-traded and those with over-the-counter-traded credits. One of the big changes in voluntary carbon markets over the past ten years has been the replacement of non-profit project developers and credit-buyers with for-profit developers and buyers. The biggest motivators for these for-profit buyers include securing "pre-compliance" credits at current low prices and pure voluntary purchases which

communicate positive public relations and branding through corporate social responsibility. The voluntary market may be relatively small, but it will provide an important source of information for the large compliance market that may eventually arrive. Data, reports, and newsletters are available at www.ecosystemmarketplace.com and www.forestcarbonportal.com..

Charles Anderson is at Imagetree. We currently are not getting to a market for ecosystem services, even carbon. How can we cheaply quantify all the offsets we will need? How can we bear these costs when most landowners are land rich and cash poor? We need public confidence in accuracy of monitoring to deal with the 56% of lands that are privately held. LiDar gives us accurate three dimensional images. By adding topography to a LiDar data stack, which can have about 200 variables per cell, we can be very accurate and reduce field plots y 2/3. At a large scale this makes a lot of sense economically and can create new jobs. Governments or big companies can gather this data, and then make it available free or cheap for the public. By using the 3-D, for example, we can understand the height diversity of trees and use this as a proxy for habitat types.

General Session: Incentivizing Co-benefits

Dr. Ryan Stockwell is Agriculture Program Manager at National Wildlife Federation. Stockwell noted the importance of thinking through the entire balance of environmental benefits that may be derived from a carbon market. We do not want to regret our decisions about the creation of a carbon market if they lead to degradation of other environmental services down the road. Stockwell called for more research on the link between carbon and co-benefits. Stockwell drew a connection between changes in land cover and management and water issues that often develop in distant cities. He noted that infiltration rates in agriculture are much higher lower than in natural settings and in conservation agriculture systems, and that this seemingly small change can have considerable costs due to increased costs associated with flooding. . We can rethink how we currently do these things, and save millions of dollars by doing this right.

Bill McGuire is a retired wildlife biologist working with the National Wildlife Federation. By doing a carbon market right we can give wildlife what they need, which is food, cover, and water. Biodiversity often leads to those outcomes, and you can add it anywhere. A specific example is the biodiversity difference between loblolly pine forest and longleaf pine forest. By making the right choice we can get much more from the land. We need to help farmers and landowners manage carbon wisely so we don't

trade one set of problems for another. The key here is whether we want to *maximize* policy for just one benefit (carbon) or *optimize* policy to get a whole host of benefits.

Martin Kleinschmit is a Nebraska farmer. Kleinschmit noted most studies in this field are about carbon, so he led a group including Center For Rural Affairs, National Resources Conservation Service, Nebraska Environmental Trust and Lewis and Clark Natural Resources District to do a study on farmers. The project brought together a group of farmers to learn about the carbon cycle, and learn about different practices that they could try on their farm to build carbon. The most interesting result, according to Kleinschmit, was that the financial incentive got them interested and started in the project, but the group learning environment kept them engaged and was most important in yielding a long-term commitment to permanently incorporating new land management techniques. Diverse rotations and cover crops are good for holding carbon and they hold water and nutrition well. After the experience farmers were more likely to be willing to work with cycles and noted they felt less peer pressure to continue conventional practices. Many farmers liked adopting more than one practice and often incorporated suggested practices onto more acres than they had initially committed.

Abe Collins is a Vermont farmer and the founder of Carbon Farmers of America. Collins noted that regenerative agricultural techniques, primarily ultra high density grazing to mimic buffalo grazing, can build soil much more quickly than people think possible. Abe uses ultra high density grazing and a sub soiler plow to quickly and effectively improve soil health. Abe argued that there are over 40 techniques like this, including using diverse sets of crops, and integrating pasture with crops. All these techniques build soil carbon, which stores and cleans water, produces healthy food, and maintains a stable climate. He pointed out that many problems that effect cities, like flooding, access to clean water, healthy food, and climate change have roots in the country. Abe argued that municipalities should pay their surrounding farmers for the ecosystem services they are receiving.

General Session: Summary Panel

The summary panel, moderated by Alan Franzluebbers, was asked to provide their thoughts on the day's presentations and discussions, with an eye toward providing next steps.

David Diaz concluded the multiple benefits of managing for carbon are striking, but we ought to ask whether a carbon market will be sufficient to get all those benefits. A key to the success of a carbon

market will be to bridge the gap between investors and scientists about transparency and accuracy of sequestration. Sharing language and technology should help in making this happen.

Julie Sibbing, Agriculture Program Director with the National Wildlife Federation: Argued we need to think bigger in terms of how much carbon we can store. No and reduced tillage are minor in their carbon storage benefits when compared to things like winter cover cropping, restoration of native grasslands and forests, etc. Yet tillage practices have been the major focus of many in agriculture when thinking about carbon offsets. Additionally, while we think about carbon storage projects, we need to think about the other great benefits we can get from these activities. Certainly, such project should first do no harm to the environment (like replacing a diverse ecosystem with a fast-growing monoculture or planting potentially-invasive species), but we should also look for synergies to leverage good results for soil, water, air, wildlife, and other ecosystem services from practices designed to store carbon or avoid greenhouse gases. We might find ways to reward additional benefits provided by such practices using USDA conservation programs, tax breaks, new incentive programs, etc. But many of these benefits might be of little or no additional cost and simply be enabled by good project design.

Rattan Lal: The enthusiasm that people have for soil carbon is excellent. But no one thought about the opportunities of climate change—making lemonade from these lemons. Abe Collins talked about sequestering very high levels of carbon—is that feasible? We should at least study these very high sequestration rates. Unfortunately, while everyone here is deeply committed and understands the importance of these issues, we are not breaking through to the international policy level.

Mark Nechodom, USDA Office of Ecosystem Markets: Wondered whether carbon is the co-benefit and everything else matters more. It seems like there are a whole lot of valuable attributes related to carbon. Environmental markets are made, not born, and the existing voluntary markets are all pre-compliance. In the US, carbon markets are lagging other countries. Unlike wetlands markets, carbon markets will be high volume and low margin. While we are all excited about the opportunities from increased capital, that capital will come with the expectation of profit. This would be a huge market, around $80 billion/year level; agencies that are likely to be in the loop are United Stated Department of Agriculture, United States Army Core of Engineers, United States Fish and Wildlife Services, National Oceanic and Aeronautic Administration, and Environmental Protection Agency.

Alan Franzluebbers (USDA - ARS and moderator): The diversity of interest groups at this event was a step towards the mainstream, as in the past it would have been dominated by soils professionals.

Q and A session with the closing panel

Participants are supportive of using farm bill money to pay for carbon, paying for tons of carbon rather than bushels of corn. The important question here is whether that replaces existing conservation funding or existing subsidy funding. In whatever further direction farm bill programs move, participants support quantifying their benefits.

Participants expressed interest in a policy design of forcing polluters to pay into a fund, and then using that fund to meet the aggregate demand for carbon sequestration. This mechanism avoids some of the monitoring and transparency issues that arise from a market system. Given the huge benefits of soil, this makes some sense. The price per ton of carbon necessary to compensate for the full value of ecosystem services and nutrients in soil was estimated at roughly $250 per ton of CO2.

Participants expressed frustration with the political process for not understanding the importance and value of soil carbon. There was an agreement on the need for further research into soils in order to understand the radical results identified by Abe Collins and Norman Uphoff.

Summary And Next Steps

Innovative practices for carbon sequestration can provide valuable ecosystem co-benefits. This event identified many of these practices, and confirmed that many remain to be discovered and developed. Based on our call for papers, six specific types were presented at the conference. These six were not pre-selected or endorsed, and are meant to inspire even further innovation. The event included discussion of high intensity grazing with subsoil aeration, the System of Rice Intensification, agroforestry, compost and cover crops in organic systems, improved forest management and aerobic manure treatment. These practices increase the amount of oxygen received by soil microbes and the amount of photosynthesis that occurs in a location. Feeding biological systems with light and oxygen increases the capacity of those biological systems to sequester carbon.

While all six practices utilize oxygen and photosynthesis, three practices focus on feeding microbes with oxygen. Subsoil aeration, the System of Rice Intensification and aerobic manure treatment all bring oxygen into new places: the deep soil, the rice field, and the manure lagoon. The

oxygen feeds microbiota, which provide nitrogen for crop growth. These microbiota provide carbon sequestration, and their nitrogen production can reduce the need for chemical inputs. Avoided input use is a particularly important greenhouse gas benefit, as reducing input production leads to an avoidance of greenhouse gas emissions. Avoided emissions are permanent and easily quantified. In the cases of high intensity grazing with subsoil aeration and in the system of rice intensification the nitrogen fixing biota of the soil feed crops directly, while in the case of manure management the effluent and compost must be reapplied to fields after treatment.

The final four practices focus more on increasing the amount of photosynthesis happening in a given location. Agroforestry, forest management, cover cropping, and composting all seek to maximize use of solar energy that strikes the ground in a particular location. By adding trees to a cropping system or extending that cropping system to cover more of the year, agroforestry and cover cropping grow plants when and where plants had not grown before. Forest management seeks to improve the photosynthetic gain of a forest by allowing maximum sunlight to strike growing trees. Composting brings together aerobic feeding of microbes with increasing photosynthesis in a given place. Aerobically processing plant and/or animal wastes feeds microbial life and then reapplies that life to the soil, bringing the nutrition of previous photosynthesis to a new crop. Organic systems that often use composting and cover crops also seek to increase the amount of plant and soil biodiversity, thereby building carbon in the soil.

The innovative practices for carbon sequestration identified at the carbon workshop need further scientific research in order to further quantify their climatic benefits. Preliminary results suggest very significant sequestration levels and reduced emissions. While all these practices have been demonstrated at the farm scale, further work is needed to explain to farmers how this could actually work for them, on their land. Farmers will need to know what the benefits and costs of specific practices are, and what payments will be available. In some cases, these practices seem to have benefits to farmers regardless of their climate impact or any carbon payment.

Given all the benefits of carbon sequestration for farmers, people and the environment, some participants wondered ‘is carbon itself the co-benefit?’ That is to say, when farmers implement outstanding practices, they can increase their income, protect water resources, and preserve soil—isn’t carbon just a side-effect of decisions intended to achieve all these benefits? For example, if someone plants a tree buffer and increases yields and reduces erosion, then carbon sequestration seems like just

a fringe benefit. This raises the question of what makes something a benefit or a co-benefit. One way to understand the issue is that the benefit causes the co-benefits. So if an increase in A causes an increase in B, C, D and E, then A is the benefit and the others are co-benefits. Policy makers might choose to support the co-benefits of B,C, D and E, or simply support A, the initial activity which causes the co-benefits. From this perspective the benefit is like a lever that moves the system in the intended direction. Next steps for policy makers and scientists are to identify the appropriate levers to achieve climate mitigation and adaption while preserving precious natural resources. If something else works as a lever, then carbon is co-benefit. We may be able to obtain multiple benefits by focusing on just one that is of concern, and of interest to land owner, and rewarding that activity, as long as we know it provides the co-benefits.

The carbon workshop identified carbon offset types that can have significant benefits to wildlife habitat, water quality and natural resources. Producing food from perennial grazing systems, managing forests to preserve their biodiversity and habitat suitability and adding trees to working cropland all improve or maintain wildlife habitat. Increasing soil organic carbon through cover cropping composting and improved grazing, reducing water needed to grow rice, and aerobically treating manure improve water quality. Practices that build soil carbon increase the ability of soil to hold water and the rate at which soil absorbs rainfall. Aerobic treatment of manure and aerobic rice growing reduce water pollution and the amounts of water needed for agriculture.

Discussion of traditional practices of biological carbon sequestration were hard to avoid, despite the successful identification of numerous innovative agricultural practices. No-till and forestry management certainly have a place in a carbon market, and they benefit from many years of scientific research and cultural acceptance. They were frequently referenced by participants and used by participants to frame their understanding of a carbon market. Perhaps because of the length of time participants have had to consider these practices, we were best able to identify potential downfalls from a poorly constructed market in reference to these practices.

The participants began to discuss the dangers of failing to address and support co-benefits in a carbon market. We learned of some key outcomes policy makers should seek to avoid. A common example might be a perverse incentive for farmers to till fields that used to be no-till, and then return to no-till for a credit. Another might be an incentive for a farmer to deforest his land and replace it with a monoculture. Or a policy might cause the replacement of diverse wildlife grassland habitat by

monoculture forest. These outcomes would significantly damage ecosystem services like clean water and biodiversity. Another biodiversity issue is exemplified by implementation of forest management to increase sequestration on an old-growth forest. Or the replacement of old growth forest with perennial grasses that sequester carbon and produce biofuels. These outcomes might have benefits, but they would destroy untouched spaces that have an intrinsic value. All these examples of bad outcomes emphasize the importance of getting the carbon market right the first time. Identifying some possible negative outcomes was our first step towards designing policies to avoid them. Making the negative outcomes clear and present helps to understand the urgency of policies necessary to avoiding them.

Participants agreed we should avoid damage to wildlife habitat and ecosystem health with any carbon offset project. Going forward we will need to develop ways to assess the relative values of wildlife habitats, biodiversity, water quality and other ecosystem services. We will also need tools to help decide which wild spaces ought to remain wild or unmanaged, and how this will relate to a market.

Participants were challenged to describe policy instruments that would incentivize co-benefits. One participant pointed out that access to a healthy futures market enabled greater funding to be accessed at the creation of a credit, thereby increasing funding for identifying and rewarding co-benefits. Another participant suggested that the best way to achieve climate mitigation and adaption in agriculture along with co-benefits was to force polluters to pay into a large fund, and then allow an appropriate group to allocate those funds to achieve the aggregate carbon reductions needed. This would avoid the challenges of developing the transparency and tracking needed by a carbon market while yet achieving greenhouse gas reduction goals, and perhaps offering an easier way to pay for co-benefits. However, a market might be more efficient in finding the cheapest sequestration or emissions reductions.

One way to evaluate various policy instruments is through the lens of which side of a market they operate: the supply side or demand side. Supply side policies could require that a percentage or all carbon offset projects provide co-benefits. Another would require that carbon sequestering activities do no harm to other environmental aspects. This method would establish minimum sustainability or environmental standards. Another supply side policy might cover monitoring and verification costs so that the expenses of monitoring and verification do not push offset prices too high. By funding monitoring and verification of co-benefits, a program administrator could reduce a financial burden on landowners who are seeking carbon credits that have co-benefits. In this scheme, project proponents

could pay into a program wide monitoring system administered by a voluntary or compliance program. This kind of policy could be scaled, and can contribute to increasing the supply of carbon offsets with co-benefits.

If demand outstripped supply, ranking of carbon projects based on the co-benefits they provide could encourage co-benefits without increasing costs. Demand side policies could fall into two categories. First, there could be different classes or values for carbon credits, demarcated through standards and certification. An expensive credit might include more bundled co-benefits. Second, there could be numerous markets for other ecosystem benefits like water or biodiversity. This schematic analysis is meant to prompt further thinking and the development of policy proposals for incentivizing co-benefits.

Regardless of political or education background, participants agreed that soil carbon is incredibly valuable. Providing plant nutrients, water management, climate benefits and countless other ecosystem services, all in attendance agreed on its importance. Participants agreed that in the coming years we must work to end the degradation of soils and begin their regeneration for all of the benefits we may gain.

Additional Online Resources:

An abstract book, attendee list and presentations are available at: www.swcs.org/carbonworkshop

For more information about the Carbon Markets: Expanding Opportunities/Valuing Co-Benefits workshop, please contact:

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