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**Cornell Policy Brief:**  
**Creating a Role for Agriculture and Forestry in Emerging  
Carbon Markets**

*Antonio Bento, Associate Professor of Resource Economics, Dept. of Applied Economics  
and Management, Cornell University, [amb396@cornell.edu](mailto:amb396@cornell.edu)*

*David Wolfe, Professor of Plant and Soil Ecology, Dept. of Horticulture,  
Cornell University [dww5@cornell.edu](mailto:dww5@cornell.edu)*

**Summary**

Encouraging agricultural and forestry carbon sequestration and greenhouse gas mitigation is a necessary tool to meet U.S. emissions targets at minimum cost, but implementation challenges have relegated the agriculture and forestry sector to a marginal role in national and international cap-and-trade and energy policies, including those currently being discussed by U.S. legislators.

However, there are policy solutions for the widely understood challenges for agriculture and forestry carbon offsets that would allow inclusion of this important sector into the U.S. carbon economy and ultimately reduce the overall cost of meeting greenhouse gas (GHG) emission targets for the nation.

The agriculture and forestry sector of the U.S. economy are unique because land managers can do more than simply reduce their own emissions of such key greenhouse gases as carbon dioxide, nitrous oxide, and methane. By adopting crop, soil, and livestock best management practices (BMPs), the sector can sequester additional carbon and/or replace fossil fuels with renewable energy sources, thus becoming part of the solution and providing carbon offsets for regulated sectors. The EPA estimates the mitigation potential of U.S. agriculture and forestry to be 10-25 percent of total annual U.S. GHG emissions. This potential is substantial, especially relative to emissions from the sector, estimated at about 8 percent of U.S. GHG emissions.

Making the agriculture and forestry sector eligible for a compliance market is particularly attractive because many abatement options are cost-neutral or net-profit-positive, require low capital investment, and rely on existing technologies. Many BMPs for mitigation include additional environmental, food safety, and sustainability co-benefits, such as improving soil health by increasing soil organic matter, and protecting soil and water resources.

With such significant potential, why has the agriculture and forestry sector remained relatively marginal in both international and national climate change and energy policies to date? The main reason is the challenges and uncertainties involved in implementation. Perhaps most daunting are concerns about high transaction costs for determination of carbon stock baselines, monitoring, and verification, especially for highly-variable soils, in a diverse sector with many individual enterprises. This sector also faces a unique set of challenges with issues of permanence, leakage, and additionality. Equity in distribution of carbon offset revenues is another factor, with small

landholders at a possible disadvantage if offset payments are based exclusively on an acreage basis.

Below we describe specific methodologies and policy approaches to address these challenges, which, if implemented, would create widespread incentives for adoption of BMPs for GHG mitigation, allow inclusion of this important sector into the U.S. carbon economy, and ultimately reduce the overall cost of meeting GHG emission targets for the nation. In general, we argue that implementation approaches that aggregate individual land managers and function at a large geographic scale can greatly reduce transaction costs and buffer the system from year-to-year variation in performance of individual enterprises, focusing instead on the collective movement of the sector toward BMPs and meeting U.S. GHG emission targets. In addition to the existing mechanisms for this sector to enter the carbon economy included in the current legislation, we suggest a parallel set-aside program that would provide an option for states (that so choose) to develop a plan for utilizing set-aside funds to create incentives for reducing GHG emissions and adoption of BMPs within their agriculture and forestry industries. To be eligible for such funds, states would need to submit a plan that includes: (1) an assessment of current carbon stocks and management practices; (2) a detailed explanation of mitigation targets and how funds will be used to achieve these targets; and (3) plans for monitoring and verification.

### **Best Management Practices (BMPs)**

Fortunately, there are long-term experiments in a broad range of environments that have identified BMP options for farmers, foresters, and other land managers to improve energy use efficiency, reduce greenhouse gas emissions, sequester additional carbon in soils and plant biomass, and produce biofuel crops—a substitute for fossil fuels.. For many of these practices we also have quantitative information on the carbon or CO<sub>2</sub>-equivalent GHG emissions reductions, although these can only be considered estimates and will need to be verified for specific regions and climates. Details of BMPs for the agriculture and forestry sector have been reviewed in-depth in numerous publications. Below is a short list that captures some of the well-documented options:

- avoid deforestation of existing tree stocks;
- increase tree carbon stocks through afforestation projects;
- produce biofuel crops;
- use renewable energy sources (solar, wind);
- reduce fossil fuel use by using renewable energy sources, reducing tillage and other tractor operations, switching to more energy-efficient appliances;
- recycle and reduce use of disposable products (e.g., plastics);
- improve manure handling, methane capture, and livestock feeding and handling;
- use manure as an energy source (anaerobic digestors);
- improve nitrogen fertilizer use efficiency, and reduce associated nitrous oxide emissions (use organic nitrogen sources (e.g., legumes, manure), better timing, placement and minimum quantity of fertilizer applications;
- increase soil carbon sequestration (reduce tillage, year-round vegetation cover, compost and other organic amendments.)

## **Verification**

The measurement of soil carbon stock changes is probably the most challenging aspect of verification for the agriculture and forestry sector. Some challenges are:

- soils and soil carbon are highly variable even within an individual field;
- annual changes with adoption of BMPs (e.g. reduced tillage) are usually small relative to existing carbon stocks so that it can take a number of years to verify soil organic carbon increase goals are being achieved;
- multiple factors in addition to management practices can affect the rate of soil carbon change (e.g., climate, soil type);
- reliable inventory systems for soil carbon are less well-developed than, for example, forest above-ground biomass inventory systems.

Existing methodologies can be used to tackle many of these challenges, and numerous research teams are developing new approaches that can streamline and reduce costs of landscape-level carbon assessment. The carbon contents of individual soil samples can currently be measured with a high degree of accuracy and at low cost. The response of soil carbon stocks to environmental variables is well known and has been incorporated into well-validated sophisticated computer simulation models. Requiring an intensive set of field measurements for each individual project participant, however, would be far too expensive and unnecessary. Instead, strategic soil sampling among sites with similar soil type, cropping system, climate, and using a sampling design to determine spatial variability, can be used to interpolate and extrapolate across a broad landscape. Field measurements can be combined with model-based approaches to expand scale and to project future soil carbon changes.

Over time, costs will be further reduced as databases improve that link BMPs with field- and model-based estimates of soil carbon. Monitoring and verification could increasingly be based on management and land-use practices, which can be monitored through a combination of remote sensing and rapid ground survey approaches.

## **Desired Characteristics of Offsets Projects and Potential Policy Options**

There are three main desired characteristics of offsets projects:

- 1) they should be permanent;
- 2) projects should only qualify for offsets if they can demonstrate additional emissions (or carbon sequestered) that would have not occurred otherwise;
- 3) offset projects should not produce leakages in the system by creating perverse incentives for other agents to (partially) undo what the project achieves.

## **Permanence**

The permanence issue with this sector is that the carbon benefit derived from many BMPs, from re-forestation to soil tillage practices, could be easily reversed by subsequent management decisions, or exogenous events, such as forest fires or floods. When addressing permanence, the first key issue is to define the ‘timing’ of the project. Is it 10, 15, or 20 years? A correct assessment of permanence requires knowledge of the different processes that lead to carbon sequestration (and the limits of sequestration). In addressing impermanence, an important objective is to ensure that the net contributions to the GHG emissions balance are accurately recorded. Therefore, carbon offsets granted to projects should take into consideration the potential for ‘market’ driven or unexpected potential

reversals. For example, unexpected reversals can occur because of a natural disaster, such as a forest fire, while market driven reversals occur whenever prices in the economy fluctuate enough to create incentives for agents to alter their behavior.

There are four main policy options to address permanence concerns:

- 1) Ex-ante discounting – The simplest possible way to address permanence is to discount upfront the value of the offset attributed to a project. To calculate the discount regulators must estimate the expected amount and timing of a potential reversal. While appealing due to its simplicity, the chief problem with this approach is that the regulator does not have full information to correctly predict neither the timing nor the potential amount of a reversal. As a consequence, this policy will always be sub-optimal;
- 2) Pay-as-you-go – Another possibility is to take carbon stock measurements at regular time intervals and impute the net credit as the change in stock occurs. Under this option, the offset producer gets compensation spread over a much longer period of time than under the earlier option. As a consequence, depending on a producer's capital constraints, such an approach may prevent many from participating in the market. At the same time, while accurate, this option would require the regulator to conduct measurements of carbon stocks regularly, thus increasing the overall cost of the program;
- 3) Offset reserve – Another imperfect option would be to simply set aside an offset reserve that could provide the safeguard in terms of assurance of emissions reductions whenever reversals occur; under this option, the total amount of offsets in the market would be lower, and as a consequence the overall costs of the cap-and-trade program would increase. Like with option (a), while simple, this option would effectively constitute a second-best solution to the problem;
- 4) Establish insurance markets for offsets – Under this policy offset producers would insure their offsets. Whenever a reversal occurs, the producer of the offset would pay back the value of the offset lost.

### **Additionality**

The key issue associated with additionality has to do with the ability of the regulator to correctly assign the emissions reductions that each project generates that are additional, that is, that would have not occurred otherwise. There are two potential public policy options to deal with additionality:

- 1) Cohort group baseline – This approach is similar to the notion of a performance standard. The regulator would use historical regional land use data to estimate the probability that a certain type of land use change might occur under 'natural' conditions, that is, in the absence of a project. The logic of such approach consists of comparing the performance of a cohort group such as other farm holdings in the same region. As discussed above, a landscape-based approach is appealing due to its comparatively lower cost of implementation. However, such approach leads directly to imperfect estimates of the baseline emissions attributed to specific projects;
- 2) Project-specific baseline – In contrast, another possibility is to directly evaluate all of the biophysical, economic, and institutional factors affecting the project in question and determine, through some combination of quantitative analysis and qualitative reasoning, whether the desired activity would have been undertaken

anyway. While this approach is more ‘spatially’ disaggregated than the previous one, the same issue of precision of baseline estimation occurs, though perhaps with smaller variance.

### **Leakage**

In addition to the two challenges related to offsets – permanence and additionality – one of the largest concerns with offsets is the possibility that they will generate leakages. Leakages occur whenever the action of an agent – in this case the producer of the offset – triggers, through market forces, actions by other agents that effectively compromise the desired goals. For example, if a farmer sets aside land for conservation and reduces agricultural production, the concern is that another farmer will undo part of the conservation realized either by intensifying production or expanding the cultivated areas. As a consequence, for certain types of projects, there is a need to carefully quantify potential leakages. For the existing conservation reserve program, for example, multiple studies have estimated that the Conservation Reserve Program (CRP) has approximately a 20 percent slippage effect, that is, each acre of cropland that enters the conservation program results in 0.2 acres elsewhere reverting to cropland.

### **Policy Solution Mechanisms**

As the discussion above suggests, in practice, policy makers will have to trade off decisions related to precision in the measurement of the quality of the offset against the cost of verification of the project. One option is to pass the cost of verification of the project to the offset producer. Another is to move away from a third-party verification process on a project-by-project basis to a more aggregate landscape approach.

Such considerations are relevant, in part, because offsets can provide additional sources of income to the agriculture and forestry sectors, but the distributional impacts to these sectors will not be uniform and are very much dependent on the costs of producing the offset, including its verification cost. In turn, depending on the scale of the farm operation, some potential producers may simply not have the financial or technical ability to participate in a federal program that requires them to go through a detailed third-party verification process. Therefore, there are multiple barriers that can prevent small and medium agricultural producers from taking advantage of the opportunities that markets for offsets could provide.

### **Supplementing Federal-Level Offset Provisions with State-Level Green Payments**

It is important to realize that offsets are only one way in which the agriculture and forestry sector has incentives to reduce emissions. However, as stressed above, there is a potential for unintended distributional impacts. Specifically, if small- and medium-scale producers do not have the ability to participate in markets at the federal level, a set-aside of allowances value can provide state-level incentives for projects that might not qualify for offset credits. Or, the set-aside will create more flexible mechanisms for smaller producers to be compensated for the GHG emissions reductions and ecosystem services that they provide. That is, the funding from this program comes from the revenues of the allowances; further states will develop programs that outline the different types of projects that would qualify for a best practice. Smaller-scale producers who otherwise would not be able to participate in a federal-level program will have the ability to participate, since this program will allow for more flexible mechanisms of verification

and will include broader ecosystem services, not just documented GHG emissions reductions. For example, as part of such programs, states can concentrate on achieving reductions in nitrogen applications. In these cases, farmers could be asked to report receipts from their fertilizer purchases as means of verification.

Such uses of revenues from the action of allowances can indeed support best management practices with more flexibility for farmers because less stringency is required with respect to the long-term impact on the atmosphere. For example, green payments could take the form of compensations to demonstrated reduction in nitrogen applications or grant incentives for shared (community-based) renewable energy projects at the farm.

**Contact Information:**

Antonio Bento: [amb396@cornell.edu](mailto:amb396@cornell.edu) 607-255-0626

David Wolfe: [dww5@cornell.edu](mailto:dww5@cornell.edu) 607-255-7888