C-AGG
Coalition on Agricultural Greenhouse Gases

C-AGG Executive Summary: Uncertainty in Models and Agricultural Offset Protocols

This Executive Summary is based on the C-AGG white paper of the same name. Both documents seek to achieve agreement on approaches to determine uncertainty related to the use of models—both empirical and mechanistic—for estimating net changes to GHGs fluxes due to changes in agricultural practices. Whereas this Executive Summary distills the important concepts of the white paper for discussion and agreement, the white paper presents a more in-depth analysis of how to assess uncertainty when using models (whether structural uncertainty introduced by the model, or uncertainty introduced by input data, for instance), and how to account for and manage this uncertainty in offset projects and/or programs.

C-AGG supports the development of GHG offset markets as a policy tool to incentivize and achieve GHG emissions reductions activities within the agricultural sector at a scale that matters. In addition to C-AGG's established Guiding Principles and Policies[i] that such programs should be science-based, rely upon quantifiable, verifiable, results-based accounting, and include comprehensive treatment of all relevant GHGs, C-AGG believes that these offset programs and policies must also address the unique nature of agricultural systems.

Agriculture involves the management of complex biological systems and is characterized by significant variability among producers, localities, and time. Farmers manage production on a daily basis, adjusting practices and inputs to address a host of biological, climate, and economic drivers. Quantifying GHG emissions from agricultural systems amid such variability is challenging compared to stationary industrial sources, and C-AGG supports the development of offset programs and policies that recognize and implement procedures to manage sources of variability and uncertainty, particularly when models are used to estimate GHG emissions or emissions reductions.

There will always be some level of uncertainty associated with quantifying GHG emissions reductions or sequestration at the field or project level. The uncertainty in GHG estimates is generally inversely related to the costs of measurement techniques, and successful offset programs must strike a balance between measurement costs and confident accounting. The key to finding this balance is in knowing how to usefully estimate uncertainty and manage it.

Models can simulate GHG dynamics at field or regional scales based on a range of environmental and management variables while capturing temporal and spatial variability. The use of models within agricultural offset protocols currently provides the most appropriate way to quantify net GHG impacts because models can effectively and cost-effectively account for the cumulative GHG impacts of a suite of management practices and other variables that affect GHG emissions. When utilizing models however, it is critical that offset programs identify and

manage the uncertainty associated with a models' estimated GHG emissions reductions, for instance through a discount to awarded credits.

In practice, the scale of uncertainty for offset programs that utilize models is also likely to evolve over time, particularly as participation rates change. In the early years of offset programs when participation rates within the agricultural sector are likely to be low, managing uncertainty may be central to program integrity in terms of ensuring conservative accounting that precludes the program from awarding more credits than the net emissions reductions achieved across participating projects. As participation rates increase over time, and scale is achieved, the certainty of model estimates will also increase. Programmatically, the utilization of models can enhance farm-scale participation (by lowering costs and allowing for approaches that promote aggregation) and help to achieve scale, creating a symmetry that provides further rationale for their use.

Agreement is sought on the following key C-AGG statements regarding how to assess and manage uncertainty when using models for agricultural offset quantification. Ultimately, C-AGG believes a consensus on these statements will address a key component of and facilitate progress toward a comprehensive, statistically-valid, and systematic validation process for the parameterization, calibration, documentation of performance, and management of uncertainty from models used in agricultural offset programs.

Key C-AGG Statements Related to Uncertainty and the Use of Models

Statement 1. While there is a relative consensus on how to directly measure GHG fluxes, direct measurements are generally too expensive to be feasible for purposes of GHG inventories and carbon markets. Models (empirical or mechanistic) can be useful to quantify emissions when they are applied under the conditions for which they were developed.

a. Evaluating the applicability of a model for its use in carbon market offset programs or GHG inventories should include key parameters. Empirical models should be limited to use in conditions under which they were developed, including soil types and conditions, climate, crop types and cropping systems, etc. Mechanistic—or process-based—models require parameterization and calibration to simulate agricultural systems, and careful analysis and decision-making is required to address the adequacy of these activities, including when re-calibration is required. Model structural uncertainty and the uncertainty in input data and its subsequent impact on model uncertainty must also be quantified. (These key variables and others are further elaborated upon in the white paper)
b. Field data to assess model accuracy, and ultimately improve model performance, is currently limited and varies in quality. Future analyses should take into account the potential error of field measurement data.

Statement 2. When models are used, analyses of both structural and input uncertainty related to their use must be completed. Structural uncertainty should only be quantified using measured field data which was not used for model development.

Statement 3. If program integrity requires that GHG emission reductions are not overestimated, an appropriate deduction should be calculated and applied to model-estimated emissions reductions based on both input and structural uncertainty.

Statement 4. The most feasible level to account for model structural uncertainty is at the program level; input data uncertainty may be most appropriately accounted for at the site, project, or program level depending on a variety of considerations.

Statement 5. When many sites are considered together, the sum of their emissions (or emission reductions) will have less uncertainty than any individual site considered alone. Therefore, the deduction for structural uncertainty will decrease as scale is achieved. Offset programs should pursue policies, such as aggregation, that mitigate this uncertainty and encourage greater participation from the agricultural sector.

Statement 6. More field data sets are required to support the implementation and expansion of models in agricultural offset programs. The creation of a central data repository to house these data sets is recommended.

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[i] **Relevant C-AGG Guiding Principles and Policy Recommendations (**excerpted from April, 2010 C-AGG Report, ***Carbon and Agriculture: Getting Measurable Results***)**

C-AGG (9) Guiding Principles

Science-based. The design of agricultural climate policy must be informed by the best available science and should be adaptable over time to integrate improved science.

Quantifiable, Verifiable, and Results-Based. Only quantifiable and verifiable programs and activities that deliver net reductions of atmospheric GHG concentrations should be rewarded.

Trade-offs between precision and accuracy of quantification and cost will be necessary but should diminish over time as innovation delivers better technology and lowers costs.
Although systems based on direct measurements are preferred, certain practices have proved to deliver results (i.e., net reductions in atmospheric GHG concentrations) with a high degree of precision and accuracy, and certain models have proved accurate in estimating reductions for particular practices when calibrated using appropriate data.

Comprehensive GHG Accounting. A comprehensive accounting should be made of all significant GHGs affected by a program or activity.

C-AGG (5) Policy Recommendations

Use the best available science and technology to develop and reward GHG abatement activities in the U.S. agricultural sector.

1. GHG abatement programs for the agricultural sector should strive toward measured GHG reduction outcomes, when possible, and away from practice-based crediting.
    a. Wherever possible, crediting should be based on scientifically and statistically sound measurement methods rather than being awarded solely on the implementation of a specific practice.

   b. The GHG offset program administrator should evaluate where performance-based crediting systems are possible, and where practice-based crediting methods might be appropriate proxies for performance.
   c. Practice-based crediting methodologies are appropriate if the level of uncertainty in performance as a result of a particular practice can be adequately characterized and accounted for.
2. Accurate, reliable, and affordable measurement and quantification tools and technologies for GHG emissions reductions and increased sequestration within the agricultural sector are needed. A major investment in research and technology development associated with measuring agricultural GHG emissions and carbon sequestration is needed in order to realize agriculture's full GHG mitigation potential. In order to overcome these barriers, research is needed to:
   a. Reduce the costs and improve the accuracy of GHG measurement technology;
   b. Further develop and calibrate modeling tools for a wide range of applications, such as for additional crops, geographies, and management practices;
   c. Enhance access, coordination, and reliability of data sets used for GHG measurement, monitoring, and modeling, particularly across federal agencies; and
   d. Develop comprehensive GHG accounting frameworks for farm-scale agricultural activities. These should quantify and account for all relevant GHG sources and sinks; consider additionality; account for any leakage of emissions outside a project's boundaries that may occur as a result of the implementation of a project, when possible; address permanence and risk of reversal; and distinguish between intentional and unintentional reversals.
3. GHG policies, programs, and rules must incorporate mechanisms that allow for adaptation and adjustment over time to accommodate emerging science, knowledge, technologies, and best practices.
   a. GHG policies should require regularly scheduled reviews of crediting methodologies, processes, and mechanisms.
   b. Programs should allow for needed program adjustments to incorporate the latest science, best practices, and best methodologies.
4. Balancing the economic costs of policies and programs and the GHG and economic benefits is an important issue for the agricultural sector and should be carefully considered in the design of federal GHG programs.
5. A better understanding of the relative costs, and the cost benefits, of emission reduction opportunities in the agricultural sector is needed.

Enable the voluntary market to play a role in the transition to a fully regulated U.S. GHG market, particularly through the development of early offset credits and methodologies. The voluntary carbon market is an important source of innovation and a test market for new or untried GHG methodologies that could potentially be graduated to mandatory markets as long as they meet the quality criteria standards established by the mandatory offset program.