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 promote agreement on approaches to determine and manage uncertainty related to the use of models for estimating net changes to GHGs fluxes due to changes in agricultural practices. Models include empirical models, which are based on historic measurements, and can include emissions factors; and mechanistic, or process models, based on scientific understanding of the biogeochemical activities being modeled. This Executive Summary presents a distillation of important concepts in the white paper, which presents a more in-depth analysis of how to assess uncertainty when using models (evaluating 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[1] 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. Innovation and flexibility are key to adapting GHG mitigation programs and policies to the agricultural sector, thus, these programs and policies should encourage innovation as a means of facilitating GHG emissions reductions at the farm scale. Models are a cost-effective and innovative way to facilitate the calculation of GHG emission reductions at the farm scale, and are, therefore, encouraged by C-AGG, on the condition that the model uncertainty can be managed. Therefore, 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

[1] Coalition on Agricultural Greenhouse Gases, ***Carbon and Agriculture: Getting Measurable Results***, Version 1, April 2010.

generally inversely related to the costs of measurement techniques. Successful offset programs must strike a balance between measurement costs and confident accounting. The key to finding this balance is in knowing how to reliably estimate uncertainty and manage it.

Models, whether they are empirical models such as emission factors, or mechanistic models such as biogeochemical process 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. This approach can help develop a cost-effective landscape-scale understanding of the land and land use change effects on GHG, though measurements are still necessary to define the certainty of model predictions.

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. Similarly, the use of mechanistic models for agricultural protocols and programs can support innovative practice changes and approaches to mitigating GHG that less flexible and less complex measurement tools cannot accommodate. However, it is critical that offset programs identify and manage the uncertainty associated with a model's 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 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, and concomitant volumes of generated carbon credits are small, 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 due to the law of large numbers. Deviations introduced by the model on one field are likely canceled out by an opposite deviation on a different participating field. 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 that are to be used to evaluate the applicability of a model. Empirical models should be limited to use in conditions under which they were developed, including soil types, 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 C-AGG Uncertainty White Paper of the same name*.)
b. Field data to assess model accuracy, and ultimately improve model performance, are currently limited and vary in quality. Future analyses should take into account the potential error of field measurement data.

Statement 2. Models can and should be tested against measured data to estimate their accuracy. 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. The use of mechanistic models in agricultural protocols and programs can support innovative practice changes and approaches to mitigating GHG that less flexible and less complex measurement tools cannot accommodate.

Statement 4. 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 5. 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 6. 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 7. 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.

This Executive Summary should be cited as: Coalition on Agricultural Greenhouse Gases, ***C-AGG Executive Summary: Uncertainty in Models and Agricultural Offset Protocols***, Version 1, May 2012.