

C-AGG Meeting Summary

Tuesday-Wednesday, July 15-16, 2014

Hyatt Regency Denver

Denver, CO – USA

Executive Summary

The meeting provided an opportunity for the group to assess the successes achieved and challenges encountered in the agricultural greenhouse gas (GHG) mitigation, ecosystem services, and sustainability arenas since the last meeting in March. Opening remarks by the group showed both a sense of optimism and uncertainty moving forward. Participants were optimistic about the opportunities for biogas in the marketplace, but were unclear what the roadmap looks like for other projects now that the Conservation Innovation Grant periods have ended, and there is yet to be significant uptake of agricultural protocols in the voluntary or mandatory markets. As one participant aptly put it, “we are in the valley of death between pilot and full scale adoption.” After reflection by the group, the morning session started with the announcement of a big accomplishment since the last meeting – the publication of USDA’s 600+ page report on the methods for quantifying GHG fluxes for agriculture and forestry. In addition to completing and thoroughly vetting the report, USDA is also currently in the process of incorporating these methods into the COMET Farm tool to better integrate tools and methodologies with the goal of making COMET Farm a more user-friendly and utilized USDA tool for producers. The group was very excited by the release, and encouraged USDA to make this a living document that is not only used in the US, but serves as a model for international programs. This session was followed by a more detailed presentation on the latest developments on quantifying soil N₂O emissions given the large uncertainty that still exists in most models. USDA has adopted a modified calculator that utilizes both default factors and modeling approaches to estimate N₂O emissions from agriculture, but acknowledges that they need more resources to gather sufficient field data to perform the analyses for all regions, and cropping systems.

C-AGG recently joined Field to Market: The Alliance for Sustainable Agriculture (FTM), which is a multi-stakeholder group that is working to engage the entire agricultural supply chain to improve the sustainability of commodity crop production. Rob Snyder, the new president, joined the meeting to give a basic overview on FTM and the three major initiatives they have underway: the Fieldprint calculator, supply chain collaboration projects, and the National Indicators Report. Participants were very interested in the methods behind the Fieldprint calculator’s outputs and FTM’s future. C-AGG and its collaborators look forward to future engagement with FTM as they execute their strategic vision.

A diverse panel of experts presented their perspectives on the proposed EPA regulation under section 111d of the Clean Air Act that aims to reduce GHG emissions within the power sector. The proposed regulation is made up of 4 building blocks: a 6% reduction in emissions of coal plants, an increase in existing natural gas combined cycle plants, an increase in renewable energy capacity, and demand side management resulting in a 1.5% increase in efficiency. The discussion focused on what was described as a broadening of EPA’s authorities and previous approaches, as reflected in the building blocks, how biomass would be accounted for, and whether there could be a role for offsets pending passage of the proposal. Since the biogenic accounting framework is still being updated by EPA, it is unclear how biomass could be used to satisfy any regulations that come out of the proposed rule. What is important, is to make sure the groups comments are heard by submitting them to EPA before the October 13th, 2014 deadline.

C-AGG and Environmental Defense Fund (EDF) provided an update on ARB's Rice Cultivation Protocol and discussed the continued struggle to include aggregation and risk based and randomized verification provisions in the protocol. While ARB has reportedly verbally committed to include "consolidated reporting," their version of aggregation, and a comparative analysis of their verification requirements alongside those recommended by C-AGG, these components are not yet included in released draft versions of the protocol, and the group will be looking for them in the next draft, to be released on around July 28. This is a very critical time in the development of this protocol, since it is the first ARB crop-based agricultural offset protocol, and if it does not enable and encourage financially viable producer participation, it may be viewed as a failed approach and may impact the development and adoption of future agricultural offset protocols within CA's cap-and-trade system, and potentially, elsewhere.

USDA provided an update on the Regional Climate Hubs, confirming that there will be 7 regional hubs and 4 sub-hubs, whose purpose is stimulation, cooperation, collaboration and service delivery on climate change mitigation and adaptation to private land managers on a regional basis/level. Specifically the hubs will provide \$6 B in technical support over the next 10 years, assessments and forecasts for producers, and outreach and education.

Project developers and financiers provided an update on the status of methane digesters in the United States. Jim Potter from AgEnergy shared his company's blueprints for the largest bio-digester in the US to be built in Weld County, Colorado. At full scale, this digester will produce 42 MW of pipeline quality natural gas, which requires the addition of many back-end technologies to clean the gas. The Innovation Center for US Dairy has been working on a smaller scale with individuals farmers to capitalize on what is projected to be a \$1.3 to \$4.7 billion industry for biogas, with many associated co-benefits. DMI hopes to turn these smaller on farm digesters into a small scale utility to increase negotiating power with the utility sector.

Participants involved in the development and piloting of rangeland management offset protocols, including rangeland enhancement through the addition of compost and other rangeland enhancement approaches presented on the opportunities and challenges associated with designing and implementing these protocols. Similar to discussions at past meetings, implementation and transaction costs and lack of adequate primary data to tailor the protocols to specific regions and farms were presented as two of the biggest challenges to fully optimize the value and the many benefits that could be seen from these types of projects.

To address some of the challenges associated with project implementation, specifically the costs associated with monitoring and verification, Bill Salas from Applied GeoSolutions, Rick Mueller from NASS, and Dave Shimel from JPL presented the latest advancements in satellite imagery and remote sensing. While some of the newer technologies and applications are still in development and the granularity needed to satisfy the level of detail needed for most protocols is still lacking, the future potential for these technologies is great. New satellites being launched by NASA will have the ability to measure active and passive soil moisture, column CO₂ concentrations and solar induced fluorescence (a measure of photosynthesis). Nitrogen utilization efficiency uptake by plants can also be monitored.

Finally, C-AGG presented on a new and exciting partnership opportunity with the agriculture sector in Brazil. In April, a four member C-AGG delegation participated in a week of meetings with government agencies, private companies, and leading NGO's in the space. The meetings illuminated many opportunities for knowledge sharing and have led to the development of two concrete project opportunities with the agricultural sector: the development of an online sustainability portal for

producers to engage in GHG mitigation activities; and a rangeland restoration project involving 60 farmers. C-AGG continues to work with Brazil to develop cost estimates for these opportunities and is making arrangements to travel to Brazil again in the fall to continue working collaboratively with these organizations, and to kick off some concrete activities.

Action Items/ Key Takeaways

- We must continue to develop an attractive business case for producers that moves credit stacking to action and that results in income generation or financial value to producers
- Once the USDA report is officially released, C-AGG will help spread the word
- The possibility of a C-AGG workshop with CSU, USDA, and producers to help provide useful comments to strengthen the COMET Farm tool will be pursued
- Submit comments to EPA regarding the proposed EPA regulations under section 111d of the CAA: deadline for comments is October 13, 2014. C-AGG will be submitting comments.
- Provide comments to ARB on the next version of the Rice Protocol (to be released July 28 for public comment); C-AGG will be submitting comments.
- When developing new agricultural offset protocols continue to look for ways to reduce costs and manage data uncertainty while maintaining the rigor behind the protocol and using realistic estimates of GHG mitigation and income generation
- Data availability and how data can be accessed and collected is another point of continued discussion – another possible topic for a C-AGG workshop with stakeholders

Tuesday, July 15, 2014

Welcome and Introductions: C-AGG Overview and Background

Debbie Reed, C-AGG Executive Director, opened the meeting with an introduction to C-AGG, including C-AGG's Executive Team, C-AGG's Steering Committee, and a round robin of participant introductions. Introductions were followed by a brief overview of C-AGG as an organization including how it operates, its focus on advancing the development and adoption of science-based policies, methodologies, protocols, projects, tools and decision support systems for GHG emissions reductions and carbon sequestration within the agricultural sector, and its future goals and activities. Debbie concluded her opening remarks by highlighting the objectives for the Denver meeting, which included:

- Continued exploration of agricultural GHG mitigation opportunities, including relevant scientific, technical, policy, and programmatic updates
- An update on agricultural offset protocols including the CA rice cultivation protocol and a broader assessment of ongoing challenges and opportunities
- An update on C-AGG activities and future goals

Assessing the Landscape: A C-AGG Discussion of Critical Issues and Trends in Agriculture and Ecosystem Services

Chris Chopyak led the group in a discussion of current trends and patterns C-AGG participants are seeing in the agriculture and ecosystem services space as it relates to GHG emissions or other issues. Participants shared some anxiety over the position many projects and protocols find themselves in – the valley between pilot and scale, which continues to be a challenging place to navigate. Others are seeing trends in the use of agriculture waste for digestion and electricity production and a renewed interest in

credit stacking for these and other types of agriculture projects. The food versus fuel debate is also being discussed in the industry as competition for land increases. Finally, it was apparent that there is a need for increased communication within the voluntary and compliance market space to explore some of the challenges being faced by those seeking to implement projects.

Entity-Scale GHG Methods Report and USDA Update

Marlen Eve, from the USDA Global Climate Change Program Office, presented a status update on the upcoming release of the completed comprehensive report on “Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory.” The report has been finalized and adequately vetted by over 38 experts in the field in addition to additional agency reviews. During the development of the report, Marlen acknowledged that the report encountered many challenges including capturing the management of entire operations, melding all methods into one tool, applying an appropriate uncertainty analysis in the final tool, and properly applying statistics to extrapolate findings to all areas of the US. USDA asked for C-AGG to continue to partner with them in three ways: continue to spread the word about the report, provide case studies of projects that have applied the methods, and provide input on the COMET Farm tool to help improve its user interface and applicability.

Many of the participants recommended to USDA that the document be considered living and updated frequently to address the constantly changing nature of the science. It was also recommended that in the next update a chapter be included on the conversion of cropland to urban and other non-agricultural uses.

Combining Process-Based Modeling and Empirical Data to Estimate Soil N₂O Emissions

Steve Del Grasso provided an overview on a fairly new method for measuring and accounting for soil N₂O emissions. In the past, default emission factors have been used to quantify these gases, but through experimental tests it has been shown that using these factors can introduce uncertainty of up to 300%. The major objectives for developing a new process based modeling standard are to utilize the strength of process-based models, incorporate scalars to address higher emissions from over-fertilization, and utilize the latest experimental data to derive updated formulas. Moving forward there is still room for improvement and an opportunity for updating the method periodically, increasing resources for model testing, and deriving scalars for more management options.

Field to Market: The Alliance for Sustainable Agriculture

Rod Snyder, the new president of Field to Market (FTM) joined the meeting to provide an overview of the collaborative initiative and to present opportunities for collaboration with C-AGG. FTM started in 2007 as a multi-stakeholder group, and currently has 60 members. FTM has three major initiatives underway: the Fieldprint calculator, supply chain collaboration projects, and the National Indicators Report. The Fieldprint calculator looks at 8 environmental indicators and relies on USDA models and data for the baseline. In addition to the Fieldprint calculator, FTM has coordinated supply chain projects that have allowed them to demonstrate the use of the calculator on the ground. Finally, FTM releases a National Indicators Report which analyzes trends over time for environmental & socioeconomic sustainability indicators, establishes a baseline against which to measure future improvements, creates enabling conditions for an informed multi-stakeholder discussion of sustainability, advances an outcomes-based, science-based approach, and provides broad-scale context for more local efforts. The results of the report are a resource use/impact per unit or production metric and a total resource use/impact for commodity crops.

FTM is looking to continue benchmarking their tool, identifying opportunities for continuous improvement, and aggregating information and enabling supply chain sustainability claims. Specifically, their metrics working group is looking to update their metrics and algorithms to ensure they are as rigorous as possible while still maintaining the streamlined nature of the calculator. To help educate the C-AGG collaborators, FTM explained their GHG metric development in detail. The metric includes direct and indirect emissions from equipment operation, irrigation energy use, crop drying, transport from field to first POS, tier 1 nitrous oxide emissions, credit for residue removal, fertilizer production, crop production products, and seed. They are looking to reopen the N₂O metric to tighten the uncertainty value, which based on previous presentations is likely around 300%.

The group had many questions around how the calculator works and the algorithms behind it. C-AGG see this as an opportunity to add some additional value given the group's expertise. Some particular concerns that the group raised are the lack of accounting for sequestration and the confidence in the data quality and consistency between producers. C-AGG has made a note of these concerns and will be sure to raise them again in the more formal metrics group meetings.

Panel Discussion of Proposed EPA Regulations under Section 111d of the Clean Air Act

Callie Videtich from EPA Region 8 provided an introduction to the Clean Power Plan also referred to as 111d regulations. This proposed rule showcases EPA Administrator McCarthy's approach to innovate rule making and implementation. The rule establishes individual state goals with an overall goal of reducing CO₂ emissions from the power sector by 30% from 2005 levels by 2030. The comment period opened on June 18th and closes on October 13th. The proposed rule is based on 4 building blocks: (1) a 6% reduction in emissions of coal fleet, (2) an increase in existing natural gas combined cycle plants, (3) an increase in renewable energy capacity, and (4) demand side management resulting in a 1.5% increase in efficiency. The agriculture industry has the potential to contribute to this rule through energy enhancements, use of renewables at individual facilities, use of methane digesters as a source of power, use of biomass as a renewable energy source, and transmission of electricity across their lands.

Jenn Jenkins stressed the point that this rule is still just proposed and many of the building blocks will likely go through litigation before they are enacted. She also provided some history on the biogenic accounting framework EPA is still revising, which will determine how biomass emissions will be accounted for moving forward. This will have major implications for offset accounting, if they are even allowed to be used under this rule, which she sees as unlikely.

Helena Chum stressed the importance of looking at agriculture and land use as a system and taking into account all positive and negative impacts when accounting for emissions. She sees biomass as one of the ways to come back from the current emissions overshoot situation the world finds itself in. Scott Weaver, from AEP, spoke to the rule from an electricity producer's viewpoint. His company is a big supporter of offsets and actively manages their GHG emissions. They are very interested in seeing how this rule plays out.

The group raised many interesting points regarding the rule and its accounting including the importance of getting the biogenic accounting correct to incentivize the best use of these products, the possible inconsistencies with establishing GHG accounting boundaries for fuel types, and the reliability issues with increasing natural gas usage. It is clear from the comments and questions that there is still a lot of confusion and miscommunication around this rule.

ARB Rice Cultivation Offset Protocol: A C-AGG Update

Debbie Reed, C-AGG, and Robert Parkhurst, EDF, presented the current status of the rice cultivation offset protocol development by ARB for the California compliance market. ARB has spent a lot of time and resources on this protocol and is eager to get it right the first time. However, some major problems still exist with the rice protocol that could prevent it from being a success; costly verification requirements and the lack of allowance for aggregation of farms are two major issues yet to be addressed in released draft versions of the protocol. C-AGG has long been engaged in discussions with ARB regarding these two issues (and prior to that, the issue of utilizing process models to measure and estimate changes in GHG emissions from the agricultural sector). C-AGG will submit comments when the next version of the protocol is released on or about July 28, and will be looking in particular at the issues that C-AGG has recommended regarding the need to allow for aggregation and randomized and risk-based sampling for verification.

It was noted that this is a very unique protocol for ARB since it is the first crop based protocol developed for the compliance market, the first model based protocol, and is the first protocol where zero offsets in any market have been generated. While ARB has reportedly verbally committed to include “consolidated reporting,” which is their version of aggregation, and a comparative analysis of field measurements with model outputs, they have not included this in written drafts of the protocol, and C-AGG participants feel that this language needs to be included to make the protocol economically viable. While ARB will be providing funding to help with verification costs during the first three years to encourage farmers to participate, without a guarantee that a comparison between the field measurements and the risk based models will be performed during these three years the funds will result in no additional value at the end of the three year period.

The risk of invalidation of credits and enforcement by ARB was brought up as another major concern that could make this protocol unsuccessful. It was acknowledged that “on-farm” fines are unlikely outside of California since they do not have jurisdictional control and invalidation will likely only penalize the purchaser of the offsets and not the farmer. Therefore, USDA officials in other states should still encourage the use of the protocol without risk of large fines. Both the California and Mid-South rice growers are expected to participate in the protocol once it is approved, but need to see the verification and aggregation issues resolved in order to participate.

USDA’s Northern Plains Regional Climate Hub

Justin Derner, from USDA Agricultural Research Service and Northern Plains Climate Hub presented on the new USDA Hub structure. There will be 7 regional hubs with the purpose of each hub being to assist ranchers, farmers, and forest land managers with decision making in the face of climate change. The key thrust behind the development of these hubs was to deliver science based knowledge and practical information to farmers, ranchers, and forest landowners through a transfer of information, tools and management practices. The hubs are looking to coordinate efforts between agencies (USDA, NOAA, and USGS) to provide useful data to producers. The hubs also encourage questions and feedback from the farmers and ranchers to allow for continuous improvement of their tools. The regional websites will be rolled out in the fall with regional vulnerability assessments performed in the winter/spring 2015. The hubs are utilizing existing resources at USDA and targeted funding from USDA NIFA grants to stand up these resources.

The COMET Farm Tool

Keith Paustian, with CSU, presented a primer of the COMET Farm tool to be demonstrated at the evening reception. COMET Farm provides a means for non-GHG specialists to easily estimate farm-scale GHG

emissions, to explore alternative management and land use strategies, and employs state-of the art methods/models based on USDA guidelines that are consistent with the US national GHG inventory. The scope and key features of COMET farm include full farm-level GHG accounting that takes into account soil and biomass C stock changes, soil N₂O and CH₄ emissions, enteric CH₄ and manure CH₄ and N₂O, and fossil fuel carbon emissions.

Wednesday, July 16, 2014

Thoughts and Reactions to Tuesday's Sessions

Chris Chopyak led the group in an opening discussion on their reactions to the information presented on Tuesday. One of the big themes that emerged is the need to simplify messaging when speaking about some of these more scientific topics with producers. There are tangible benefits that can be communicated to producers such as saving fertilizer, water, and money. If this is properly communicated then carbon credits will be a natural and comfortable extension making projects an easier sell to producers. C-AGG participants were excited about the continued alignment on tools and metrics within USDA and exhibited support for the continued development of the COMET Farm tool. Finally, additional protocols are under development in the voluntary carbon space and the voluntary registries are very hopeful and positive about the growth they have seen in the market since C-AGG's last meeting.

Methane Digesters Panel Discussions: State of Art Technology, Offsets Potential, Co-Benefits, Barriers to Entry

Jim Potter from AgEnergy USA kicked off the panel with a very detailed discussion of the new technology his company is building in Weld County Colorado. The project collects local dairy waste and turns it into renewable natural gas of electricity pipeline quality to be injected into the local SMUD natural gas line. The technology is above ground thermophilic with a high ratio of manure to substrate. The digester has been designed to produce 42 MW of power and began started producing and injecting gas on March 19th of this year. One of the biggest problems encountered by digesters is the need to manage the digestate and other co-products of electricity generation. The state of CO gave AgEnergy a label that allows them to classify their digestate as an organic soil amendment, which has made the sale of it to local farms for use on their fields much easier. In addition to the digestate management challenge, project financing and the requirement of multiple back end technologies makes this type of project more challenging than smaller scale digesters.

Jerry Bingold with the Innovation Center for US Dairy followed Jim's presentation with a discussion on how smaller more disperse dairies are hoping to manage their waste. When he first joined DMI the industry didn't know two things: size of the prize (number of digesters possible) and the total market value. DMI worked with economic consultants to determine that the size of the prize nationally was between 1300 - 2600 digesters and the market value was between \$1.3 - \$4.7 billion dollars. It was also noted that the electricity generation from the digesters was less than 50% of the total possible revenue. The market study has provided a roadmap for how the industry can economically scale up digesters with hopes of one day strategically offsetting rural electricity usage using the biogas from digesters. The next steps for DMI are working to implement projects in California where the state's 12.8 cent feed-in tariff to the grid makes this location more profitable. DMI's future plans include looking at how to structure these digesters more like a utility than as individual digesters to give them more purchasing and negotiating power. One of the major obstacles to overcome is the lack of properly structured deals with

equity partners. DMI must figure out the equity piece to be able to build digesters at the rate and scale needed.

Teresa Koper with The Climate Trust (TCT) discussed TCT's role as a financier of these types of projects. TCT finds digester projects attractive since they can generate voluntary or compliance based offsets, have immediate and more predictable GHG reductions, produce additional co-benefits, and make good business sense to generate GHG credits. Moving forward, TCT would like to see a simplified protocol that can facilitate the aggregation of smaller projects and intends to invest additional up-front financing in this area.

During the discussion, many participants were interested in hearing about challenges faced with working with land owners; Jerry and Jim both professed to having had limited negative experiences in this regard. The most challenging aspect of working with land owners has been ensuring that the digestate provided to them contains the necessary, known, and consistent levels of N and P required for their fields. Another challenge for the industry is securing funding for the smaller scale digesters, which will likely be the future of the industry as Jim estimates there are only about 12 places across the country that could support a facility as large as the one AgEnergy is installing in Weld County.

Rangeland Management: Update on Offset Protocol Development, Related Activities, and Projects

Bob Brobst, from CO EPA spoke to the results of soil carbon accumulation 22 years following the first application. As part of his research, he added organic matter and biosolids, which are roughly organic C in three different rates – 10, 20, and 30 Mg/Ha. After 22 years, the soil had almost 4 times the amount of soil C that had been applied, which is a lot higher than the natural rate. In addition to the soil carbon changes, other side benefits of applying this amendment were a cooler temperature at just 5 cm especially during the summer and a hydraulic conductivity roughly double that of the control.

Jeffrey Creque, from the Carbon Cycle Institute and The Marin County Project, presented on how land management can enhance carbon sequestration in soils. Based on experimental data, the application of compost to California soils increases soil moisture and the ability of the soil to store carbon with long turnover times. Based on these results, his group along with Terra Global Capital and EDF developed a protocol for GHG Reduction from Compost Additions to Grazed Grasslands. Applying this methodology to all available CA rangeland, if they are able to capture 1/2 ton per acre they would be capturing 28 MMT CO₂e per year. The biggest limitation is the amount of compost that can be generated in CA. His group is currently in the process of scaling up the project area by applying compost to additional research farms where they are hoping to continue to capture and sequester carbon. They will be using this project to help test and inform the COMET Farm tool on modeling compost additions.

Billy Gascoigne, from Ducks Unlimited (DU) presented his perspective on developing a project using the avoided grassland conversion protocol. The project was developed in the prairie pothole mosaic of North Dakota, where they have been experiencing a significant amount of land conversion from wetlands to corn and soybean production. This has led to loss of habitat for local water fowl. DU worked with landowners in 2008-2009 to secure perpetual easements and GHG rights to the project lands with the goal for the region to provide a 5% revenue through conservation efforts. They finished modeling the impacts of conversion prevention in May 2014, the project plan was submitted to ACR in June 2014, and it is currently undergoing verification and validation. He is hoping they are a few months away from bringing the first credits online under this protocol. As a new member of the team and new to the protocol he encountered a few major challenges that he thinks C-AGG could help ensure are

appropriately address in future protocols. Challenges included the use of large discount factors in developing the protocol, the burden of modeling each individual soil type, and the costs associated with pursuing this type of project versus the estimated returns. He stressed the importance of honest communication to project developers and to agricultural producers and the need to fully acknowledge the tough economics of these types of projects. “Just because you build it, doesn't mean credits will come.”

Sara Snider, with EDF, presented from the perspective of an NGO having worked with Ducks Unlimited to develop the avoided grasslands protocol and with The Carbon Cycle Institute on the rangeland enhancement via compost protocol. Through a USDA CIG, EDF has been focused on determining a set of cost-effective best management practices that increase soil carbon sequestration and other ecosystem services on rangelands and developing accounting protocols based on these practices. The rangeland compost protocol is currently in peer review status and further stakeholder engagement and economic analysis are needed. EDF wants to make data collection easier and aggregation a realistic part of this protocol since they acknowledge this is the only way these projects will be successful. As part of their new CIG application they are hoping to continue data collection in CA for the compost protocol, so they can bring these projects to scale.

The discussion after the panel focused on addressing the challenges that were illuminated during the participants’ presentations, mainly the costs associated with implementing projects and data availability. These two themes emerged during many of the panel sessions and the group is still struggling with a cost effective way of resolving these to make these protocols cost-effective and value-added for agricultural producers.

Satellite Imagery and Remote Sensing Data: Current applications to Measure, Monitor, and Verify Changes in Agricultural GHG Emissions

Bill Salas, from Applied GeoSolutions, started the panel presentations with a discussion of the role of satellite based remote sensing (RS) in measuring, monitoring and verifying agricultural GHG emissions. He provided a survey of the technologies that can give the industry a look at individual projects and field management practices, using rice as an example. Remote sensing can be used to document field eligibility (e.g. rice has been grown at least 3 of the past 5 years on this plot), baseline management (e.g. general plant/harvest dates), and project monitoring (e.g. rice field was drill seeded). His group is currently looking to map crop residue over the entire year over all rice growing areas. They currently have some private sector funding and are continuing to pursue support from government agencies. Bill then provided case study examples of how RS has been used to look at tillage practices across large landscapes, document effects of management on rangeland productivity, and the monitoring of rice planting and harvesting dates. Remote sensing can be used to map crop types, management information, and can thus help reduce the costs of verification. However, it should be acknowledged that RS is not perfect, but can be used in a risk management framework by developers and verifiers.

Rick Mueller, from USDA NASS Remote Sensing Agriculture Monitoring Activities, presented on tool USDA currently has to help with monitoring including the cropland data layer, an annual land cover product that for the past 6 years has been national; the California Crop Data Layer Fallow/Idle Land project, which is published monthly to understand how the land is being used; VegScape, a product that updates the vegetative condition on a daily and weekly basis; and remote sensing yield, which shows the biomass and land surface temperature.

Dave Shimel, from JPL, presented on the agricultural science applications of new NASA spaceborne and airborne sensors. The first of the new satellites is the Orbiting Carbon Observing Project (OCO-2), which will likely begin producing data in August 2014 on the column CO₂ concentration (a million measurements a day) and solar induced fluorescence. Under high light conditions, the fluorescence emitted is a good indicator of photosynthetic rate. The satellite samples long transects and takes small images along those transects going over the same area every 16 days. The fluorescence seems to have one of the better correlations with yields and productivity than other methods used for collecting this data. The satellite has been focusing on the 7 global bread baskets looking at large commodity agriculture. This method of measuring productivity picked up a major reduction in 2012 when the rest of the data sources showed average conditions including the veg index. The future goal will be to combine this data with the veg index, which should result in a complementary data set.

A second satellite that observes soil moisture, SMAP (Soil Moisture Active-Passive) is scheduled to launch in November 2014. The new satellite will provide an overview of world soil moisture cover with a few constraints. The active measure does not cover as large an area as passive, the satellite does not see through a vegetation canopy very well, but it will be excellent in agriculture areas since it will be able to capture surface soil moisture and root soil moisture. It will have a resolution of 9 km with some 3 km data and is very useful in areas that have multiple inundation fractions such as the ND potholes. The technology will also allow you to look at the difference between morning and afternoon canopy moisture to measure transpiration which is highly correlated with fluorescence.

Since many agriculture applications are not well served by these higher resolution satellites, JPL has relabeled some of their planes as the Agriculture Airborne Observatory to measure soil moisture, crop health, crop yields, and other measures at a more granular scale. These observatories can cover several 100 square kilometers in a day. With the airplanes, you can match the on the ground measurements with the satellites to help with calibration. JPL will now be measuring a lot of the climate parameters that had previously been estimated, which can help validate models.

C-AGG Brazil Update and Future Plans

Three out of the four C-AGG delegates who participated in the April meetings in Brazil, Debbie Reed (C-AGG), Bill Salas (Applied GeoSolutions), and John Kadyszewski (Winrock International), presented on the highlights of the trip and current status of activities. Debbie started the discussion with some background information on how C-AGG started working in international markets. The Packard foundation is increasingly interested in agricultural GHG mitigation opportunities in other high impact regions around the world, and Brazil and China are at the top of the list for this type of engagement. Debbie visited China in 2013 and determined it will take a little more work to understand where C-AGG would play in this space. However, there was a much clearer opportunity in Brazil, given the established work and presence of CLUA, and their relationships in the region.

The delegation traveled to Brazil in April for a week of meetings with government agencies, NGOs, and financing partners focused on establishing collaboration in Brazil in support of incentivizing agricultural GHG mitigation activities at a scale and in a timeframe that is meaningful. Each delegation member was focused on a specific aspect: Bill - spoke about measurement verification and monitoring; Alastair - our learnings from Canada; John - the technical aspects and protocols; Debbie - our learnings and policies in the USA.

Our potential collaborators in Brazil were very interested in what has happened in the US and Canada and how they can learn from our previous activities including measurement and the appropriate amount

of rigor, potential policy choices to bring about effective change, the USDA methodology report, and the COMET farm tool as Brazil is now working to develop a similar tool. C-AGG also presented more detailed learnings on data management, program architecture, and funding. In Brazil, as part of the ABC project the Bank of Brazil makes up front financing available for projects, closing the temporal financing gap that we have seen in the US, however there are still some issues with this process including high interest rates and extensive paperwork. While a lot of investment has happened, a theme that emerged from the meetings was that there is no monitoring of activities associated with the Agriculture Low Carbon Program credit lines, though there is consistent desire to establish a monitoring program.

As a result of the meetings in Brazil, C-AGG has continued discussions with key personal at CNA, Bank of Brazil, WRI and Embrapa and hopes to start developing pilot projects in the region in the coming year. The delegation will be returning to Brazil in the fall to start working with CNA and Embrapa on project development and implementation. CNA is eager to develop carbon markets in Brazil and is working with Embrapa to develop systems to measure and monitor agriculture GHG emissions and emission reductions. It should be noted that Rio has already established an exchange system to monitor its forest offsets being traded, which has the potential to be expanded.

During the discussion, C-AGG participants pointed to the importance of recovery of pasture land to the prevention of Amazon forest destruction as this land can be used to increase sugarcane production, which is one of the crops competing for land in Brazil. CSU also indicated that they are currently working with contacts in Brazil on a COMET Farm like tool, which is an addition potential opportunity for joint collaboration.