C-AGG
Coalition on Agricultural Greenhouse Gases

C-AGG Meeting Summary

Tuesday-Wednesday, July 12-13, 2016

Sheraton Denver Downtown

Denver, CO – USA

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Executive Summary

Debbie Reed, C-AGG's Executive Director, opened the Denver meeting with an overview of C-AGG's mission, operating model, and organizational structure followed by a review of the meeting's objectives. The Denver meeting goals and objectives included an update on state-of-the art soil greenhouse gas (GHG) research, metrics, and policies, how these learnings and findings can be incorporated into appropriate policies such as the upcoming farm bill, and how C-AGG and other stakeholders can reward farmers for implementing these innovative practices. In addition to these major themes, participants also received an update on California's Short Live Climate Pollutant Plan from Ryan McCarthy with the CA Air Resources Board (ARB).

Day One. Rattan Lal of Ohio State University set the stage for the first day with an overview of the current state of soil carbon sequestration research. Dr. Lal provided a survey of the impact humans and agriculture have had on the state of the world's natural resources, including the health of our soils, since the dawn of crop cultivation. Agriculture significantly impacts soil quality, water quality, groundwater availability, and tropical deforestation to name a few. Soils, and soil carbon specifically, form the foundation for global food security, biodiversity, climate change adaptation and mitigation, and land and soil restoration. Improving the health of soils and their ability to store carbon is one pathway the global community needs to pursue to achieve its global goal of holding temperature increases to under 2°C.

Steven Ogle of Colorado State University built on Dr. Lal's presentation with a discussion of the specific opportunities farmers can implement to achieve climate smart soils globally. He presented the results of his recently published paper on the importance of climate-smart soils for climate change adaptation and mitigation. According to the study's estimates, if climate smart soil practices are deployed globally this could reduce emissions by 1.5 Pg CO_2e/yr. to 5.3 Pg CO_2e/year, depending on economic constraints.

Cliff Snyder with the International Plant Nutrition Institute (IPNI) continued the theme of improving our management and understanding of climate smart soils with a presentation on a proposed update for Field to Market: The Alliance for Sustainable Agriculture's (FTM) GHG metric used within their FieldPrint calculator. Currently, the metric uses the Tier 1 Intergovernmental Panel on Climate Change (IPCC) report emissions factor for direct and indirect nitrous oxide (N_2O) emissions, which is not sensitive to changes in management practices. To improve this metric, IPNI in collaboration with The Fertilizer Institute (TFI) led a group of leading soil scientists and agronomists through the process of proposing more practice-specific emission factors that would consider application rate, timing, place, and source. The results of this effort are currently being review by FTM for potential future integration into the FieldPrint calculator.

Bill Salas with Applied Geosolutions provided a quick update on recent modifications and enhancements to the Global Research Alliance Modeling Platform (GRAMP). GRAMP,

launched in 2009, is a repository of process based models created with the goal of deepening and broadening mitigation research efforts across agricultural sub-sectors. The platform was designed as a comprehensive resource for GHG models, and was developed to improve GHG model cyber infrastructure transparency, enhance use of models, provide educational materials, and collect and disseminate field data for model validation. C-AGG recently funded an expansion to the platform's N_2O database, helping to add 771 new data records to the database from 51 published peer-reviewed sources. Building on this effort, GRAMP is collaborating with MAGGnet and Yara to add hundreds to thousands of global field data records to the database, which should ultimately help modelers calibrate and validate process models.

Sean Babington with the US Senate Committee on Agriculture, Nutrition, and Forestry presented an overview of current programs in the farm bill and how they are helping USDA achieve progress towards their goal of reducing emissions by 120 MMT of CO_2e by 2025. The major programs include the Conservation Innovation Grants (CIG), Environmental Quality Incentives Program (EQIP), Regional Conservation Partnership Program (RCPP), and Conservation Reserve Program (CRP). C-AGG participants also provided initial suggestions for updates to the 2018 Farm Bill that focused on capturing the value of soil health in risk assessments and insurance premiums.

Day 2. Ryan McCarthy with CA ARB provided an update on the status of CA's Short Lived Climate Pollutant (SLCP) plan since C-AGG's March meeting. The draft SLCP plan was re-released for public comment in April, and includes reduction goals for black carbon (50% by 2030 from 2013 level), methane (40% by 2030 from 2013 level) and hydro fluorocarbons (40% by 2030 from 2013 level). In this latest plan iteration, CA proposes to use regulations as the primary mechanism for controlling methane emissions, exclusive of enteric livestock emissions, which will be targeted through an established goal. The current version of the plan is undergoing a final round of revisions and will go before ARB's Board in September. While much uncertainty exists within CA around the future of their climate programs, ARB and the Governor's Office are committed to achieving the reductions they put forth.

To better understand and frame some of the opportunities for managing enteric methane emissions from ruminants, Garth Boyd from the Prasino Group presented the findings from research performed by DSM on the effectiveness of 3-nitrooyxpropanol (3-NOP) as a feed additive. Initial trials show that adding a 60 ppm dose 3-NOP to beef and dairy cattle rations can reduce methane emissions by 30%. Long-term feeding trials are needed to determine the appropriate dose for each type of feed ration and to document the additional benefits of the compound on animal health, but DSM hopes to begin commercial sales of 3-NOP by 2019. This has the potential to be a game changer for the industry if it can increase feed efficiency, improve breeding performance, and reduce GHG emissions of methane, a SLCP.

Sara Kroopf from EDF and Jim Pollack from Prassack Advisors presented the results of a study EDF commissioned to assess the current landscape of on-farm management software and its ability to meet the data requirements of nutrient management protocols in the carbon market. Prassack mapped the needs of the protocols to the current data being collected by these on-farm

systems. He determined it would be possible with additional work by both the on-farm management software providers and the biogeochemical process model developers to sync the two systems to minimize data collection burden of project developers. However, there are many steps that need to be taken to put this process into motion including a consolidation of the on-farm management systems. Prassack and EDF will continue to investigate the level of effort required to sync the systems and continue to watch how the industry develops in the coming years.

Bill Salas presented the preliminary results of a joint effort with CTIC to improve the use of satellite imagery for conservation practice tracking. This specific demonstration project, aptly referred to as the Operational Tillage Information System (OpTIS), focused on mapping tillage practices across the state of Indiana. The system has been designed with scale in mind and the eventual goal of the project is to scale the final algorithms nationally. The work, primarily funded by USDA, will help the agency incorporate conservation practices into the national inventory, spatially link practice data with the soil and climate modules in the DayCent model, and help to validate the Climate Smart Agriculture Building Blocks claims. The system also has the potential to be used to monitor conservation program implementation, crop insurance issuances, and provide MRV for ecosystem service markets, but it will require community support for national implementation.

Finally, Debbie Reed, C-AGG, and Charles Stanier of the University of Iowa pitched a joint proposal for the development of a Climate Smart Agriculture award. Debbie and Charles solicited feedback and insights on the proposal to develop an innovation award in climate smart agriculture that would raise the profile of the great work being accomplished in the industry.

Action Items/ Key Takeaways

- Please visit C-AGG's Denver Resources webpage for additional articles from Dr. Rattan Lal including this article on the societal value of soil carbon: http://c-agg.org/cm_vault/files/docs/Societal_value_of_soil_carbon_by_Lal_2014.pdf.
- C-AGG will circulate updates and additional papers generated from the research process led by IPNI and TFI and presented by Cliff Snyder as it becomes available.
- The Global Research Alliance Modeling Platform's (http://gramp.org.uk/emissions/) N_2O database now includes an additional 771 data records from 51 published peer-reviewed sources. These records can be used to cost-effectively validate and calibrate the process-models carbon market projects use to estimate changes in GHG emissions.
- California's Air Resources Board (ARB) released another version of their draft Short Lived Climate Pollutant (SLCP) strategy in April, which is currently undergoing final revisions based on public comments received. A final version will go before the board in September, but the current version can be found here: http://www.arb.ca.gov/cc/shortlived/meetings/04112016/proposedstrategy.pdf.
- During the discussion on the business case for conservation practices, Don McCabe referenced a presentation given by Glenn Farris from AGCo at a precision agriculture

workshop in Canada: http://www.oaft.org/pdf/glenn-farris–AGCO-corporation.pdf. Full precision agriculture workshop agenda and presentations can be found: http://www.oaft.org/resources.aspx

- C-AGG and Charles Stanier (U. of Iowa) have jointly developed a proposal for a Presidential Leadership and Innovation Award in Climate Smart Agriculture. We are seeking feedback on the current version of this proposal, which can be found here: http://c-agg.org/cm_vault/files/docs/climate_smart_ag_awards_program_ver_may12.pdf. Please send comments or suggestions to Debbie (dreed@drdassociates.org) and Charles (Charles-stanier@uiowa.edu).

Meeting Summary

Tuesday, July 12, 2016

Welcome and Introductions: C-AGG Overview and Background

Debbie Reed, C-AGG's Executive Director, kicked off the meeting with an overview of C-AGG, its guiding principles, its mission and vision, and current steering committee members. C-AGG's multi-stakeholder coalition builds sustainable agriculture and climate change mitigation capacity that accelerates change across organizations, sectors and regions. C-AGG works to create incentives and value for the agricultural sector to reduce greenhouse gas emissions and deliver ecosystem services at scale. C-AGG achieves this mission by building consensus on tools, policies, and decision support systems that drive towards thriving carbon and environmental markets. Consensus is reached through an open collaboration policy amongst participants during C-AGG's three annual two-day meetings. These meetings bring participants working across the agricultural value chain together to discuss key issues facing the sector and to learn more about the current state of the science, policy, and tool development for quantifying, monitoring and verifying emission reductions from the sector. Between meetings C-AGG hosts intermittent workshops focused on issues requiring a deeper dive; distributes key sector updates via a participant email list serve; and posts regular updates to its website. C-AGG believes that the agriculture sector can provide ecosystem services and environmental solutions to society that complement the sector's current and very important role of feeding, clothing, and fueling the country and the world.

The meeting objectives for the two days in Denver included:

- Learning about the current state of soil greenhouse gas research, metrics, and policies including sequestration, fluxes, and mitigation practices and potentials;
- Discussing the legislative calendar for the 2018 farm bill;
- Learning about the Short-Lived Climate Pollutant (SCLP) plan in California and what opportunities may exist for the agriculture sector;

- Learning about the latest efforts to reduce the data burden for agricultural carbon market projects; and
- Contributing feedback to the development of a climate-smart agriculture awards program.

Soil Carbon Sequestration: Science & Implementation of the 4/1000 Initiative on US Croplands and Grasslands

Rattan Lal, the director of the Carbon Management and Sequestration Center at The Ohio State University, took the group on a historical journey from the dawn of industrial agriculture to present day practices to highlight the impacts and benefits humans and agriculture have had on the rest of earth's natural systems. Humans began cultivating crops around 8,000 BC, which was facilitated by the stabilization of global temperatures and atmospheric CO_2 concentrations, often referred to as "the long summer." Fast forward to 1750, when the next inflection point in human history, the industrial revolution, led to an increase in agriculture's productivity allowing the population to grow a thousand fold from 2-20 M to 7.3 billion in roughly 250 years. This level of population growth over this short-period of time has led to massive impacts on our natural systems including:

- **Soil erosion** – close to 2 B hectares (ha) per year leading to massive soil degradation;
- **Salinization of soil** – 20% of all irrigated lands have been impacted;
- **Algal blooms** (eutrophication) - 900 miles of the Ohio river were impacted last year and every year the Gulf of Mexico struggles with a growing dead zone;
- **Loss of agriculture land to sealing and urbanization** – by 2030 urban land cover will increase by 152 M ha putting pressure on farmers' land;
- **Loss of biodiversity** - 1000 to 10,000 species are estimated to be lost each year;
- **Tropical deforestation** - 7-8 M ha/yr. in the 2000s though trends show a slowing;
- **Ground water depletion** – numerous acquirers around the world are facing pressures from increased irrigation; and
- **Loss of terrestrial C pool** - 486 Pg carbon lost from land use change and 78 Pg carbon from soil since prehistoric time.

In 1992, the United Nations established the first set of sustainable development goals, Agenda 21, which were followed by the Millennium Development Goals (MDGs) and more recently the Sustainable Development Goals, which have all been focused on eradicating poverty and food insecurity globally. While much focus and money was put towards achieving these goals neither Agenda 21 nor the MDGs were accomplished according to official reports. When you consider that agriculture accounts for 38% of Earth's terrestrial surface and 70% of global freshwater withdrawals and produces enough food to feed the current population, it is unsettling that 1 in 7 is still food-insecure and 2-3 in 7 are malnourished – the system is clearly broken.

To find a solution and an answer to this problem, society must look to the soils.[1] Applying Hubbert's curve to soil shows that there is a peak soil number past which land grabs and civil unrest will occur. Based on the curve, optimal soil is 0.25 ha/capita with 0.05 ha/capita being the tipping point for land grabs. To prevent unrest around the world, society must focus on preserving soils and their vital ecosystem service functions. Soil can be characterized by its health and its quality. Soil quality is a bigger umbrella term of which soil health[2] is a component. Soil quality is used to describe the soil's function whereas soil health presents the soil as a finite and dynamic living resource and is directly related to plant health. One of the principal components of soil is soil organic matter (SOM). SOM is made up of stabilized organic matter, an active fraction of decomposing organic matter, fresh residue, and living organisms.

SOC which is contained within SOM drives the physical, chemical, ecological, and biological functions of the soil and acts as the main source of energy for soil microorganisms. While SOC has historically never been used as an indicator of environment quality and system performance, there are numerous advantages to adopting it as an indicator of soil health including: ability to directly measure, linkage to ecosystem performance and services, well defined properties, and the ability to calculate its uncertainty. Soil health is the engine that drives economic development and forms the foundation of the ecosystem service pyramid. A policy lag and instability has resulted in a degradation and fracturing of this foundation and leaders on soil health need to bring this issue to the forefront of the current political landscape. The current model of extractive farming is no longer sustainable and is leading to hunger, malnutrition, political unrest, war and insecurity.

Farming practices and policies need to begin recognizing this need for agriculture that is regenerative and rebuilds the SOC, which can be achieved through conservation practices and emerging technologies. To achieve improved sequestration in the agriculture sector, producers will need to leave residues across rotations, use cover crops, reduce tillage, and better integrate nutrient management. Research has demonstrated that using these techniques has increased yields in a poor growing season, reduced water run-off, improved soil quality, conserved nutrients, and increased SOC.

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[1] Soil, a dynamic natural body at the atmosphere and lithosphere interphase, is teeming with life that performs numerous ecosystem functions including recycling of dead and decaying organic matter into plant nutrients, denaturing of pollutants and filtering of water, moderating climate and sequestering carbon, storing germplasm and enhancing biodiversity, and providing the basis of all terrestrial life. – Lal (2016)

[2] Soil's capacity, as a dynamic and biologically active entity, within natural and managed landscapes, to sustain multiple ecosystems services including net primary productivity, food and nutritional security, biodiversity, water purification and renewability, carbon sequestration, air quality and atmospheric chemistry and elemental cycling for human wellbeing and nature conservancy. – Lal (2016)

The importance of SOC recently received international attention during the climate negotiations held in Paris in December 2015, when the French Agriculture Minister announced an aspirational goal to enhance soil C stocks by an average of 0.4% per year to 40-cm depth. To better understand the potential for this initiative in the US, Dr. Lal and Dr. Adam Chambers with USDA-NRCS recently published a paper estimating the current potential for soil carbon sequestration in the US falls between 144-432 Tg C per year. However, to reach these goals the government will need to enact policy solutions that properly account for the cost of this ecosystem service and incentivize conservation behaviors through some form of ecosystem service payment to producers and land managers. Dr. Lal estimates that the cost of payment would need to be at least $16/acre/year to achieve the goal.

As the newly elected president of the Soil Science Society, a two-year term position, Dr. Lal will be leading the society in implementing their current goals focused on improving carbon sequestration and soil health with a longer term focus on climate-resilient agriculture. Society has the job of teaching current and future generations that soil is the basis for all life on this planet and that it must be valued and taken care of to continue to support life as we know it.

Climate-Smart Soils

Steven Ogle from the Natural Resource Ecology Laboratory at Colorado State University built on Dr. Lal's discussion of the importance of soil carbon by presenting the results of his recent paper on managing land for climate-smart soils. The majority of GHG emissions from the agriculture sector are in the form of nitrous oxide (N_2O) from soil and nutrient management practices and methane (CH_4) from livestock operations via enteric fermentation and manure. To mitigate emissions from the sector, USDA and others have coined a suite of climate smart practices focused on improving food security while also reducing GHG emissions and adapting to the already changing climate. Improving soil management with a focus on increasing soil carbon sequestration is one climate smart practice that is gaining traction post-Paris. Sequestration can be achieved by increasing the carbon input into the soil carbon cycle through the addition of soil amendments such as biochar, the use of cover crops, and for certain areas and climates a decrease in tillage to reduce the impact on soil aggregates. In cold climates, no till can result in a shorter growing season and less soil carbon accumulation making it a regionally specific climate smart practice. Through the use of isotopes, studies are beginning to understand the soil dynamics that lead to recalcitrant carbon in soils. Research has shown that the non-structural and cellulose components of soil add to the longer term pool whereas the lignin tends to be a shorter term form of carbon.

Microbial activity in the soil and the carbon residence time compared to erosion rates are two additional components of soil that can impact carbon sequestration numbers, but their impacts are still being researched. Further, opportunities for the livestock sector to reduce emissions are centered on increasing soil sequestration followed by improved digestibility of feed.

N_2O emissions, which are the leading source of GHG emissions from agriculture, result from the nitrification and DeNitrification process that occurs in the soil as a result of naturally

occurring nitrogen pool and the addition of nitrogen from manure or synthetic sources. The quantity of emissions resulting from this process are largely dependent on the amount of water present and the pore space of the soil, where a pore space around 60-80% results in the highest potential N_2O emissions. To manage these emissions, it is recommended that farmers follow the 4R principles of application, which rely on right source, rate, time, and place. 4R management can be achieved through the use of new technologies such as variable rate applicators, nitrogen inhibitors, and slow release fertilizers. While N_2O emissions are generally higher than other GHG emissions from soils, CH_4 emissions must also be considered and managed when working with wet soils.

Dr. Paustian and Dr. Ogle's recently published paper on managing for climate-smart soils outlines the best questions to ask when looking to reduce GHG emissions and offers the most appropriate mitigation practices to implement to achieve climate-smart soils. These practices include reducing tillage, increasing nutrient application on degraded lands, trying out new crop rotations, and adding amendments such as compost and biochar. The list does not take into account regional systems and local conditions, so it should be used as a guidepost to begin further investigation rather than an absolute recommendation. To determine the mitigation potential of implementing these technologies on all possible lands across the world, the authors calculated the size of each opportunity based on an estimated quantity of land where the practices could be implemented focusing only on supply side solutions. While the opportunity falls somewhere between 1.5 Pg CO_2e/yr. and 5.3 Pg CO_2e/yr. depending on economic constraints, demand side changes such as reductions in food waste and loss are still necessary to keep rising temperatures below 2°C.

Another question that still remains is how to accurately monitor, report, and verify that these practice changes have occurred and have resulted in the intended emissions savings. To monitor, report, and verify the impacts of these practice changes, either empirical models that use a static emission factor or process based models that takes into account the dynamic nature of soil can be used. Process models produce more refined emissions quantifications if they have been properly evaluated and parameterized for a specific location using published data sources. Additionally, another key to using process models is the ability to calculate and apply to the final calculations the model's inherent structural uncertainty. The complexity of these models leads to a certain level of uncertainty, which must be calculated in order to fully understand the potential range of emissions and emissions reductions. Static empirical models are unable to calculate an accurate uncertainty value making these numbers challenging to defend. To verify the accuracy of the final emissions results from a process model, the results should be verified against an independent data source from the same region, which is a major challenge due to a lack of available data domestically and globally. CSU has been working with USDA for 10 years to develop a soil monitoring network to evaluate the results of these models. Currently, the survey has around 500 records compared to the 5,000 that are needed for a valuable comparative inventory.

CSU has also been working with NASA to understand if there are satellite sensors that could be used to verify these emissions, however, satellite sensors are likely a decade away from being used for these purposes.

To achieve climate smart agriculture and soils, governments and other actors in the value chain need to implement national and international GHG mitigation programs, strengthen GHG offset and ecosystem service markets, improve agricultural product supply chain management, develop appropriate decision-support systems, and enhance land-user engagement. Food production is certain to increase as population grows, which will make managing soils in a climate-smart manner the only way to ensure food security for future generations.

Improved Nitrogen (N) Management to Help Achieve Reduced N_2O Emissions and Minimize Other N Losses

Cliff Snyder from the International Plant Nutrition Institute (IPNI) presented the findings of a recent effort to improve the N_2O emissions factor used by Field to Market: The Alliance for Sustainable Agriculture (FTM) in their FieldPrint calculator, which is a quantification tool to help farmers track their continued improvement against 8 environmental indicators. Currently, the calculator relies on a simple N rate dependent multiplier to estimate N_2O emissions and gives broad consideration to nitrification inhibitors. The current multiplier is based on the IPCC's default emission factor which assumes 0.01 kg N_2O-N per ha per year for direct emissions and another 0.004 kg N_2O-N per ha per year for indirect emissions. This multiplier does not take into account specific management practice decisions or the remaining three R's (right source, time, or place) and it does not rely on the most current USDA published science (Marlen Eve's methods report) for baseline emissions. IPNI and other members of FTM identified this as a major problem with the current FieldPrint calculator, so IPNI teamed up with The Fertilizer Institute (TFI) to begin a science-based process for improving the metric with the goal of making it more accurate and more dynamic to capture a host of sustainability practices being implemented by farmers.

To improve the metrics accuracy, the team recommends using the USDA methods report to update the calculator's current N_2O baseline to make it more regionally specific. The USDA methods report contains estimated baseline N_2O emission rates for each dominant crop for 3 soil texture classes within a climatic region using process-based model simulations, which develop factors at the USDA land resource region (LRR) scale. The runs from these simulations were provided to IPNI to provide a better understanding of the mean and standard deviations associated with the base emission rates.

To understand how these rates are impacted by management practices, IPNI and TFI convened a group of soil and atmospheric scientists in March 2015 to discuss the current state of the science around N_2O emissions changes from on-farm management practices and options for capturing these in the emission factor used by FTM. IPNI and TFI developed a series of strawman tables for the scientists to review that categorized on farm practices by basic (practices adopted by 50% of farmers), intermediate (practices adopted by 20% of farmers), and

advanced (practices adopted by 5% of farmers) for seven different cropping systems for each 4R management framework. The practices included in the matrices were reviewed and agreed upon by the scientists, which formed the foundation for the next stage of the process – assigning more specific emission factors.

After the tables were agreed to, INPI received funding to investigate the literature that connected emission rates with the practices in the table for the specific cropping systems. IPNI reviewed studies comparing N_2O emissions to various plant N factors to determine the best indicator for emissions. Results showed a strong and consistently positive linear relationship between N_2O emissions and net nitrogen balance (NB), regardless of location. Using this premise, the science team scoured the literature for estimates of how N_2O emissions changed based on changes in NB resulting from the implementation of the intermediate and advanced 4R practices. Studies showed that implementing at least 50% of the intermediate 4R practices reduced emissions by 7% below baseline and the use of advanced 4R practices resulted in a 14% reduction.

Based on these results, TFI and IPNI are advocating for FTM to align their N_2O baseline to USDA's LRR, crop, soil texture, N rate baselines and adjust this number proportionally up or down using the difference between farmer-applied N rates and those found in USDA's ARMS 2010 survey baseline N rate for a specific region. For the calculation of direct plus indirect emissions, IPNI and TFI suggest using the 3-tiered management suite approach that lowers emissions by 7% if intermediate practices are implemented and 14% if advanced practices are utilized. Updating the FTM FieldPrint metric using this proposal will make it sensitive to variations in cropping systems, Land Resource Region, soil texture, and N management. Additionally, IPNI found through comparing FieldPrint model simulations to 15 measured emissions that the calculator is consistently underestimating field N_2O emissions. While this new framework significantly improves the ability of the FieldPrint calculator to capture on-farm climate smart practices, it still has its challenges including the ability to accurately account for every specific combination of practices utilized by a farmer. However, IPNI and TFI see it as a much improved step forward for capturing one of the major sources of GHG emissions from row crop agriculture.

The Global Research Alliance Modeling Platform (GRAMP): New Features to Help Model Changes in Soil Carbon and Nitrogen

Bill Salas with Applied Geosolutions provided an overview of the Global Research Alliance Modeling Platform (GRAMP) including discussion of recent updates to the website that will help the modeling community better model soil carbon and nitrogen dynamics. GRAMP, launched in 2009, is a repository for process based models typically utilized for ecosystem service markets and was designed with the goal of deepening and broadening mitigation research efforts across the agricultural sub-sectors. The platform, which aims to be a comprehensive resource for GHG models, was developed to improve GHG model cyber infrastructure transparency, enhance use of models, provide education materials, and collect

and disseminate field data for model validation. The initial focus of the platform was on the DeNitrification/Decomposition (DNDC) model and has since expanded to include the ECOSSE model with DayCent/CENTURY model on deck for inclusion.

In addition to being a house for the model source codes, GRAMP also provides structured analysis and compilation of available experimental databases for benchmarking, develops model performance indicators, and creates a cyber infrastructure for the models. The cyber infrastructure includes a web user multi-tiered authentication system, a model user's database system, a content management system, a GIS-based map system, a field database query system, and associated model training materials. The platform allows researchers, who have been authenticated as such, to add new research data and peer-reviewed journal articles to the system making the platform an open source data repository.

GRAMP is primarily a platform to learn about models, to develop a global collaborative community to further models and for storing and distributing them. All of the models and their source code are accessible and downloadable from the site. Additionally, all of the data sets and associated publications used to calibrate a certain model run can be easily accessed and downloaded from the site. C-AGG recently funded an expansion to the N_2O database on the site helping to add 771 new data records to the database from 51 articles. To continue to build out the data repository, GRAMP is collaborating with MAGGnet and Yara to add hundreds to thousands of global field data records to the database.

GRAMP was designed as a resource for model developers and users and intended to enhance market development. The platform is researcher and modeler driven and relies on the community to make the important improvements to the models and data sets needed to improve the uncertainty associated with the use of these process models.

Climate Smart Agriculture and Congress: The 2018 Farm Bill and Beyond

Sean Babington with the US Senate Committee on Agriculture, Nutrition, and Forestry works on the minority committee staff for Senator Debbie Stabenow (D) of Michigan and led the group in a brainstorming session about possible changes the group would like to see in the upcoming farm bill. Historically, the Farm Bill has been one of the few pieces of legislation to consistently have bipartisan support and be passed on time. However, the 2014 bill saw this trend begin to waiver as the passage of the 2014 was delayed, which could continue through the next reauthorization.

The programs included in the farm bill should be seen as one avenue for mainstreaming the developments coming out of the academic and research communities, including those who presented earlier in the day. The government's role is to protect the commons such as clean air, clean water, and ecosystem services for the public interest. The farm bill is one vehicle that can be used to achieve this. The farm bill should be seen as a way to bring conservation and pollution prevention practices into wider adoption while also providing the safety net farmers need to take these risks that will result in benefits to society.

The current farm bill expires in September 2018 which makes now the appropriate time to begin discussions around the topics and programs that should be included in the next iteration. Sean encouraged the group to think about ideas for updating current programs, adding or authorizing new programs, or eliminating programs that may not be working. The timing for this type of discussion with policy makers is ripe given the recent attention on GHG emissions (Paris Agreement, 4 by 1000 initiative, International Year of Soils, USDA's Climate Smart Building Blocks) and the upcoming legislative cycle. C-AGG and its members could provide a well-rounded and diverse perspective on farm bill updates that those on the committee find incredibly valuable.

USDA's Climate Smart Building Blocks provide a good framework for reviewing the current farm bill programs and what gaps may need to be addressed in order for the agency to reach the goal of reducing emissions by 120 MMT of CO_2e by 2025. To review the current farm bill programs, Sean used the USDA Building Blocks as a framework and discussed how the farm bill is helping to achieve each block's goal.

Soil Health. NRCS has received funding to increase capacity (17 new hires) to provide technical assistance specifically targeted at soil health conservation. NRCS has also funded 24 Conservation Innovation Grants looking at soil health, which is funded through the Environmental Quality Incentives Program (EQIP), a farm bill program. The National Institute of Food and Agriculture (NIFA), which was authorized under a previous farm bill, has also received $8.4 M in new funding to study and develop new approaches for the agriculture sector to reduce climate change.

Nitrogen Stewardship. EQIP funding has been used to finance CIGs including the Environmental Defense Fund's (EDF) exploration into how annual and perennial crops can take advantage of the carbon markets by improving nitrogen use efficiency on farms.

Livestock Partnerships. The Rural Energy for American Program (REAP), a signature program of the energy title program under the farm bill, has provided $12.5 M in financing for digesters in 17 states as of last October, which will generate 167,000 MW of renewable power annually. The program currently has $50 M in mandatory funds and $15 M in discretionary funding, which Sean would appreciate support in keeping and increasing.

Conservation of Sensitive Lands. CIGs, the Regional Conservation Partnership Program (RCPP) and Conservation Reserve Programs (CRP) are all strategies and farm bill funded programs aimed at increasing conservation. Recently, USDA made a $4 M investment in CRP acres in forested riparian buffers in the Chesapeake Bay watershed to improve water quality and sequestration benefits. In addition to this funding, multiple CIGs and RCPP projects have been awarded in the past year.

Grazing and pasturelands. USDA made a $700,000 investment to improve GHG markets for grassland projects mainly through CIG awards including a TerraGlobal project that helped develop the initial protocols and projects for avoided conversion of grasslands protocols.

With this background, Sean opened up the floor to C-AGG meeting attendees who contributed the following initial ideas for new programs and updates for the 2018 Farm Bill:

- Providing an insurance policy that would protect against yield losses if farmers are properly implementing soil health practices. This will require an education campaign for policy makers that does a better job of explaining the benefits of soil health.
- Developing an education or coaching program for beginning farmers on climate education. Potentially tie this to beginning farmer loans and add it to FFA curriculum.
- Tie crop insurance to indicators of greater farm resiliency such as soil health and higher SOC levels. A recent Government Accountability Office study proved that the government is not using the latest state of the science to evaluate its own exposure to risks when it comes to the two major government funded insurance programs: flood insurance and crop insurance.
- Adding a climate focus to the CREATAS program.
- Tying soil carbon rates to public grazing land leases.
- Increasing funding for measurement and monitoring of SOC rates across the country including the use of remote sensing and remote monitoring to monitor the impact of programs currently on the ground.

Wednesday, July 13, 2016

CA Short-Lived Climate Pollutants Plan Update

Ryan McCarthy provided an update on CA's draft strategy on short-lived climate pollutants (SLCP), which was re-released for a second round of public comment in April. The SLCP plan covers black carbon, methane, and hydro fluorocarbons (HFCs) that have global warming potentials (GWP) that are tens to thousands of times greater than CO_2 and as a result account for about 40% of current global warming. CA understands that strong, immediate action to cut both CO_2 and SLCP emissions is critical for mitigating climate change. Passed in 2014, CA Senate Bill 605 requires ARB to develop a strategy for mitigating SLCP by January 1, 2016 after a thorough review of the research, a completion of the state's inventory, and the identification of existing and new control measures. While the draft strategy was completed before the initial deadline, the final draft will go before the board in September for final approval.

Since C-AGG's March meeting, ARB held 3 additional workshops to discuss the plan with key stakeholders and presented the draft plan to the board in May as an informational update. ARB is in the process of making updates to the latest version of the plan based on the most recent round of feedback received and will present this final version of the plan to the board in September. The SLCP plan is just one of the many plans ARB is in the process of developing to combat climate change. ARB is also developing an air quality plan to reduce emissions in the central valley and southern CA, where NOx and particulate matter is a huge driver. They are

developing a mobile source plan for 2030 and an updated Scoping Plan focused on developing a strategy for achieving the state's new 2030 climate goals.

The SLCP includes very aggressive emissions reduction targets for all gases including a target of reducing methane emissions from dairy manure by 20% in 2020 and 50% in 2025 making it one of the largest reduction goals from an absolute quantity perspective since the low carbon fuel standard was enacted. Ryan provided the group with an overview of the current targets and reduction strategies included in the current version of the plan for the relevant agricultural gases.

Black carbon. To reduce black carbon emissions and meet the state's 50% reduction goal by 2030, the plan focuses on improving off-road diesel emissions and increasing the use of biodiesel in these engines. While forest fire emissions are not included in the plan, CA recognizes the challenge they face trying to manage 66 M dead trees especially as they are shuttering some of their biomass burning facilities due to age. They could use some help thinking through the most beneficial uses for this biomass source.

HFCs. One of the challenges the state is still struggling with related to managing HFCs is the use of sulfuryl fluoride as a fumigant during almond and walnut storage. It replaced methyl bromide as the chemical of choice and there is no better alternative at present. However, this high global warming potential gas is not currently included in the state's inventory and therefore not covered by the SLCP plan, so it is potentially a large source of emissions that are currently unaccounted for, but that ARB is monitoring closely.

Methane. ARB is proposing new regulations for each major source of methane emissions excluding enteric emissions which will only be covered by a proposed goal. New regulations will be passed to minimize leaks and improve the infrastructure for the oil and gas industry. The state has proposed eliminating all organics from landfills by 2025 with a target to rescue 10% of food waste by 2020 and 20% by 2025. For the dairy industry, ARB will begin a regulatory process early next year to manage emissions from manure. The regulatory process has not yet been defined, but is certain to be a collaborative effort with the industry to minimize leakage to other states and to ensure the policies put in place effectively address both the emissions and the challenges faced by the industry. The policy will consider costs, leakage, and status of other programs to support emissions reductions, environmental justice concerns, water quality issues, and air quality concerns.

Since March, ARB has run an economic analysis of the proposed options for reaching the proposed emissions reduction targets, which focused mainly on the digester pathway for methane. The analysis concluded that if the output of the digester can be used as a renewable fuel and receive a favorable feed-in tariff (likely close to $0.17 compared to a current rate of $0.127) it is possible to economically meet the proposed targets through the sale of Renewable Fuel Standard (RFS) and Low Carbon Fuel Standard (LCFS) credits at current prices in addition to the revenue received from other traditional sources (i.e., the gas). Kern County has been selected as a potential pilot site to test the feasibility of implementing a dairy digester cluster

that can produce gas, renewable electricity from this gas, and renewable transportation fuel. SoCal Gas is currently investigating the potential use of these clusters to meet their goals of increasing renewable gas to the pipeline.

One major challenge to meeting all of CA's climate goals is the current uncertain policy environment in the state. Last year, uncertainty surrounding the reauthorization of the RFS caused prices to drop to $20 from a normal average over $100. Currently, CA's landmark cap-and-trade legislation (AB32) is up for renewal past 2020 and reauthorization is not a given, which has slowed auction sales in recent months. Additionally, the governor is pushing for a 2/3 majority vote for AB32's reauthorization to allow funds from the program to be put towards any state program – at present they can only be used for programs that reduced GHG emissions. There are currently two bills going through the state legislature that would reauthorize AB32, which will be voted on before the end of session at the end of August.

The oil and gas industry is lobbying hard this session after a big win last year to have a 50% reduction in gasoline clause removed from the governor's climate legislation, which means the LCFS and Senate Bill (SB) 1383, which would codify the state's SLCP targets, could both face an uphill battle this legislative season. The dairy industry and waste haulers are also uncertain how to approach SB 1383 since they would prefer more clarity on when ARB would regulate dairies and what conditions would need to be met to trigger regulation. ARB is hopeful a compromise can be achieved and that the legislature will approve funds to support the SLCP plan, which were not passed during the June budget review.

There is still much uncertainty around the future of CA's climate programs, but ARB and the Governor are committed to meeting the targets they have put forth. As Mary Nichols said in a recent call to action, "we should be able to figure out how to eliminate food waste and keep manure out of our waterways before Elon Musk puts boots on Mars."

Decreased Enteric Methane Emissions from Livestock Seen with Use of 3-NOP as a Feed Additive

Garth Boyd a consultant for DSM Nutritional Products presented new research on the effectiveness of 3-nitrooxypropoanol (3-NOP) as an enteric methane emissions suppressant in ruminants. Garth and his partners at the Prasino Group have been working since 2010 to find a feed additive that can reduce methane emissions in ruminants resulting in the generation of carbon credits. Prasino received a grant from NRCS 5 years ago to work with the American Carbon Registry (ACR) to adapt an enteric methane emissions protocol for the US using the Alberta market's protocol as a framework. Since this original quest, research around the world has unearthed multiple opportunities to reduce emissions from ruminants. DSM (based in Switzerland) has been trying to develop compounds that can be added to feed to reduce emissions and were the first to investigate 3-NOP as a potential emission suppressant. They began this journey with sustainability at the forefront, but have since investigated the other positive animal husbandry benefits needed to drive adoption.

3-NOP has been shown in research trials to reduce enteric emissions by up to 30% while improving cattle feed efficiency through improved rumen function. The compound works by inhibiting methanogenesis[3] in the rumen by blocking an enzyme in the rumen from attaching to its proper position during the final stage of methanogenesis. Studies performed on dairy and beef cattle have shown adding a 60 ppm dose of 3-NOP to feed reduces methane emissions by at least 30%, increases milk protein in dairy cattle, and leads to feed efficiency and better body weight gain for both beef and dairy cattle. Additionally, there is hope that the compound could improve breeding performance, which would be a game changer for the industry.

3-NOP has a half-life of 30 minutes and to date has not appeared in the milk or meat produced from animals consuming the additive. DSM is currently going through the risk assessment process with FDA to have the compound approved for commercial use. To date, DSM has completed the risk assessment on animal safety and is in the process of completing the worker and consumer safety pieces. DSM has completed 45 different studies to try to find residues of the compound in milk, but to date none have been found. The final piece of the puzzle is greater understanding the NO pathway that results from the addition of 3-NOP and if it increases other gas emissions.

Currently, DSM is in the process of developing a go to market strategy that focuses on improved feed efficiencies and possibly improved breeding performance while marketing the emissions benefit as an ancillary benefit. While cattlemen are not as concerned about methane emissions, Consumer Packaged Goods (CPG) and retailers are, so companies like Danone are looking at how this would help them meet their corporate goals. Fair Oaks has considered using the compound in combination with their other sustainability initiatives to achieve carbon neutral milk.

DSM still needs to run more on-farm trials to better understand how the compound's efficacy changes depending on the feed provided to the beef and dairy cattle in addition to determining the appropriate dose that should be used to generate optimal efficiency of both emissions reductions and weight gain. The goal is to bring the compound to commercial trials soon with the hope of fully rolling it out in a jurisdiction by 2019.

The compound will likely be easiest to use at dairies and large feed lots where feed rations are controlled and provided, but DSM is investigating options for pasture raised animals. Unfortunately, since the compound acts as a suppressant once it is removed emissions will return making constant consumption necessary to achieve maximum emission reduction potential. The compound holds large potential for emissions reductions around the world and will be exciting to follow in the coming years as more research trials are performed and results released.

[3] Methanogenesis is a 7 step process that occurs in the rumen resulting in the production of methane from the breakdown of cellulose by microbes known as methanogens.

Streamlining Data Flow from Farms to Models: Reducing Burdens & Barriers for Carbon Market Projects

Jim Pollock with Prassack Advisors and Sara Kroopf with Environmental Defense Fund presented on the outcomes of a recent study on reducing the burdens and barriers associated with data collection and transfer required for the generation of carbon credits. EDF hired Jim's consulting firm to develop a concise overview of the on-farm data management landscape and how it maps to the current data requirements for the carbon market protocols, which is one of EDF's deliverables for their 2015 Conservation Innovation Grant award. Prassack Advisors have deep expertise in the development of on-farm Application Program Interfaces (API) that allow farmers to pull in ancillary operations data such as weather and disease pressures to better inform their field and farm management decisions and therefore have a deep understanding of the industry.

EDF's nitrogen management CIG has two major goals: (1) improve the infrastructure needed to develop nitrogen management carbon credits and (2) drive implementation of existing protocols. In terms of infrastructure development, the CIG is focused on improving protocols and improving quantification tools and data collection procedures to reduce project development barriers. EDF is working with a host of players in the agriculture space on this effort and the development of this data flow analysis piece has helped the team better understand ways to reduce data collection barriers.

The data flow analysis identified carbon credit generation efficiencies that can be gained by leveraging the software and data inputs the growers are already gathering through their various piece of on-farm equipment. The analysis specifically investigated how the data being collected by the on-farm equipment can easily feed into the biogeochemical process models used for quantifying emissions fluxes and how the data maps to the carbon market protocol and registry requirements.

Prassack identified 4 major challenges related to collecting agriculture data, which provided the initial framework for investigating the potential of linking farm data to models. These challenges included:

1. **Capturing complexity of on-farm activities**. How to measure and represent all farm activities that contribute to GHG emissions.
2. **Managing volume of data**. How to store and query the gigabytes of data that are collected from each tracker, combine and drone pass.
3. **Complexity of current data collection industry**. There are a plethora of companies trying to solve data collection how do you know which horse to pick?

4. **Managing the tension between difficulty and motivation for the farmer**. Which tools strike the appropriate balance between the data needed for the carbon credit generation and the level of effort required by the farmer to capture quality data.

EDF's major intention with this report was to uncover the top 5 on-farm management tools that could be used to drive an N_2O model and investigate what the data transfer process would require. To this end, Prassack created clusters of companies and tools that typically interact in what they termed 'dominant data ecosystems.' They then looked at the type of data these ecosystems were collecting and compared that to the type of data needed to run the N_2O models to determine how well the different systems accomplished this task. This assessment also considered structured versus unstructured data to determine if the format of the data would be easily transferable. Finally, they looked at if the on-farm software systems already had APIs and how easy it would be to export and synchronize the on-farm systems with a model platform.

Based on the results of this analysis, Prassack sees three models for how the grower and the on-farm management software could sync with the models and the registry requirements.

Model 1, termed the "carbon centric" model, starts with the carbon model platform and creates an interface to pull the needed data from the different farm management applications in the process model. This would require the creation of another user interface and would likely need more consolidation in the on-farm management software space to ensure the interface is compatible across all farm software. While doable this solution is not ideal.

Model 2 is an intermediary option that does both a push and a pull. The option requires a third party intermediary (currently a project developer) to pull information from the on-farm management systems to then push it to the carbon model for the carbon calculations. The third-party is then responsible for filling out the carbon credit application and pushing the money back out to producers. This model most closely resembles how the market works today and as many have expressed over the years leaves room for improvement.

Model 3 centers around the on-farm management software being at the center of all activity. The system would push all necessary data to both the carbon model and the registry. It would use an API to connect with the carbon model and then use the output of this model to turn around and sync directly with the registry's system. While this clearly does not exist right now, it is the simplest and most efficient model since it reduces the number of parties involved. This would require some additional QA/QC since it removes the project developer from the traditional middle man role.

Now that the model options are complete the next step is to test the level of interest from farm management software companies to integrate with carbon models. Prassack has already spoken to 25 or more companies and a few are close to capturing all of the necessary model data

already. The results of this analysis have already been shared with carbon modelers including DNDC and COMET-Farm, so they can begin to think through changes needed on the model side to make "model 3" work. Finally, Prassack will be facilitating introductions between various data flow players, so they can begin to think about this possibility when updating their software.

OPTIS: A Pilot Project to Track Conservation Tillage and No-Till Use on Agricultural Lands Using Remote Sensing Technology

Bill Salas with Applied Geosolutions (AGS) presented the preliminary results of a joint project between AGS and the Conservation Technology Information Center (CTIC) to map conservation practices at field to watershed scale in an effort to better inform the national inventory and the agricultural community more broadly. Numerous peer reviewed studies on the use of remote sensing for mapping conservation practices like tillage, cover cropping and artificial field drainage (tile drainage) have been published, but most have only been successful at mapping practices over small areas for which the algorithms have been calibrated. This study attempted to operationalize the system of mapping conservation practices for consistent wide range mapping.

USDA has spotty data on where and how conservation practices are being implemented across the country. CTIC historically provided this type of survey data to USDA, but this program was discontinued in 2004, so at present Conservation Effects Assessment Project (CEAP) data and the National Agricultural Statistics Service (NASS) survey data are the only collection vehicles for on-ground conservation practices, which are not very granular. While these surveys provide useful conservation information there is no way to track it via space or time. The industry is in need of a more consistent, systematic system for capturing baseline data for use of conservation practices. Existing satellite-based approaches to monitoring this have been limited to single area for a single time period using often only a single satellite.

To fill these gaps, AGS and CTIC were awarded a grant to use satellite remote sensing data run through automated algorithms and GIS science decision trees and validated by on the ground measurements to develop a Web-GIS and mobile application data delivery system that accounted for, monitored, and reported on conservation practices at a larger scale. This system referred to as the Operational Tillage Information System (OpTIS) could then be used by USDA and others to understand current practices on the ground and how they have changed and are changing over time.

OpTIS's algorithms are applicable across large sets of sensors (optical and SAR), a variety of platforms (i.e., space borne and unmanned aerial vehicles), and across various time periods. The algorithms can analyze data from multiple satellites, which can be combined with other geospatial data sets to generate crop residue and cover crop maps over wide areas over a

historical period of time. For this project, this method for data analysis was applied to a set of smaller watersheds in Indiana to calibrate the final algorithms.

The main goal of the project is to understand how well the OpTIS system performs when applied across a wide region over many years. To achieve this goal, AGS gathered time series observations from Landsat and MODIS to generate time series maps; compiled field-based information from historical transects to understand historical practices on the ground; and compiled ancillary geospatial data such as soils, weather, and crop type to see how that impacted the images. The raw satellite data was converted to crop residue cover estimates from which estimates of tillage practices from residue cover were derived. This screen was then applied statewide at 30m pixel resolution. The final step in the process is the field level validation using data collected by AGS and CTIC. The final results, to be released at the end of August, will be distributed at HUC8/10 and county scales. The results will be made publicly available by AGS and CTIC after a presentation to their funders. Maps for cover crops across the state will also be generated in a similar fashion by using an algorithm to map the presence and absence of cover crops.

The system works really well when you have well timed images and no cloud interference, but cloud cover has been a challenge in certain years. Therefore, the system tracks the data quality for each year of data to allow users to decide the threshold of allowable data confidence they want to use in their map. If a year falls below this confidence interval it is excluded from the set.

AGS is also simultaneously working with a review panel from USDA to validate the approach used to generate the maps, so it can be scaled nationwide to better inform the US GHG inventory. The major issue with scaling will be the differences between cropping system residues profiles, which will require the algorithm to be recalibrated.

USDA plans to use the final system to support the national inventory, spatially link it with the soil and climate modules in the DayCent model, and help to validate the Climate Smart Agriculture Building Blocks claims. The system also has the potential to be used to monitor conservation program implementation, crop insurance issuances, and provide MRV for ecosystem service markets, but it will require community support for national implementation.

Presidential Leadership and Innovation Award in Climate Smart Agriculture: A Joint Proposal by C-AGG and University of Iowa

Debbie Reed, C-AGG, and Charles Stanier a professor with the University of Iowa presented a joint proposal for the development of a Climate Smart Agriculture award to solicit participant feedback and insights on the proposal. As a chemical engineer and professor of chemical engineering and sustainability, Dr. Stanier was very familiar with the Environmental Protection Agency's Green Chemistry awards that have been in existence since 1996. As his research started to transition into the climate and agriculture arena and he increasingly attended related

conferences and meetings he was remiss to find that a similar high profile award did not exist for farmers and producers implementing innovative climate smart practices. An idea that could help to drive progress in this space. Dr. Stanier approached USDA with the idea to gauge their interest in supporting an award for the farming community and USDA directed him to C-AGG, who they saw as a potential leader on this effort.

After an initial conversation with Debbie, they jointly developed a concept paper for an innovation award in climate smart agriculture based on the green chemistry award that would raise the profile of the great work being accomplished in the industry. The award currently is not envisioned to be financial in nature, which is similar to the green chemistry award, and there is no fee to apply. The current version of the award proposal has been reviewed by 10 key individuals in the agriculture value chain and has received mostly positive support. The award would include two different groups: Group A, which is open to everyone, and Group B, which is only open to producers. Debbie and Charles are looking for feedback on the concept, the categories, and potential partners. During the meeting, the US Global Change Research Program was identified as a potential partner.