Location: **White House**

Date/Time: **Tuesday, April 5, 2016 / 1-2 pm EST**

Title: **Measuring Carbon Sequestration in Agricultural and Rangeland Ecosystems: Overview of Findings, Research Needs, and the 1(00) Million Tonne/yr Challenge**

Executive summary:
We will report on the following programs in order to share what we are learning about the potential roles of regenerative agriculture/grazing in climate mitigation, the restoration of soils and water cycles, and improvements in farmer and rancher enterprises.

The Palouse Low Disturbance Cropping (LDC) Study – (*funded by USDA, NRCS Conservation Innovation Grant*). This study has confirmed that cost effective, practical landscape-scale improvements to soil organic carbon (SOC) levels can be measured in farm fields where LDC has been used in the ~7-million-acre project area. Annual SOC improvements were measured in LDC (one pass farming, compared to 2-3 pass no-till cropped) fields of 0.5-1.35 tC/ha/yr in meteorological zones with >40 cm annual precipitation and half these rates with <40 cms. This program used the *The Earth Partners Soil Carbon Quantification Method (*www.v-c-s.org) for sampling design, data analysis, and carbon stock accounting and computations.

The Alberta AMP Grazing Pilot Study – (*funded by Shell "GameChanger*). This study measured differences in soil carbon stocks and estimated accrual rates between Adaptive Multi-Paddock (AMP) grazing and Heavy and Light Continuous Grazed (HCG/LCG) ranches to 1 meter depth in upper, mid and lower slopes in each soil catena following the VCS method. Simultaneously, Decagon double ring infiltrometers were used to measure water infiltration, and plant cover, frequency and diversity were measured in 1 meter square quadrats in the paired paddocks. AMP paddocks used highly intensive, short-duration grazing followed by long recovery periods to emulate large herd migrations of species such as bison, caribou, wildebeest that coevolved with grassland ecosystems. This study followed Teague (2011) for creating paired comparisons between AMP, HCG and LCG paddocks and documented highly significant increases in soil organic carbon (mean of 3 tC/ha/yr) over each of the ten years after AMP grazing was initiated. In Alberta, AMP paddocks accrued an additional 1.4 – 2.4 tC/ha/yr compared to HCG paddocks. Water infiltration rates increased on average1.3 to 27 cm/hour in AMP paddocks. At one Alberta ranch pair, we used $^{13}CO_2$ stable isotope pulse labeling to track C uptake and fate and the microbial processes mediating carbon cycling in soil. Whole soil microbial genome DNA sequencing is now being completed.

We now intend to assess the scalability and benefits of GHG sequestration in a broader geographical set of agricultural systems and rangelands based on results from these pilot projects. This larger system science effort is focused on understanding the climate mitigation benefits if LDC or AMP grazing were scaled-up. For example, given ~4 gigatons of excess atmospheric GHG emissions annually and the ~3.5 billion hectares of grazed grasslands and ~1 billion hectares of row cropped agricultural lands, could regenerative agriculture and grazing greatly reduce legacy and future atmospheric GHG's. In theory, and we ask, can a 1% average increase in SOC annually sequester an additional ~4.5 gigatons of SOC? These pilot studies suggested 1-3% annual increases in SOC may be achievable even in semi-arid grasslands and agricultural landscapes.

Science Needs, and 1 Million Tonne Challenge – These pilot projects demonstrate that using regenerative cropping and grazing management can enhance both stored soil organic carbon and rates of water infiltration. We have designed a national study in 36 paired, triple-replicated ranch clusters, to geographically expand the pilot grazing study. We also intend to measure soil microbes, fungi, insect groups, birds, socio-economics, greenhouse gas fluxes (carbon dioxide, nitrous oxide and methane), and rancher & animal well-being. Our intent is to complete a system assessment of the GHG mitigation potential, system dynamics, socio-economic impediments and opportunities to inform how to most effectively scale-up real-on-the ground climate improvements and associated co-benefits.

The pilot projects have led us to also conceptually develop the **1(00) Million Tonne Challenge**. During the first three years this challenge is intended to result in a measurable increase of SOC of 1 million tonne/yr in participating ranches. The concept continues to sequester an additional 10 million tonnes C/yr during years 4 -6; and an additional100 million tonnes of new sequestered SOC in years 7- 9.

Communications – Communicating science findings, and the rancher personal experience in transitioning between HCG/LCG to AMP grazing, has reached diverse audiences using short video productions. ***Soil Carbon Cowboys*** has been watched in over one hundred & fifty countries by hundreds of thousands of people. All field science sampling was filmed for video production and presentation to educators, scientists, policy makers, consumers, corporations, health care providers, and others.

*Presenters** and Team Members in Attendance:*

****Steven I. Apfelbaum,** Chairman, Senior Ecologist, Applied Ecological Services, Inc. WI
****Richard Teague,** PhD, Texas A&M University, Grazing Land Ecologist and Management Specialist
Christian Davies, Ph.D., Soil Scientist, Shell International Exploration and Production Inc., Biofuel sustainability R&D, TX.
Peter Byck, Prof. of Practice, Arizona State University; Director+Producer, Carbon Nation
Russ Conser, CEO**,** Standard Soil, PBC; Retired head of Shell GameChanger, TX
Henk Mooiweer, PhD, Chemist, Innovation consultant, retired Shell GameChanger, TX

Examples of Team Members Prior Work:

Short Films by Peter Byck

- ***Soil Carbon Cowboys***
- ***Soil Carbon Curious***

Publications

- **Apfelbaum, Steven I.**, and John M. Kimble. 2007. "A Dirty Way to Fight Climate Change: A Promising Strategy: Store Carbon in the Soil." *Christian Science Monitor* (November 29).
- **Apfelbaum, Steven I.**, and Alan Haney. 2010. *Restoring Ecological Health to Your Land.* Washington, D.C.: Island Press.
- Bradford M. A., Keiser A. D., **Davies C. A.**, Mersmann C. A. and Strickland M. S. 2012. Empirical evidence that soil carbon formation from plant inputs is positively related to microbial growth. *Biogeochemistry* (113), 1-11.

- Guzman, Jose G., Rattan Lal, Shana Byrd, **Steven I. Apfelbaum**, and Ry L. Thompson. 2014. "Carbon Life Cycle Assessment for Prairie as a Crop in Reclaimed Mine Land." *Journal of Land Degradation & Development* (May 6). http://doi/10.1002/ldr.2291.
- Kimble, John M., Charles W. Rice, Debbie Reed, Sian Mooney, Ronald F. Follet, Rattan Lai, and **Steven I. Apfelbaum**. 2007. S*oil Carbon Management: Economic, Environmental and Societal Benefits*. Boca Raton, FL: CRC Press.
- Mello F. F., Cerri C. E. P., **Davies C. A.,** Galdos M. V., Holbrook M., Paustian K., Maia S. M. F., Bernoux M., Cerri C. C. 2014. Soil carbon and sugarcane ethanol payback time. *Nature Climate Change* (4), 605-609.
- Robertson A. D., **Davies C. A.**, Smith P., Dondini M., and McNamara N. 2015. Modelling the carbon cycle of *Miscanthus* plantations: existing models, current validation efforts and future development. *Global Change Biology Bioenergy* (7), 405-421.
- Smith P., **Davies C. A**., Ogle S., et. al. 2012. Towards an integrated global framework to assess the impacts of land use and management change on soil carbon: current capability and future vision. *Global Change Biology* (18), 2089-2101.
- **Teague, W.R**., Dowhower, S. L., Baker, S.A., Haile, N., DeLaune, P.B., Conover, D.M. 2011. Grazing management impacts on vegetation, soil biota, and soil chemical, physical and hydrological properties in tall grass prairie. *Journal of Agriculture Ecosystem & Environment* 141(3-4):310-322.
- **Teague, W.R., Steven I. Apfelbaum**, Rattan Lal, Urs P. Kreuter, Jason Rowntree, **Christian A. Davies, Russ Conser**, Marcia DeLonge, Mark Rasmussen, Jerry Hatfield, Tong Wang, Fugui Wang, **Peter Byck**. 2016. The Role of Ruminants in Reducing Agriculture's Carbon Footprint in North America. *The Journal of Soil and Water Conservation* 71(2):156-164.
- Wang, T., **Teague, W.R.**, Park, S.C., Bevers, S. 2015. GHG Mitigation potential of different grazing strategies in the United States Southern Great Plains. *Journal of Sustainability* 7(10):13500-13521 (2015)