Carbon Cycle Institute

TO: CalPac Section, SRM
FROM: Jeff Creque
DATE: 4/15/17
SUBJECT: Response to Dr. Joel Brown's Critique of Ryals et al 2015; CalPac Spring meeting, Rush Ranch, 4/4/17.

Dr. Joel Brown made a number of statements during his presentation to the CalPac meeting at Rush Ranch on 4/4/17, suggesting experimental soil carbon gains achieved through compost applications on California rangelands were not statistically significant and that the practice is ill advised. By focusing on a single figure from a modeling paper (Ryals et al 2015) -used to demonstrate the capacity to apply models to field data, not to report field results- Dr. Brown's comments ignore a body of peer-reviewed research and discourage both further exploration of this emerging climate change mitigation strategy and support for a proposed NRCS practice standard for compost application on grazed rangeland. Absent the opportunity for in-depth discussion on this topic at the meeting, the following is offered in response.

In his critique, Dr. Brown referred to Figure 2, Ryals et al 2015, to support his conclusion that compost applied to rangelands has no affect on carbon cycling. Indeed, error bars in this figure show no difference between controls and treatments. However, Dr. Brown presented Figure 2 out of its proper context; Ryals et al 2015 does not report on experimental field data; it is a modeling paper, reporting upon efforts to calibrate the DayCent ecosystem carbon model to accurately represent the effects of compost application on grazed rangeland. Figure 2 in this paper is intended to show adequate validation of model parameterization, not differences by treatment or site. That information is provided in Ryals and Silver 2013, Ryals et al 2014 and Ryals et al 2016, which report comprehensive data on site and soil characteristics, carbon pools and fluxes, soil moisture and vegetation characteristics.

This published, peer-reviewed field-based research has demonstrated statistically significant increases in carbon storage in California rangelands by increasing rates of carbon inputs relative to carbon outputs (Ryals and Silver 2013), as determined by direct measurement of bulk soil carbon, soil carbon fractionation, and chemical analysis of soil fractions (Ryals et al 2014). A process-based model was subsequently used to project impacts through time, based on the field data (Ryals et al. 2015), and a lifecycle model to compare greenhouse gas emissions of compost addition to rangelands with alternative scenarios was developed (DeLonge et al 2013). Dr. Brown's focus on a single figure (Figure 2, Ryals et al 2015) overlooks a suite of important data that can be used to evaluate benefits and tradeoffs of

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compost amendment of rangeland soils or to develop new research questions pertaining to the carbon dynamics of managed rangelands.

Dr. Brown also criticized Ryals et al 2015 based on its alleged failure to adequately characterize soil texture. However, as the paper explicitly states, soils were evaluated for texture during the field phase of this research (Ryals and Silver 2013), and model runs used separate site descriptions to test the model across differences in soil texture (Ryals et al 2015). Dr. Brown suggested soil C should be regressed against soil clay content to reduce standard errors, and indeed, the cited papers reporting detailed field data do include soil texture in their statistical evaluation of the data (Ryals and Silver 2013, Ryals et al. 2014). Dr. Brown similarly lamented the apparent lack of power analysis in the Ryals et al 2015 paper, but here he assumes the lack of statistical significance in Figure 2 reflects field experiments reported in Ryals and Silver 2013, which it does not.

Dr. Brown also challenged model results showing an increase in soil respiration, suggesting this increase necessarily reflects a net decrease in soil carbon. Accounting for net changes in ecosystem carbon storage must include carbon inputs, carbon losses, and/or residence time of carbon in soil organic matter pools. It is true that both measured and model results indicate increases in soil respiration (the major carbon loss pathway). But this is expected, as the nutrients and moisture provided by compost increase soil biological activity and root growth, which contribute to heterotrophic soil respiration and autotrophic soil respiration, respectively. Importantly, these losses were significantly outweighed by higher gains in carbon through increases in above- and below- ground net primary productivity. Further, compost increased carbon storage in physically protected soil aggregates (Ryals et al 2014).

Dr. Brown further dismissed the potential of compost amendment of rangelands as a climate change mitigation/adaptation strategy, referring to the practice as the application of "waste" to rangelands. It is important to emphasize that compost is not "waste," but the biochemically stable end product of a managed aerobic, thermophilic decomposition process that is regulated (in California) by the state EPA. Further, nutrients in compost are largely in organic form, such that "agronomic rates" are not appropriately determined by total nutrient content, but by mineralization rates. Indeed, one purpose of the modeling exercise (Ryals et al 2015) was to quantify the rate at which compost is mineralized in order to parameterize the model accordingly. It is also important to note that the 35 tons per acre rate (not 70 tons, as stated by Dr. Brown) used in the field experiment was a one-time application, equivalent to ½" of compost, applied to standing vegetation. This application was not repeated during the 3-year field trial, and model results suggest that lower application rates distributed over longer time periods would be

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equally effective. Again, one purpose of this modeling exercise was to address the question of how long impacts of a single compost application might persist and what quantity and frequency of compost application could induce the ecosystem carbon increases observed in the field research (Ryals and Silver 2013).

Peer reviewed research has shown that a one-time application of compost to grazed rangelands in California can indeed be an effective climate change mitigation strategy by increasing ecosystem carbon uptake and storage. Nor should we ignore co-benefits that accompany –and can drive further- increases in soil organic carbon, including increases in the ability of soil to retain water, supply energy and nutrients to the plant-soil system, and buffer against temperature fluctuations, drought and high intensity rainfall. While compost application is clearly neither feasible nor desirable in every rangeland context, robust peer reviewed research supports its efficacy as a rangeland restoration and climate mitigation strategy and its adoption as a NRCS rangeland conservation practice within the NRCS Conservation Planning framework.

Literature Cited:

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