

Western Compost Trials: Key Lessons Learned and Insights for Future Successes

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Executive Summary

Grazed grasslands in the Western United States provide essential ecosystem services, including forage production, biodiversity conservation, water cycling, and soil carbon sequestration. However, these landscapes are increasingly at risk due to higher temperatures, drought, soil degradation, declining productivity, and historically heavy grazing pressure. Compost amendment of grasslands has emerged as a promising strategy to enhance soil health, increase carbon sequestration, and improve the resilience of grassland ecosystems.

This white paper provides evidence supporting the expansion of conservation practices such as USDA NRCS Conservation Practice Standard CSP 336 and CSP 808, which promotes the use of organic amendments for sustainable soil management. Here we explore lessons learned from compost applications in grassland systems based on trials conducted in California, Colorado, Arizona, and New Mexico. We honor the Indigenous peoples of these lands—past, present, and future—who have long practiced regenerative land stewardship rooted in deep inter-relational knowledge. We recognize their enduring relationships with the soil, plants, and animals that we seek to understand and restore. By evaluating the impacts of compost on soil carbon storage, soil health, and plant productivity, this document aims to provide practical insights for land managers, researchers, and policymakers wishing to further explore, trial or implement the practice.

Key findings include:

- Compost applications can enhance soil organic carbon (SOC) in many systems; however, their effectiveness depends on site-specific conditions such as soil type, presence of vegetation, moisture availability, and the composition of the compost.
- Compost can significantly improve soil structure, microbial activity, and water retention, contributing to long-term ecosystem health.
- Site degradation, application rate, timing, irrigation methods (if any), and grazing management are critical factors influencing compost effectiveness.
- While compost amendments can boost forage yields in some cases, outcomes vary depending on site-specific conditions.

Lessons from field trials underscore the need for understanding the core mechanics of plant derived soil carbon sequestration, careful site assessment, and project design including vegetative cover type and density, local growing seasons, seasonal weather patterns, appropriate compost selection, and integration with other adaptive land management practices.

By refining compost application strategies and addressing implementation challenges, land stewards can leverage this practice to enhance soil carbon sequestration, improve grassland productivity, and contribute to climate resilience in Western rangelands. Enhanced resilience in rangelands and irrigated pasturelands enables ranchers to sustain their contributions to the food supply chain, promotes rich and sustainable habitat for wildlife, and provides essential ecosystem services including carbon, water and nutrient cycling.

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Compost in Western Rangelands

Compost Trials for Soil Health and Carbon Sequestration in Grasslands

Introduction

Grasslands, including irrigated pastures and rangelands, are critical ecosystems in the Western United States. They provide essential ecosystem services such as forage production, biodiversity conservation, and the potential for increased soil carbon (C) sequestration under certain regenerative management practices (Bengtsson et al., 2019). However, these landscapes are increasingly at risk due to certain management practices, such as intensive grazing, which can degrade soils, reduce plant productivity, and heighten vulnerability to drought under a changing climate (Bai et al., 2008). Globally, grasslands store a significant proportion of the world's soil organic carbon (SOC), but many are now losing carbon in the form of carbon dioxide (CO₂) due to land use pressures and climate-related disturbances (Conant, 2012; Köchy et al., 2015; Phukubye et al., 2022). Recent studies have found a massive “hemorrhaging” of C from federal grasslands, stemming from both management and the effects of worsening climate change (Bai & Cotrufo, 2022). Climate change reduces SOC storage in grasslands by disrupting plant C inputs and microbial activity through increased extreme temperatures, drought, and flooding (Zhou et al., 2024). To effectively arrest the loss of soil C and transition to a state of sequestration, it is necessary to modify management practices. This involves altering ecological elements to optimize SOC levels and ensure a sustained long-term response. Compost amendments have emerged as a promising tool to restore soil health, increase net primary productivity and improve resilience in these grasslands systems (Kutos et al., 2023a). Adding compost to grasslands can help enhance C sequestration and long-term storage, which interests local, state, and federal agencies as an effective climate mitigation tool (Silver et al., 2018).

This white paper explores the potential of compost applications in grassland systems, focusing on trials funded by various parties in Colorado, Arizona, and New Mexico. By examining the principles of compost application, its effects on SOC storage and soil health, and insights from various state trials, this document aims to inform land managers, researchers, and policymakers about the opportunities and challenges of adopting compost as a management practice.

Conservation Practice CSP 336 California CSP 808

The United States Department of Agriculture’s (USDA) Natural Resources Conservation Services (NRCS) developed the Soil Carbon Amendment conservation practice to improve soil health by applying organic materials like compost and biochar. Initially introduced as Interim Conservation Practice Standard Code 808 in December 2019, this practice focused on enhancing soil organic matter, improving soil aggregate stability, increasing plant productivity, and promoting efficient water use (see Appendix: Conservation Field Trial (GM 403.3)). After successful evaluations, it became a permanent national standard under Conservation Practice Standard Code 336 in November 2022, maintaining its focus on soil health and carbon sequestration. In California, the NRCS supports the adoption of these practices through programs like EQIP, which provides financial assistance for purchasing compost and biochar applications. This document intends to provide

evidence supporting the adoption of this conservation practice standard across various states, promoting regenerative grassland management to improve the resilience of these ecosystems.

What is Compost?

Compost is a biologically active material produced through the managed, aerobic, thermophilic decomposition of organic materials. Thermophilic composting is a composting method that utilizes heat-loving bacteria and fungi to generate high temperatures, which helps kill pathogens and weed seeds in the compost pile. These materials, often referred to as feedstocks, include yard trimmings, food scraps, and animal manures, each with distinct nutrient profiles and initial carbon-to-nitrogen (C:N) ratios (Shen et al., 2024). During composting, microbial activity transforms these inputs into a stabilized product rich in organic matter, nutrients (e.g., nitrogen, phosphorus, potassium), and beneficial microorganisms (Amuah et al., 2022; Azim et al., 2018).

One of the most important characteristics of finished compost is its C:N ratio, which is the proportion of carbon to nitrogen in organic matter, which strongly influences microbial decomposition and nutrient dynamics in the soil once amended (Wilson et al., 2018). Microbes need both carbon and nitrogen for building cellular components. The C:N ratio of the available organic matter dictates how efficiently they can grow and decompose materials (Gaudel et al., 2024). Soil microbial biomass typically has a C:N ratio of ~8:1, meaning that organic matter with similar ratios is quickly decomposed. When compost has a low C:N ratio (<20), it contains sufficient nitrogen to support microbial growth, leading to rapid decomposition and net nitrogen mineralization, making nitrogen available to plants. In contrast, high C:N compost (>30–35) can cause nitrogen immobilization, as microbes scavenge nitrogen from the soil to meet their needs, temporarily reducing nitrogen availability for crops (Zhu et al., 2021).

Compost with a C:N ratio between 20 and 30 tends to strike a balance, stimulating microbial activity without triggering strong immobilization or excessive nutrient release. Choosing a compost with a C:N ratio that matches site goals, whether short-term fertility or long-term carbon storage, can enhance both microbial function and soil health outcomes.

Unlike synthetic fertilizers, compost provides a slow-release source of nutrients, improving soil fertility over time (Al-Bataina et al., 2016). It also introduces beneficial microbes that stimulate soil biological activity and contribute to nutrient cycling (Xu et al., 2023). These properties make compost a versatile amendment suitable for grassland systems where restoring productivity is a top priority.

What Does Compost Do in Grassland Systems?

When applied to grasslands, compost delivers multiple benefits that enhance biological, chemical, and physical soil properties. From a producer's standpoint, compost applications can lead to increased forage production and improved forage nutrient quality (Li et al., 2021). This improvement is driven by the addition of plant-available nutrients and improved soil water holding capacity provided by compost, which directly support plant growth and development. From a policy and state perspective, compost applications can play a significant role in climate mitigation by increasing the draw-down of CO₂ from the atmosphere via plant photosynthesis (Figure 1).

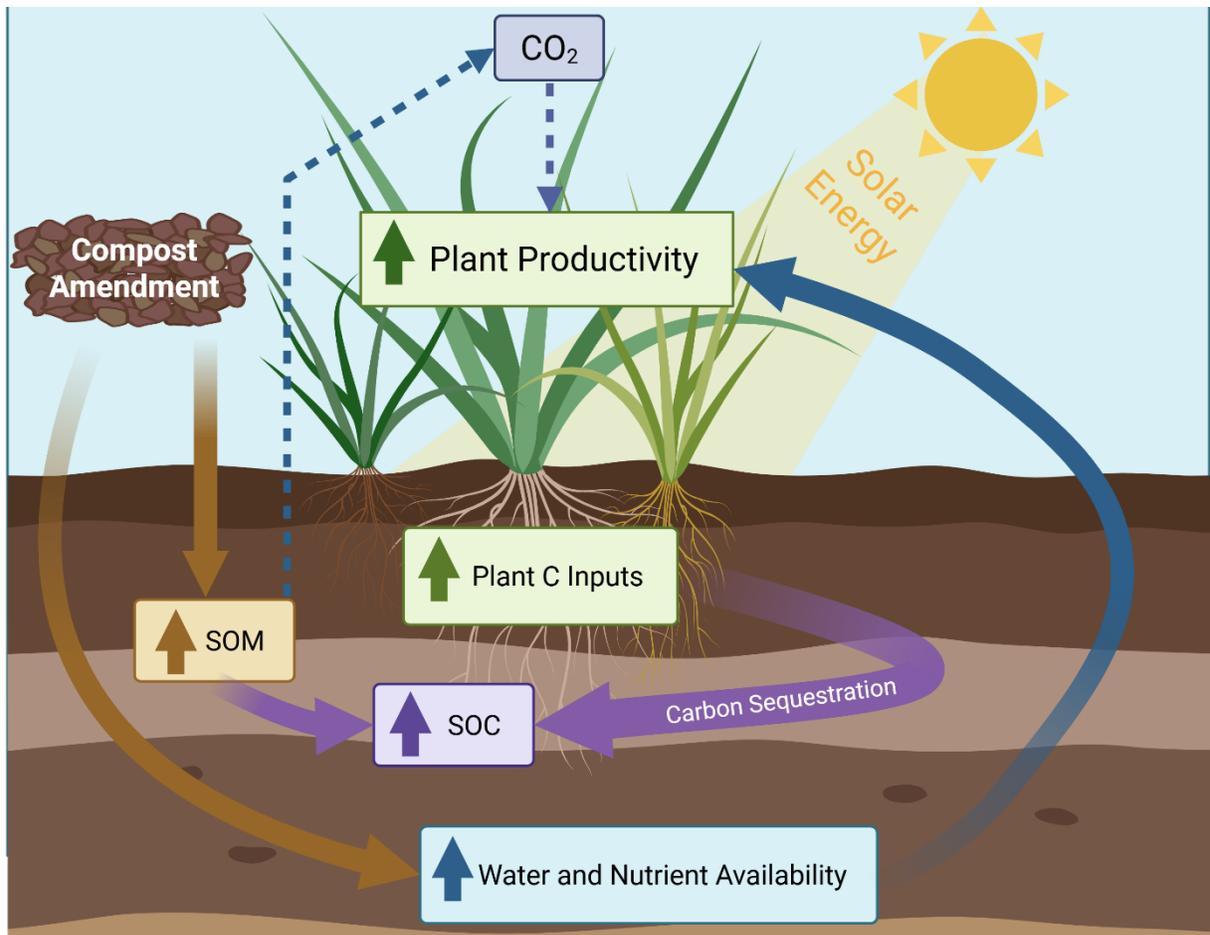


Figure 1. Conceptual diagram of the influence of compost amendments in grassland systems.

When applied to the soil surface, compost delivers both organic and inorganic nitrogen, along with soil organic matter (SOM). The nitrogen fraction can enhance plant productivity, while the effects of compost on the soil carbon cycle emerge over time. These longer-term benefits depend on microbial activity, soil moisture, and broader edaphic conditions. The OM in compost—approximately 50% carbon by mass—contributes to increased soil organic carbon (SOC) stocks, supporting carbon sequestration. As SOC builds, it improves water and nutrient availability, further reinforcing plant productivity and ecosystem resilience.

Moreover, compost contributes to soil health improvements that indirectly support increased forage production. Compost improves the soil's water-holding capacity by enhancing soil structure and increasing the soil organic matter (SOM) content, which in turn does increase the SOC of the soil (Ryals et al., 2014). These effects are particularly significant in semi-arid and arid regions, where water availability is a limiting factor for plant growth (Wan et al., 2022). These combined effects not only support higher forage yields but also improve the overall resilience of grassland systems, making them more productive over time (Ng et al., 2015).

Ecosystem context matters: compost in annual vs. perennial grasslands

Grasslands in the western U.S.—ranging from low-elevation annual systems to high-elevation or arid perennial grasslands—present distinct ecological conditions that influence how compost affects soil carbon cycling. These differences stem from variation in rooting depth, plant life history, microbial activity, and moisture regimes.

Annual grasslands are typically dominated by shallow-rooted species that germinate quickly with moisture and complete their life cycle within a season (Blair et al., 2013; Ning et al., 2022). The studies in California annual

rangelands have found that a single application of compost increased soil carbon by $2.1 \pm 1.0 \text{ Mg C ha}^{-1}$ in one growing season, and can start a cascading positive effect of net ecosystem storage of carbon for up to 15 years (Ryals & Silver, 2013). Most studies of annual grasslands have been conducted in California (Fenster et al., 2023; Ryals et al., 2016; Ryals & Silver, 2013), leaving a large uncertainty of the influence of compost amendments in annual grasslands found in Southwestern states.

Perennial grasslands, in contrast, are slower-growing systems dominated by deep-rooted, long-lived species. These systems tend to cycle nutrients more conservatively, with lower microbial turnover and less responsive productivity. Compost in perennial grasslands often decomposes more slowly, increasing the potential for soil carbon stabilization (Cooper & DeMarco, 2021). Additionally, the structural and water-holding benefits of compost can support deeper root growth and reinforce the persistence of perennial cover under arid conditions (Brown & Cotton, 2011; Conant et al., 2017). However, compost does not always yield positive outcomes. In some arid perennial rangelands, compost additions have been linked to unintended consequences, such as the promotion of invasive species like cheatgrass (Blumenthal et al., 2017).

Understanding these ecosystem-level differences is key to developing effective compost strategies. While annual systems have demonstrated strong responses to single applications, perennial systems may benefit from tailored compost types and timing that align with their slower ecological rhythms and water limitations.

How Does Compost Work?

Compost improves soil health through interconnected biological, chemical, and physical mechanisms that work synergistically. These components interact dynamically in response to the added organic matter, enhancing overall soil function.

Biological Mechanisms:

By introducing organic matter, compost serves as a substrate for soil microorganisms such as bacteria, fungi, and archaea, playing a central role in nutrient cycling (Wu et al., 2024)). Microbial activity decomposes organic materials, converting them into plant-available forms, thereby improving soil fertility and promoting vegetation growth. Compost can enhance microbial activity, supporting processes like decomposition and nutrient mineralization (Heisey et al., 2022). This boost in biological activity is critical for degraded soils, where microbial communities may be depleted. Studies have shown that compost application can significantly shift microbial soil communities over multiple cropping cycles, enhancing nutrient availability and plant health (Ros et al., 2006).

Chemical Mechanisms:

Compost contributes to the stabilization of organic matter in soils through dynamic interactions driven by microbial activity and chemical processes (Anthony et al., 2024; Jain & Kalamdhad, 2020). As compost decomposes, organic compounds are transformed by the microbiome (bacteria and fungi) into simpler molecules, with some being mineralized and released as CO_2 while others become chemically bound to soil minerals or form complex organic structures that persist in the soil over time (Gougoulis et al., 2014). These stabilized organic compounds are vital for improving soil properties, including nutrient retention and carbon storage.

Physical Mechanisms:

The addition of compost improves soil structure by enhancing aggregation and porosity, leading to enhanced water retention and reduced erosion (Gonzalez & Cooperband, 2002; Lynch et al., 2005). These changes reduce soil compaction and facilitate water infiltration, which is critical for maintaining productivity in dryland systems. Improved soil structure also aids in root penetration and reduces erosion. Research indicates that compost can directly increase SOM content, available phosphorus, and exchangeable potassium, while also improving porosity and water holding capacity (Ho et al., 2022).

How Much Does Compost Cost?

The cost of compost application varies based on factors like production methods, transportation, application rate and techniques. Based on our research, compost + delivery costs range from \$30 to \$160 per ton (Hills, 2020). Often, transportation can be more expensive than the compost itself. While initial costs can be a barrier, the long-term benefits, such as improved forage production and enhanced soil health, often justify the investment. For example, increased water retention and nutrient efficiency can reduce the need for irrigation and synthetic fertilizers, generating economic savings over time (Ho et al., 2022). The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program run by the USDA NRCS that provides financial and technical assistance to farmers, ranchers, and forest landowners to implement conservation practices on their land. These programs help make compost more accessible to landowners, encouraging broader implementation and fostering sustainable land management practices.

How much should be applied?

Determining the appropriate compost application rate is one of the most challenging aspects of designing field trials. Rates vary depending on site conditions, compost quality, and intended outcomes, whether aimed at short-term fertility, carbon sequestration, or ecosystem restoration.

A widely cited example comes from Ryals et al., who applied a 1.3 cm layer of dry organic green waste compost (C:N 11) to California annual grasslands. This depth-based application was equivalent to 70 Mg/ha, delivering 14.2 Mg C/ha and 1.29 Mg total N/ha.

In contrast, the California Department of Food and Agriculture's (CDFA) Soil Health White Paper recommends a more conservative rate of 9 to 11.9 Mg/ha (Gravuer, 2016). These suggested rates are grounded in a precautionary approach, aiming to improve soil health without altering plant species dynamics—particularly in native or invaded rangelands where compost could unintentionally favor nitrophilic plants that favor and proliferate in nitrogen-rich soils, or invasive species.

To assess how these recommendations align with actual practice, we reviewed compost rates from the 36 studies included in the CDFA white paper. Our synthesis found an average application rate of 43.3 ± 5.5 Mg/ha, indicating that many studies apply higher amounts, especially when targeting measurable gains in soil carbon storage or productivity.

If compost is intended to offset or replace synthetic fertilizers, the nitrogen demand of the crop should be matched to the amount of plant-available nitrogen in the compost (Hernández et al., 2016; Lawrence & Melgar, 2023). This requires not only knowing the total nitrogen content of the compost but also estimating its first-year mineralization rate, that is, the proportion of nitrogen that becomes available to plants during the growing season.

Compost Field Trials: Applications in California, Colorado, Arizona, and New Mexico

Compost field trials across California, Colorado, Arizona, and New Mexico evaluated the effects of compost applications in diverse grassland systems. These studies were selected because of their participation in the NRCS Field trials. Each state presented unique environmental and management challenges and choices, offering valuable insights into the factors that influence the success of compost applications. These trials provided key lessons on when and where compost applications are most effective, as well as how application rates impact soil health outcomes.

Soil Health Indicator Explanations

Physical Indicators

- **Bulk Density (BD):**
Measures the mass of dry soil per unit volume (g/cm^3), indicating compaction. Affects root penetration, porosity, aeration, and water infiltration. Lower values generally reflect better soil structure.
- **Hydraulic Conductivity:**
Indicates how easily water moves through saturated soil. Higher conductivity suggests better infiltration and drainage, supporting water availability and reduced runoff.
- **Soil Aggregate Stability:**
Reflects the soil's ability to resist disintegration when exposed to water. Stable aggregates promote infiltration, prevent erosion, and protect microbial habitats.

Chemical Indicators

- **Electrical Conductivity (EC):**
Measures soluble salt concentration. High EC can impair plant water uptake and microbial function; moderate EC can signal nutrient availability or salt accumulation.
- **Total Carbon (Total C):**
The sum of all carbon forms in the soil, including organic and inorganic. Serves as a broad indicator of carbon storage and soil buffering capacity.
- **Inorganic Carbon:**
Primarily present as calcium carbonate in arid regions. It contributes to soil alkalinity and long-term carbon sequestration but does not support biological processes.

- Total Nitrogen (Total N):
Represents all nitrogen forms in the soil. Essential for plant and microbial growth and a key indicator of fertility potential.

Biological Indicators

- Soil Organic Matter (SOM):
Decomposed organic residues that fuel microbial activity, enhance nutrient retention, improve structure, and support overall biological function.
- Microbial Biomass:
The living component of soil organic matter, including bacteria and fungi. A sensitive indicator of biological activity, nutrient cycling, and soil ecosystem functioning.

Soil Organic Carbon (SOC) Stocks:

- SOC stocks represent the amount of organic carbon stored in the soil, typically expressed as Mg C ha⁻¹ to a specified depth. This metric is central to evaluating a soil's role in climate mitigation. While increases in SOC can result from organic amendments like compost or biochar, true carbon sequestration implies enhanced in situ carbon capture via plant photosynthesis, root turnover, and microbial stabilization. To disentangle carbon sources, it's critical to distinguish between exogenous inputs (e.g., added compost) and autochthonous inputs (e.g., increased plant biomass from cover crops or improved productivity).
- A meaningful accounting of carbon sequestration must quantify not just the presence of added organic matter, but the extent to which soil systems are functionally cycling and stabilizing new carbon inputs from plant-driven processes. This often requires paired measurements of SOC, SOM fractions, and plant productivity, alongside isotopic or modeling approaches to partition sources. True climate benefits are achieved when carbon inputs exceed losses and are retained over decadal timescales.

Experiments Included in the study:

1. Compost amendments up to one inch restore dry rangeland soil health by Strickler et al. 2024

- Sites: The study was conducted at two ranches in New Mexico: a pork farm (PF) and a regeneratively managed cattle farm (CF). The PF site was characterized by fine sandy loam soils, while the CF site had clay loam soils. CF was rotationally grazed, while PF was not grazed. Species present were primarily native perennial grasses.
- Soil Types: The PF ranch consisted of Silver and Witt very fine sandy loam soils, while the CF ranch was characterized by Vegocito and Gallinas clay loam soils.
- Compost: All compost used in the study was produced on-site at Polk's Folly Farm using manure, woody mulch, and food waste from hog pens. The material was piled into windrows and aerated with a skid steer, reaching temperatures of 135–160°F for 3 to 15 days. After active composting, the piles were

cured for at least nine months, resulting in a mature compost with a carbon-to-nitrogen (C:N) ratio of 29:1 and elevated potassium content

- Application Rate: Variable rates of 63.9, 128.0, and 256.0 Mg/ha.
- Experimental Design: At each ranch, twelve 4.75 × 9.14-meter plots were established on flat, relatively uniform ground. Three plots were randomly assigned as unamended controls, while the remaining nine received a single surface top dressing of compost at one of three depths: 0.64 cm, 1.3 cm, or 2.5 cm. Two 5 m transects were placed 1 m inside the plot edges to assess vegetation composition, and two 1 m² clip plots were established 1 m from the narrow edge to measure aboveground biomass. One quadrat per plot was fenced (1.2 m high) to serve as an enclosure.
- Measurements: plant composition and biomass, soil bulk density, hydraulic conductivity, aggregate stability, and total C content (0–10 cm depth) up to two years after addition.
- Results:
 - Vegetation and plant composition did not respond to compost amendment, but there was an increase of 41 g m⁻² of belowground root biomass. Compost significantly improved hydraulic conductivity, bulk density decreased 0.05 g cm⁻³ per cm, and twice as much soil C than controls across both ranches.

2. Infrequent compost applications increased plant productivity and soil organic carbon in irrigated pasture but not degraded rangeland by McClelland et al, 2022.

- Sites: Two experiments were conducted on working ranches in northern Colorado, USA. One experiment was on an irrigated pasture (IP) and the second experiment was on degraded rangeland (DR). IP was primarily managed as a hay field which was previously intensively grazed by both cattle and horses, whereas the DR had rotational cattle grazing in these pastures year-round, and grazing varied in timing and frequency. Species present were a mix of exotic and native cool and warm season grasses, legumes, forbs and shrubs. Some invasive species were present like cheatgrass and rye brome.
- Soil Types: The primary soil in IP is a Nunn clay loam (fine, smectitic, mesic Aridic Argiustoll) and the DR Connerton-Sylvan Dale complex (fine-loamy, mixed, superactive, mesic Torriorthentic Haplustolls-Pachic Argiustolls) and Kirtley loam (fine-loamy, mixed, superactive, mesic Aridic Argiustoll).
- Compost: Commercially available composted livestock manure (C:N ratio 8:1) was applied twice; once in March 2012 (IP only) and again in March 2018 (DR and IP).
- Application Rate: DR: 6.7 Mg ha⁻¹, IP 11.2 Mg ha⁻¹
- Experimental Design:

- The IP experiment comprised of two levels of treatment – compost addition and unamended control with eight replicated blocks. The plots measured 10 × 10 m. Compost was applied twice, with a 6-year gap, at a rate of 11.2 Mg ha⁻¹ by compost spreader, which was equivalent to 123 kg N ha⁻¹, 974 kg organic C ha⁻¹. Field data were collected for three growing seasons across both experiments from 2018 to 2020,
 - The DR experiment utilized a randomized complete block design and there were two levels of treatment: compost and an unamended control with six replicated blocks. The compost treatment was the same compost material applied in IP, but it was applied at a lower rate and only once in DR to better reflect potential investment a rancher might make on degraded rangeland with lower potential productivity. In DR, compost was applied at a rate of 6.7 Mg ha⁻¹ by compost spreader on March 25, 2018, which was equivalent to 74 kg of total N ha⁻¹, 583 kg organic C ha⁻¹.
- Measurements: Aboveground biomass, grazed biomass removal, belowground biomass, soil carbon, nitrogen, physical properties, and soil respiration.

- Results: Compost increased aboveground biomass in IP by an average across the study of 3.87 ± 0.17 Mg ha⁻¹ yr⁻¹ compared to the control of 2.93 ± 0.17 Mg ha⁻¹ yr⁻¹. At the DR site, compost marginally increased aboveground biomass C and N in both the first (1.6 ± 0.4 vs. 1.1 ± 0.4 Mg ha⁻¹ yr⁻¹) and second (2.2 ± 0.4 vs. 2.0 ± 0.4 Mg ha⁻¹ yr⁻¹) years compared to the control. There was a significant increase in biomass C and N content for IP for 2018, and 2020, but not for DR. No difference in standing root biomass or BD for either site. No difference in standing root biomass or BD. Soil organic C stocks significantly increased by 16% in the treatment soils by the end of the study compared to baseline. Soil inorganic C were 42% higher in control than treatment. Soil organic C stocks increased by 4.7 Mg OC ha⁻¹ more over eight years in the compost treatment from 0 to 10 cm than in the unamended control. The treatment effect was primarily observed in the surface soils. No change in soil carbon respiration.

3. Compost Application in Irrigated Pasture: Synthesis & Recommendations by Bruegger & Machmuller 2025.

- Site: Two experiments were conducted on irrigated hay fields in Fruita and Ridgeway, Colorado. The Fruita site is furrow irrigated and a wheatgrass/ brome grass mix, historically used for alfalfa and replanted with lower water use grasses. It is irrigated and then used for hay with 2-3 cuttings per year. The other site is in Ridgeway, CO on private land. It is a brome/ orchard grass/ tall fescue mix. It is flood irrigated with gated pipe and typically gets 1 cutting / year. Cows graze pastures starting in October, the field is under a NRCS CSP contract that prohibits grazing/ haying below a 4-inch stubble height.
- Soil types: Not mentioned. By looking at Web Soil Survey – Fruita soils were Fruitvale clay loam (Fine-loamy, mixed, active, mesic Typic Argigypsis), while the Ridgeway soils were Mudcap loam (Fine, mixed, active, frigid Oxyaquic Argiustolls).

- Application rate: Determined by nitrogen demand of hay for each site: Ridgeway compost application was 42.1 Mg ha⁻¹, and 13.5 Mg ha⁻¹ when combined with fertilizer. Fruita compost application was 23.3 Mg ha⁻¹, and 13.5 Mg ha⁻¹ when combined with fertilizer.
- Compost: Composted manure (C:N ratio 18:1)
- Experimental Design: In each location, there were four treatments (control, compost, compost + fertilizer, and fertilizer) which were replicated 3 times randomly in strip plots. Drop seeder calibrated for ton/acre applications were used for compost spreading. Compost was applied at a rate of 42.1 Mg ha⁻¹ at Ridgeway and 23.3 Mg ha⁻¹ at Fruita for the compost-only treatment, delivering approximately 10,515 kg C ha⁻¹ and 101 kg N ha⁻¹ at Ridgeway and 5,829 kg C ha⁻¹ and 56 kg N ha⁻¹ at Fruita. For the compost + fertilizer treatment, both sites received 13.5 Mg ha⁻¹, contributing 3,363 kg C ha⁻¹ and 32 kg N ha⁻¹.
- Measurements: Species composition, yield, grass nutritional value, soil organic carbon at various depths, C:N ratio, N stocks, bulk density, and various soil health metrics spanning chemical, physical and biological.
- Results: Yields were not significantly increased with compost, only with fertilizer. A 1-time application of compost did not increase soil organic carbon stocks. There were no differences among treatments at any horizon sampled. There no treatment effects were detected on total nitrogen stocks. Despite high application rates, compost did not increase soil salinity. There were no treatment differences among treatments in soil health metrics analyzed.

4. Mulch more so than compost improves soil health to reestablish vegetation in a semiarid rangeland by Leger et al., 2022

- Site: This study occurred on an active rangeland in the Altar Valley in Pima County, Arizona. Cattle were present at low stocking rates during winter with evidence of grazing by other wildlife. Exclosures were not installed. NRCS's state-and-transition models indicate that the site was in a "Mesquite, Natives" state in the process of shifting to a "Natives, Mesquite, Eroded Surfaces" state.
- Soil types: Sandy loam texture and are classified as Ustic Haplocambids in the Altar-Sasabe soil complex.
- Application rate: Two rates, 159 Mg ha⁻¹ and 336 Mg ha⁻¹
- Compost: Yard waste and organic dairy manure (C:N 11.5:1)
- Experimental Design: Researchers studied five treatments from 2018-2019 in areas of bare soil on an actively grazed rangeland. Two control plots: one with no treatment, and one seeded with native grasses. And three experimental plots: one with mesquite branch mulch laid on top of seeded soil, a second with branch mulch on top of 3 cm seeded compost, and a third with mulch on 6 cm seeded compost. Researchers laid the mesquite branch mulch in 15-20 cm thick layers that did not completely

cover the soil surface. Plots were hand-seeded with native cool and warm season grasses chosen based on the ecological site description.

- Measurements: soil microclimate (temperature and moisture), soil aggregate stability (resistance to erosion), amount of soil organic matter, and plant available nitrogen. Along with cover and abundance of seeded native grasses and non-seeded plants in degraded rocky soils.
- Results: In dry conditions, mesquite branch mulch alone (without compost) increased grass abundance and cover by 42%. Under wetter conditions, it boosted grass abundance by 5.5 times more than any other treatment. In 2018, when conditions were wetter, adding 3 cm of compost further increased seeded grass cover by 15%—about 5% more than mulch alone. All three organic treatments lowered soil temperatures and improved soil moisture compared to controls, with soil moisture increasing by 50% across both years. However, none significantly improved soil stability, plant-available nitrogen, or soil organic matter content.

Carbon Sequestration Outcomes

Among the four studies reviewed, two documented a significant increase in SOC storage following compost applications, while three found limited or no improvements in carbon storage.

Successful Carbon Storage:

- Stricker et al., (2024) (New Mexico): Found a significant increase in SOC at the 0–10 cm depth after two years, with site-level variability ranging from 7.1 to 12.4 Mg/ha, highlighting differences in SOC storage. The proportion of compost derived C vs plant inputs are not disentangled within this study.
- McClelland et al., (2022) (Colorado): Reported increased SOC in irrigated pastures, where over eight years, SOC stocks rose by 0.6 Mg/ha in the 0–10 cm depth—resulting in a net gain of 0.3 T/ha after accounting for compost-derived SOC. The small increase in this study compared to the above two is likely due to their ability to disentangle and remove the addition of C from compost and accurately represent the increase due to C sequestration.

Limited or No Carbon Storage:

- Brunberg et al. (2023) (Colorado): Found no significant SOC increase after two years, suggesting that a single compost application may provide slow or inconsistent benefits. While there were no changes in SOC, there were higher levels of soil inorganic carbon in the control plots. These sites had very high levels of carbonate, which could impact the results – removing carbonates in the soil and then running on the elemental analyzer can create a lot of error. Recent studies are increasingly recognizing the role of SIC in soil, as it has been largely underrepresented in research, applications, and modeling despite its significant contribution to global carbon stocks (Raza et al., 2024). Given that SIC has a long turnover time but is vulnerable to losses under intensive agricultural practices, it plays a crucial role in the global carbon cycle and climate change. Soils with high SIC levels require special attention in removal processes, and carbon

analysis methods should adapt to better account for SIC dynamics, ensuring a more complete representation of soil carbon cycling in climate models.

- Leger et al. (2022) (Arizona): Reported no SOC gains from compost application in arid rangelands, with mesquite mulch proving more effective for soil health improvements in this highly degraded rangeland. The null result of compost application is likely due to the too high application rate paired with little to no vegetation cover.
- McClelland et al. (2022) (Colorado): One of the trials of this study was conducted on degraded rangeland and did not show an increase in SOC storage. Researchers suggested this may be due to the lack of vegetation, combined with high winds after application, which likely blew most of the compost off the plots.

Key Takeaways

Compost amendments can enhance SOC storage, but outcomes are highly dependent on site-specific factors such as soil type, moisture availability, vegetative cover, and compost composition.

- Irrigated systems and moderate to high application rates are more likely to show increases in SOC, particularly when vegetation is well established and compost is incorporated into an active nutrient cycle.
- In contrast, dryland and degraded rangelands often show limited SOC response. In these systems, compost may need to be applied repeatedly, timed to moisture availability, or combined with complementary practices such as mulch to support soil health and carbon accumulation.
- Null results in some studies may reflect challenges with site selection, application rate, timing, or post-application loss (e.g., wind erosion), rather than the ineffectiveness of compost itself.
- Some studies measured total SOC without distinguishing between compost- and plant-derived carbon, while others accounted only for sequestered C. These methodological differences complicate direct comparisons and highlight the importance of clear carbon accounting.

Overall, while compost is a promising tool for increasing SOC and improving soil function, its success is context-dependent. Effective implementation requires aligning compost strategy with the site's climatic, biological, and management conditions.

Soil Health Responses

The reviewed studies illustrate that compost amendments can significantly enhance soil health in rangeland and pasture ecosystems beyond just increasing soil organic carbon. Stricker et al. (2024) found that compost applications improved soil structure, increased microbial activity, and promoted overall plant productivity in dry rangelands, indicating a restoration of ecosystem function. McClelland et al. (2022) noted similar enhancements in irrigated pastures, where compost amendments led to increased plant growth and higher microbial activity, demonstrating improved soil health dynamics. However, a three-year study by Colorado State University (2020–2023) found no significant differences in soil organic carbon or soil health metrics between one-time compost-treated plots and controls, indicating that a single compost application may provide slow or inconsistent

benefits. Additionally, Leger et al. (2022) reported that mesquite mulch was more effective than compost in improving soil health in semiarid rangelands, highlighting that while compost can enhance microbial activity and nutrient cycling, it may not always create positive outcomes.

Yields

In terms of yields, several studies highlighted positive outcomes associated with compost applications. McClelland et al. (2022) reported substantial increases in forage production in irrigated pastures following compost amendments, Stricker et al. (2024) also indicated increased plant productivity in dry rangelands due to compost application, reinforcing the potential for compost to enhance forage yields conversely, the three-year study by Colorado State University (2020–2023) found no significant differences in yields between compost-treated plots and controls, suggesting that a single application of compost may not be effective for immediate yield improvements. . Overall, while compost amendments can positively influence yields in some contexts, the outcomes may vary based on site conditions, compost application frequency, and the specific management practices employed.

Understanding the effects of compost amendments on soil health and productivity requires careful consideration of various site-specific factors that contribute to variability among research trials. Differences in soil health status and degradation levels, grassland types, vegetation cover, topography, soil types, research trial design, compost feedstocks, timing of application, application rates, and grazing management practices can all influence the outcomes of compost studies. This variability can mask broader trends across sites, making it challenging to generalize findings. For instance, a trial conducted in a highly degraded pasture may show different responses to compost compared to a healthy grassland, highlighting the importance of site selection and management history. By disentangling these variables, researchers can better assess the effectiveness of compost amendments and develop more targeted recommendations for land managers, ultimately enhancing the ability to improve soil health and ecosystem function in diverse rangeland and pasture ecosystems.

Future Trial Recommendations

Site Selection

In many cases, site selection is dictated by landowner willingness rather than optimal research conditions. Several factors emerged as critical in determining the effectiveness of compost applications:

Soil Health and Degradation

- Compost application was less effective in severely degraded soils, particularly those impacted by past high-intensity hay production, non-rotational grazing, or prolonged fallow periods. In such cases, compost alone did not significantly increase SOC (e.g., findings from Colorado and Arizona studies).

Grassland Type

- Irrigated pasturelands might be more suited to compost amendments – due to the increased water availability which can stimulate greater aboveground forage production and belowground root biomass (Cooper & DeMarco, 2023; McClelland et al., 2022). However, there have been studies that show that arid rangelands also can show improvements from compost amendments (Stricker et al., 2025). In

addition to water management, perennial vs annual grasslands is especially of interest. The most impactful studies on SOC storage have occurred in California, on annual grasslands (Ryals et al., 2014), which might relate to the annual nature of grasses and their root turnover. Annual might be more inclined to use fresh inputs on available N from compost in comparison to deeper rooted perennial grasses. However, to achieve true climate mitigation from this approach, all grassland types, if applicable, should be utilized to increase long term carbon storage.

Vegetation Cover

- The presence of existing vegetation was essential for compost to contribute to carbon sequestration. In sites that were highly degraded with little to no plant cover (Leger et al. (2022); McClelland et al., (2022), compost application alone was insufficient to promote carbon storage. Since soil carbon sequestration is a plant-driven process, vegetation is necessary for compost to be effective.

Topography

- **Water Drainage:** Poor drainage in low-lying areas can lead to waterlogging, which may impact microbial activity and nutrient cycling. Conversely, excessively well-drained soils on steep slopes may not retain enough moisture for optimal decomposition.
- **Soil Depth and Compaction:** Shallow soils or compacted layers (e.g., hardpan) can restrict root growth and microbial activity, limiting the effectiveness of compost applications.
- **Equipment Accessibility:** Ensure the site can accommodate machinery for compost applications, soil sampling, and monitoring without causing excessive disturbance.

Soil Type

- Soil texture and composition significantly affect compost efficacy. Mollisols and Alfisols, with their higher clay and silt content, are more conducive to SOC storage due to their enhanced mineral associations. In contrast, sandy soils tend to promote particulate organic matter accumulation, which is more prone to decomposition and loss.

Research Trial Design

Effective site research trial design is essential for accurately assessing soil responses to compost amendments. Well-structured trials account for soil variability, ensure robust sampling methods, and incorporate multiple factors to capture meaningful trends.

- The most effective trials should incorporate random sampling within treatment plots and sampled beyond 10 cm depth to assess deeper soil changes.
- Proper experimental design, including buffer zones, is necessary to prevent runoff and lateral transfer of compost into control plots with rain events or irrigation.
- High-quality should evaluate soil carbon alongside biological, chemical, and physical properties to provide a comprehensive understanding of soil ecosystem responses to compost amendments.

- Strong trial designs often included variable compost application rates (e.g., 0.5, 1, and 2.5 cm) to identify potential linear trends or saturation points (Stricker et al., 2025).

The NRCS suggested trial design, comprises of a 1-acre experimental plot divided into control and compost additions of ½ acre each. In the middle, see Figure 2, it is highly advisable to include a grazing enclosure to account for the influence of grazing in the pasture.

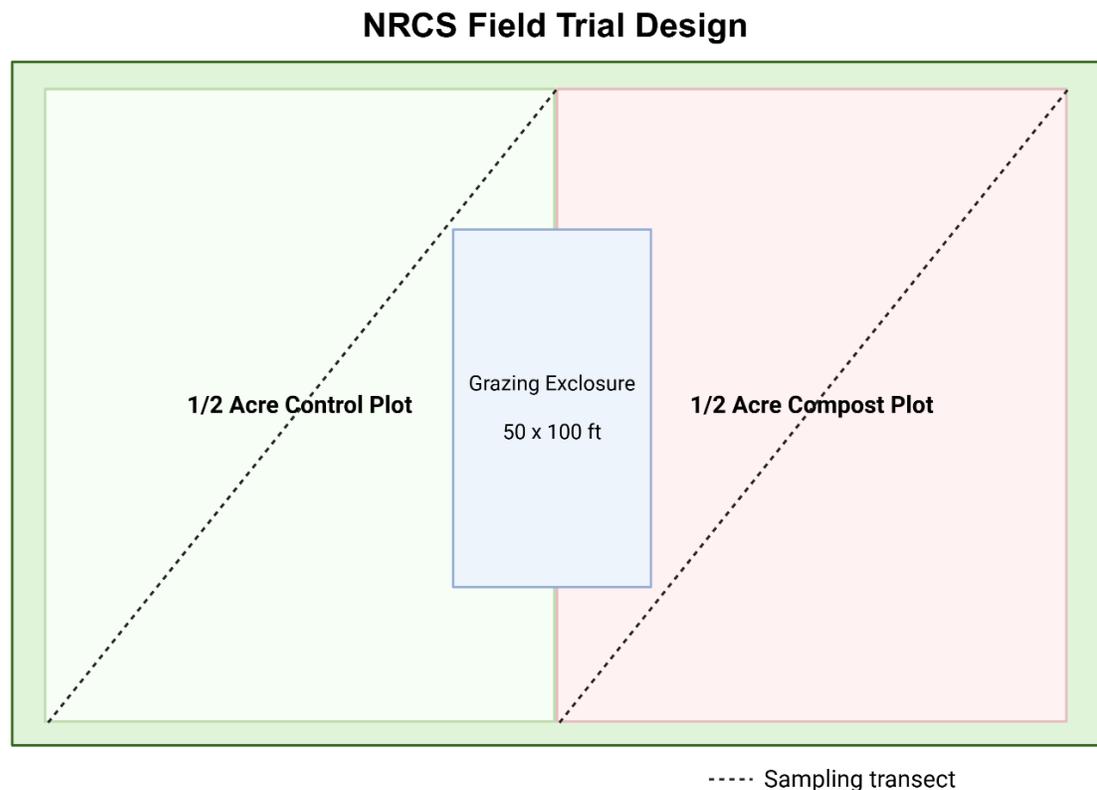


Figure 2. NRCS field trial design for a 1-acre plot., comprising two ½ acre subplots Left hand subplot represents control with no compost, and the right hand represents the treatment subplot with compost additions. The dashed line denotes the 150 feet long sampling transect. Redesigned copy of original by Jeff Borum.

Compost Feedstocks

The type of compost used in trials varies based on available feedstocks, including manure-based compost, food and yard waste compost, and biosolids. No single type proved superior; instead, selection depended on locally available resources.

Key considerations:

- The C:N ratio is a critical factor in determining compost's impact on soil microbial activity and nutrient availability.
- Properly matured compost must be free of weeds and invasive species. Compost should reach sufficiently high temperatures for long enough to kill pathogens and seeds.

- Additional concerns include:
 - Salt content: High salt levels can negatively impact plant growth, particularly in manure-based compost. However, in Brunberg et al., no significant change in EC was observed with manure compost application (2023).

Timing of Application

Timing is a critical factor for successful compost amendments in grassland systems – prior to application historical weather and precipitation patterns should be consulted to ensure the best possible outcome.

- Spring applications (post-snowmelt in temperate regions) are generally recommended to optimize soil moisture retention and minimize losses.
- Heavy rains: If possible, time application after heavy rains not before, but application should wait until soil is dry enough for application with heavy machinery.
- High winds: Compost should be applied when wind speeds are low to prevent loss. In one trial in Colorado, compost was applied on a highly degraded site with little vegetation and bare ground, nearly all of the compost was blown off in a high wind event, which led to null findings (McClelland et al., 2022). In some cases, application before snowfall has been effective in securing compost in place in areas that experience high winds.
- Mineralization time: If compost is being used for its co-benefit of nitrogen supply, then the timing of compost applications relative to plant nutrient demand is crucial. For example, compost with a high C:N ratio may require application at least six months before plants require nitrogen, in the study by (Brunberg et al., 2023), their decreased production compared to fertilizer trials might be due to an underestimation of mineralization rates of the compost, and they suggested that a winter application might have helped the compost available N be increased in time for plant requirements.

Application Rate

Application rates varied widely across studies, ideally in future trials it would be helpful to create a variable application rate to test across systems potentially organized into low and high rates.

- Compost application strategies can be tailored to trial objectives, following two general pathways: higher-nitrogen composts are suited for meeting agronomic nutrient needs and boosting plant productivity, while lower-nitrogen composts are more appropriate for promoting long-term carbon storage. Application rates should consider projected nitrogen mineralization, overall soil health goals, and the desired balance between immediate fertility and sustained soil organic carbon gains.
- Excessive application rates can be detrimental. For example, in an Arizona trial, 6 cm of compost acted as a smothering mulch, suppressing plant establishment and failing to increase carbon storage (Leger et al., 2022).
- In the New Mexico study, SOC increased linearly with compost depth. The 2.5 cm application—representing the highest rate—nearly doubled soil carbon content compared to the control over the same time period (Stricker et al., 2025).

Grazing Management

Compost alone can improve SOC in rangeland systems but pairing it with adaptive grazing management might be key to unlocking its full potential. While compost has demonstrated the ability to increase SOC stocks on its own, its long-term impact may be limited without complementary changes in grazing practices. Observations from compost-amended sites indicated that cattle preferred to graze these areas, potentially increasing grazing pressure (Cooper & DeMarco, 2021; Ryals & Silver, 2013). If grazing pressure remains unchecked, particularly through continuous or overgrazing, any gains in SOC from compost can be rapidly undone (Ren et al., 2024). In contrast, adaptive strategies such as rotational or multi-paddock grazing, which has been shown to foster increased carbon storage (Dahal et al., 2020; Stanley et al., 2025), when paired with compost amendments could create synergistic effects—enhancing compost outcomes by increasing belowground biomass, stimulating root exudation, and improving photosynthetic carbon capture. Ultimately, compost must be part of an integrated approach. Without adjusting grazing management to support soil recovery, compost alone is unlikely to deliver sustained improvements in SOC.

Recommendations

Based on the findings from compost trials across various regions, the following recommendations are proposed to enhance the effectiveness of compost applications in grassland systems:

1. **Site-Specific Assessment:** Conduct thorough soil and site assessments before compost application to determine suitability and expected benefits.
2. **Optimized Application Timing:** Apply compost during seasons with favorable moisture conditions to maximize nutrient retention and minimize losses due to wind or runoff.
3. **Appropriate Compost Selection:** Use compost with a balanced C:N ratio (< 12:1) and free contaminants to ensure optimal soil health benefits.
4. **Integration with Grazing Management:** Implement rotational or adaptive grazing strategies—where livestock are moved between pastures to allow recovery and regrowth of vegetation—to complement compost application and enhance SOC accumulation through increased plant biomass and root inputs.
5. **Long-Term Monitoring:** Establish long-term monitoring programs to track soil health improvements and carbon sequestration over multiple years.
6. **Policy and Incentive Support:** Expand conservation programs and financial incentives, such as USDA NRCS programs, to encourage widespread adoption of compost amendments.
7. **Collaboration with Indigenous Communities:** Acknowledge the lack of compost trials on Indigenous-managed lands and prioritize inclusive research partnerships. Collaborations rooted in Indigenous knowledge can enhance soil stewardship and expand resilience strategies across all landscapes.

By adopting these recommendations, stakeholders can maximize the benefits of compost applications, improve grassland resilience, and contribute to climate mitigation efforts.

Conclusion

Compost applications in grasslands offer a promising strategy for enhancing SOC storage and improving ecosystem health. However, site conditions, vegetation presence, topography, soil type, and application timing

all play pivotal roles in determining success. Future trials should integrate these factors into experimental designs to optimize compost’s potential for long-term soil health improvements.

To maximize the benefits of compost applications, stakeholders must adopt a holistic approach that combines compost amendments with adaptive management strategies. Long-term monitoring, site-specific application adjustments, and supportive policy frameworks are essential to ensuring sustained success. This is already being demonstrated in ranching communities across the Western U.S., where compost-enhanced pastures are yielding healthier forage, retaining more water, and improving long-term soil productivity. Healthy, carbon-rich grasslands don’t just benefit soils—they safeguard rural livelihoods, support biodiversity, and help buffer communities from the extremes of a changing climate. In the face of ecological degradation and climate instability, compost-amended grasslands offer a rare win-win: sequestering carbon while restoring the living foundation of food, water, and life itself.

Appendix

Conservation Field Trial (GM 403.3)

Range Compost Application

USDA – NRCS Davis, CA

Background

Many acres of rangeland in California had been farmed to small grain crops during the 1920's until the end of WWII. During this time equipment was used to till the soil on an annual basis. As the market decreased for small grains, so did dryland farming on these lands. They were left fallow to return to rangelands. Today many of those areas exhibit poor resource conditions with low soil aggregate stability, low organic matter, soil surface loss and are infested with various annual weedy species including medusahead, barbed goatgrass and yellow star thistle and others. This Conservation Field Trial will target these degraded rangelands for compost application with hopes that added organic matter, and nutrients will improve soil health and rangeland health.

An Environmental Evaluation Worksheet, CPA-52 is attached for reference showing negative environmental effects of compost application.

A cultural resource review of each site will be conducted prior to application, in accordance with Title 190, General Manual, Part 410, and Compliance with National Environmental Policy Act (NEPA).

Objective

The objective of the study is to track changes in the following after compost application:

1. Species composition
2. Forage production
3. Soil aggregate stability
4. Organic Matter
5. Infiltration rates
6. Organic Carbon

The project will be done on grazed rangelands. Previous studies have shown that forage production improvements of up to 60% have occurred after compost application. Compost has been shown to increase nutrient cycling, improve soil fertility and increase soil microbes, thus increase soil carbon sequestration. This has not been well documented at the field level.

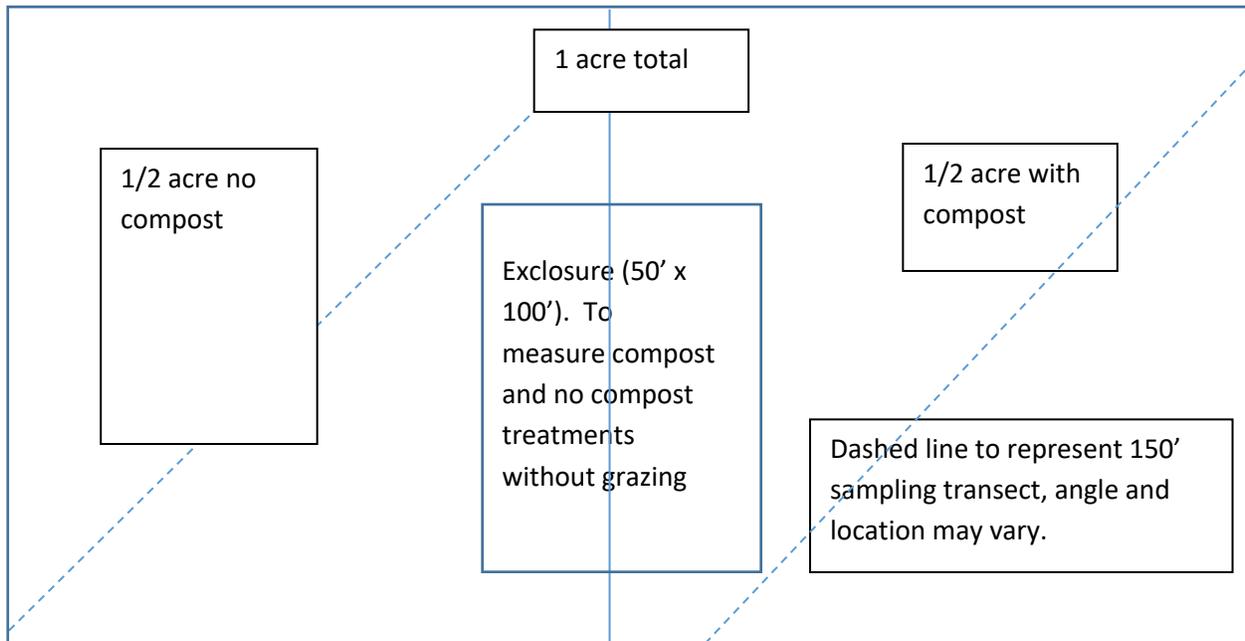
Tentative Protocol for NRCS Range Compost Field Trials (CFT)

At each site, a one-acre plot will be staked and marked with GPS coordinates. Baseline conditions will be measured and documented well inside the boundaries in order to account for edge effect. The following baseline items will be measured at each site:

- 1) Soil carbon at 0-10cm, 10-30cm, 30-50cm, 50-100cm
 - a. Isotope fractionation

- b. Elemental analysis
- 2) Species composition, using line-point intercept, and categorized by species and into functional and structural groups.
 - a. 150 ft. transect; data collection locations every 3 ft. with up to three data points at each location
 - 3) Soil aggregate stability
 - a. Slake test: ranked from 0 to 6; http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051287.pdf
 - 4) Soil types identified and mapped
 - a. NRCS Web Soil Survey
 - 5) Peak vegetation production
 - a. Biomass sampling of forage every 30 ft. with a 0.96 ft² hoop on same 150 ft. transect used for species composition
 - 6) Infiltration rate
 - a. Double-ring infiltrometer; http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052494.pdf
 - 7) Compaction
 - a. Penetrometer and observational data
 - 8) Total nitrogen in soil solution
 - a. Spectrophotometer
 - 9) Identify wildlife habitat on site
 - a. Visual and auditory observations
 - 10) Bulk density
 - a. Field and lab analysis; http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050957.pdf
 - 11) Soil texture
 - a. Particle size analysis
 - 12) pH
 - a. pH meter, electrode & probe

The following is the plot design:



Each trial site is one acre, divided into two equal sized subplots, with one side compost and one side without compost applied. Both subplots are grazed (there is no non-grazed treatment), except at the Plant Materials Center. Each plot includes a fenced subplot (50 feet by 100 feet). Within the fenced subplot (compost applied and compost not applied) vegetation will be clipped annually at the end of growing season to characterize gross productivity and species composition. Each subplot is characterized by a 150 foot transect, with subsampling along transects for soil and vegetative parameters. In certain instances, trial plot measurements may be altered due to items such as logistical feasibility.

At each site (3) monitoring transects will occur:

1. On the $\frac{1}{2}$ acre compost treated side
2. On the $\frac{1}{2}$ acre control
3. Within the excluded subplot

Site characterization baseline information will be collected spring of 2016. Each site will be geo-referenced at each corner.

Data collection methods will follow those described in the Monitoring Manual for Grassland Shrubland and Savanna Ecosystems, Vol 2. Herrick, J., Van Zee, J., Havstad, K., Burkett, L, Witford, W. USDA – ARS Jornada Experimental Range, 2005.

1. Line Point Intercept for species composition and percent bare ground
2. Soil Surface Stability using the soil stability test kit

3. Forage Production by clipping with a .96 ft² hoop within the enclosure at peak production; after each collection, the area will be grazed or mowed down so that the peak production collection for the next year is not altered significantly by residual dry matter (RDM)
4. Compaction using a penetrometer & infiltration using a double-ring infiltrometer and observational evidence
5. Soil Carbon/Organic Matter utilizing isotope fractionation and elemental analysis

Parameters to be measured, are kept to a minimum to allow for consistent data collection by a diversity of partners on twelve field sites. Also, to keep project cost down to a level consistent with the conservation field trial methodology. Additional data may be collected by partners at their sites, at their own discretion, and may be included in the final report as appropriate.

Data will be collected at least annually for a minimum of three years before compiling the final report. Data will be collected, at minimum, once per year at the end of the growing season, which may vary slightly by location. This will include first year (2016) for baseline data, one year after plot establishment - 2017, Year Two (2018), and Year Three (2019), with a report due by the beginning of Fiscal Year 2020 (October 1, 2019).

The final report will include site characterization, baseline data results, and treatment response data results, with explanations of any variations from the basic project design. Also, reference tools, such as COMET Planner and the Interim Practice Standard will be used to inform the final report, as appropriate and available. The final report will inform revisions as needed to the interim standard, and to specifications and practice implementation requirements for compost applied to rangeland.

Resources needed to accomplish the objective include the sites donated by landowners as described in the Table 1 below. Marin Carbon offered to provide compost, to Cal-Recycle specifications and with quality analyses, to all participating sites.

Project Timeline

2016

- July – Sampling protocol establishment conference
- August – Plot site finalization; prep for baseline soils testing and compost application
- September/October – Baseline soil sampling and treatment application

2017 – 2018

- April/May – Vegetation & soil sampling
June/July - Species comp (mostly for annuals)
- September/October – Soil sampling

2019

- April/May – Vegetation & soil sampling
June/July - Species comp (mostly for annuals)
- September – Soil sampling

- October - Final report

Partners that have volunteered to assist with data collection, financial support and technical review include:

1. Point Blue Conservation Science
2. Marin Carbon Project
3. Rathmann Family Foundation
4. UC Cooperative Extension
5. East Stanislaus Resource Conservation District
6. California State Water Quality Control Board
7. Environmental Protection Agency
8. Landowners – Various as shown in Table 1

Landowners agree to donate the plots for compost application and document grazing use on the sites (season of use, animal numbers, type and class of livestock, duration of grazing on the site). A Grazing Record Worksheet will be provided to the landowners. Photographs will be taken before grazing and after grazing periods.

As a condition for landowner participation, each trial site must have a contact person and an individual or entity able to secure access to the property so that initial plot lay-out can be completed and baseline conditions assessed. Thereafter, entry must be provided to apply the compost treatment (with assistance from Marin Carbon Project), then take periodic measurements as described above.

Table 1: Trial locations, with contact information and site descriptions; two to three more sites are currently being added in different MLRAs or similar MLRAs with diverse precipitation regimes.

#	Partner Contact	Site name	Site notes	Site Description			
				County	MLRA	Vegetation	Management
1	Nick G.	Yolo Ranch #2	Baseline data from Beardsley et al.	Yolo	17	Oak woodlands, perennial and annual grasses	Cow-calf grazing, managed to encourage perennial grasses
2	Nick G.	Yolo Ranch #1	Severe Medusahead, some NRI-type plots established	Yolo	15	Annual grasses and other invasive species	Sheep grazed, very short duration seasonal
3	Alyson A.	TK Ranch	Dryland farming for several decades	Alameda	15	Annual grasses	Grazed by horses sporadically
4	Hilary P.	CC Delta	Limited information	Contra Costa	16	Annual grasses	Grazed heavily historically
5	Trina W.	O. Ranch	Low accessibility for future field days	Stanislaus	17	Annual grasses, no natives	Cow-calf, some stockers
6	Anne C.	C. Ranch	Plot size altered to avoid potential soil delineations	Santa Barbara	20	Mostly annual grasses	Cow-calf, some stockers
7	Kevin M.	EA Ranch	Slope >5% in some areas of plat, but runoff has been accounted for	San Diego	20	Mostly annual grasses with small patches of natives near low points	Newly purchased parcel
8	Steve K.	Rush Ranch	Ongoing data collection	Solano	16	Varies	Ecologically-minded rotational grazing
9	Jeremy J.	SFREC – Browns Valley	Ongoing data collection	Yuba	18	Oak woodland and grass	
10	Stephanie L.	SLT – Sears Pt.	Limited information	Sonoma	15	TBD	TBD
11	Margaret S-K	Lockeford PMC	Only site without grazing	San Joaquin	17	Farmed for various crops	N/A
12	John W.	W. Ranch	Ongoing data collection	Marin	4B	Varies	

Technical Responsibility Assignment

The NRCS California State Range Conservationist will be the project coordinator, under the oversight of the State Resource Conservationist and State Conservationist. The NRCS is providing some start-up funding to support the project with partners willing to provide funds and in-kind services necessary to complete the

project. The East Stanislaus RCD will employ a project coordinator for day-to-day management. NRCS technical specialist will complete the final report with review from technical partners including UC Cooperative Extension and Range Scientists with Marin Carbon Project.

Work Plan Signatures Required

The work plan will be signed by the State Conservationist. Additional signatures will be added, if necessary, by Regional and National review and concurrence.

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