Grasslands

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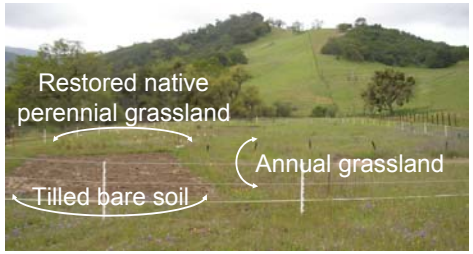
Introduction

jective:

erstand mechanisms hich plant species ct soil carbon esses when tilled are converted to slands.

ntral pothesis:

t life form alters the and atmospheric ronment in ways that add or detract from soil carbon storage tilled soils are verted to grasslands, by annual vs. nnial habit, rooting h, or litter type.



Treatments at the UC Hastings Reserve:

Restored native perennial grassland (2 yrs of tillage prior to seeding perennials in 1997)

Annual grassland (last tilled 68 yrs ago)

Tilled, bare soil (8 yrs of tillage and Round-up after 60 yrs of annual grassland)

Methods

itored surface CO_2 ssions, CO_2 centrations with depth, soil moisture in tilled e soil, restored native ennial grassland, and -term annual sland on Sheridan rse sandy loam.

estored native ennial grassland, ked the fates and cts of added C_4 plant (*Bouteloua gracilis*) in microcosms with a ve annual legume *inus bicolor*) and/or

All treatments

Soil gas was sampled by tubes with fine-mesh steel screen at a designated depth. The upper soil layer was sampled using canulated needles. Surface CO2 efflux was measured for 30 min with capped chambers. Gas analyzed with IRGA. Each treatment was replicated twice.

Restored perennial grassland

Each cylinder contained a native perennial grass (*Nassella pulchra*). *Bouteloua gracilis* (C_4) litter was added to half the treatments. More C_4 than ambient C_3 litter was

40 cylinders were sampled last month

Results

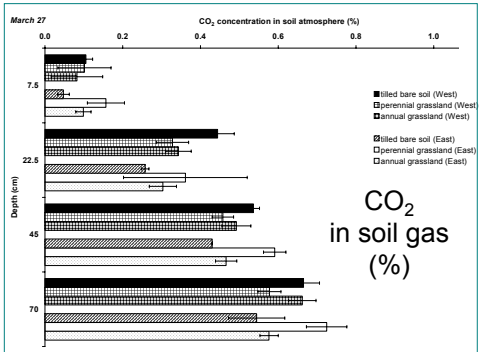
Major Findings:

- Total soil carbon at the surface (0-15 cm depth) decreased with conversion to perennial grassland using tillage.
- Below 15 cm depth, all soils had similar characteristics (e.g., total C, microbial biomass, PLFA profiles*), including CO_2 in the soil gas.
- Annual vs. restored perennial grassland showed only slight differences in:
  - CO_2 emissions & CO_2 concentrations with depth
  - root distribution*
  - microbial communities (PLFA analysis).*
- Adding a litter mulch or N-fixing lupins may increase growth of native perennials, total C sequestration, and biodiversity of native plants (in progress)*.

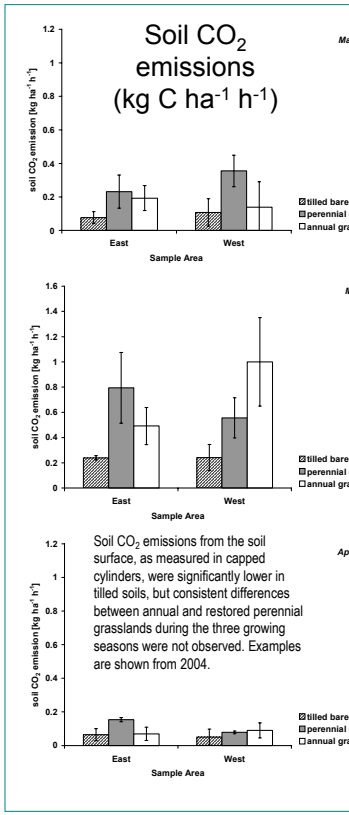
* data not shown

	Total Soil C (g kg^{-1}) 0-15 cm depth		
	mean	*sd*	
Ann. grassland	9.88	0.22	**b**
Per. Grassland (between bunches)	8.50	1.09	**ab**
Per. Grassland (near bunches)	7.28	1.23	**a**
Tilled, bare soil	6.85	1.44	**a**

Total soil C in the surface layer was lower in soils restored with native perennial grasses after 6 years.



Soil gas concentrations were measured at 4 depths on ten sampling dates in 3 growing seasons. An example is shown for March 27, 2004, at peak plant growth. No large or consistent differences in CO_2 concentration in the soil gas between treatments were observed, but further data analysis will test the effects of temperature, moisture and community type.



Soil CO_2 emissions from the soil surface, as measured in capped cylinders, were significantly lower in tilled soils, but consistent differences between annual and restored perennial grasslands during the three growing seasons were not observed. Examples are shown from 2004.

Implications

- Restoration of native perennials on tilled soil did not increase carbon storage compared to annual grasslands on the short-term (5-10 years).
- The slightly deeper root system of perennial grasses had little effect on CO_2 concentrations, microbial biomass or microbial communities below 15 cm depth.
- Unexpectedly, CO_2 production and carbon storage below 15 cm depth remained stable in soils that were surface-tilled.
- Improved management practices (e.g., tillage, mulches, legumes) are needed for abandoned agricultural land, so that the biodiversity of native

Recent publications:
Steenwerth, KL, LE Jackson, FJ Calderon, KM Scow, DE Rolston. Respo
microbial community composition and activity in agricultural and grassla
a simulated rainfall. In press, *Soil Biology and Biochemistry*.
Potthoff, M, LE Jackson, KL Steenwerth, I Ramirez, MR Stromberg, DE F
2005. Soil biological and chemical properties in restored perennial grass
California. *Restoration Ecology* 13:61-73.

Thanks to the Kearney Foundat