Carbon sequestration in irrigated pastures

G. E. Shewmaker[1], J. A. Entry[2] and R. E. Sojka[2]
[1]*The University of Idaho, Twin Falls Research and Extension Center, Twin Falls, Idaho 83303-1827, U.S.A.*
[2]*USDA Agricultural Research Service, Northwest Irrigation and Soils Research Laboratory, 3793 North 3600 East, Kimberly, Idaho 83341, U.S.A. Email: gshew@uidaho.edu*

Keywords: carbon sequestration, irrigation, pasture

Introduction Carbon sequestration potential for irrigated grazing lands is significant. We measured organic and inorganic C stored in southern Idaho soils having long-term land use histories that supported native sagebrush vegetation (NSB), irrigated pasture systems (IP), irrigated conservation tillage sites (ICT), and irrigated moldboard plowing systems (IMP). This study estimates the amount of possible organic, inorganic and total C sequestration if irrigated pasture land was expanded by 10%.

Materials and methods The study area is the Snake River Plain between 42°30' and 43°30' N and 114°20' and 116°30' W, 860 to 1300 m elevation. The climate is temperate semi-desert with cool, moist winters and hot, dry summers. Annual precipitation is 175 to 305 mm. Average annual temperature is 9 to 10°C and soils are typically well-drained loams and silt loams (Aridisols) derived from loess deposits overlying basalt. Soil samples were taken from 3 NSB, 3 IP, 3 ICT (past 8 years), and 3 IMP sites. Ten random 2.4-cm diameter replicate soil cores were taken from each site and partitioned into 0-5, 5-15, 15-30 and 30-100 cm depths. Roots greater than 1.0-cm diameter were measured separately. Inorganic C in each sample of mineral soil was determined by titration (Loeppert and Suarez 1996). Concentration of organic C in each sample of mineral soil was determined by the Walkley-Black procedure (Nelson and Sommers 1996). Total C ha^{-1} to a 100-cm depth of mineral soil was calculated assuming 0.44 g C g^{-1} organic matter with correction for soil bulk density.

Results Inorganic C and total C (inorganic + organic C) in soil were higher in IP than NSB. If irrigated pasture land was expanded by 10%--meaning NSB land was converted to IP--a possible gain of 9.6×10^8 Mg total C (1.7 % of the total C emitted in the next 30 year) could be sequestered in soils worldwide. If irrigated agricultural land was expanded worldwide and NSB was converted to IP, while an equal amount of less-productive rainfed agricultural land was returned to native grassland, a possible gain of 9.3×10^9 Mg total C (11.9 % of the total C emitted in the next 30 yr) could be sequestered in soils.

Table 1 Total C sequestered in soils during a 30-year period by a 10% conversion from NSB to irrigated conservation tillage and irrigated pasture lands; and 10% conversion from irrigated moldboard plow to IP.

Vegetation Conversion		Western United States		Worldwide	
	Mg C ha^{-1}	Mg C	% C_s/C_{EW}	Mg C	% C_s/C_{EW}
NSB to irrigated conservation tillage	8.0	1.9×10^7	0.03	2.1×10^8	0.37
NSB to IP	35.6	8.7×10^8	1.53	9.3×10^9	16.32
10% of irrigated moldboard plow to IP	37.1	9.0×10^7	0.16	9.6×10^8	1.68

Land area in irrigated crop land in the Western United States is 2.43×10^7 ha and worldwide is 2.60×10^8 ha. % C_s/C_{EW} = C sequestered (C_s) divided by the amount of C projected to be emitted worldwide during the next 30 years, which is 5.7×10^{10} Mg C (C_{EW}) multiplied by 100.

Conclusions The expansion of irrigated pasture land would significantly increase C sequestration in soils world-wide. Land use shift from relatively low productivity rainfed agricultural land to temperate forest or native grassland could also cause meaningful reductions in atmospheric CO_2.

References

Nelson, D.W., and L.E. Sommers. 1996. Total Carbon, Organic Carbon and Organic Matter. In J.M. Bigham (ed). Methods of Soil Analysis. Part 3, Chemical and Microbiological Properties. American Society of Agronomy, Madison, Wisconsin, 961-1010

Loeppert, R.H. and D.L. Suarez. 1996. Carbonate and Gypsum. In. D.L. Sparks and others (eds). Methods of Soil Analysis. Part 3, Chemical Methods. American Society of Agronomy, Madison, Wisconsin, 437-474.