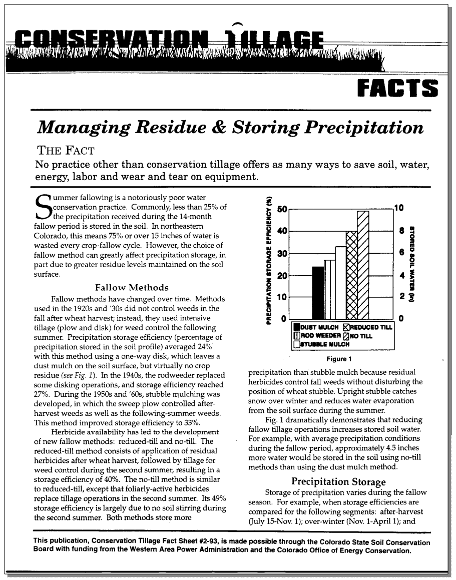
GRACEnet (Greenhouse gas Reduction through Agricultural Carbon Enhancement network): An Assessment of soil C sequestration and greenhouse gas mitigation by agricultural management

Members: V. Acosta Marinez, L. Ahuja, S. Albrecht, H. Allen, D. Archer, J. Baker, N. Barbour, K. Balkcom, J. Bunce, M. Cavigelli, H. Collins, S. DelGrosso*, C. Dell, J. Derner, P. Doraiswamy, D. Douds, R. Follett*, A. Franzluebbers, H. Gollany, S. Griffith, J. Gross, J. Hatfield, S. Haille-Mariam, A. Halvorson, W. Honeycutt, Huggins, M. Jawson[†], J. Johnson*, B. Kimball, H. Kludze, S. Kronberg, S. Lachnicht Weyers, M. Lehman, Y. Liang, M. Liebig, L. Ma, D. Martens, G. McCarty, M. Mikha, J. Morgan, D. Morris, J. Nagahashi, J. Novak, T. Oschsner, K. O'Neill, T. Parkin*, S. Phillips, K. Potter, S. Prior, J. Reeves, D. Reicosky, C. Rodiquez, B. Runion, R. Sharpe, S. Shafer[†], K. Sistani, D. Smith, J. Smith*, R. Sojka, D. Sullivan, J. Steiner, D. Stott, T. Strickland, T. Griffin, U. Sainju, G. Varvel, R. Venterea, M, Vigil, G. Wall, C. Walthall[&], J. White, R. Wright[&], L. Ziska, T. Zoebeck

*Co-lead Scientists, [&]National Program Leaders, [†]Original organizers

Products: Guidelines and Summary Documents

USDA-ARS and Colorado Conservation Tillage Association



CONSERVATION TILLAGE FACTS

Managing Residue & Storing Precipitation

THE FACT

No practice other than conservation tillage offers as many ways to save soil, water, energy, labor and wear and tear on equipment.

Summer fallowing is a notoriously poor water conservation practice. Commonly, less than 25% of the precipitation received during the 14-month fallow period is stored in the soil. In northeastern Colorado, this means 75% or over 15 inches of water is wasted every crop-fallow cycle. However, the choice of fallow method can greatly affect precipitation storage, in part due to greater residue levels maintained on the soil surface.

Fallow Methods

Fallow methods have changed over time. Methods used in the 1920s and '30s did not control weeds in the fall after wheat harvest; instead, they used intensive tillage (plow and disk) for weed control the following summer. Precipitation storage efficiency (percentage of precipitation stored in the soil profile) averaged 24% with this method using a one-way disk, which leaves a dust mulch on the soil surface, but virtually no crop residue *(see Fig. 1)*. In the 1940s, the rodweeder replaced some disking operations, and storage efficiency reached 27%. During the 1950s and '60s, stubble mulching was developed, in which the sweep plow controlled after-harvest weeds as well as the following-summer weeds. This method improved storage efficiency to 33%.

Herbicide availability has led to the development of new fallow methods: reduced-till and no-till. The reduced-till method consists of application of residual herbicides after wheat harvest, followed by tillage for weed control during the second summer, resulting in a storage efficiency of 40%. The no-till method is similar to reduced-till, except that foliarly-active herbicides replace tillage operations in the second summer. Its 49% storage efficiency is largely due to no soil stirring during the second summer. Both methods store more

Figure 1

precipitation than stubble mulch because residual herbicides control fall weeds without disturbing the position of wheat stubble. Upright stubble catches snow over winter and reduces water evaporation from the soil surface during the summer.

Fig. 1 dramatically demonstrates that reducing fallow tillage operations increases stored soil water. For example, with average precipitation conditions during the fallow period, approximately 4.5 inches more water would be stored in the soil using no-till methods than using the dust mulch method.

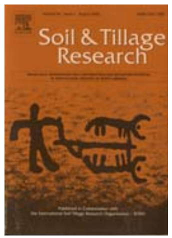
Precipitation Storage

Storage of precipitation varies during the fallow season. For example, when storage efficiencies are compared for the following segments: after-harvest (July 15-Nov. 1); over-winter (Nov. 1-April 1); and

This publication, Conservation Tillage Fact Sheet #2-93, is made possible through the Colorado State Soil Conservation Board with funding from the Western Area Power Administration and the Colorado Office of Energy Conservation.

Greenhouse Gas Contributions and Mitigation Potential in Agricultural Regions of North America

Edited by Alan J. Franzluebbers and Ronald F. Follett



Volume 83, Issue 1, Pages 1-172
August 2005: Special Issue

Franzluebbers, A.J., Follett, R.F. 2005. Greenhouse gas contributions and mitigation potential in agricultural regions of North America: Introduction. p. 1-8.

Del Grosso, S.J., Mosier, A.R., Parton, W.J., Ojima, D.S. 2005. DAYCENT model analysis of past and contemporary soil N_2O and net greenhouse gas flux for major crops in the USA. p. 9-24.

Liebig, M.A., Morgan, J.A., Reeder, J.D., Ellert, B.H., Gollany, H.T., Schuman, G.E. 2005. Greenhouse gas contributions and mitigation potential of agricultural practices in northwestern USA and western Canada. p. 25-52.

Gregorich, E.G., Rochette, P., VandenBygaart, A.J., Angers, D.A. 2005. Greenhouse gas contributions of agricultural soils and potential mitigation practices in Eastern Canada. p. 53-72.

Johnson, J.M-F., Reicosky, D.C., Allmaras, R.R., Sauer, T.J., Venterea, R.T., Dell, C.J. 2005. Greenhouse gas contributions and mitigation potential of agriculture in the central USA. p. 73-94.

Martens, D.A., Emmerich, W., McLain, J.E.T., Johnsen, T.N. 2005. Atmospheric carbon mitigation potential of agricultural management in the southwestern USA. p. 95-119.

Franzluebbers, A.J. 2005. Soil organic carbon sequestration and agricultural greenhouse gas emissions in the southeastern USA. p. 120 -147.

Follett, R., Castellanos, J.Z., Buenger, E.D. 2005. Carbon dynamics and sequestration in an irrigated Vertisol in Central Mexico. p. 148-158.

Follett, R.F., Shafer, S.R., Jawson, M.D., Franzluebbers, A.J. 2005. Research and implementation needs to mitigate greenhouse gas emissions from agriculture in the USA. p. 159-166.

Jawson, M.D., Shafer, S.R., Franzluebbers, A.J., Parkin, T.B., Follett, R.F. 2005. GRACEnet: Greenhouse gas reduction through agricultural carbon enhancement network. p. 167-172.

Journal of Soil and Water Conservation Feature article

Franzluebbers, A.J., Follett, R.F., Johnson, J.M-F., Liebig, M.A., Gregorich, E.G., Jawson, M.D., Martens, D.A. 2006. Agricultural Exhaust: A reason to invest in Soil. J. Soil Water Conserv. 61: 98-101.

Table 1. Summary of global warming potential as affected by agricultural management strategies in different regions of North America (adapted from Franzluebbers and Follett, 2005). All units have been adjusted to CO_2-C equivalence. Negative values represent sequestration in soil. Positive values are emission to the atmosphere.

Management comparison	Region in North America				
	Northwest	Northeast	Central	Southwest	Southeast
As change in soil organic carbon (Mg CO_2-C equivalents · ha^{-1} · yr^{-1})					
Conservation *vs* conventional tillage	–0.27	0.07	–0.48	–0.30	–0.42
More complex cropping systems	–0.12	--	–0.18	–0.29	–0.22
Addition of animal manure[a]	–0.15	--	--	--	–0.72
Addition of N fertilizer[a]	–0.09	--	--	--	–0.18
Conversion of cropped land to grass	–0.94	--	–0.56	–0.32	–1.03
Grazed versus ungrazed grassland	–0.16	--	--	0.03	–0.76
Invasion of woody plants in grassland	--	--	--	–0.22	--
As N_2O emission (Mg CO_2-C equivalents · ha^{-1} · yr^{-1})					
Crop systems	0.51	0.50	--	--	--
Grass systems	0.08	0.16	--	0.97	--
As CH_4 emission / uptake by soil (Mg CO_2-C equivalents · ha^{-1} · yr^{-1})					
All cropping systems	–0.03	0.00	--	--	--

[a] Excludes carbon cost of manufacture and distribution.

Other Popular Press Articles

Enerson, D. 2006. Carbon credit program: It's good for farm income and the environment. North Dakota Union Farmer. May 2006. p. 1, 10-11.

Kolpack, D. 2006. Farmers group offers credit for conservation. Bismarck Tribune. 25 May 2006. p. 3B.

Tonneson, L. 2006. Carbon cash. Dakota Farmer. July 2006. p. 1, 6-7.

Recent GRACEnet Related Scientific Publications:

Allen, L. H., S. L. Albrecht, K. J. Boote, J. M. G. Thomas, Y. C. Newman, and K. W. Skirvin. 2006. Soil Organic Carbon and Nitrogen Accumulation in Plots of Rhizoma Perennial Peanut and Bahiagrass Grown in Elevated CO_2 and Temperature. JEQ. 35(4):1405-1412.

Causarano, H.J., Franzluebbers, A.J., Reeves, D.W., Shaw, J.N. 2006. Soil organic carbon sequestration in cotton production systems of the southeastern United States: A review. JEQ. 35:1374-1383.

Cochran, R.L., H.P. Collins, A.C. Kennedy and B.F. Bezdicek. 2006. Soil carbon pools and fluxes following land conversion in a semi-arid shrub-steppe ecosystem. Soil Bio. Fert. Soils. In Press.

Franzluebbers, A.J., Stuedemann, J.A. 2005. Bermudagrass management in the Southern Piedmont USA: VII. Soil-profile organic carbon and total nitrogen. SSSAJ. 69:1455-1462.

Liebig, M.A., J.R. Gross, S.L. Kronberg, J.D. Hanson, A.B. Frank, and R.L. Phillips. 2006. Soil response to long-term grazing in the northern Great Plains of North America. Ag. Eco. Env. 115:270-276.

Madari, B.E., Reeves III, J.B., Coelho, M.R., Machado, P., DePolli, H. Coelho R.M, Benites, V.M., Souza L.F., McCarty, G.W. 2005. Mid- and near- infrared spectroscopic determination of carbon in a diverse set of soils from the Brazilian national soil collection. Spectro. Let. 38:721-740.

McCarty G.W. and Reeves III, J.B. 2006 Comparison of near infrared and mid infrared diffuse reflectance spectroscopy for field scale measurement of soil fertility parameters. Soil Sci. 171:94-102.

Parkin, T.B., Kaspar, T.C. 2006. Nitrous oxide emissions from corn/soybean systems in the Midwest. JEQ. 35:1496-1506.

Potter, K.N., and J.D. Derner. 2006. Soil carbon pools in central Texas: Prairies, restored grasslands, and croplands. JSWC 61:124-128.

Reeves, J.B. III., R.F. Follett, G.W. McCarty,and J.M. Kimble. 2006. Can near or mid-infrared diffuse reflectance spectroscopy be used to determine soil carbon pools? CSSPA. 37:1–19. 2006.

Sainju, U.M., A. Lenssen, T. Caesar-Tonthat, and J. Waddell. 2006a. Carbon sequestration in dryland soil and plant residue as affected by tillage and crop rotation. JEQ. 35:1341-1347.

Sainju, U.M., A. Lenssen, T. Caesar-Tonthat, and J. Waddell. 2006b. Tillage and crop rotation effects on dryland soil and residue carbon and nitrogen. SSSAJ. 70:668-678.

Schumacher J.A., Venteris E.R., McCarty G.W., Ritchie J.C., Kasper T.C., Colvin T.S., Jaynes, D.B. Karlan, D.L., Fenton T.E., Schumacher, T.E., Lindstrom, M.J. 2005. Identifying spatial patterns of erosion for use in precision conservation. JSWC. 60:355-362.

Varvel, G.E. 2006. Soil organic carbon changes in diversified rotations of the Western Corn Belt. SSSAJ. 70:426-433.