The Science Behind Healthy Soil: NRCS Soil Health Literature Review

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A Collaborative Project of the NRCS SSRA and S&T Deputy Areas

Deputy Chief for Soil Science and Resource Assessment

Soil Science Division

National Soil Survey Center

Soil Quality and Ecosystems Staff

- Direction and Review
- Literature Search, Analysis, Development, and Summary

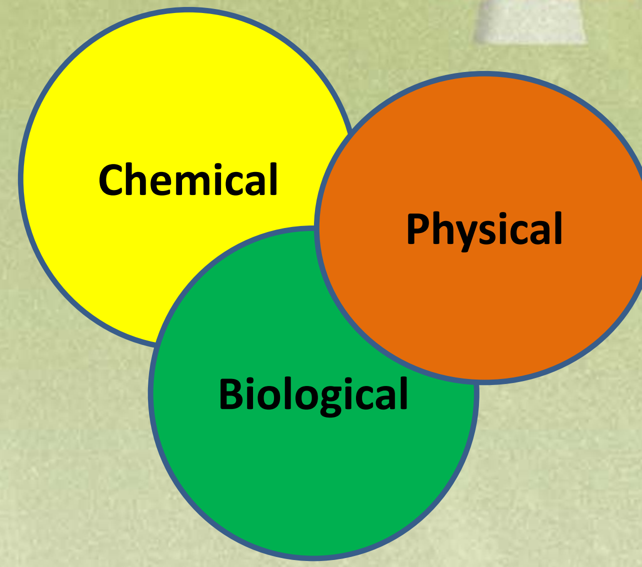
Deputy Chief for Science and Technology

East National Technology Support Center

National Soil Health and Sustainability Team

- Direction and Review
- SharePoint and Web site Development

Features of the Soil Health Literature Review Project



- Peer-reviewed papers
- Scientific underpinning
- Focus on physical properties (limited chemical and biological properties papers included)
- Primarily cropland practices
- Tool for NRCS and partners (internal and external)
- Biological and economic impacts are targeted (future)

Features, cont.

- Random, unbiased selection of papers
- Searchable by practices and properties
- Literature search not all-inclusive (dynamic)
- Submittal process
- Targeted by practice and physical properties
- National Ag Library
- Digi top, Google Scholar
- Journal Articles (NSSC Library)
- US and abroad

Soil Health Definition

- Capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans
  - Nutrient cycling
  - Water (infiltration & availability)
  - Filtering and Buffering
  - Physical Stability and Support
  - Habitat for Biodiversity

Soil Health vs. Soil Quality

- The two terms are often used interchangeably.
- Some use the term *Soil Quality* to refer to *Inherent* Soil Properties such as texture and depth and *Soil Health* to refer to *Dynamic* Soil Properties such as organic matter, bulk density and aggregate stability.
- Soils with good quality are more resilient (bounce back from abuse) and more resistant to degradation.
- Dynamic soil properties are near optimum for a healthy functioning soil (soil functions provided are important).
- Soil Health = Living Ecosystem vs. Soil Quality = specific SQ indicators measured.

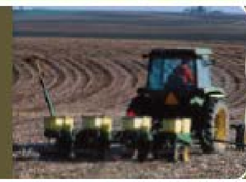
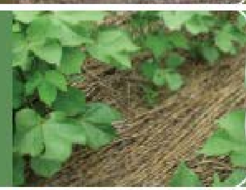
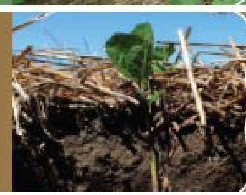
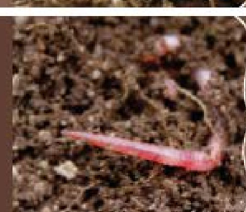
Soil Health Planning Principles

1. Manage more by <u>Disturbing Soil Less</u>
2. <u>Use Diversity of Plants</u> to add diversity to soil microorganisms
3. <u>Grow Living Roots</u> throughout the year
4. <u>Keep the Soil Covered</u> as much as possible

- Integrate livestock
- Manage compaction
- Control erosion


Goal: To create the most favorable habitat possible for the soil-food web unlock the SECRETS IN THE SOIL

Soil Health Management Systems Include:

What is it?		What does it do?	How does it help?
Conservation Crop Rotation Growing a diverse number of crops in a planned sequence in order to increase soil organic matter and biodiversity in the soil.		• Increases nutrient cycling • Manages plant pest (weeds, insects, and diseases) • Reduces sheet, rill, and wind erosion • Holds soil moisture • Adds diversity so soil microbes can thrive	• Improves nutrient use efficiency • Decreases use of pesticides • Improves water quality • Conserves water • Improves plant production
Cover Crop An un-harvested crop grown as part of planned rotation to provide conservation benefits to the soil.		• Increases soil organic matter • Prevents soil erosion • Conserves soil moisture • Increases nutrient cycling • Provides nitrogen for plant use • Suppresses weeds • Reduces compaction	• Improves crop production • Improves water quality • Conserves water • Improves nutrient use efficiency • Decreases use of pesticides • Improves water efficiency to crops
No Till A way of growing crops without disturbing the soil through tillage.		• Improves water holding capacity of soils • Increases organic matter • Reduces soil erosion • Reduces energy use • Decreases compaction	• Improves water efficiency • Conserves water • Improves crop production • Improves water quality • Saves renewable resources • Improves air quality • Increases productivity
Mulch Tillage Using tillage methods where the soil surface is disturbed but maintains a high level of crop residue on the surface.		• Reduces soil erosion from wind and rain • Increases soil moisture for plants • Reduces energy use • Increases soil organic matter	• Improves water quality • Conserves water • Saves renewable resources • Improves air quality • Improves crop production
Mulching Applying plant residues or other suitable materials to the soil surface to compensate for loss of residue due to excessive tillage.		• Reduces erosion from wind and rain • Moderates soil temperatures • Increases soil organic matter • Controls weeds • Conserves soil moisture • Reduces dust	• Improves water quality • Improves plant productivity • Increases crop production • Reduces pesticide usage • Conserves water • Improves air quality
Nutrient Management Managing soil nutrients to meet crop needs while minimizing the impact on the environment and the soil.		• Increases plant nutrient uptake • Improves the physical, chemical, and biological properties of the soil • Budgets, supplies, and conserves nutrients for plant production • Reduces odors and nitrogen emissions	• Improves water quality • Improves plant production • Improves air quality
Pest Management Managing pests by following an ecological approach that promotes the growth of healthy plants with strong defenses, while increasing stress on pests and enhancing the habitat for beneficial organisms.		• Reduces pesticide risks to water quality • Reduces threat of chemicals entering the air • Decreases pesticide risk to pollinators and other beneficial organisms • Increases soil organic matter	• Improves water quality • Improves air quality • Increases plant pollination • Increases plant productivity

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Targeted Conservation Practices

Name

- 311- Alley Cropping
- 328- Conservation Crop Rotation
- 329- Residue and Tillage Management- No Till
- 340- Cover Crop
- 344- Residue and Tillage Management- Seasonal
- 345- Residue and Tillage Management- Reduced Till
- 449- Irrigation Water Management_Yield_Salinity
- 484- Mulching
- 511- Forage Harvest Management_ Perennials_Harvest
- 512- Forage and Biomass Planting_Perennials_Harvest
- 585- Stripcropping
- 590- Nutrient Management_Organic Amends_Application Methods

Selecting Soil Quality Indicators

- **Chemical**
  - Soil test, such as N, P, K, pH, NA, salinity, sodicity, etc.
- **Physical**
  - Aggregate stability
  - Available water capacity and water retention
  - Crusting
  - Compaction layers
  - Bulk density
  - Infiltration
- **Biological**
  - Organic matter (soil color)
  - Potential mineralizable N
  - Active carbon
  - Respiration
  - Microbe analysis
  - Earthworms
  - Fungi

Soil Properties

- Properties in the Matrix (abbrev)
  - BD, Compaction, Soil H_2O, Ksat, Infil/Drain, Earthworm, Crust/Seal, Aggregate, Structure, Surf Rough, SOM, Fungi, Nitrogen, Phosphorus, Soil pH/EC/NA, Hvy Metals, Pest Mvmt/Degr
- Primarily Physical Properties



Features of the Soil Health Literature Review

Public Web site http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/

- Summary of effects of conservation practices on soil properties
- Excel spreadsheet (matrix) of addressed practices, properties, and climate for each paper/author(s)
- Data dictionary
- Short summaries and citations of papers
- Link to USDA Employee SharePoint

Soil Health Literature Summary

Key conservation practices summarized:

- 328 Conservation Cropping Rotation
- 329 Residue and Tillage Management, No-Till
- 340 Cover Crops
- 484 Mulching
- 590 Nutrient Management
- Additional practices in the future

Soil Health Literature Summary— Effects of Conservation Practices on Soil Properties in Areas of Cropland

Soil Health Literature Summary, cont.

Table of Contents

Soil Health Literature Summary, cont.

Conservation Practice 329—Residue and Tillage Management, No-Till

Definition: Limiting soil disturbance to manage the amount, orientation, and distribution of crop and plant residue on the soil surface year-round (NRCS National Handbook of Conservation Practices, 2014)

Purpose: This practice allows for in-row tillage during the planting operation and use of equipment for closing the seed row or furrow. Full-width tillage is not allowed. The practice is used to support one or more of the following—

- Reduce sheet, rill, and wind erosion
- Reduce tillage-induced particulate emissions
- Maintain or increase soil quality and organic matter content
- Reduce energy use
- Increase efficiency of water use and precipitation storage
- Provide food and escape cover for wildlife

Purposes of this practice that directly relate to improving soil physical properties include: reduce sheet, rill, and wind erosion; maintain or increase soil quality and organic matter content; and increase efficiency of water use and precipitation storage.

Degradation of agricultural soils as a result of excessive tillage has spurred interest in no-till cropping systems. These systems help to maintain the physical conditions of a relatively undisturbed soil. Residue is left on the surface of the soil, making it less susceptible to wind and water erosion (Baker and Saxton, 2007). Tillage accelerates mineralization (breakdown) of crop residue and loss of soil organic matter (Stubbs et al., 2004).

No-till (NT) systems have been compared to various tillage practices under a range of conditions. Studies on how the practices affect physical soil properties had mixed results. Overall, NT systems tend to increase macropore connectivity while generating inconsistent responses in total porosity and soil bulk

Soil Health Literature Summary, cont.

Table 1.—Impact of No-Till Systems and Associated Practices on Physical Soil Properties

(Definitions of abbreviations: AgS—aggregate stability; AWC—available water capacity; BD—bulk density; CT—conventional till; Ksat—saturated hydraulic conductivity; MT—mulch till; N/A—not applicable; NT—no-till; POR—porosity; PR—penetration resistance; RT—ridge till; SOM—soil organic matter)

Impact of NT and associated practices (negative effects underlined)	Tillage system and associated practices with the most beneficial or least detrimental impact	Systems compared	Years of NT	Moisture regions	Soil temper-ature regime	Soil texture/ limitation; location of study	Reference (first author, date)
Improved Ksat	NT; perennial grasses in rotation (328)	CRP, NT with corn, soybeans, and wheat rotation and clover cover crop; MT with corn and soybeans rotation; NT with perennial hay and corn rotation	Short term	Subhumid	Mesic	Claypan soil; Missouri	Jiang, 2007
Higher BD, lower POR, higher microporosity, higher AWC	NT; corn, peanuts, cotton-sorghum, and soybeans	NT, CT, organic crop production, plantation forestry-woodlot, abandoned-field succession, integrated crop–livestock	8 years	Humid	Thermic	Sandy loam and loamy sand; Goldsboro, North Carolina	Raczkowski, 2012
Slight improvement in SOM	NT; small grain without fallow (328)	NT, MT, and CT with small grain, with and without fallow	11 years	Semi-arid	Frigid	Coarse sandy soils; SW Saskatchewan	Campbell, 1996
Improved SOM, POR, AWC, BD, and PR	NT; corn and soybeans rotation with winter cover crops (hairy vetch and cereal rye) (340)	NT with corn and soybeans rotation and winter cover crops	Short term	Humid	Mesic	Silt loam; Illinois	Villamil, 2006

No-Till Literature Summary (keys)

- Limitations of the soil and site
- Previous management
- Soil temperature and moisture regime
- Diversity and intensity of the crop rotation
- Type and amount of crop residue (C:N ratio)
- Removal of residue after harvest
- Irrigated vs. rainfed
- Adaptive management!!!

No-Till Literature Summary, cont.

- Amount of disturbance (no-till vs. strip-till)
- Fertilizer and manure application
- Synergistic impact of multiple practices (use of other practices, such as rotation, cover crops, and mulching along with no-till)
- Research protocols used (variability)
- Weather impacts
- Plots vs. field-size research
- Duration practice or system has been in place (transition)

Matrix/Spreadsheet

Soil_Health_Literature_Matrix_of_Soil_Prop

File Home Insert Page Layout Formulas Data Review View Acrobat

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	A	B	C	D	E	F	G	H	I
1	Reference, Citation & Summary	Standard	BD	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthworm
2	Abbas and Fares, 2009	590	Yes	No	No	Yes	No	No	No
3	Abdollah et al., 2013	340	No	Yes	Yes	No	No	Yes	No
4	Anderson et al., 2009	391; 393	No	No	Yes	No	Yes	No	No
5	Arvidsson and Bolenius, 2006	344; 345	Yes	Yes	No	Yes	No	No	No
6	Aslam et al., 2009	595	No	No	No	No	No	No	No
7	Aziz et al., 2013	329	No	No	No	No	No	No	No
8	Bacigaluppo et al., 2011	329	No	Yes	No	Yes	No	Yes	No
9	Bainard et al., 2012	311	No	No	No	No	No	No	No
10	Baker and Mickelson, 1994	345; 595	No	No	No	No	No	No	No
11	Baker and Saxton, 2007	329	No	No	Yes	No	No	No	Yes
12	Benjamin et al., 2007	512	Yes	No	No	Yes	Yes	Yes	No
13	Benjamin et al., 2008	328; 329; 345; 512	Yes	Yes	Yes	Yes	No	No	No
14	Bhardwaj et al. 2008	345; 449; 590; 610	No	No	No	Yes	No	Yes	No
15	Bhattacharyya et al., 2007	590	No	No	No	Yes	Yes	No	No
16	Blackshaw, 2008	595	No	No	No	No	No	No	No
17	Blanco-Canqui et al. 2004	328; 329; 345	Yes	Yes	No	Yes	No	No	No
18	Blanco-Canqui and Lal, 2007	484	No	No	Yes	Yes	Yes	Yes	Yes
19	Blanco-Canqui et al., 2007	329; 511	Yes	No	Yes	Yes	No	Yes	Yes
20	Blanco-Canqui and Lal, 2008	329	Yes	No	Yes	Yes	Yes	Yes	Yes

Data Dictionary

Soil Health Literature Matrix Data Dictionary, July 21, 2014

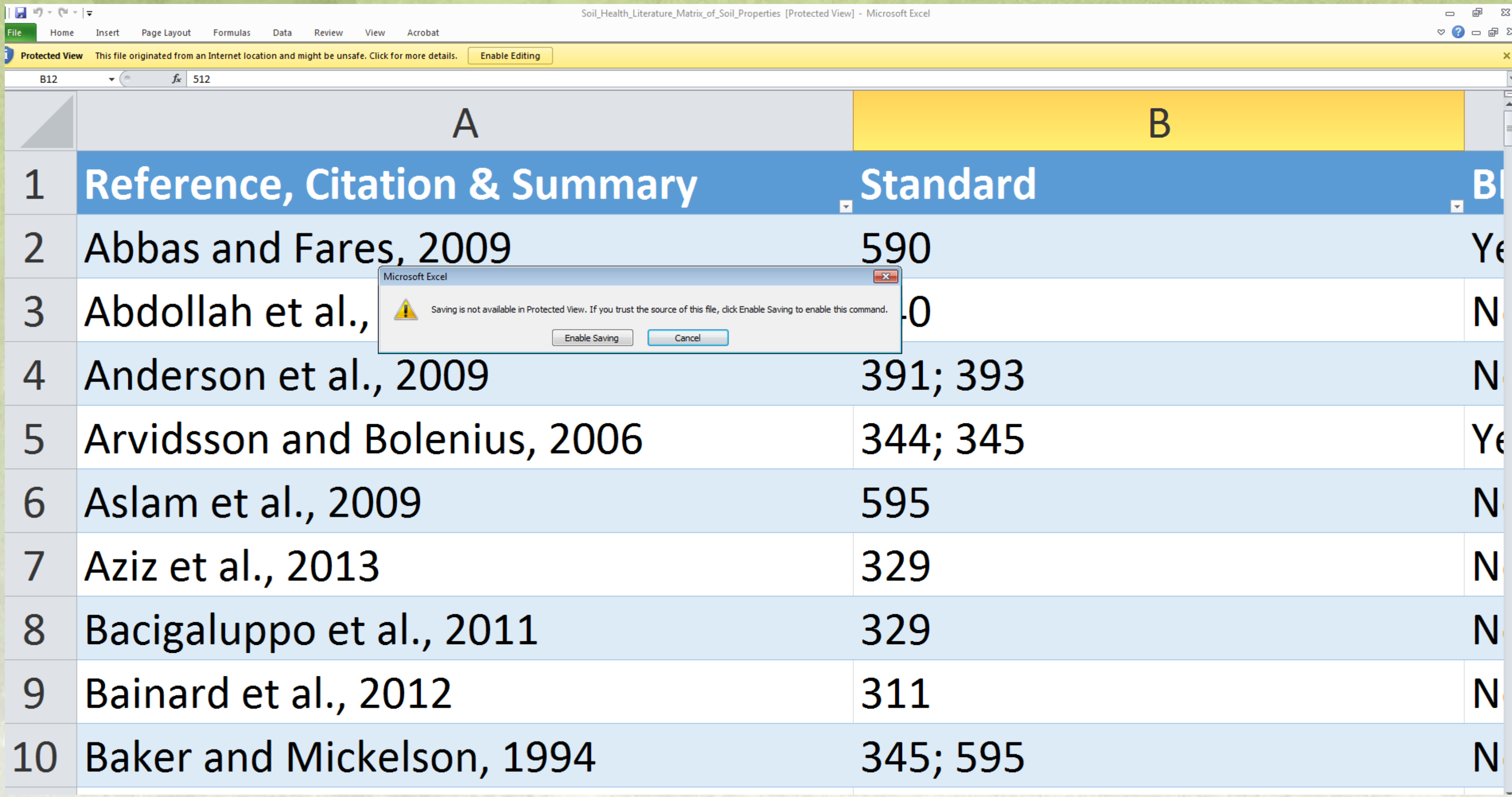
Column Short Name	Column Full Name	Data	Definition
Reference, Citation & Summary	Peer Reviewed Literature Citation and Short Summary of Literature	Shortened citation from NRCS summary of peer reviewed literature	This entry provides the last name of the first author listed and the year the peer reviewed literature was published. The summary that is referred to is a shorter summary (modified abstract) of the literature completed by NRCS staff and is not the same as the abstract, summaries, or conclusions found in the actual article (e.g. .statistics and introductory sentences are omitted from the abstract and additional information may be added important to soil health that was in the article but not noted in the abstract.
Name	Literature File Name	Link to peer reviewed literature pdf file	This entry contains the first author's last name and year published with a link to pdf file of peer reviewed literature. Available only to USDA employees using the Soil Health Literature Review SharePoint.
Standard	NRCS Conservation Practice Standard Number(s)	NRCS Conservation Practice Standard Number or Not Applicable (NA)	NRCS Conservation Practice Standard Number is from the National Handbook of Conservation Practices. The conservation practice numbers listed are addressed in the peer reviewed literature. Multiple entries or not applicable (NA) possible. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/
BD	Bulk Density	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on bulk density is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on bulk density is not included.

Data Dictionary, cont.

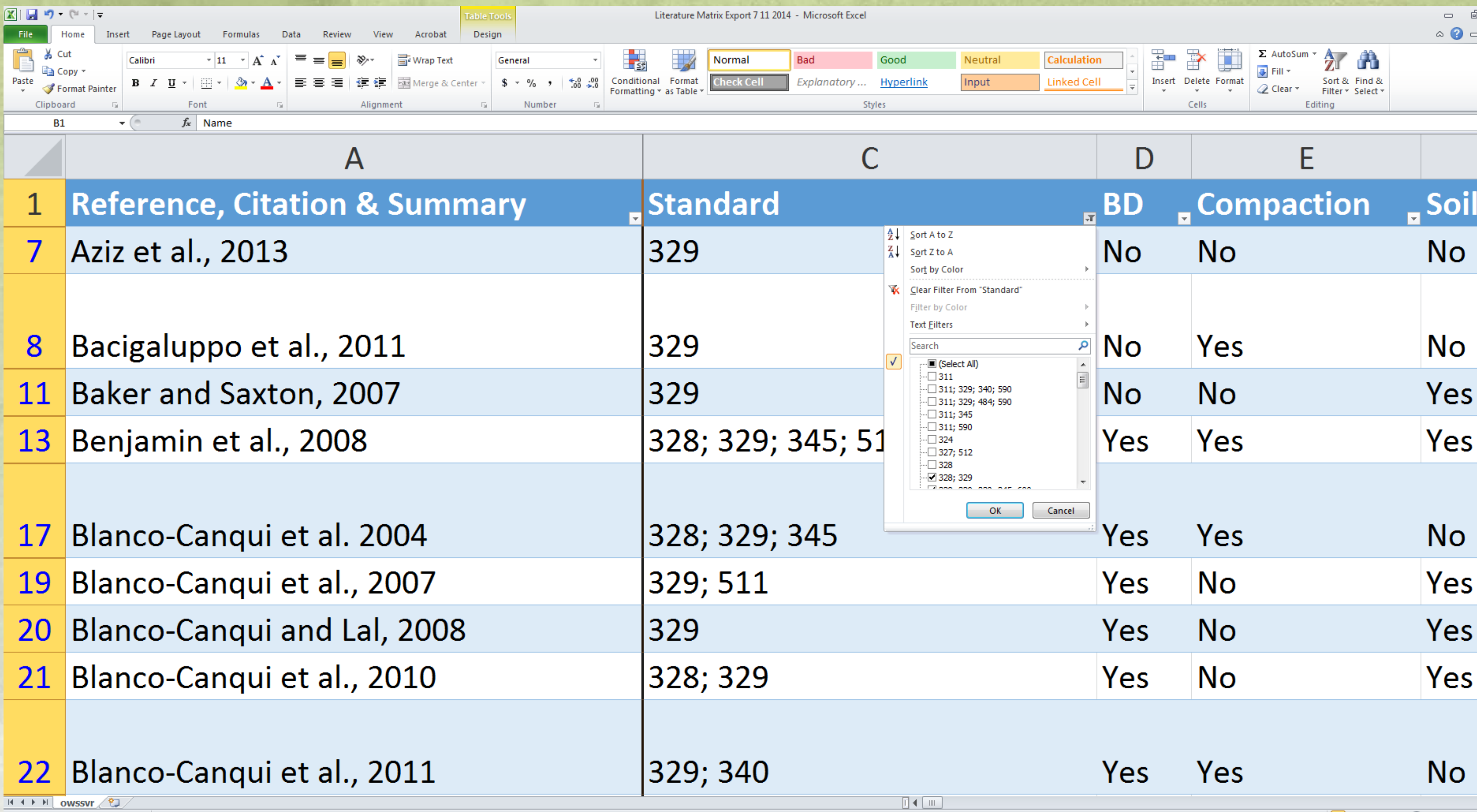
Soil Health Literature Matrix Data Dictionary, July 21, 2014

Column Short Name	Column Full Name	Data	Definition
Infiltr/Drain	Infiltration/Drainage Water Management	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on infiltration/drainage water management or related topics is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on infiltration/drainage water management or related topics is not included.
Pore Size	Pore Size/Porosity/Pore Type	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on pore size/type, porosity, macropores, micropores, or related topics is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on pore size/type, porosity, macropores, micropores, or related topics is not included.
Earthworm	Earthworms	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on earthworms or related topics is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on earthworms or related topics is not included.
Crust/Seal	Soil surface crusting and/or sealing	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on soil surface crusting/sealing or related topics is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on soil surface crusting/sealing or related topics is not included.
Aggregate	Aggregate Stability	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on aggregate stability or related topics is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on aggregate stability or related topics is not included.
Structure	Soil Structure	Yes or No	If "Yes" is shown, information about the impacts of conservation practices on soil structure or related topics is contained in the peer reviewed literature, and if "No" is shown, the impacts of conservation practices on soil structure or related topics is not included.

Enable Saving

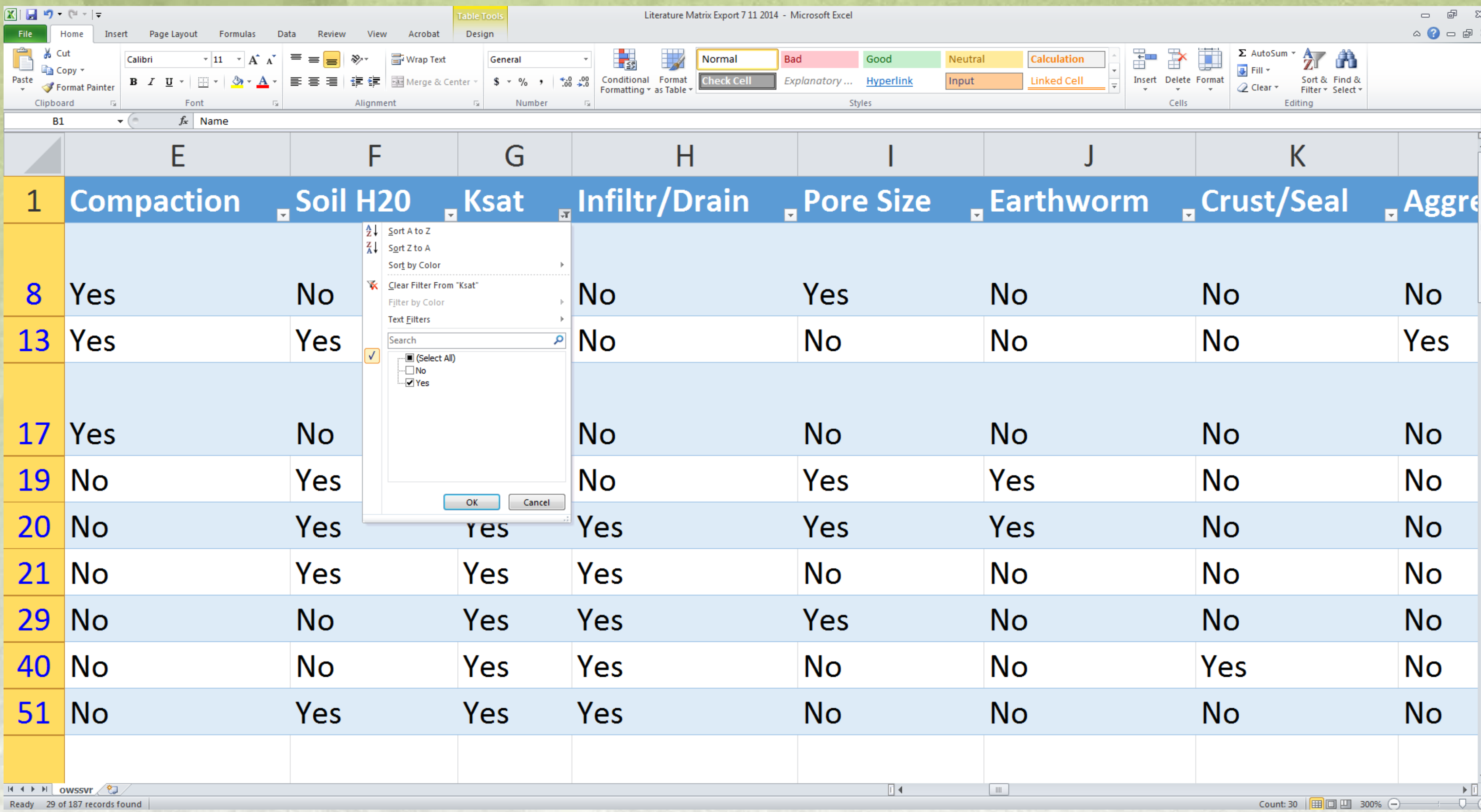


Filter Data by Practice Standard(s)



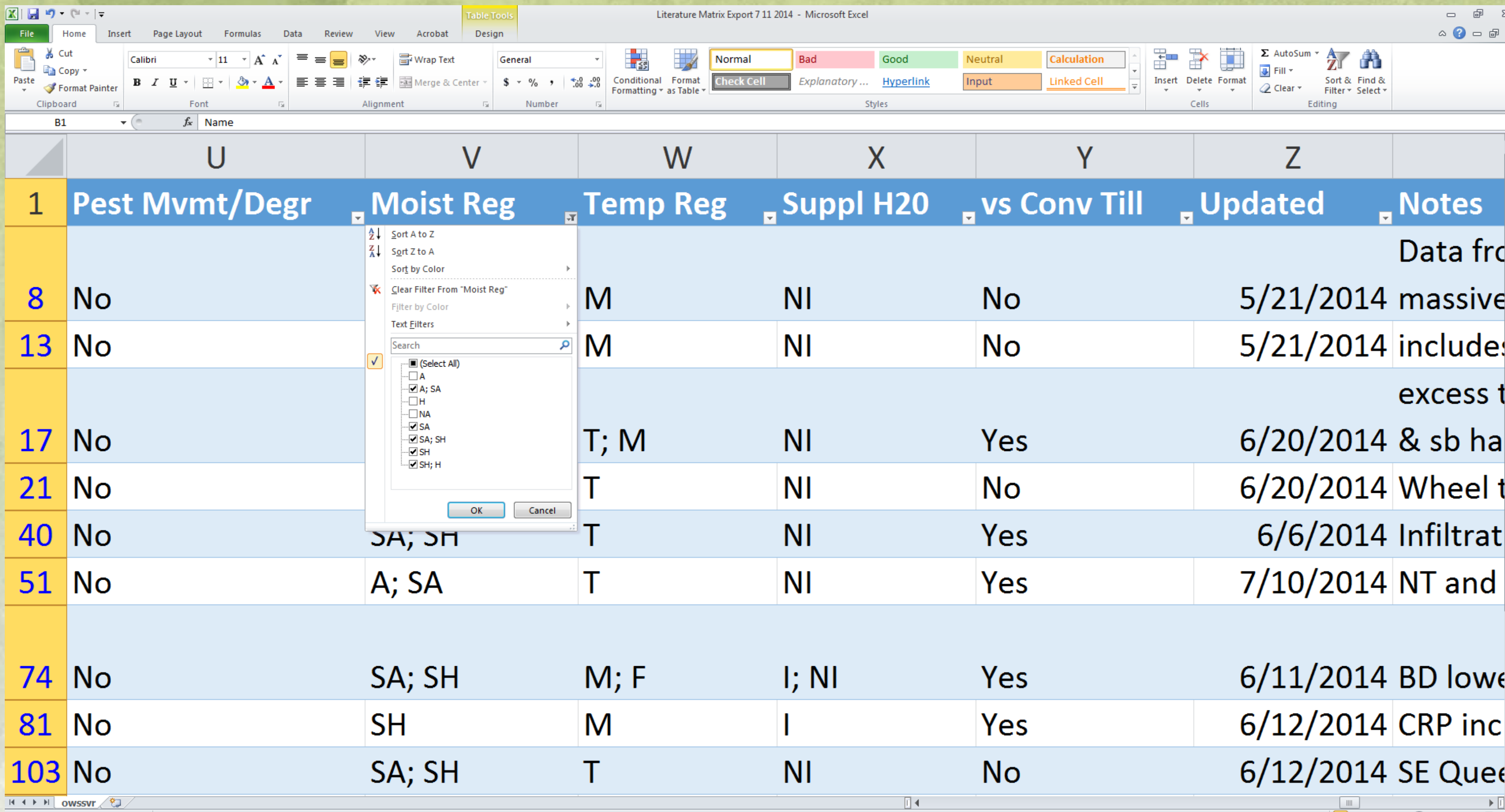
Row	Reference, Citation & Summary	Standard	BD	Compaction	Soil
7	Aziz et al., 2013	329	No	No	No
8	Bacigaluppo et al., 2011	329	No	Yes	No
11	Baker and Saxton, 2007	329	No	No	Yes
13	Benjamin et al., 2008	328; 329; 345; 51	Yes	Yes	Yes
17	Blanco-Canqui et al. 2004	328; 329; 345	Yes	Yes	No
19	Blanco-Canqui et al., 2007	329; 511	Yes	No	Yes
20	Blanco-Canqui and Lal, 2008	329	Yes	No	Yes
21	Blanco-Canqui et al., 2010	328; 329	Yes	No	Yes
22	Blanco-Canqui et al., 2011	329; 340	Yes	Yes	No

Filter by Property



	E	F	G	H	I	J	K	
1	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthworm	Crust/Seal	Aggre
8	Yes	No		No	Yes	No	No	No
13	Yes	Yes		No	No	No	No	Yes
17	Yes	No		No	No	No	No	No
19	No	Yes		No	Yes	Yes	No	No
20	No	Yes	Yes	Yes	Yes	Yes	No	No
21	No	Yes	Yes	Yes	No	No	No	No
29	No	No	Yes	Yes	Yes	No	No	No
40	No	No	Yes	Yes	No	No	Yes	No
51	No	Yes	Yes	Yes	No	No	No	No

Filter by Moisture Regime



Applicable Papers (329 & SA)

	Reference, Citation & Summary	Standard	BD	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthwo
8	Bacigaluppo et al., 2011	329	No	Yes	No	Yes	No	Yes	No
13	Benjamin et al., 2008	328; 329; 345; 512	Yes	Yes	Yes	Yes	No	No	No
17	Blanco-Canqui et al. 2004	328; 329; 345	Yes	Yes	No	Yes	No	No	No
21	Blanco-Canqui et al., 2010	328; 329	Yes	No	Yes	Yes	Yes	No	No
40	Dao, 1993	329; 345	Yes	No	No	Yes	Yes	No	No
51	Evett et al., 1999	329; 345	No	No	Yes	Yes	Yes	No	No
74	Jabro et al., 2009	329	Yes	Yes	Yes	Yes	No	No	No
81	Jiang et.al, 2007	328; 329; 340; 484	Yes	No	Yes	Yes	No	Yes	No
103	Li et al., 2008	329; 345	Yes	No	No	Yes	No	No	No
111	Malone et al., 2003	329	No	No	No	Yes	No	Yes	No
149	Sasal et al., 2010	328; 329	Yes	No	No	Yes	Yes	Yes	No
158	Sharratt et al., 2006	329; 345	No	No	Yes	Yes	Yes	No	No
162	So et al., 2009	329	Yes	No	Yes	Yes	Yes	Yes	No

Literature Matrix Export 7 11 2014 - Microsoft Excel

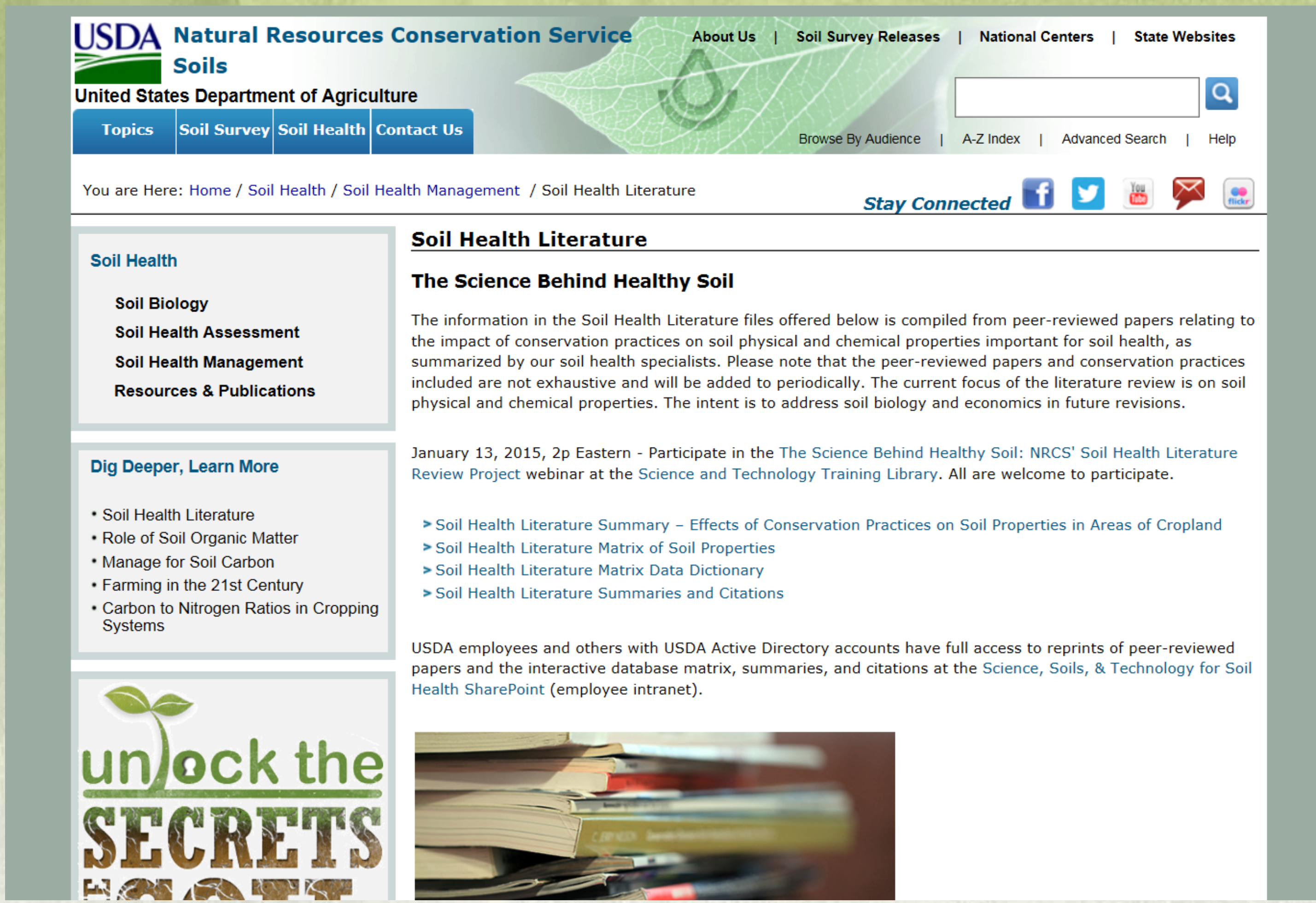
Ready 14 of 187 records found

Soil Health Literature Summaries and Citations

Soil Health Literature Matrix of Soil Properties **As of July 11, 2014**

Reference	Summary	Citation	Updated
Abbas and Fares, 2009	The objectives of this study were to: (i) simulate the effect of OM application rates (0, 168, 336, and 672 kg total N ha−1) and types (chicken and dairy manures) on soil organic C (SOC) and CO_2 emissions from a Hawaiian tropical soil (Waialua gravelly clay variant (very-fine, mixed, superactive, isohyperthermic Pachic Haplustoll)) on 2 to 6% slopes at the Waimanalo agricultural research station (21°20′15″ N, 157°43′30″ W) ; and (ii) correlate SOC, CO_2 emissions, and two major soil properties: bulk density (ρb) and saturated hydraulic conductivity (Ksat). Measurements of SOC and ρb were conducted on samples collected from the top 10 cm of soil tilled before and after manure application, cultivated with sweet corn, and drip irrigated for two consecutive growing seasons. The Ksat values were calculated from infiltration data measured with a tension infiltrometer. The Rothamsted C turnover model was used to simulate SOC and CO_2 emissions. Results revealed that SOC, CO_2 emissions, and Ksat increased while ρb decreased with increasing OM rates. There was no significant effect of OM type. There was a highly significant correlation between the measured and simulated SOC and between the measured SOC and the simulated CO_2 emissions. The Ksat values significantly correlated with the measured and simulated SOC and the simulated CO_2 emissions. A significant inverse relationship between ρb and Ksat was observed. We concluded that, in addition to improving soil aggregation, decreasing ρb, and increasing Ksat, OM application to this tropical soil increases SOC pools that contribute to atmospheric CO_2 following tillage and other agricultural practices.	Abbas, F. and A. Fares. 2009. Soil Organic Carbon and Carbon Dioxide Emission from an Organically Amended Hawaiian Tropical Soil. SSSAJ: Volume 73: Number 3.	7/11/2014

Public Web site & Questions



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- Carbon to Nitrogen Ratios in Cropping Systems

Soil Health Literature

The Science Behind Healthy Soil

The information in the Soil Health Literature files offered below is compiled from peer-reviewed papers relating to the impact of conservation practices on soil physical and chemical properties important for soil health, as summarized by our soil health specialists. Please note that the peer-reviewed papers and conservation practices included are not exhaustive and will be added to periodically. The current focus of the literature review is on soil physical and chemical properties. The intent is to address soil biology and economics in future revisions.

January 13, 2015, 2p Eastern - Participate in the The Science Behind Healthy Soil: NRCS' Soil Health Literature Review Project webinar at the Science and Technology Training Library. All are welcome to participate.

- Soil Health Literature Summary – Effects of Conservation Practices on Soil Properties in Areas of Cropland
- Soil Health Literature Matrix of Soil Properties
- Soil Health Literature Matrix Data Dictionary
- Soil Health Literature Summaries and Citations

USDA employees and others with USDA Active Directory accounts have full access to reprints of peer-reviewed papers and the interactive database matrix, summaries, and citations at the Science, Soils, & Technology for Soil Health SharePoint (employee intranet).

Features of the USDA SharePoint Site

- Sortable matrix of practices, properties, and climate of study site
- Journal summaries and full transcripts
- Overall summary
- Announcements, literature review products, and Web links

Soil Health Literature - Abbas and Fares, 2009

VIEW

Edit Item | Version History | Shared With | Delete Item | Manage | Alert Me | Actions

Name: Abbas_2009

Reference: Abbas and Fares, 2009

Summary: The objectives of this study were to: (i) simulate the effect of OM application rates (0, 168, 336, and 672 kg total N ha−1) and types (chicken and dairy manures) on soil organic C (SOC) and CO2 emissions from a Hawaiian tropical soil (Waialua gravelly clay variant (very-fine, mixed, superactive, isohyperthermic Pachic Haplustoll)) on 2 to 6% slopes at the Waimanalo agricultural research station (21°20′15″ N, 157°43′30″ W) ; and (ii) correlate SOC, CO2 emissions, and two major soil properties: bulk density (ρb) and saturated hydraulic conductivity (Ksat). Measurements of SOC and ρb were conducted on samples

Soil & Tillage Research 100 (2008) 141–153

Contents lists available at ScienceDirect

Soil & Tillage Research

journal homepage: www.elsevier.com/locate/still

Soil physical responses to cattle grazing cover crops under conventional and no tillage in the Southern Piedmont USA

Alan J. Franzluebbers *, John A. Stuedemann

ARTICLE INFO

ABSTRACT

Soil Health Literature Summary— Effects of Conservation Practices on Soil Properties in Areas of Cropland

Soil Health Literature Matrix - Instructions

Click Reference, Citation & Summary to view the full summary and citation for the peer-reviewed paper. Click the linked Name to access a PDF copy of the paper. Hove matrix record for the paper in the form view. Hover over column names to use sorting and filtering options. Use Actions to export the data.

Refer to the Soil Health Literature Matrix Data Dictionary for matrix content and column header definitions.

Actions ▾

Reference, Citation & Summary	Name	Standard	BD	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthworm	Crust/Seal	Aggregate	Struc
Abbas and Fares, 2009	Abbas_2009	590	Yes	No	No	Yes	No	No	No	No	No	No
Abdollah et al., 2013	Abdollah_2013	340	No	Yes	Yes	No	No	Yes	No	No	No	No
Anderson et al., 2009	Anderson_2009	391, 393	No	No	Yes	No	Yes	No	No	No	No	No
Arvidsson and Bolenius, 2006	Arvidsson_2006	344, 345	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes
Aslam et al., 2009	Aslam_2009	595	No	No	No	No	No	No	No	No	No	No

Table of Contents

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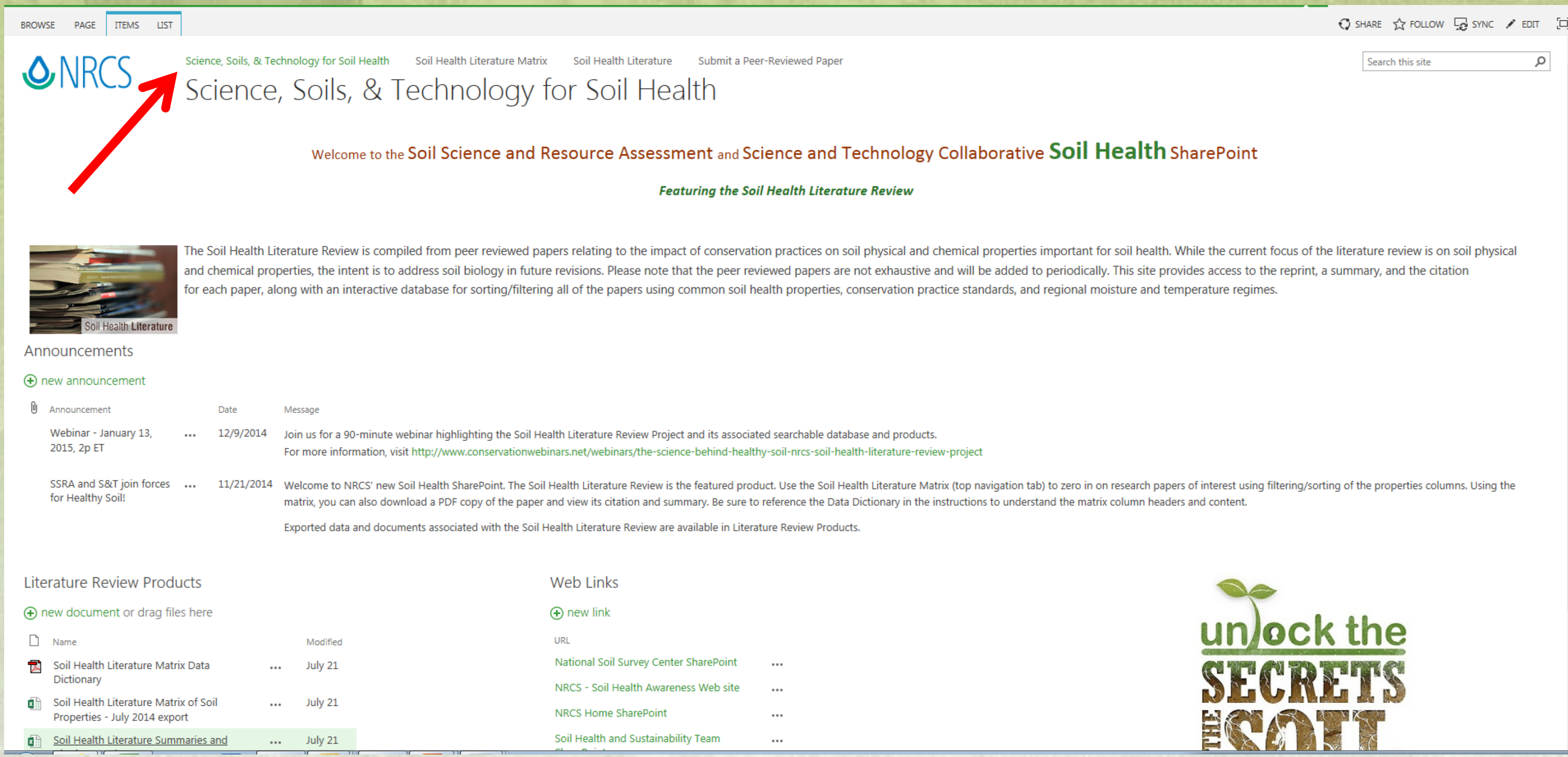

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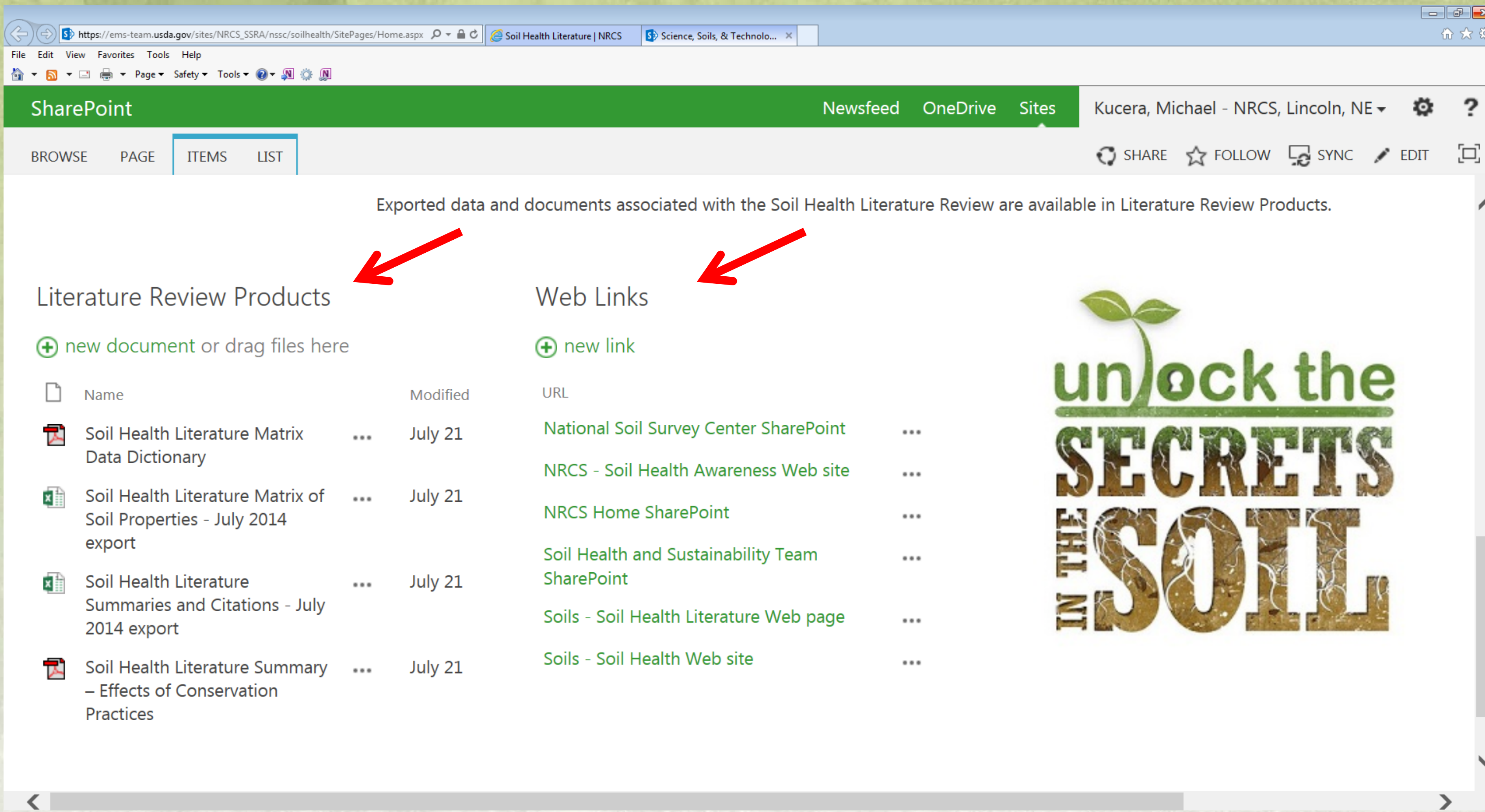
exhaustive and will be added to periodically. This site provides access to the reprint, a summary, and the citation for each paper, along with an interactive database for sorting/filtering all of the papers using common soil health properties, conservation practice standards, and regional moisture and temperature regimes.

Announcements

⊕ new announcement

Announcement		Date	Message
Webinar - January 13, 2015, 2p ET	...	12/9/2014	Join us for a 90-minute webinar highlighting the Soil Health Literature Review Project and its associated searchable database and products. For more information, visit http://www.conservationwebinars.net/webinars/the-science-behind-healthy-soil-nrcs-soil-health-literature-review-project
SSRA and S&T join forces for Healthy Soil!	...	11/21/2014	Welcome to NRCS' new Soil Health SharePoint. The Soil Health Literature Review is the featured product. Use the Soil Health Literature Matrix (top navigation tab) to zero in on research papers of interest using filtering/sorting of the properties columns. Using the matrix, you can also download a PDF copy of the paper and view its citation and summary. Be sure to reference the Data Dictionary in the instructions to understand the matrix column headers and content. Exported data and documents associated with the Soil Health Literature Review are available in Literature Review Products.

Products and Web Links



Soil Health Literature Matrix

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Science, Soils, & Technology for Soil Health | Soil Health Literature Matrix | Soil Health Literature | Submit a Peer-Reviewed Paper

Soil Health Literature Matrix

Soil Health Literature Matrix - Instructions

Click Reference, Citation & Summary to view the full summary and citation for the peer-reviewed paper. Click the linked Name to access a PDF copy of the paper. Hover over the linked N view the complete matrix record for the paper in the form view. Hover over column names to use sorting and filtering options. Use Actions to export the data.

Refer to the Soil Health Literature Matrix Data Dictionary for matrix content and column header definitions.

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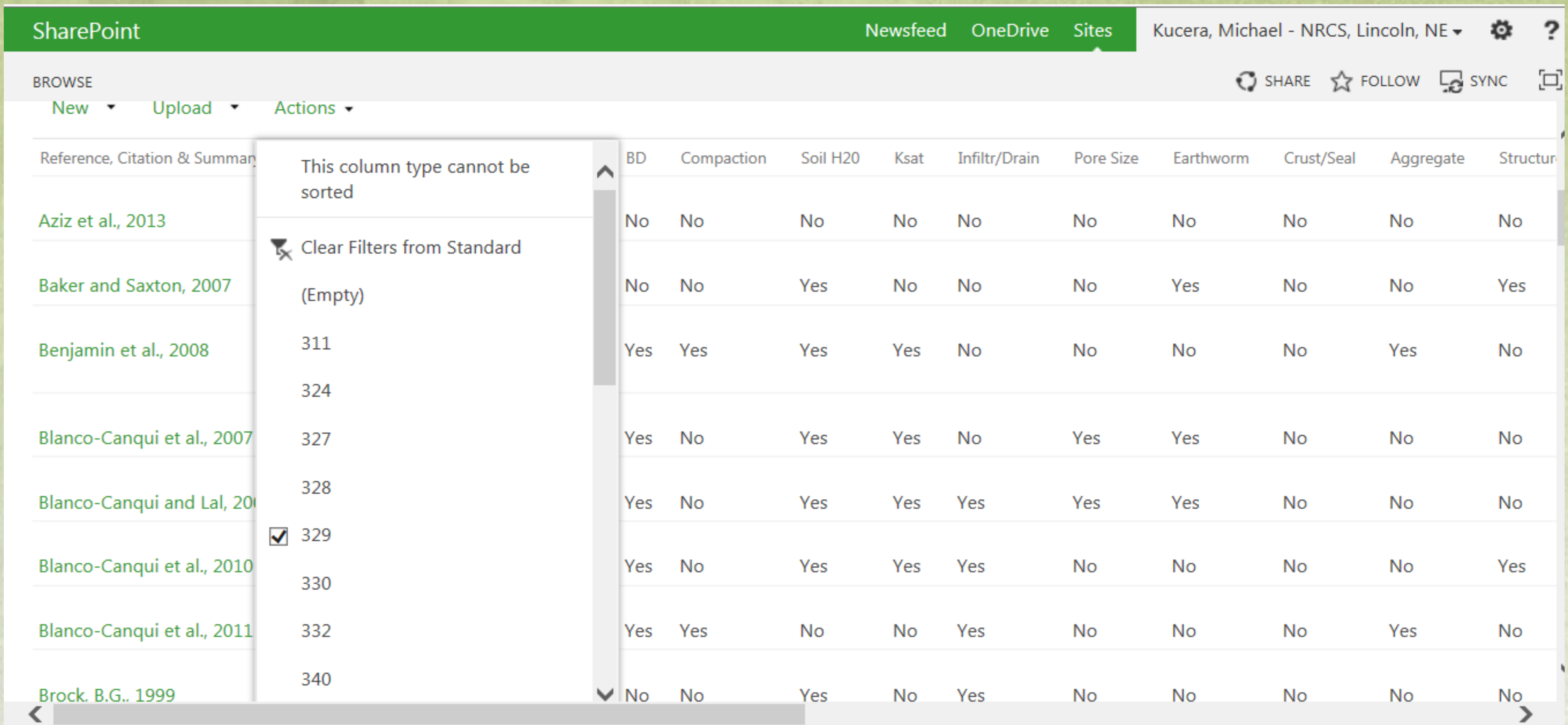
Reference, Citation & Summary	Name	Standard	BD	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthworm	Crust/Seal	Aggregate	Structure
Abbas and Fares, 2009	Abbas_2009	590	Yes	No	No	Yes	No	No	No	No	No	No
Abdollah et al., 2013	Abdollah_2013	340	No	Yes	Yes	No	No	Yes	No	No	No	No

Filter Column Headers



Reference, Citation & Summary	BD	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthworm	Crust/Seal	Aggregate	Structur
Aziz et al., 2013	No	No	No	No	No	No	No	No	No	No
Baker and Saxton, 2007	No	No	Yes	No	No	No	Yes	No	No	Yes
Benjamin et al., 2008	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
Blanco-Canqui et al., 2007	Yes	No	Yes	Yes	No	Yes	Yes	No	No	No
Blanco-Canqui and Lal, 20	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Blanco-Canqui et al., 2010	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes
Blanco-Canqui et al., 2011	Yes	Yes	No	No	Yes	No	No	No	Yes	No
Brock, B.G., 1999	No	No	Yes	No	Yes	No	No	No	No	No

Filtered by No-Till 329 Conservation Practice

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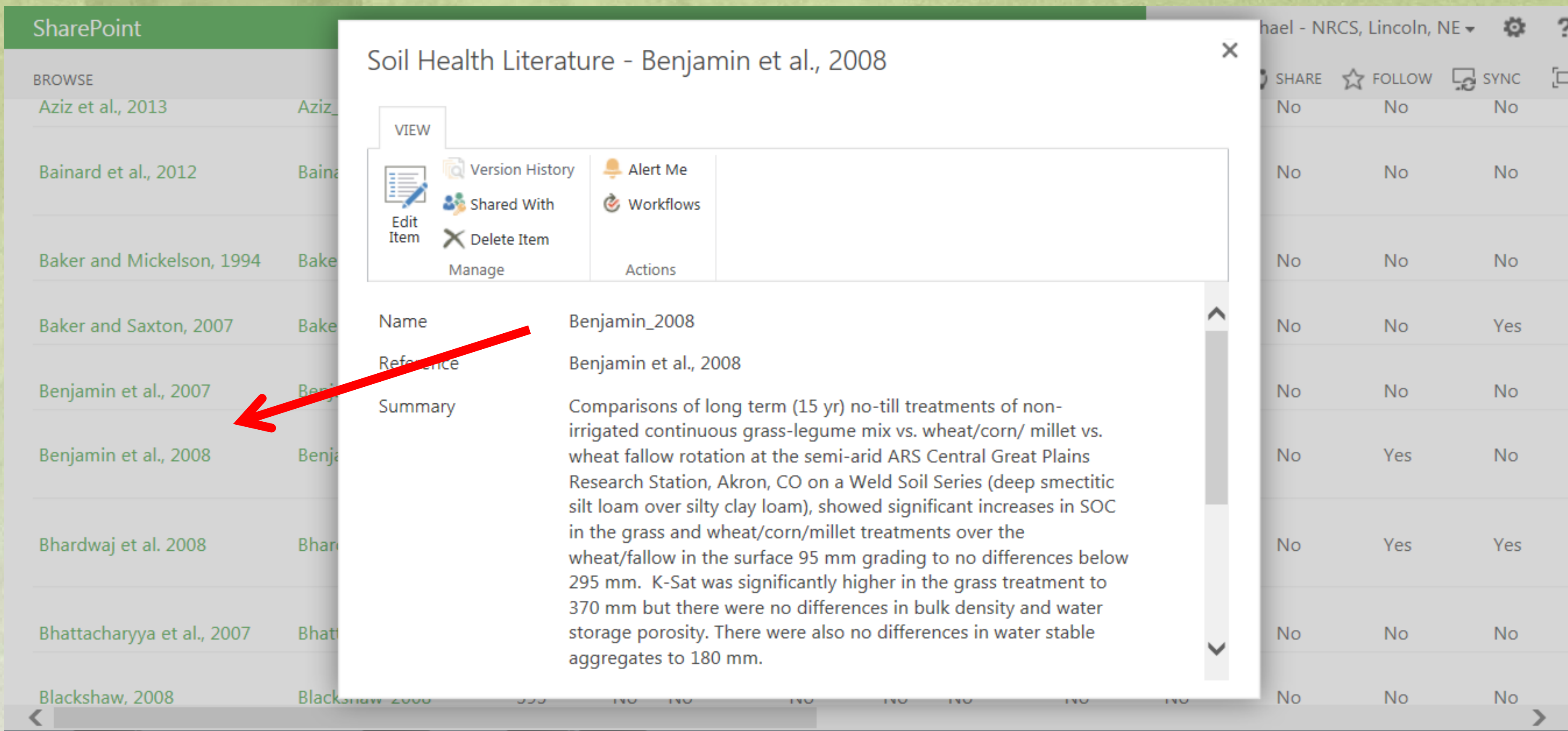
Reference, Citation & Summary	Name	Standard	BD	Compaction	Soil H20	Ksat	Infiltr/Drain	Pore Size	Earthworm	Crust/Seal	Aggregate	Structu
Aziz et al., 2013	Aziz_2013	329	No	No	No	No	No	No	No	No	No	No
Baker and Saxton, 2007	Baker_2007	329	No	No	Yes	No	No	No	Yes	No	No	Yes
Benjamin et al., 2008	Benjamin_2008	328, 329, 345, 512	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
Blanco-Canqui et al., 2007	BlancoCanqui_2007_2	329, 511	Yes	No	Yes	Yes	No	Yes	Yes	No	No	No
Blanco-Canqui and Lal, 2008	BlancoCanqui_2008	329	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No
Blanco-Canqui et al., 2010	BlancoCanqui_2010	328, 329	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes
Blanco-Canqui et al., 2011	BlancoCanqui_2011	329, 340	Yes	Yes	No	No	Yes	No	No	No	Yes	No
Brock, B.G., 1999	Brock_1999	329	No	No	Yes	No	Yes	No	No	No	No	No

Summary and Citation



Click on Benjamin 2008 (2^{nd} column)

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Abdollah et al., 2013	Abdollah_2013	340	No	Yes	Yes	No	No
Anderson et al., 2009	Anderson_2009	391, 393	No	No	Yes	No	Yes
Arvidsson and Bolenius, 2006	Arvidsson_2006	344, 345	Yes	Yes	No	Yes	No
Aslam et al., 2009	Aslam_2009	595	No	No	No	No	No
Aziz et al., 2013	Aziz_2013	329	No	No	No	No	No
Bainard et al., 2012	Bainard_2012	311	No	No	No	No	No
Baker and Mickelson, 1994	Baker_1994	345, 595	No	No	No	No	No
Baker and Saxton, 2007	Baker_2007	329	No	No	Yes	No	No
Benjamin et al., 2007	Benjamin_2007	512	Yes	No	No	Yes	Yes
Benjamin et al., 2008	Benjamin_2008	328, 329, 345, 512	Yes	Yes	Yes	Yes	No
Bhardwaj et al. 2008	Bhardwaj_2008	345, 449, 590, 610	No	No	No	Yes	No

Peer-Reviewed Paper

Organic Carbon Effects on Soil Physical and Hydraulic Properties in a Semiarid Climate

Joseph G. Benjamin*
Maysoon M. Mikha
Merle F. Vigil
USDA-ARS
Central Great Plains Research Station
Akron, CO 80720

Increasing cropping intensity in the central Great Plains of the United States has the potential to increase organic carbon (OC) stored in the soil and lead to improved soil physical properties. A cropping systems study was started in 1990 at the Central Great Plains Research Station near Akron, CO. In 2005 soil samples were taken in six 95-mm increments to a depth of 370 mm to measure OC, water stable macroaggregates (water stable aggregates > 250 μm), bulk density (ρ_b), total porosity (φ_{total}), water storage porosity (φ_{ws}), and saturated hydraulic conductivity (k_{sat}). Samples were collected from permanent grass plots {45% smooth brome [*Bromus inermis* (Leyss.)], 40% pubescent wheat grass [*Agropyrons trichophorum* (Link) Richt.], and 15% alfalfa [*Medicago sativa* (L.)]}, plots in a wheat {[*Triticum aestivum* (L.)]–corn [*Zea mays* (L.)]–millet [*Panicum miliaceum* (L.)]} rotation, and plots in a wheat–fallow rotation. Increased cropping intensity significantly increased OC, water stable macroaggregates, and k_{sat}, but had no significant effect on ρ_b, φ_{total}, or φ_{ws}. Permanent grass increased OC compared with the annually cropped rotations, particularly deeper in the soil. Plots in permanent grass had greater k_{sat} and this may indicate greater pore continuity and stability under saturated conditions. Organic carbon and water stable macroaggregates were poorly correlated. Water stable macroaggregates was negatively correlated with ρ_b and positively correlated with k_{sat}. Increasing soil OC may not immediately lead to changes in soil aggregation in a semiarid climate. Increased time and biological activity may be needed to convert the crop residues into organic compounds that stabilize aggregates and soil pore systems.

Abbreviations: CI, cropping intensity; k_{sat}, saturated hydraulic conductivity; OC, organic carbon; WCM, wheat–corn–millet; WF, wheat–fallow; θ_{g33}, gravimetric water content; θ_{v1500}, wilting point water content; ρ_b, bulk density; φ_{total}, total porosity; φ_{ws}, water storage porosity

Soil organic matter plays an important role in stabilizing soil aggregates. Tisdall and Oades (1982) noted that transient and temporary organic bonding agents were the main binding

field capacity (–33 kPa) and lower cation exchange capacity associated with the loss of organic matter. On the other hand, Bauer and Black (1981) measured no significant soil bulk den-

Organic Carbon Effects on Soil Physical and Hydraulic Properties in a Semiarid Climate

- Practices 328 Crop Rotation, 329 No-Till, 345 Residue Mgt Reduced Tillage, 512 Forage-Biomass Planting
- Properties: BD, compaction, soil H_2O, K_{sat}, aggregate stability, and soil organic matter
- Climate: Semi-arid, mesic soil temperature regime
- Non-irrigated
- Not compared to conventional tillage
- Primarily compared grass to NT wheat/corn/millet to wheat-fallow cropping systems

Short Summaries

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Science, Soils, & Technology for Soil Health   Soil Health Literature Matrix   Soil Health Literature   Submit a Peer-Reviewed Paper

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Name

Abbas and Fares, 2009   Abbas_2009

The objectives of this study were to: (i) simulate the effect of OM application rates (0, 168, 336, and 672 kg total N ha−1) and types (chicken and dairy manures) on soil organic C (SOC) and CO2 emissi variant (very-fine, mixed, superactive, isohyperthermic Pachic Haplustoll)) on 2 to 6% slopes at the Waimanalo agricultural research station (21°20′15″ N, 157°43′30″ W) ; and (ii) correlate SOC, CO2 emi and saturated hydraulic conductivity (Ksat). Measurements of SOC and ρb were conducted on samples collected from the top 10 cm of soil tilled before and after manure application, cultivated with sw seasons. The Ksat values were calculated from infiltration data measured with a tension infiltrometer. The Rothamsted C turnover model was used to simulate SOC and CO2 emissions. Results revealed decreased with increasing OM rates. There was no significant effect of OM type. There was a highly significant correlation between the measured and simulated SOC and between the measured SOC a significantly correlated with the measured and simulated SOC and the simulated CO2 emissions. A significant inverse relationship between ρb and Ksat was observed. We concluded that, in addition to increasing Ksat, OM application to this tropical soil increases SOC pools that contribute to atmospheric CO2 following tillage and other agricultural practices.

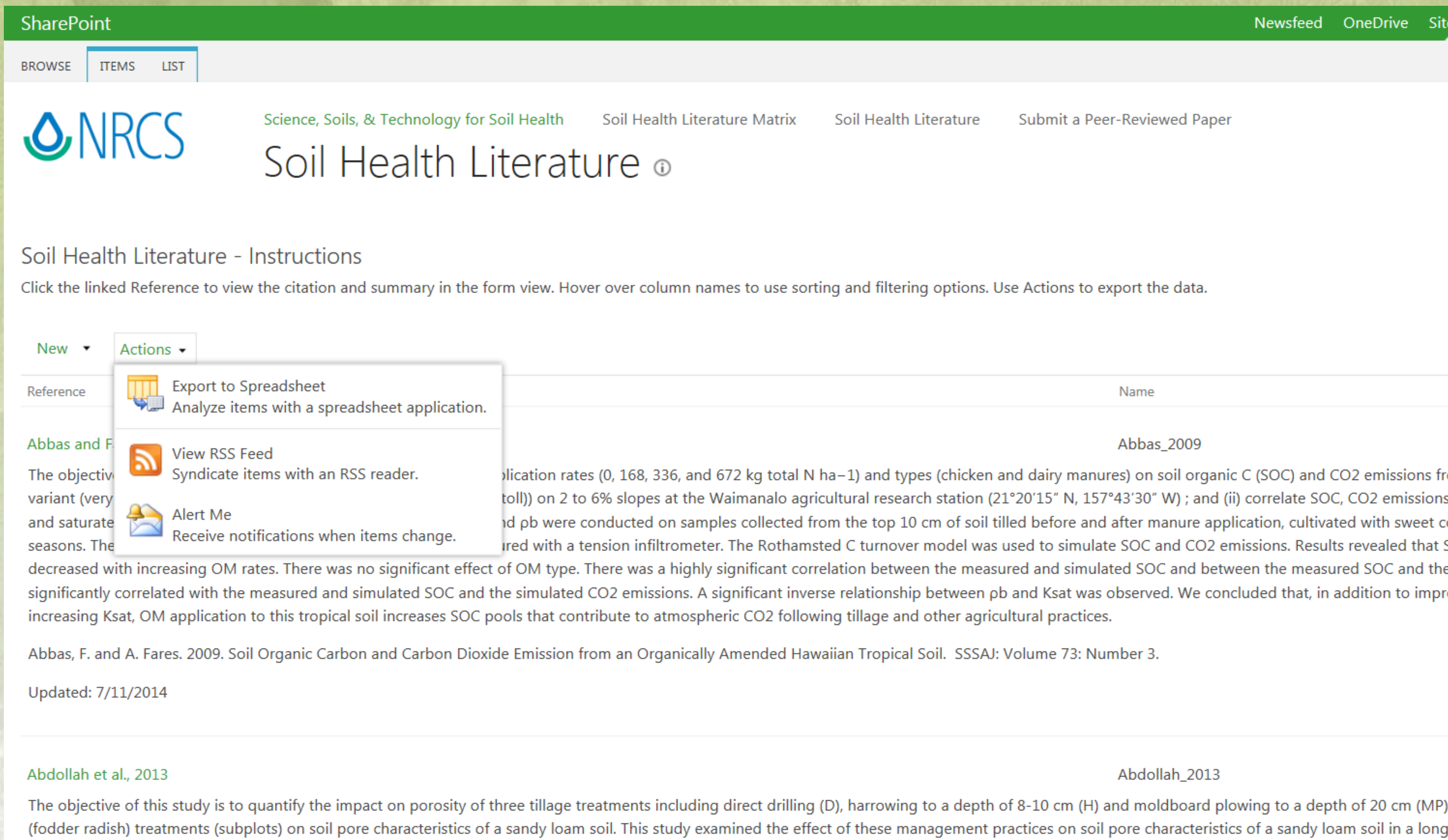
Abbas, F. and A. Fares. 2009. Soil Organic Carbon and Carbon Dioxide Emission from an Organically Amended Hawaiian Tropical Soil. SSSAJ: Volume 73: Number 3.

Updated: 7/11/2014

Abdollah et al., 2013   Abdollah_2013

The objective of this study is to quantify the impact on porosity of three tillage treatments including direct drilling (D), harrowing to a depth of 8-10 cm (H) and moldboard plowing to a depth of 20 cm (fodder radish) treatments (subplots) on soil pore characteristics of a sandy loam soil. This study examined the effect of these management practices on soil pore characteristics of a sandy loam soil in a included direct drilling (D), harrowing to a depth of 8-10 cm (H) and moldboard plowing (MP). The cover crop treatments were subplot with cover crop (+CC) and without cover crop (-CC). Minimally c and 18-27 cm depth intervals in the spring of 2012 before cultivation. Soil water retention and air permeability were measured for a range of matric potentials ranging from -1 to -30 kPa. Gas diffusivity scanning was also used to characterize soil pore characteristics. At 4-8 cm and 18-27 cm depths pore characteristics did not differ significantly between tillage treatments. At 12-16 cm depth, negative

Actions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Syndicate items with an RSS reader.
Alert Me
Receive notifications when items change.
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Name
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(fodder radish) treatments (subplots) on soil pore characteristics of a sandy loam soil. This study examined the effect of these management practices on soil pore characteristics of a sandy loam soil in a long-

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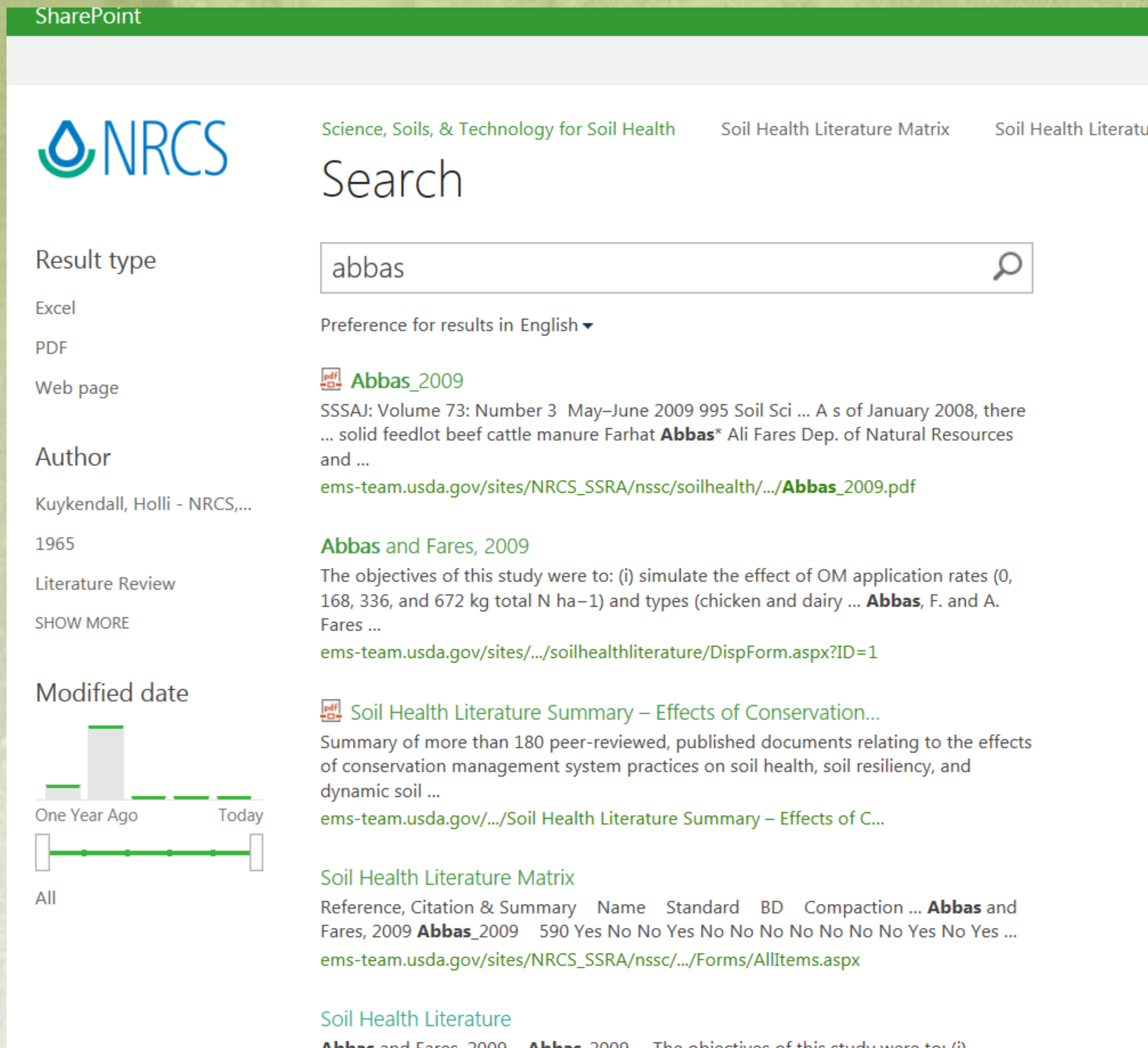

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Abbas_2009

SSSAJ: Volume 73: Number 3 May–June 2009 995 Soil Sci ... A s of January 2008, there ... solid feedlot beef cattle manure Farhat **Abbas*** Ali Fares Dep. of Natural Resources and ...

ems-team.usda.gov/sites/NRCS_SSRA/nssc/soilhealth/.../**Abbas**_2009.pdf

Abbas and Fares, 2009

The objectives of this study were to: (i) simulate the effect of OM application rates (0, 168, 336, and 672 kg total N ha−1) and types (chicken and dairy ... **Abbas**, F. and A. Fares ...

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Soil Health Literature Summary – Effects of Conservation...

Summary of more than 180 peer-reviewed, published documents relating to the effects of conservation management system practices on soil health, soil resiliency, and dynamic soil ...

ems-team.usda.gov/.../Soil Health Literature Summary – Effects of C...

Soil Health Literature Matrix

Reference, Citation & Summary   Name   Standard   BD   Compaction ... **Abbas** and Fares, 2009 **Abbas**_2009   590 Yes No No Yes No No No No No No Yes No Yes ...

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Soil Health Literature

Abbas and Fares, 2009   **Abbas**_2009 ... The objectives of this study were to: (i)

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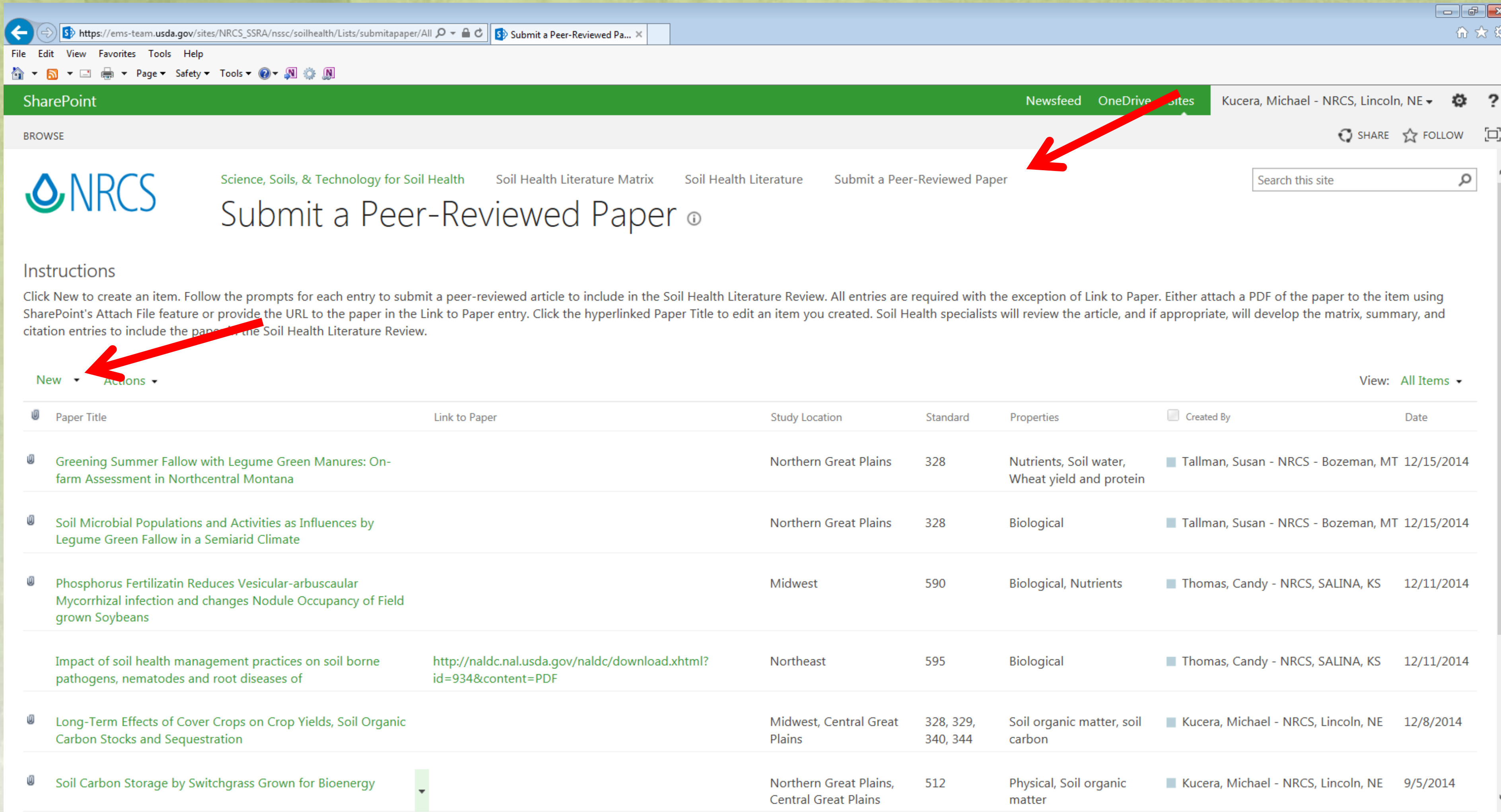

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Soil Health Literature Matrix

Soil Health Literature

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Type the description:

Enter the full URL that provides access to the submitted paper. If the paper is not available online, attach a pdf copy of the paper using SharePoint's Attach File option in the menu bar immediately above.

Author *

Enter the last name of the first author.

Basis *

Briefly describe the soil health basis for submitting the paper.

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- ☐ East
- ☐ Northeast
- ☐ Southeast
- ☐ South
- ☐ Midwest
- ☐ Northern Great Plains

Complete Data Entry, cont.

Attach File | Spelling
Actions | Spelling

- ☐ Pacific Northwest
- ☐ Southwest
- ☐ NA
- ☐ Specify your own value:

Select the US regional location of the study or specify City, State or Country using the Fill-in option.

Standard *

- ☐ 311
- ☐ 324
- ☐ 327
- ☐ 328
- ☐ 329
- ☐ 330
- ☐ 332
- ☐ 340
- ☐ 344
- ☐ 345
- ☐ 390
- ☐ 391
- ☐ 393
- ☐ 412
- ☐ 449
- ☐ 484
- ☐ 511
- ☐ 512
- ☐ 528
- ☐ 590
- ☐ 595
- ☐ 600
- ☐ 610
- ☐ NA

Select the conservation practice standards supported by the paper.

Properties *

- ☐ Physical
- ☐ Chemical
- ☐ Biological
- ☐ Economic
- ☐ Biological diversity
- ☐ Nutrients
- ☐ Soil organic matter
- ☐ Soil water
- ☐ Water quality
- ☐ Specify your own value:

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Submit Papers (Montana Example)

doi:10.2489/jswc.68.4.270

Greening summer fallow with legume green manures: On-farm assessment in north-central Montana

J.K. O'Dea, P.R. Miller, and C.A. Jones

Abstract: Replacing summer fallow practices with annual legumes as green manures (LGMs) may increase the sustainability of northern Great Plains wheat (*Triticum aestivum* L.) systems. Viability hinges on soil water use management and realizing biologically fixed nitrogen (N) benefits. Plot-scale research has shown that managing LGMs with first-flower stage termination and no-till practices conserves soil water and that rotational N benefits can increase wheat grain quality. Nonetheless, farmer adoption of LGMs has been negligible. To better understand this practice and its regional adoption potential, we conducted a participatory on-farm assessment of no-till LGM versus summer fallow–wheat rotations in north-central Montana. Soil water and nitrate (NO_3) levels to 0.9 m (3 ft), potentially mineralizable N (PMN) to 0.3 m (1 ft), wheat yields, conservation potential, and producer adoption challenges were assessed at five farmer-managed, field-scale sites. Compared to fallow, LGM treatment diminished mean wheat yield by 6% (0.24 Mg ha^{-1} [3.7 bu ac^{-1}]), diminished grain protein by 9 g kg^{-1} when wheat was fertilized with N (p = 0.01), and increased grain protein by 5 g kg^{-1} when wheat was unfertilized (p = 0.08). Small soil water depletions in LGM treatments below fallow at wheat seeding (17%; 30 mm [1.2 in]) and near-record high rainfall during

wheat with early terminated (anthesis stage, i.e., "first flower") annual legumes, termed legume green manure (LGM), may be a water-conservative way to realize rotational legume benefits in this region, particularly regarding fixed nitrogen (N) and mitigating negative effects of summer fallow that lead to soil degradation, nitrate (NO_3) leaching, and saline seeps (Tanaka et al. 2010).

Beginning in the early 1900s, research initiatives in the NGP on LGMs fluctuated with concerns about inherent soil fertility declines (Army and Hide 1959; Brown 1964; Janzen 2001), N fertilizer price, and sustainability initiatives (Hargrove and Frye 1987; Biederbeck et al. 1993; Peoples et al. 1995). In the NGP, LGM interest has been persistently tempered by water use constraints affecting wheat yield. Historically, studies established that excessive water use by LGMs preclude wheat yield benefits from crop diversification or N fixation (Brown 1964; Biederbeck et al. 1996; Zentner et al. 1996; Janzen 2001) and that LGM biomass production and soil water conservation must be balanced for the practice to be viable (Zentner et al. 2004). Also, N fertilizer has generally been cost effective and reliable, effectively

Example, cont.

https://ems-team.usda.gov/sites/NRCS_SSRA/nssc/soilhealth/Lists/submitapaper/At

Figure 1

Example of field site during (a) legume green manure (LGM) stage and (b) subsequent wheat stage. Photos a and b were taken from the same vantage point at Box Elder, with (a) LGM crop at the appearance of first flowers (June 23, 2009) and (b) wheat crop on July 20, 2010. Box Elder was the only site with a visual treatment effect, attributed to slightly delayed maturity on the LGM side. Also shown are no-till LGM residue breakdown stages in (c) September of 2009 and (d) the following August of 2010. Image c shows residue cover heading into winter, and c and d illustrate amounts of LGM residue not yet incorporated into soils (c) by winter wheat seeding and (d) at wheat harvest.

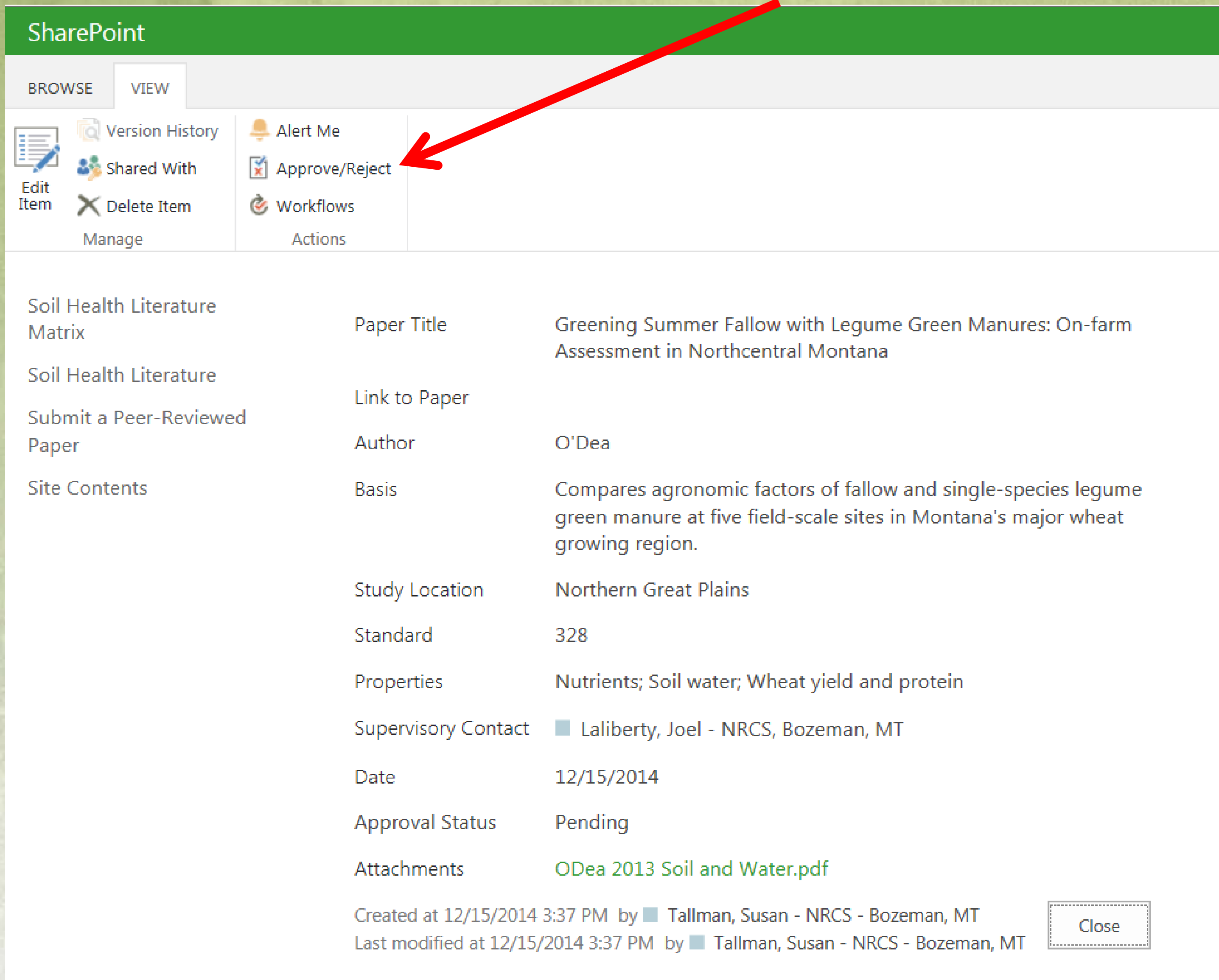
(a)

(c)

(b)

(d)

Approval Management



Summary of Project

- Web site updates
- SharePoint updates
  - Matrix additions
  - Semi-annual updates
  - Update practice summaries
  - Additional properties (biological and chemical)
  - Economics of practices
  - Gaps in science
- Uses
  - Standard development
  - Designing SHMSs
  - Program priorities
  - Technical background
  - Program targeting (basis)
  - Presentations

Questions??

Mike Kucera, NRCS Agronomist; michael.kucera@lin.usda.gov

Google/Bing: Soil Health Literature Review

Concluding Comments

- Bianca Moebius-Clune, Director, Soil Health Division
- David Hoover, National Leader for Soil Quality and Ecosystems
- David Lamm, Leader, National Soil Health and Sustainability Team