

Pathways to Progress Digging Deeper into Soils



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Pathways to Progress Digging Deeper into Soils

Today's Speakers



Dr. Jesse Daystar Vice President & Chief Sustainability Officer



David Lamm Project Manager Healthy Soils for Sustainable Cotton





Type your questions using the Q&A feature at any time during the webinar.



A recording of this webinar will be available on **cottonworks.com**.

Webinar

Support

Generation Z Highly Concerned About Climate

Environmental issues top list of Gen Z concerns

Most important challenges facing our world today:



Climate Change in the Headlines

More Than a Third of Heat Deaths Are Tied to Climate Change, Study Says

Sweeping new research found that heat-related deaths in warm seasons were boosted by climate change by an average of 37 percent.

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Cool drinks were distributed on a New Delhi roadside in 2017. Tsering Topgyal/Associated Press



https://www.nytimes.com/2021/05/31/climate/heat-deaths-climate-change.html

https://www.retaildive.com/spons/consumers-demand-action-on-climate-change-and-its-time-for-retailers-to/572572/

https://www.voguebusiness.com/sustainability/fashion-and-carbon-emissions-crunch-time

Consumers demand action on climate change — and it's time for retailers to listen

Published Feb. 21, 2020





SUSTAINABILITY

Fashion and carbon emissions: Crunch time

The international fashion industry must urgently cut emissions by 50 per cent to reach a 1.5 °C target, says a new report from McKinsey and the Global Fashion Agenda.

> BY BELLA WEBB 26 AUGUST 2020





Climate Change Impacting Business

The New York Times

Climate and Environment > Animal Crossings Connected Satellites Heat Deaths F.A.Q.'s

Climate Activists Defeat Exxon in Push for Clean Energy

Shareholders elected at least two of the four directors nominated by a coalition of investors that said the oil giant was not investing enough in cleaner energy.



Photo: Digital commons

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https://www.flickr.com/photos/jeepersmedia/14746295420

https://www.nytimes.com/2021/05/26/business/exxon-mobil-climate-change.html



Science-Based Targets Initiative





35 Years of Reduced Environmental Impact



Source: Field to Market: The Alliance for Sustainable Agriculture National Indicators Report (2016). https://fieldtomarket.org/national-indicators-report-2016/



U.S. Cotton's Sustainability Goals for 2025







Regenerative Practices and Agriculture

Regenerative practices

 No or low till plowing, cover cropping, multi-use systems, rotational farming, precision agriculture, integrated pest management, and intentional use of inputs that are landscape specific.

Regenerative agriculture

- Is not a one size fits all prescriptive practice
- Is a combination of regenerative practices that support resilience as well as build and nourish our ecosystem

Resulting outcome

- Over time, regenerative practices can increase production and naturally reduce the need for external inputs
- The health of the agriculture ecosystem and farmer economic stability can be improved

The Carbon Cycle and Agriculture



"Soil organic carbon harbors three times as much carbon as Earth's atmosphere."

Science 2017 355 1420

IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.



2/3 of fields gaining soil carbon



- Soil Health is the ability of the soil to meet the crops needs for nutrients, water, and disease suppression
- It includes chemical, physical, and biological parameters
- The easiest measure of soil health is soil carbon
- Our goal is 2/3 of the fields increasing soil carbon



Soil Conditioning Index



The key drivers of increased soil organic carbon are **further adoption of cover crops** and **no-till along with improved microbial biomass** – all of which will store carbon.

This graph shows the carbon depletion or increase from the Field to Market sample fields. **40% of the sampled fields had a net gain in carbon**.

Goal is for 2/3rds to have a net gain in 10 years.



Organic Matter Use



Daystar, Jesse S., et al. "Sustainability trends and natural resource use in US cotton production." BioResources 12.1 (2017): 362-392.



Cotton Carbon Uptake



Photo: USDA

Soil Carbon Sequestration & Greenhouse Gas Mitigation

Achieving Soil Organic Carbon Sequestration with Conservation Agricultural Systems in the Southeastern United States

Conservation management of degraded land has the potential to build soil fertility, restore soil functions, and mitigate greenhouse gas emissions as a consequence of surface soil organic matter accumulation. Literature from the southeastern United States was reviewed and synthesized to: (i) quantitatively evaluate the magnitude and rate of soil organic C (SOC) sequestration with conservation agricultural management; (ii) evaluate how conservation management affects surface SOC accumulation and its implications on ecosystem services; and (iii) recommend practical soil sampling strategies based on spatial and temporal issues to improve the detection of statistically significant SOC sequestration. Soil organic C sequestration was 0.45 ± 0.04 Mg C ha⁻¹ yr⁻¹ (mean \pm standard error, n = 147, 20 ± 1 cm depth, 11 ± 1 yr) with conservation tillage compared with conventional tillage cropland.

Every acre of no-till cotton stores ~400 lbs. of carbon in the soil and ~400 lbs. of carbon in the fiber

SSSAJ: Volume 74: Number 2 • March-April 2010

Alan J. Franzluebbers*

Watkinsville, GA 30677

1420 Experiment Station Rd.

USDA-ARS



Emerging Carbon Markets: Opportunity?

(Ya)

02 N PLANT

With our deep portfolio of

3rd-party and proprietary products and value-added ronomic and field services

we can create a customize recipe of inputs and agronom

recommendations that are proven to drive positive

03 NN PRODUCE

In addition to providing season-long agronomic support and advice, we will work with

growers to collect farm and field-level data to reliably

measure carbon and other

sustainability outcomes

leading digital platform

through our industry

(ff)



NUTRIEN'S CARBON PROGRAM

Introducing the agriculture industry's most comprehensive carbon program, offering end-to-end support for growers to drive improved sustainability performance and increased profitability.

01 \ PLAN

Building on our trusted relationship with our grower customers and our focus on full-acre solutions, this program will help growers integrate the use of sustainable agronomic practices into their farm planning process.



05 NNN PRESERVE

Our program will reward growers for the adoption of sustainable agronomic practices, empowering them to continue to meet the challenge of feeding a growing global population, while minimizing their environmental footprint, while helping to establish the Ag industry as a leader in climate action.

04 NN PROFIT

At the end of the season, carbon outcomes will be verified using industry accepted standards, generating carbon credits available for purchase by Nutrien, other value-chain partners and cross-industry buyers, generating incremental profit for growers.



TRUTERRA

Streamlining the path to agricultural carbon and ecosystem services markets.

Building carbon markets from the ground up.

Truterra, LLC, is at the forefront of helping farmers estimate, evaluate, and develop ecosystem services credits, such as carbon removal, for sale in a rapidly emerging marketplace. As the only farmer-driven, farmer-owned sustainability company, Truterra improves the accessibility of ecosystem services markets to create a more efficient, less cumbersome process for farmers to better share in the value they are providing.



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Sustainability Test Plot: Agricenter International



Implications of Tillage



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Soil Loss in the News

~*	ASK US ABOUT OUR FOOD CHANGE COUNTRY Welcome to Global Site						
General Mills						SEARCH	Q
	COMPANY	BRANDS	CAREERS	RESPONSIBILITY	HEALTH	NEWS	INVESTORS
						Ser.	Nº LANCE
NEWS			S. R				
Awards							
Blog	INEWS REleases						
Issues	SED 17 2020						
News Releases	SEP 17, 2020						
Publications	General Mills partnership with Gunsmoke Farms to transition 34,000 acres of conventional farmland to organic culminates with USDA certification						





ENVIRONMENT

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A Giant Organic Farm Faces Criticism
That It's Harming The Environment

May 3, 2021 · 4:04 PM ET Heard on All Things Considered

DAN CHARLES 🔰

"The area developed from an ancient ocean floor, and the soil is full of clay. 'Once you disturb it, nothing holds that soil together. It just turns into powder,' [Dwayne Beck] said, vulnerable to rain or wind that can carry it away."



Implications of Widespread Soil Loss: Dustbowl



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https://www.flickr.com/photos/97097847@N03/9336340795

https://loc.getarchive.net/media/dust-bowl-farmer-driving-tractor-with-young-son-near-cland-new-mexico-i-left-28c32f





- Soil loss is the pounds of topsoil eroded from a field in relation to the cotton produced.
- Since soil is produced over geological time, it is necessary that we conserve all the soil and ideally regenerate soil on some fields.
- This goal balances soil genesis with soil loss.



Soil Conservation



The Field to Market Soil Conservation metric is based on the NRCS model of soil erosion where T represents a balance between soil formation and soil loss (i.e., T = zero net soil loss).

The 10-year goal is T averaged across the U.S. which is 5 tons per acre soil loss.

This 10-year Goal is ambitious and below trend line. But, from the progress made to 2010, this goal appears achievable. Cultivation likely increased soil loss since 2010, a problem largely corrected for most growers with new weed control technologies.

Goal: 50% Reduction



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Trends in Tillage Systems

Conventional tillage is fairly constant, but a shift to even less intensive tillage for those using Some form of conservation tillage.





Sources of Winter Cover



Daystar, Jesse S., et al. "Sustainability trends and natural resource use in US cotton production." BioResources 12.1 (2017): 362-392.



Practices to Control Erosion



Daystar, Jesse S., et al. "Sustainability trends and natural resource use in US cotton production." BioResources 12.1 (2017): 362-392.



Conservation to Reduce Soil Loss and Increase Habitat







Conservation Improving Profitability

Red acres removed to cut costs, improve field yield/profit average and APH, and improve water, soil, and biodiversity health













Soil Health Planning Principles: A Practical Approach to Farming in the 21st Century

David Lamm Soil Health Institute







If we don't understand how soils are supposed to function, we accepted degraded soil conditions as being the norm, thinking there is nothing we can do to change this conditions.







Soil Health:

The <u>continuous capacity</u> of a soil to <u>function</u> as a vital, <u>living ecosystem</u> that sustains plants, animals, and humans.


Soil Health Functions

- Nutrient cycling
- Water (infiltration & availability)
- Filtering and Buffering
- Physical Stability and Support
- Habitat for Biodiversity
- 90% is mediated by soil microbes





Soil Health Principles





Most farmers have seen the principles at work



The Fence Row Effect

- Notice it through yield monitors
- Soil Health Principles have been in effect for years



Principle 1: Minimize Soil Disturbance

- What is "Soil Disturbance?"
- Disrupt or Destroy the "Soil Biological Hotspots"
 - Aggregates
 - Pore space
 - Residue
- Destroy "Habitat" for Soil Organisms
- Creates a "Hostile" Environment
- Three Types of Disturbance
 - Physical
 - Chemical
 - Biological





What is Tillage?

The physical manipulation of the soil for the purpose of:

- Management of previous crop residue
- Control of competing vegetation (weeds)
- Incorporation of amendments (fertilizer/manure)
- Preparation of a soil for planting equipment
- Recreation for folks who don't fish or golf.





Human Nature Drives Us to Tillage

•We enjoy power •Feel in control •We can see what we accomplished



"The truth is that no one has ever advanced a scientific reason for plowing."



Ploughman's Folly by E.H. Faulkner

What Tillage Does to the Soil

Destroys aggregates

Exposes organic matter to decomposition

Compacts the soil

Damages soil fungi

Reduces habitat for the Soil Food Web

Disrupts soil pore continuity

Increases salinity at the soil surface



What Tillage Does to the Soil



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Basic Components of Microaggregates-Macroaggregates



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- Plant and fungal debris
- Silt-size microaggregate
- Clay microstructures
- Particulate organic matter

Plant root

Mycorrhizal hyphae



Pore space; polysaccharides and other amorphous interaggregate binding agents



Mechanical disturbance by tillage disrupts aggregation, exposes SOM protected within the aggregates to microbial attack.









The loss of SOM within the aggregates due to microbial attack causes dispersion of clay particles, clay microstructure, and silt & clay microaggregates.





January 8, 2017



Raindrops seal soil surface - runoff

Adjacent Field - Same Day



Protected from raindrops - Roots for infiltration



What things change when you stop tilling the soil?

- Soil pores remain continuous
- Soil aggregates form and are not destroyed
- Soil food web increases and diversifies
- Weed seeds are not planted
- Water is captured and stored
- Bulk density increases slightly; then stabilizes
- Soil fungi and earthworms increase
- Microarthropods increase (>20% of nutrient cycle)







Hard to believe that the same results can be achieved using simpler biological methods





What Farmers Are Doing to Minimize:

- Using multi-species cover crops
- Rolling them down
- Planting into high residue cover crops
- Healthy soils are forgiving soils







SOIL HEA

Chemical Disturbance



Impact of Fertilizer on Soil Health

Short-circuits the rhizosphere & P cycle

Depresses activity of natural N fixers

Stimulates bacterial decomposition of SOM

Excess N at risk for leaching or denitrification

Increased soil salinity (Synthetic fertilizers are salts)



Biological Disturbance

- No diversity in the crop rotation
 - Growing single species or few crops in rotation
 - Lack of diversity limits diversity of plant root exudates
 - Hampers the development of a diverse soil biota

• Overgrazing

- Plants are exposed to intensive grazing for extended periods of time, without sufficient recovery periods
- Many pasture have single species grasses





Soil Health Principle 2: Maximize Diversity

Use a diversity of plants to add diversity to soil organisms

- Plants interact with microbes
 - Trade sugar from roots for nutrients
- Microbes convert plant material to OM
- Requires a diversity of plant carbohydrates to support the variety of soil organisms
- Lack of plant diversity will drive system to favor some microbes more than others





Soil Biology

- Aggregate stability will only be regenerate biologically.
- Colonizing mycorrhizal fungi and aerobic microbes (e.g.-rhizobium) build soil structure and cycle nutrients









Why Add Grazing?

- Impact of livestock
- Distribution of manure, urine, saliva
- Most nutrient pass through
- Trampling of residue cover
- Long rest periods necessary
- Adds revenue source







Crop Classification for Diversity

Plant morphology	Broad leafGrasses
Plant growth habits	 Cool season Warm season







Crop Classification Warm Season







Crop Classification Cool Season







Soil Health Principle 3: Provide Continuous Living Roots

Benefits:

- Increases microbial activity
- Increases plant nutrient uptake
- Increases biodiversity and biomass of soil organisms
- Improves physical, chemical, and biological properties of soils
- Sequesters and redeposits nutrients
- Increases OM





All Crops Planted in Rows

- Planting
- Harvesting
- In-season management
- GPS compounds the problem

Results:

SOIL HEALTH

- Roots don't get to the row middles
- Limited food source for soil biology



Rhizosphere: Biologically Active Region Along Roots

- Plant roots stimulate microbes
- Microbes: fungi, bacteria, protozoa, nematodes
- Symbiosis
- Chemical signaling
- Nutrient cycling





Root Mass in Top 4" of Soil



1-Jan 1-Feb 1-Mar 1-Apr 1-May 1-Jun 1-Jul 1-Aug 1-Sep 1-Oct 1-Nov 1-Dec



How to Keep a Living Root All Year Long

Lengthen Rotation

• Add small grain

Select Shorter Season Varieties

• Choose 100 -104 day

Plant Cover Crops

- Summer & Winter
- Only need 6 8 weeks to provide benefit

Inter Seed into Growing Crops

SOIL HEALTH

• Planting cover crop before harvesting of cash crop



Broadcast While Defoliating Cotton

- Seeded a multi-species cover crop mix
- Cereal rye
- Crimson clover
- Hairy Vetch



Penn State Cover Crop Inter Seeder & Applicator



Soil Health Principle 4: Maximize Cover

Benefits:

- Control Erosion
- Protect Soil Aggregates
- Suppresses Weeds
- Conserves Moisture
- Cools the Soil
- Provides Habitat for Soil Organisms





Cool Wet Soils in the Spring?







Soil Temperatures

- Conserve moisture and reduce temperature
- Crop yields are limited more often by hot and dry, not cool and wet





When Soil Temperature Reaches...





J.J. McEntire, WUC, USDA SCS, Kernville TX, 3-58 4-R-12198. 1956
Soil Organic Matter & Available Water Capacity

Percent SOM	Sand	Silt Loam	Silty Clay Loam
1	1.0	1.9	1.4
2	1.4	2.4	1.8
3	1.7	2.9	2.2
4	2.1	3.5	2.6
5	2.5	4.0	3.0

Inches of Water/One Foot of Soil

1 acre inch = 27,150 gallons of water



Soil Health Principles Affect on the Soil Ecosystem







Pathways to Progress Digging Deeper into Soils

Sustainability Goals for U.S. Cotton

Topics > Sustainability > Cotton Sustainability

ADD TO LIST

Commitment & Innovation Define U.S. Cotton Production

U.S. cotton producers are leading the way in responsible cotton production practices.

Through the support of research and implementation of technology. U.S. cotton production is on the path to continual improvement, maximizing efficiencies while minimizing inputs.

Download U.S. Cotton Ten-Year Sustainability Goals: Pathways to Progress.



Sustainability Goals for U.S. Cotton

U.S. cotton producers are leading the way in responsible cotton production practices.

Learn more at cottonworks.com/ sustainability-goals-us-cotton

Cotton Sustainability Basics

Topics > Sustainability > Cotton Sustainability

ADD TO LIST

Sustainable Cotton Production

More sustainable cotton production means using our natural resources — water, land, and energy — more efficiently. U.S. cotton producers are leading the way in responsible cotton production practices that dramatically reduce water use, land use, soil loss, and energy use while increasing soil health and yield per acre. Key to these advances in the sustainability of cotton production has been the development of innovative technologies, management systems, and conservation approaches driven by science-based environmental goals and targets.

Let's take a closer look at the issues, progress, prospects, and goals for increased efficiency in the use of the three key natural resources in cotton production:



Cotton Sustainability Basics

Learn more about the issues, progress, prospects, and goals for increased efficiency in the use of the three key natural resources in cotton production: water, land, and energy.

Go to cottonworks.com/ cotton-sustainability-basics



PAST WEBINARS:

Pathways to Progress: Reducing Climate Impacts in Agriculture	Pathways to Progress: Setting Sustainability Goals	Plastic Free: Proving a Natural Solution
Sourcing Cotton: Understanding Chinese Cotton & U.S. Import Regulations	Advancements in Cationic Cotton Technologies	Sourcing Cotton: Basic Information for Adjusting Sourcing Strategies

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Topics > Sourcing & Manufacturing > Fiber Science

ADD TO LIST

Basic Information for Developing or Adjusting Sourcing Strategies

The United States imports textiles from more than 80 countries. Brands, retailers, and companies importing apparel and other textiles have many choices when it comes to the geography of sourcing cotton and cotton products. As companies develop or adjust their sourcing strategies, it is helpful to understand vital information about cotton; trade in cotton and production, and manufacturing practices that can affect sourcing and traceability.

Many companies are searching for information about cotton production in China and how this may be affected by current regulations by U.S. Customs and Border Protection:

Sourcing Cotton Webinars

Basic Information for Adjusting Sourcing Strategies

If business conditions, regulations, or compliance requirements have you rethinking your cotton sourcing strategy, this webinar takes you through basic information essential to evaluating your cotton sourcing plan.

Download PDF: Sourcing Cotton: Basic Information for Adjusting Sourcing Strategies

Webinar originally played 2/10/21

Understanding Chinese Cotton & U.S. Import Regulations

Learn how cotton flows through each stage of China's supply chain and how a leading trade association for U.S. importers is helping companies assess the situation

Download PDF: Sourcing Cotton: Understanding Chinese Cotton & U.S. Import Regulations

Webinar originally played 3/9/21





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July 20 | Water July 27 | Measurement

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