Residuals and the Soil Health Awakening

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University of New Hampshire

2015 International Year of Soils

Outline

- Soils: diverse, deep, and in danger
- Soil Health: a framework worth pursuing?
- Including residuals in the soil health "awakening"

SOILS

are diverse

Hermon Soil Series, Maine
Photo: Dave Turcotte

Within a field

ries, Maryland

Biological Diversity

Photo: Ray Weil

Soils are (can be) deep

Our impacts can be deep, too

Pedology

Soil Profile Transformation after 50 Years of Agricultural Land Use

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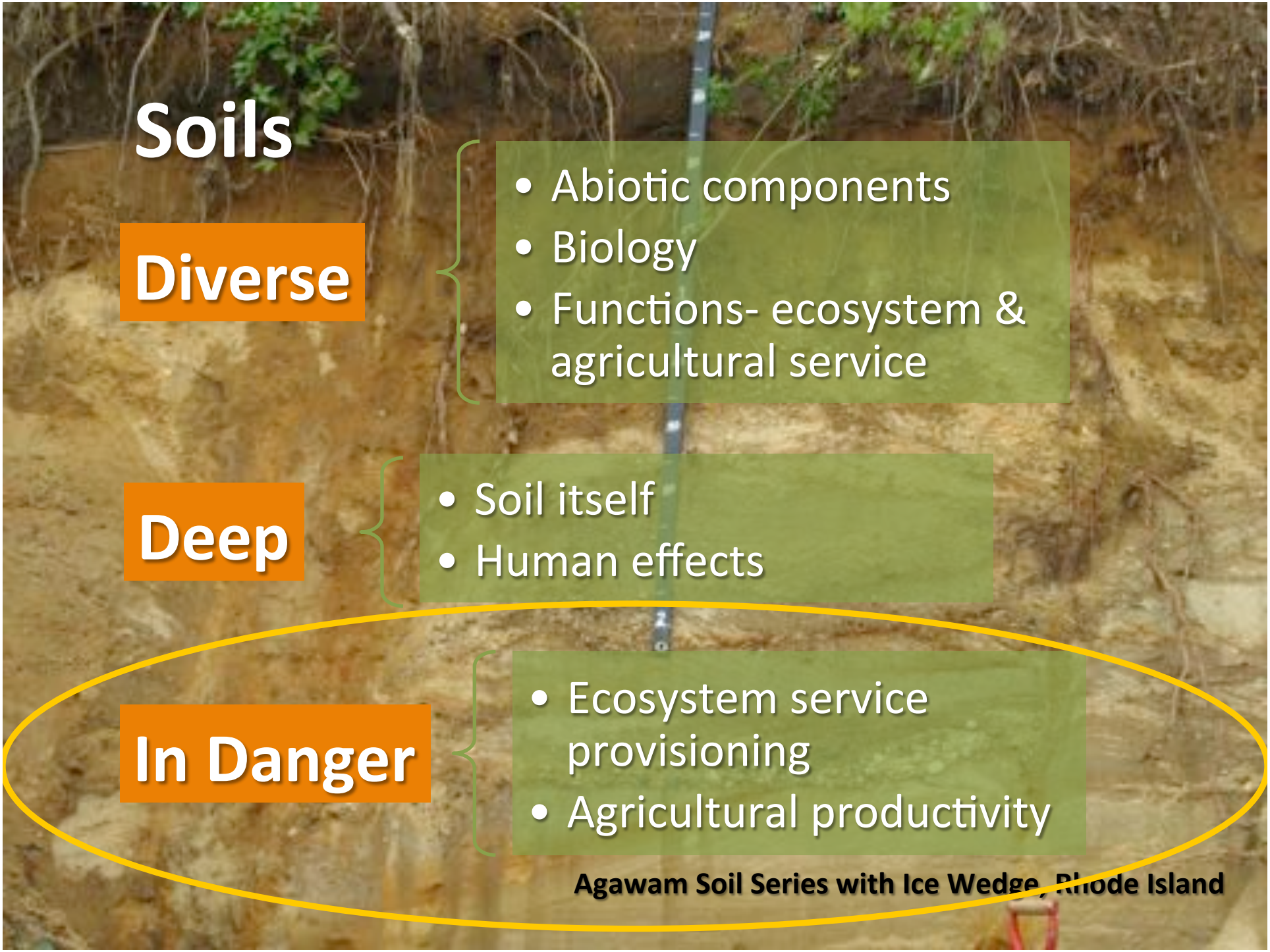
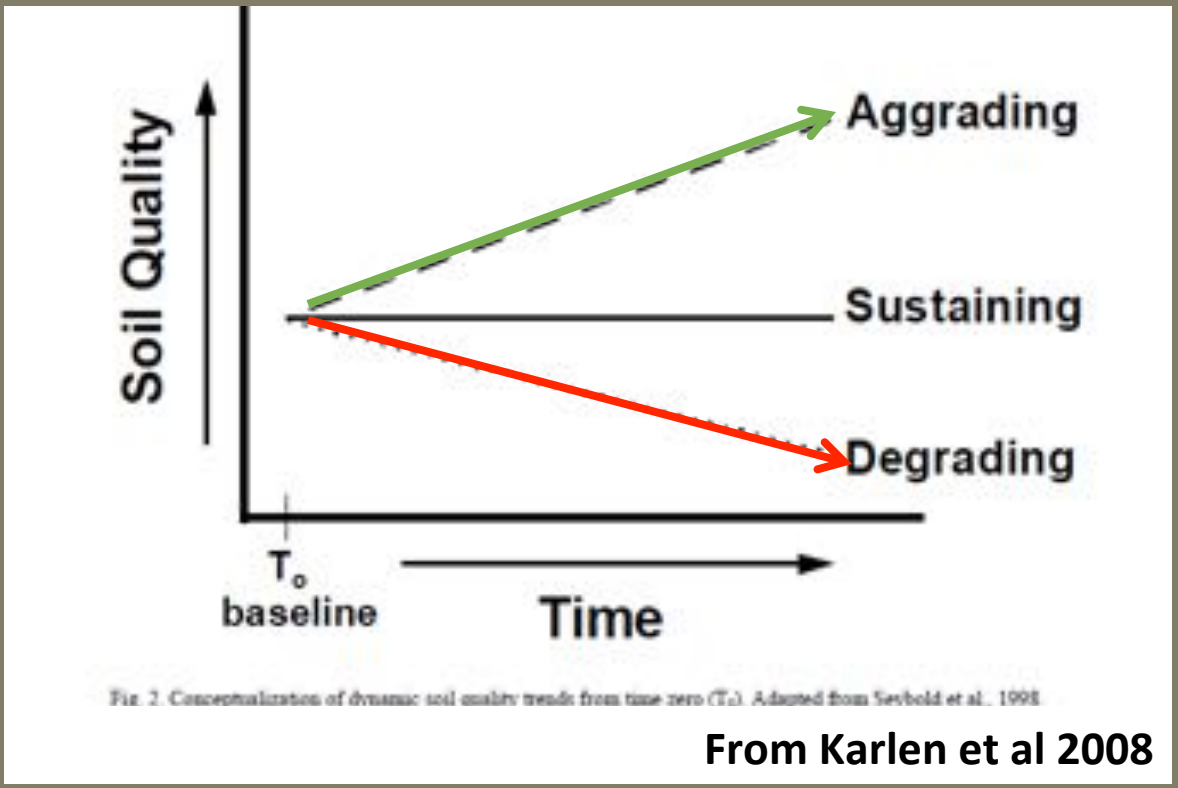
Despite a large body of scientific research that shows that soils change on relatively short time scales under different management regimes, classical pedological theory states that we should expect these changes to occur only in the surface few centimeters and that they are not of adequate magnitude to suggest fundamental changes in pedon character over short periods of time. In fact, rarely, do the scientists that make these comparisons report on any properties deeper than 30 to 45 cm in the soil profile. With this study, we evaluate soil transformation to a depth of 150 cm after 50 yr of intensive row-crop agricultural land use in a temperate, humid, continental climate (Iowa, United States), by resampling sites that were initially described by the United States soil survey between 1941 and 1963. We find that, through agricultural land use, humans are accelerating soil formation and transformation to a depth of 100 cm or more by accelerating erosion, sedimentation, acidification, and mineral weathering, and degrading soil structure, while deepening dark-colored, organic-matter rich surface horizons, translocating and accumulating organic matter deeper in the soil profile and lowering the water table. Some of these changes can be considered positive improvements, but many of these changes may have negative effects on the soils' future productive capacity.

Abbreviations: SOC, soil organic carbon.

Rare & endangered manganiferous soil, Maryland


Soils
Diverse
• Abiotic components
• Biology
• Functions- ecosystem & agricultural service
Deep
• Soil itself
• Human effects
In Danger
• Ecosystem service provisioning
• Agricultural productivity
Agawam Soil Series with Ice Wedge, Rhode Island

Soils in Danger → Soil Quality



Management

From Karlen et al 2008

"The capacity of a living soil to function… to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health." –Doran, 2002

Soil Quality ~ Soil Health

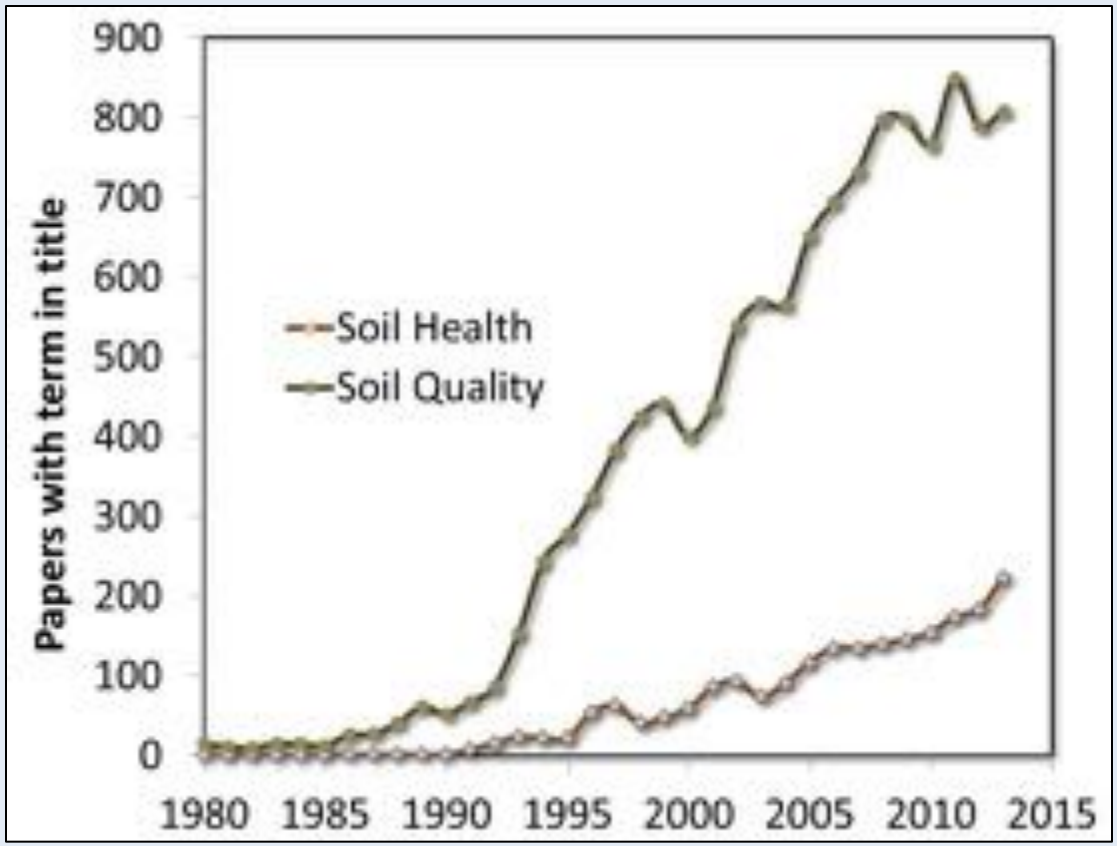
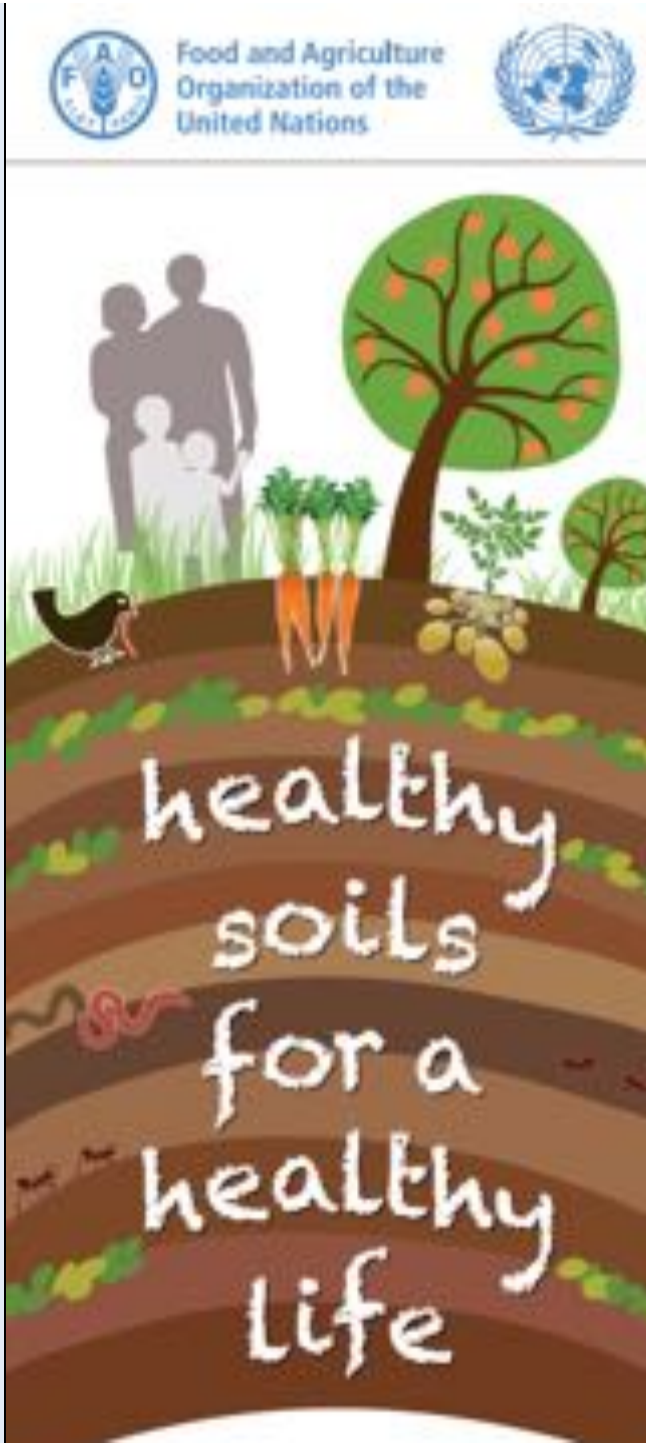
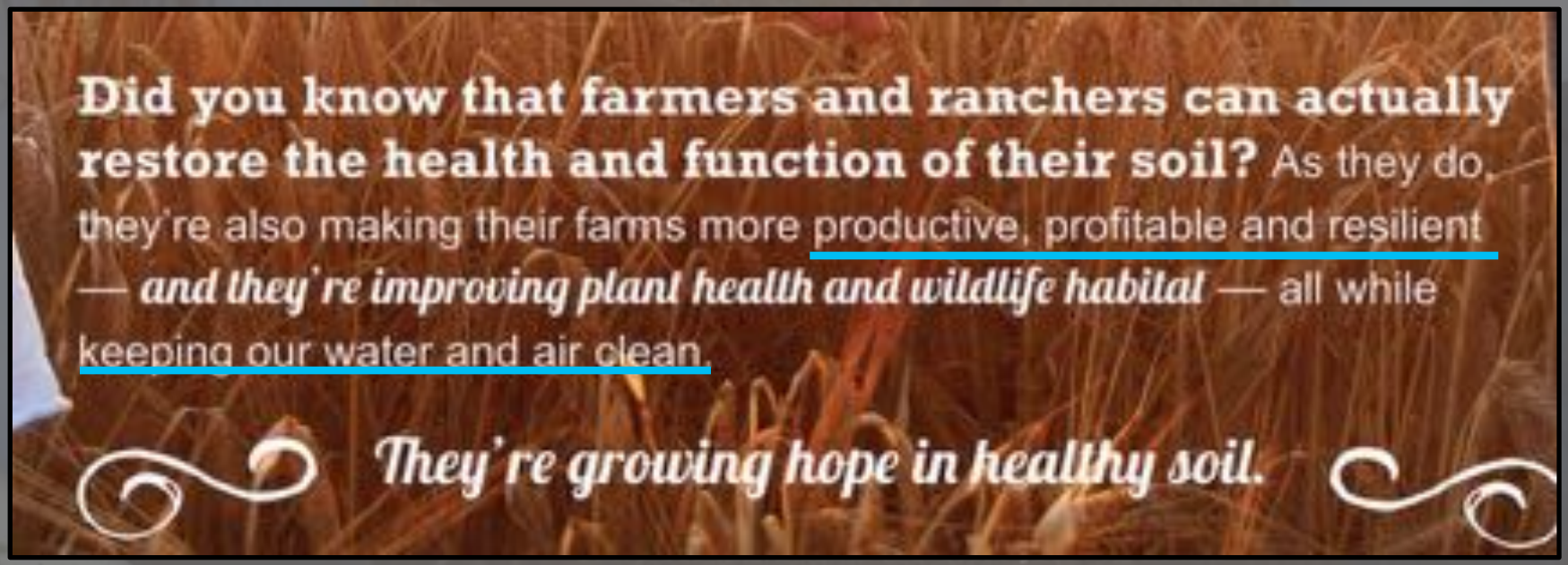


Figure courtesy of Ray Weil



Farm productivity & resilience

Ecosystem services



unlock the SECRETS in the SOIL

information kit and learn more at
www.nrcs.usda.gov

USDA United States Department of Agriculture

Health- easy to understand?

Human health:

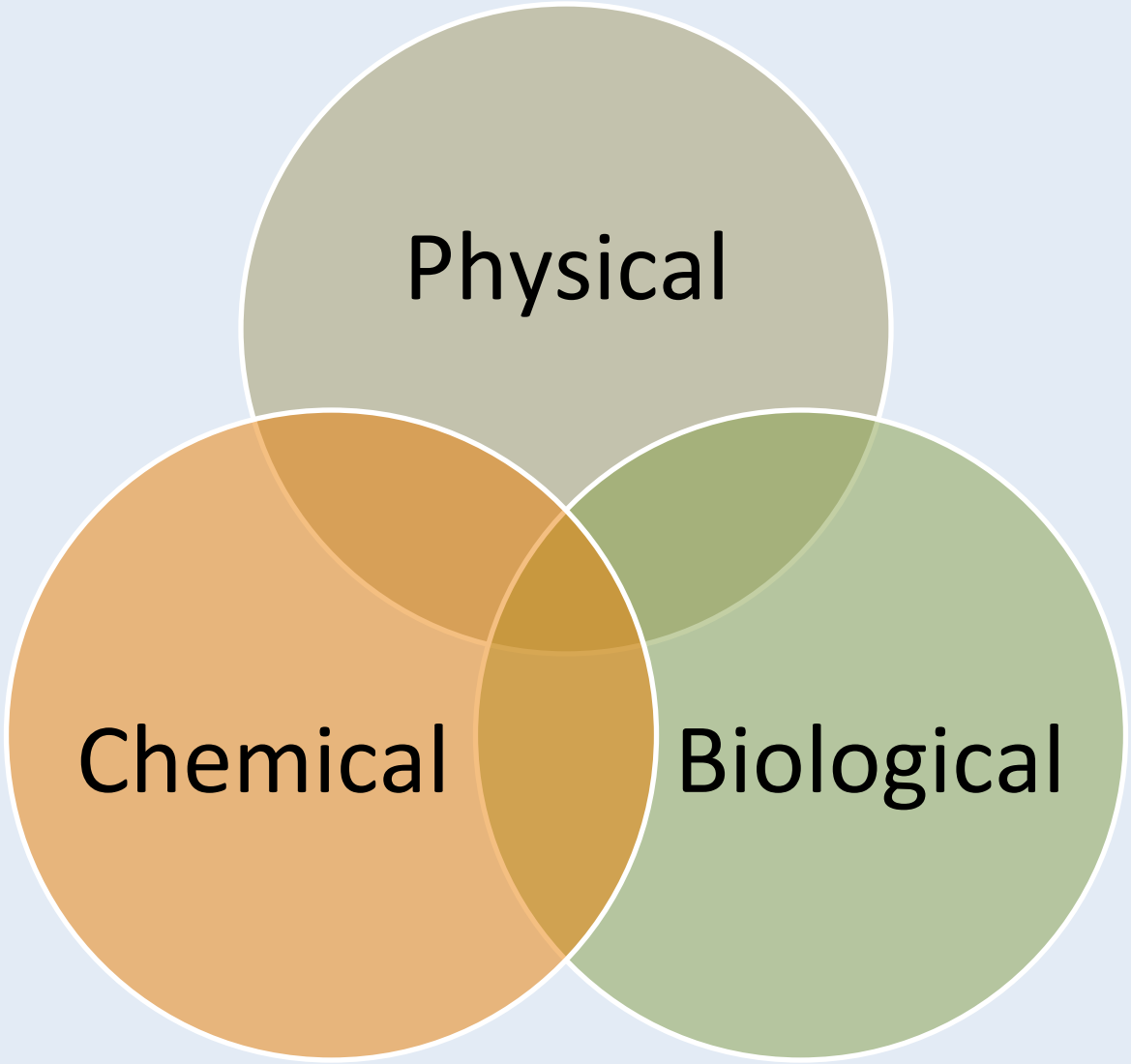
- **A holistic concept**
- **Baseline "indicators" vary among people**
- **Strongly influenced by "management"**
- **Strongly influenced by "microbiome"**
- **Negatively affected by toxins**

Soil health:

- **A holistic concept**
- **Baseline "indicator" values vary among soils**
- **Strongly influenced by "management"**
- **Strongly influenced by "microbiome"**
- **Negatively affected by toxins/ contaminants**

Yet still kind of elusive.

The three-legged stool of soil health



Carbon transformations

Nutrient Cycles

Soil structure maintenance

Regulation of pests and diseases

How can we assess soil health?*

***and is it worth it?**

How can we manage soil health?

How can we assess soil quality/health?

Soil Quality Assessment: Past, Present and Future

Douglas L. Karlen[1]*, Susan S. Andrews[2], Brian J. Wienhold[3] and Ted M. Zobeck[4]

ABSTRACT

Soil quality assessment may be one of the most contentious topics ever debated by the soil science community. Our objective is to examine the history, present status, and potential for using soil quality assessment as a tool to monitor soil physical, chemical, and

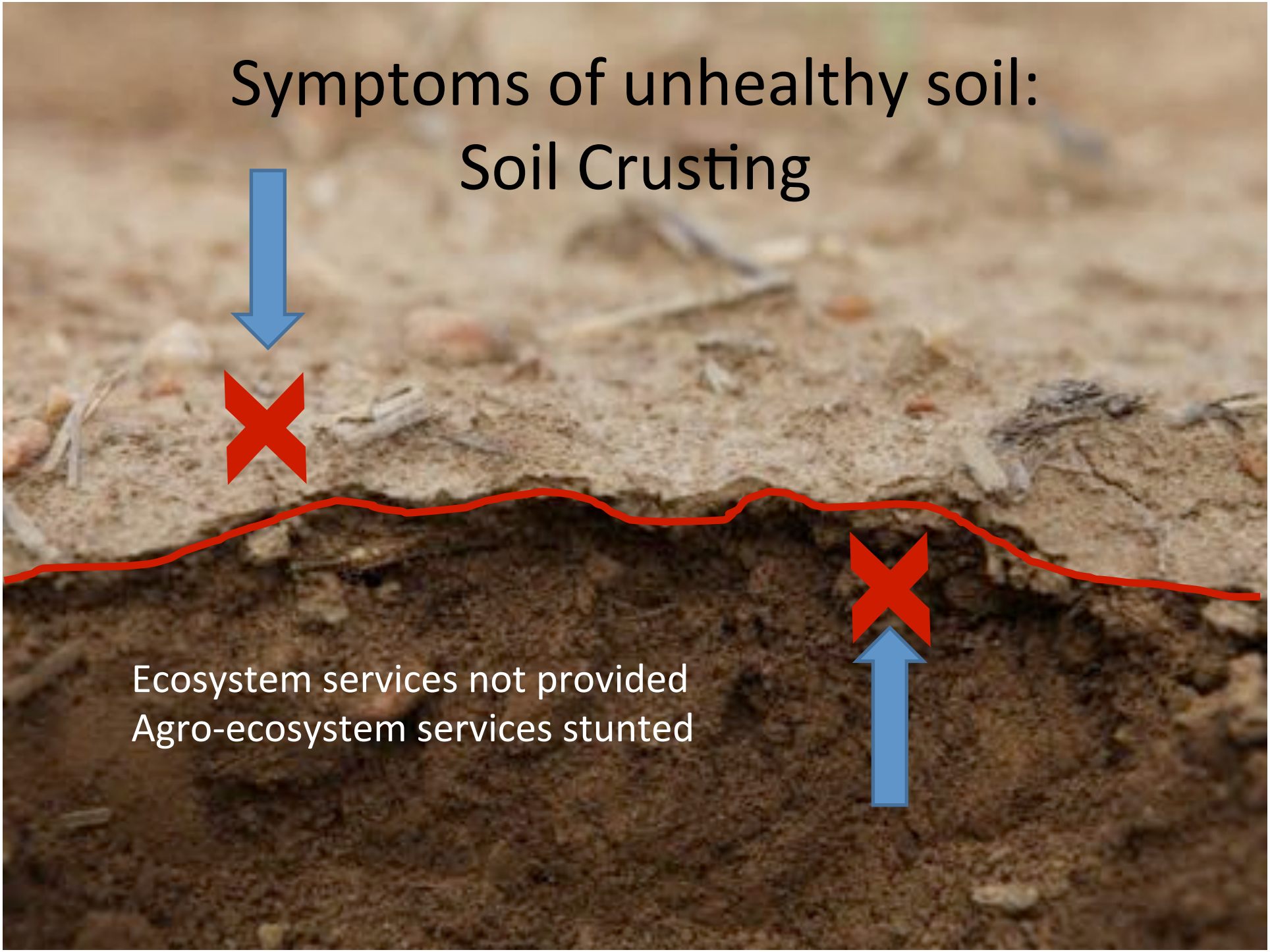
INTRODUCTION

The concepts of soil quality, soil health, and soil quality/health assessment are highly contentious within the soil science community, because many

"Soil quality assessment may be one of the most contentious topics ever debated by the soil science community."

"If you don't measure it, you can't manage it."*

*but is what we're measuring meaningful?


Symptoms of unhealthy soil:
Soil Crusting
Ecosystem services not provided
Agro-ecosystem services stunted

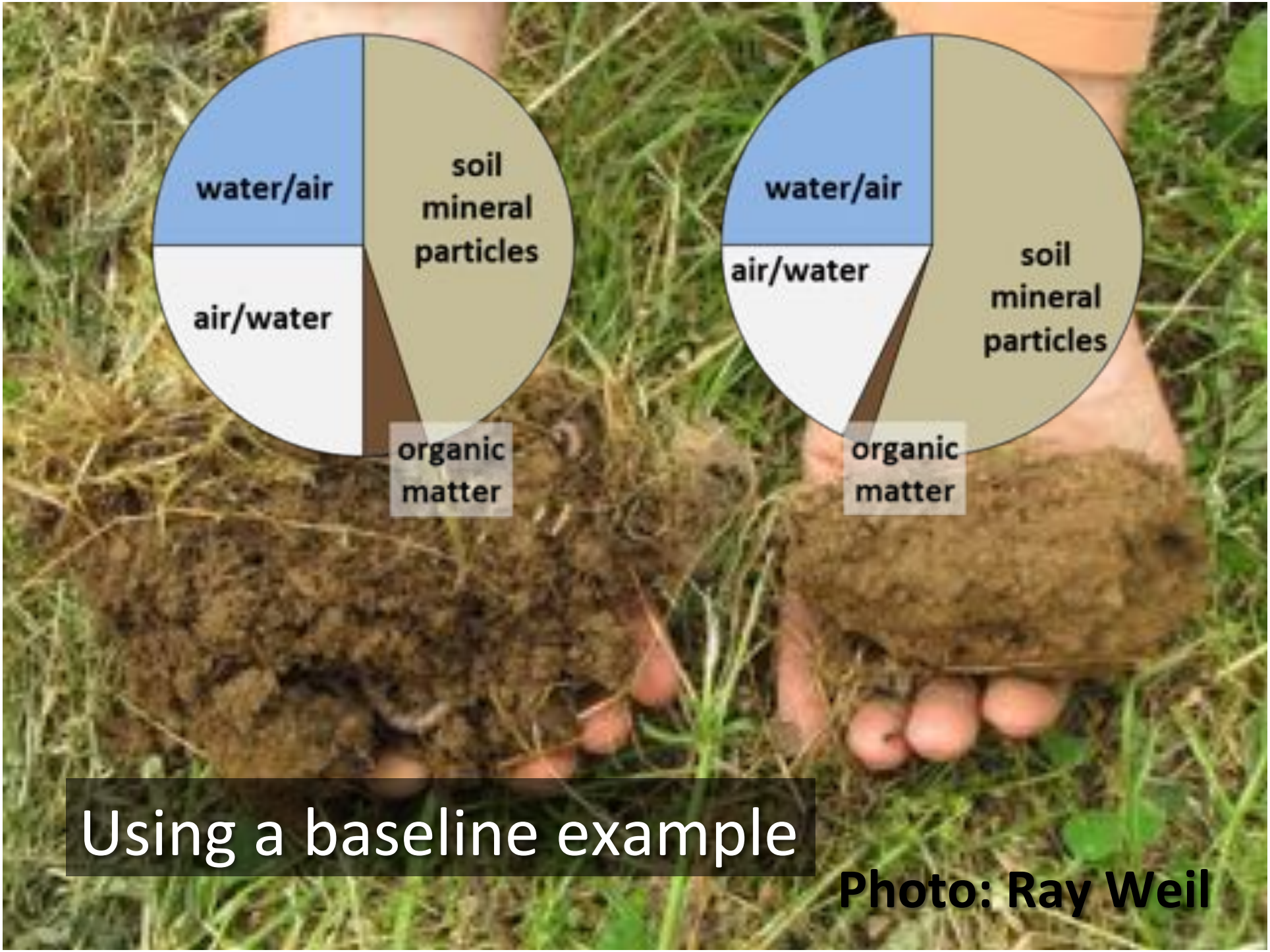

Soil compaction
(symptom & cause…)

Poor aggregation

Photo: Ray Weil


Erosion

Farming can be really tough on soil



Using a baseline example

Photo: Ray Weil


Field Margins
(not plowed in 30+ years)
Tilled Field
(history of field corn
and currently vegetables)

Soil Health

- Soil Health - Home
- Soil Biology
- Soil Health Assessment
- Soil Health Management
- Resources & Publications

Dig Deeper. Learn More

- Soil Health Literature
- Soil Quality Indicator Sheets
- Soil Health for Educators
- Soil Health Cards
- Soil Quality Test Kit

Soil Health Assessment

Soil health is an assessment of how well soil performs all of its functions now and how those functions are being preserved for future use. Soil health cannot be determined by measuring only crop yield, water quality, or any other single outcome. Soil health cannot be measured directly, so we evaluate indicators.

> Soil Quality Indicator Sheets

Indicators are measurable properties of soil or plants that provide clues about how well the soil can function. Indicators can be physical, chemical, and biological properties, processes, or characteristics of soils. They can also be morphological or visual features of pla

Useful indicators:

> are easy to measure,
> measure changes in soil functions,
> encompass chemical, biological, and physical properties,
> are accessible to many users and applicable to field conditions, and
> are sensitive to variations in climate and management.

Indicators can be assessed by qualitative or quantitative techniques. After measurements are collected, they can evaluated by looking for patterns and comparing results to measurements taken at a different time or field.

Indicator Examples and Relationship to Soil Health

Cornell Soil Health Assessment

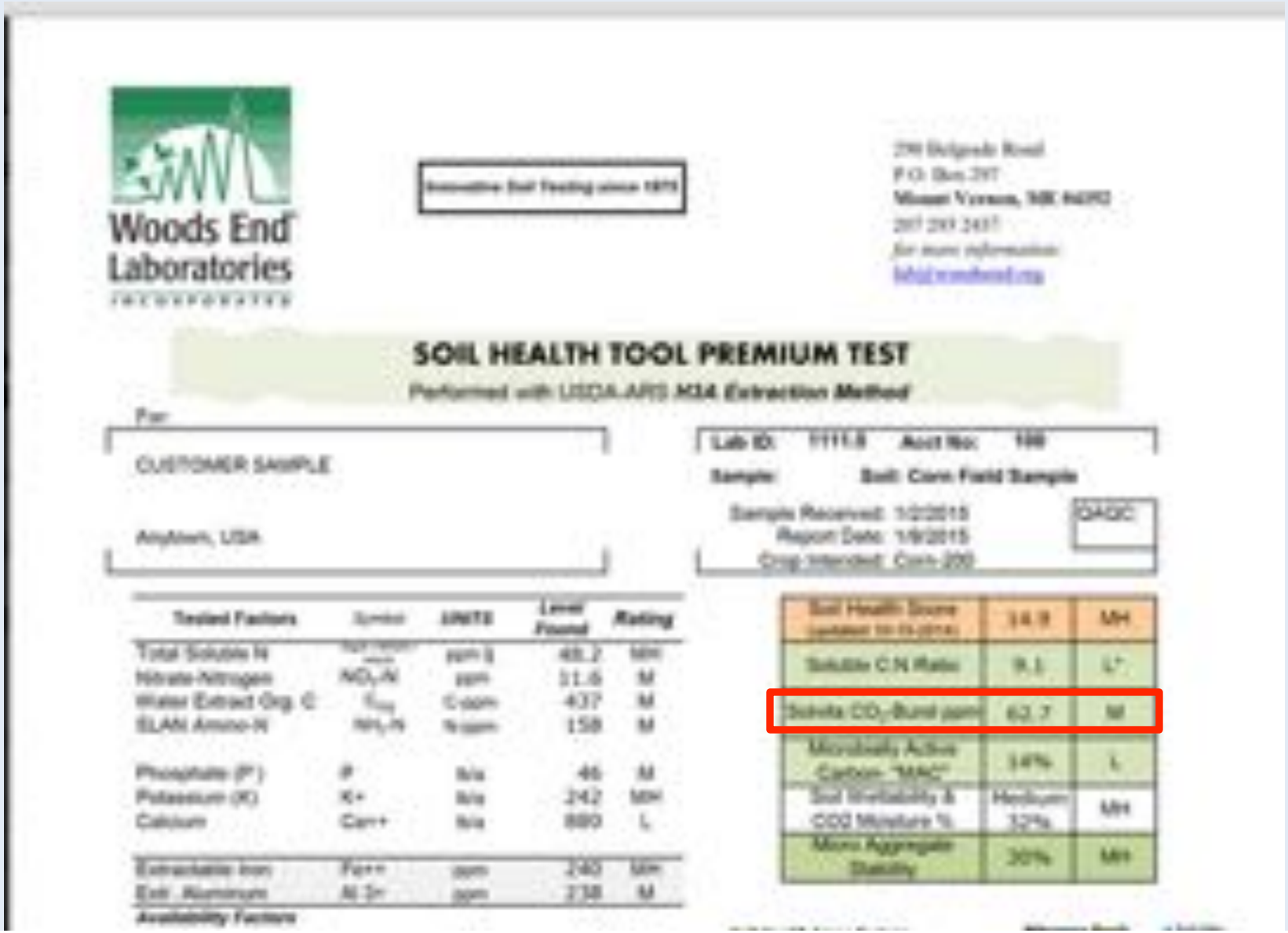
Nutrient cycling

Soil structural maintenance

Carbon transformations

Disease and pest resistance

Haney Soil Health Test



Woods End Laboratories

SOIL HEALTH TOOL PREMIUM TEST

Performed with USDA-ARS *H34 Extraction Method*

For:

CUSTOMER SAMPLE

Anytown, USA

Lab ID: 1111.0 Acct No: 100

Sample: Soil: Corn Field Sample

Sample Received: 1/2/2015
Report Date: 1/9/2015
Crop Intended: Corn 200

QA/QC

Tested Factors	Symbol	UNITS	Level Found	Rating
Total Soluble N		ppm N	48.2	MH
Nitrate-Nitrogen	NO_3-N	ppm	11.6	M
Water Extract Org. C	C_{wa}	C-ppm	437	M
SLAN Amino-N	NH_2-N	N-ppm	158	M
Phosphate (P)	P	lb/a	46	M
Potassium (K)	K+	lb/a	242	MH
Calcium	Ca++	lb/a	889	L
Extractable Iron	Fe++	ppm	240	MH
Exch. Aluminum	Al 3+	ppm	238	M

Availability Factors

Soil Health Score	14.9	MH
Soluble C:N Ratio	9.1	L*
Solvita CO_2-Burst ppm	62.7	M
Microbially Active Carbon "MAC"	14%	L
Soil Workability & CO_2 Moisture %	Hardpan 12%	MH
Micro Aggregate Stability	30%	MH

What do results mean?
Assessment → Management

- Parameterization of models--regional
- Baseline for a farm/field
- Fertilizer recommendations?
- Recommend other management practices
  - Cover Crops
  - Reduced tillage
  - Residuals

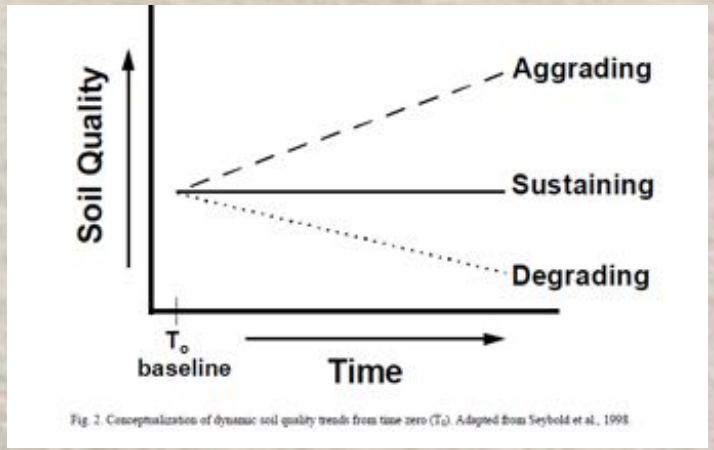


Fig. 2. Conceptualization of dynamic soil quality trends from time zero (T_o). Adapted from Seybold et al., 1998.

Cover crops

- Maximize photosynthesis- carbon capture
- Provide living roots for microbial associations, carbon storage and aggregation
- Prevent erosion
- Capture nutrients

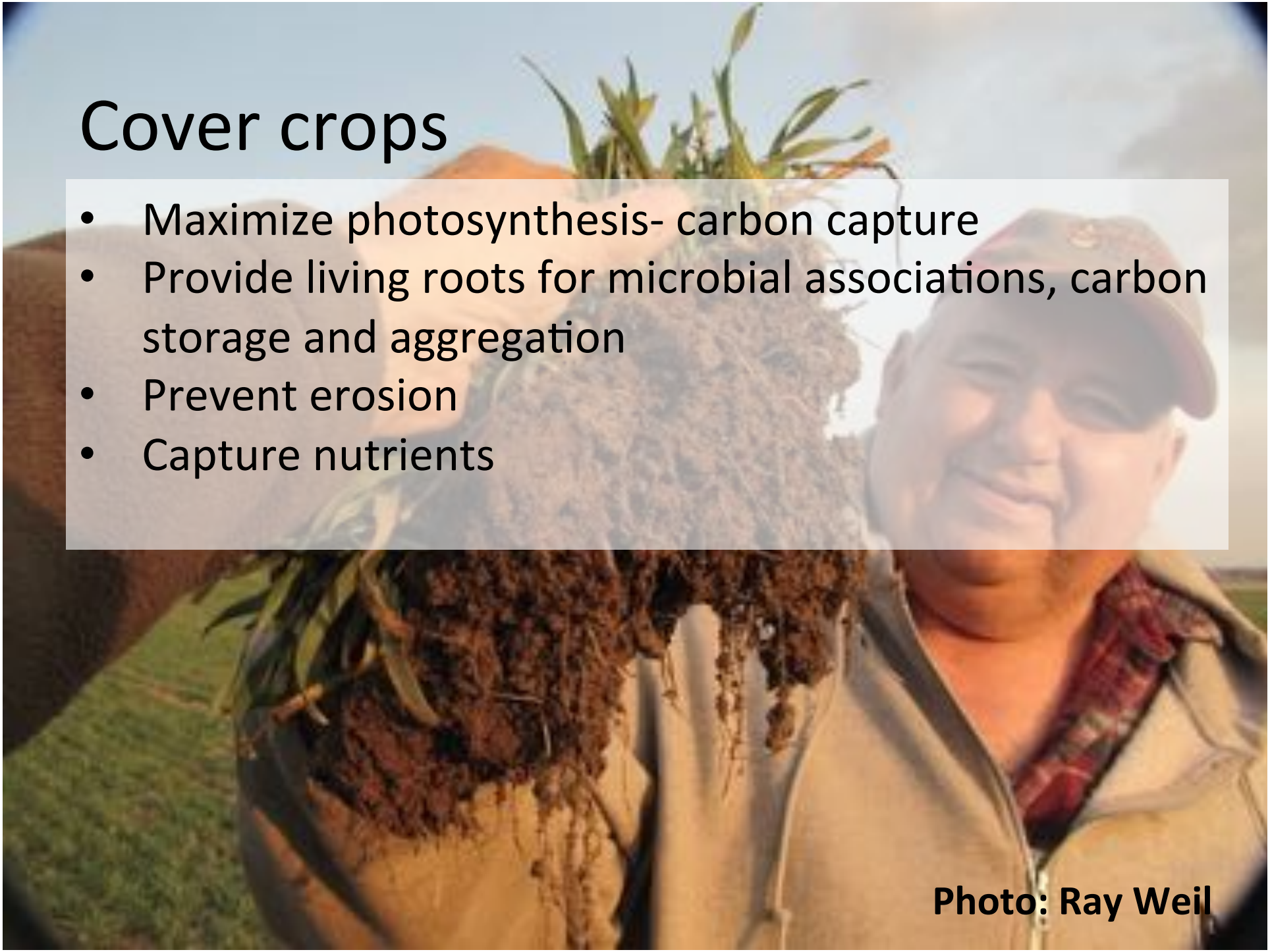
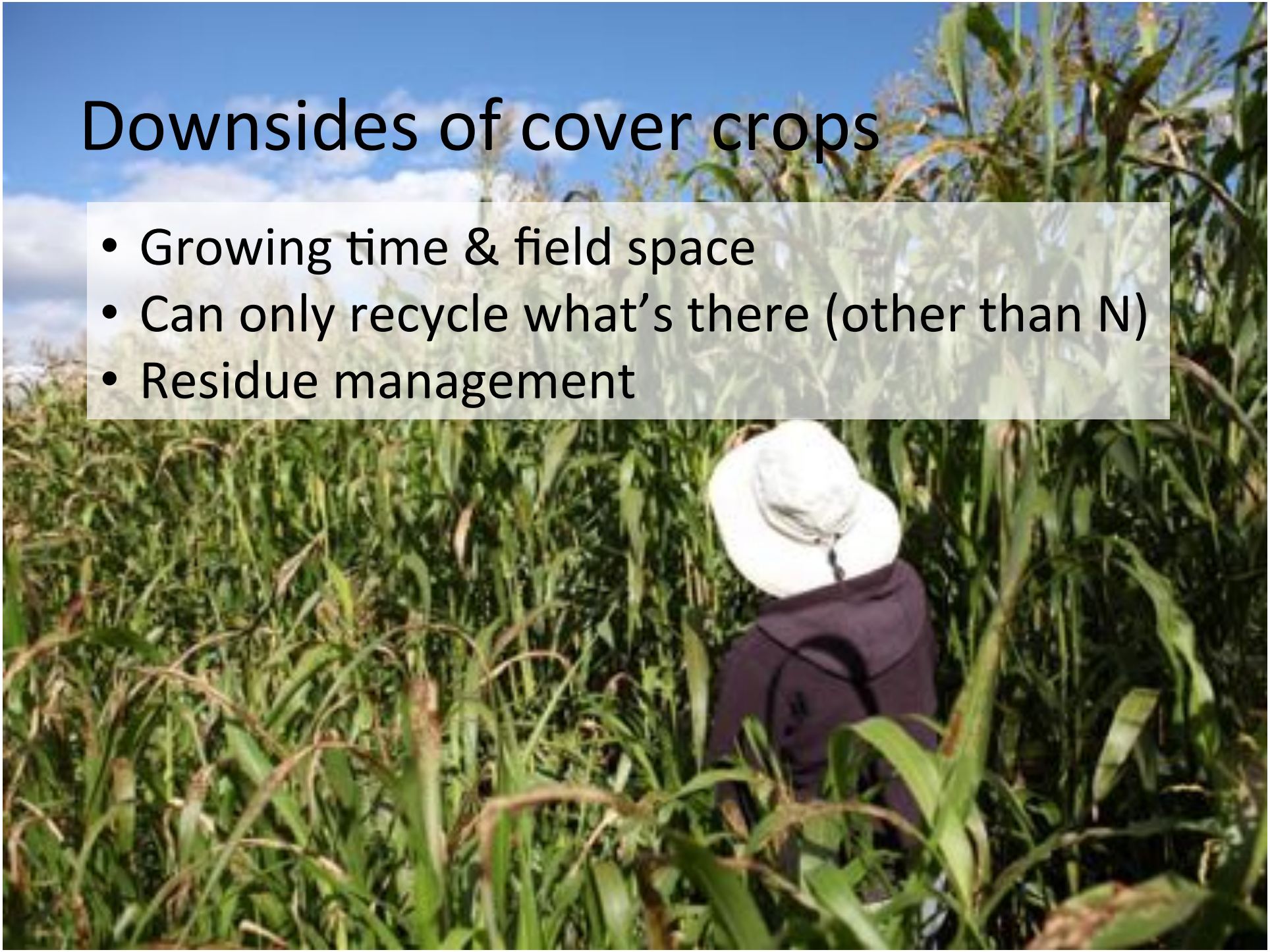


Photo: Ray Weil

Downsides of cover crops

- Growing time & field space
- Can only recycle what's there (other than N)
- Residue management



Residuals and Soil Health

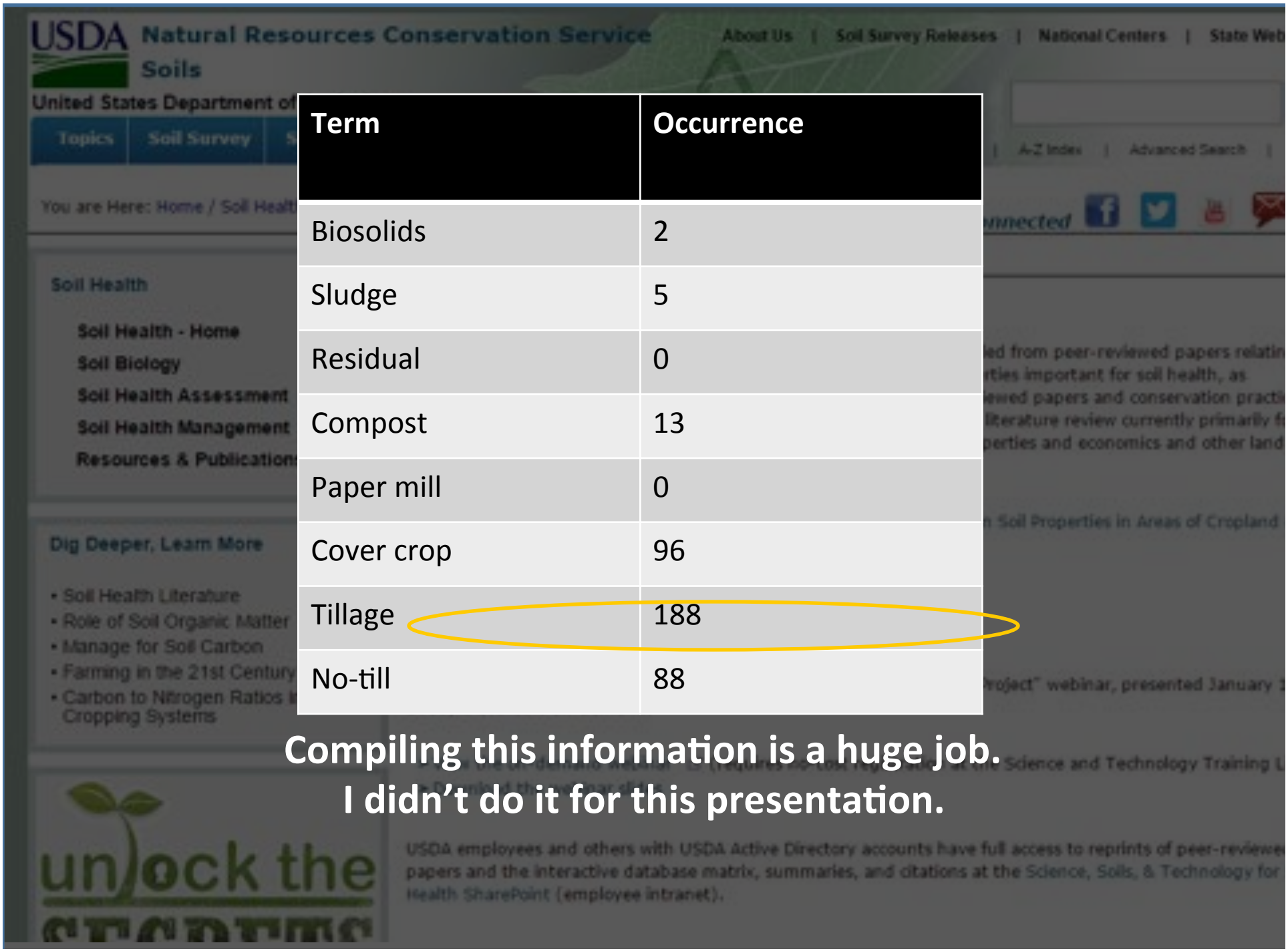
part branding, part science

Photo courtesy of Dominic Brose, Metropolitan Water Reclamation District of Greater Chicago

How do organic residuals affect:

- Carbon transformations
- Nutrient cycles
- Soil structure maintenance
- Regulation of pests and diseases?

All together!



Term	Occurrence
Biosolids	2
Sludge	5
Residual	0
Compost	13
Paper mill	0
Cover crop	96
Tillage	188
No-till	88

Compiling this information is a huge job.
I didn't do it for this presentation.

How can residuals complement other management practices?

Reduced tillage & no-till
Synergies with cover crops?


Questions?
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