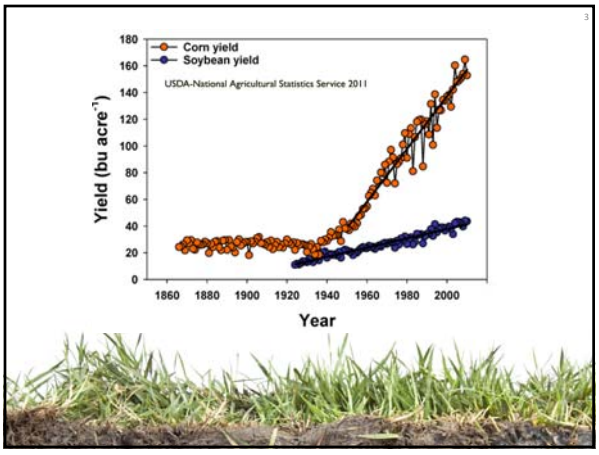
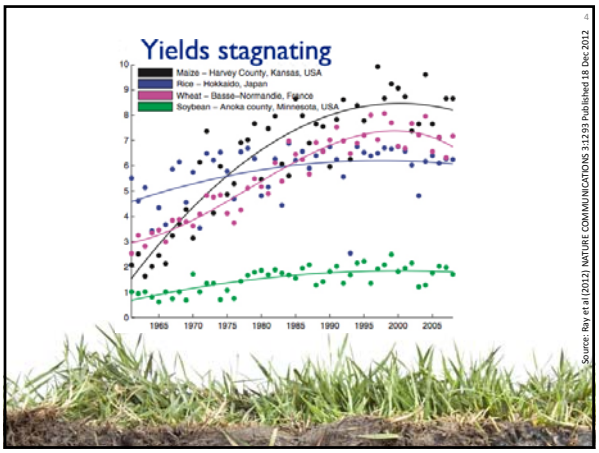
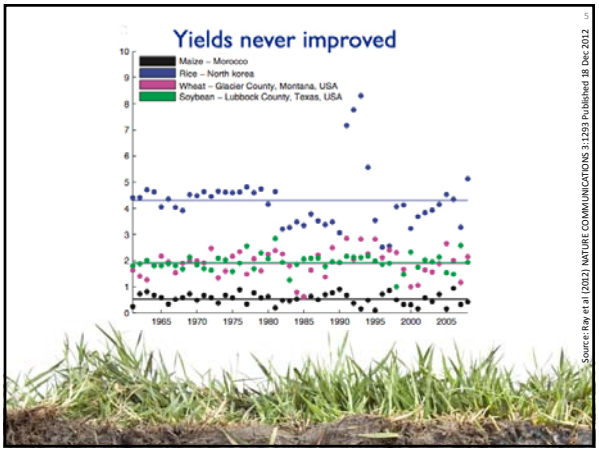
The Relevance of Soil Biology In Assessing Fertility & Soil Health

PRESENTER: William F Brinton
Founder, Director Woods End Soil Laboratories
& Faculty Associate, University of Maine

HOST: USDA NRCS United States Department of Agriculture Natural Resources Conservation Service





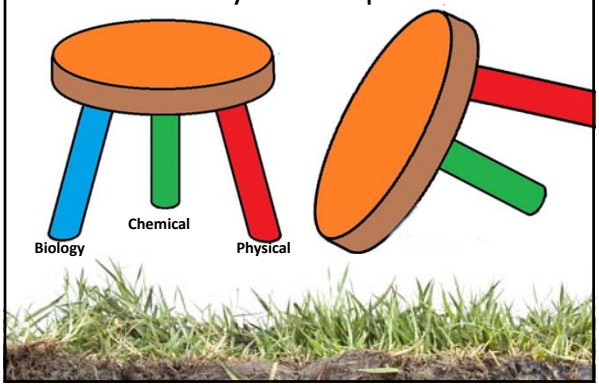


Factors cited for yield stagnation:

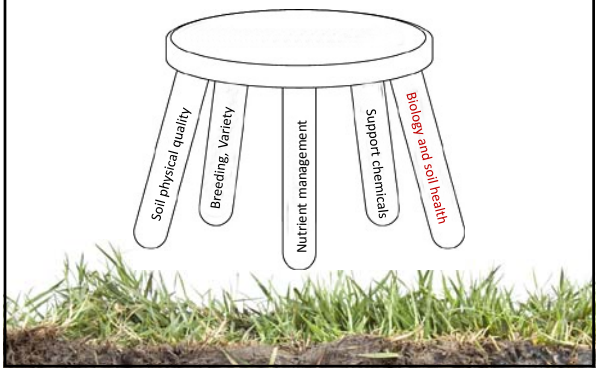
"… climate-change stress; salinization, soil erosion; pest and disease build-up; *depletion of soil fertility*"

Source: Ray et al (2012) NATURE COMMUNICATIONS 3:1293 Published 18 Dec 2012

Theory of Collapse

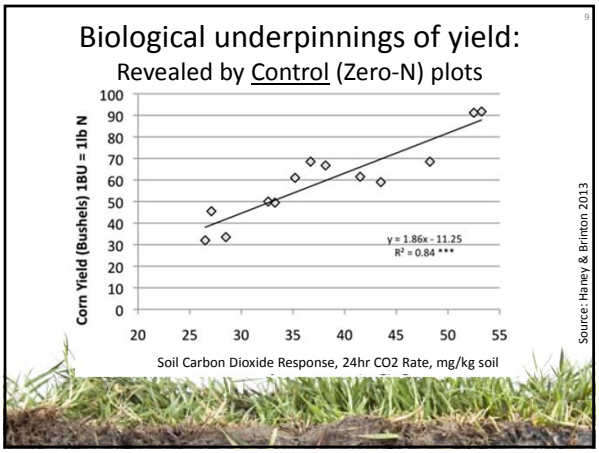


Complexity adds to stability



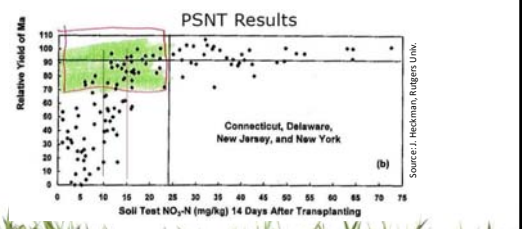
Biological underpinnings of yield:

Revealed by Control (Zero-N) plots



10

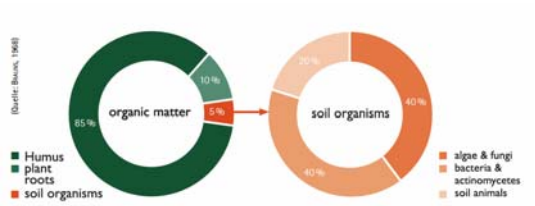
Soils that perform well but soil test data predict more N needed

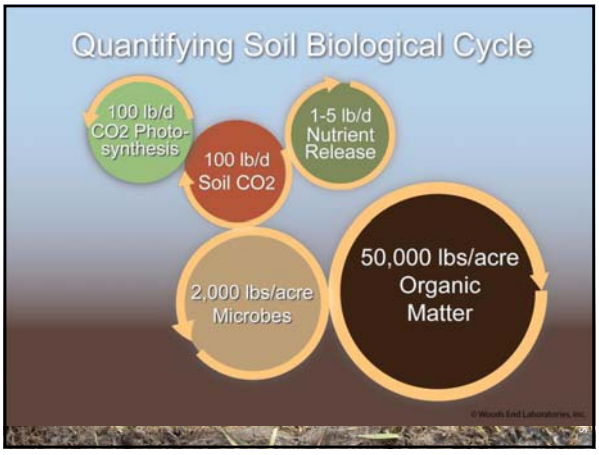


11

The basis of soil life

(and the source of soil respiration)





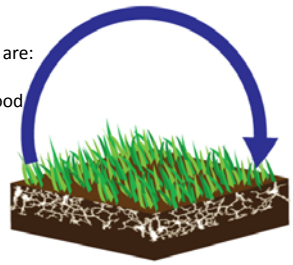
13

Whole system

Soil biology (CO2) transactions are:

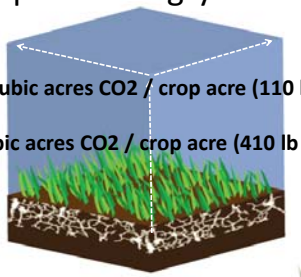
-Furnishing soil animals with food
-Sequestering CO_2
-Meeting plant needs for CO_2
-Releasing available N and P
-Dissolving soil minerals

Nature is balancing several equations simultaneously



14

Crops are hungry for CO_2



Wheat – 10 cubic acres CO2 / crop acre (110 lb CO2/day)

Corn – 38 cubic acres CO2 / crop acre (410 lb CO2 / day)

15

Where's all the CO_2 ? (from soil biological activity)

ppm:
400
(ambient)

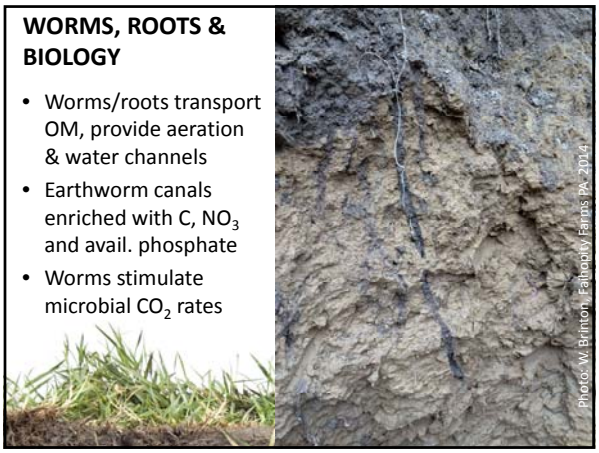
800

1,500

4,000

WORMS, ROOTS & BIOLOGY

- Worms/roots transport OM, provide aeration & water channels
- Earthworm canals enriched with C, NO_3 and avail. phosphate
- Worms stimulate microbial CO_2 rates

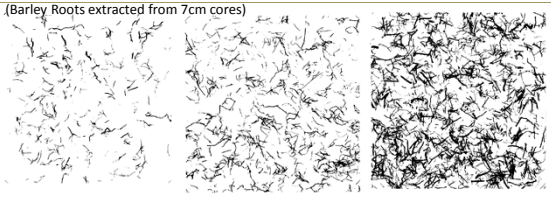


17

Example of Root Quantification

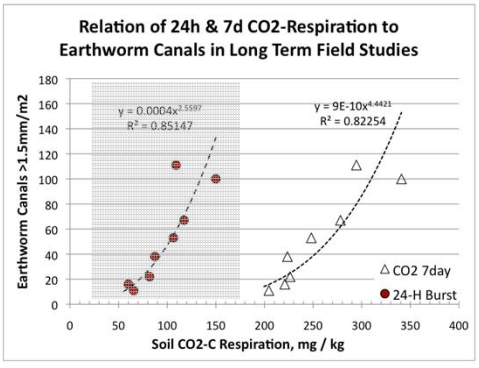
46	495	852 ft² / cubic foot

(Barley Roots extracted from 7cm cores)



Stressed root growth | Moderate growth | Vigorous, healthy roots

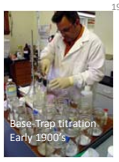
18



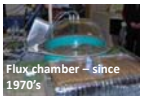
Source: Brinton et al. (1981) Swedish 17-yr Field Plot Studies: CO2 Rates vs Earthworm Canals. Medl #27 Järna Sweden

A multitude of (excellent, impractical) CO_2 methods.

- Base-Trap potentiometric titration
- IRGA Pulse Infrared method
- CO_2-Train – flow & IR capture
- GC- Gas Chromatography
- CO2-Manometry
- Flux chamber


Base-Trap titration Early 1900's


IRGA System 1-3 day 1980's technology


Flux chamber – since 1970's


Manometer since 1860


GC – since 1960's

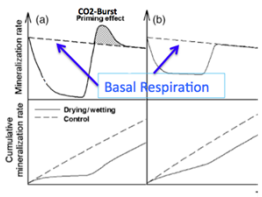

CO2-Train for long term tests 1995 era

Scaling soil biology measurements as cost effective for soil labs & farms

Soil Respiration for Soil Labs

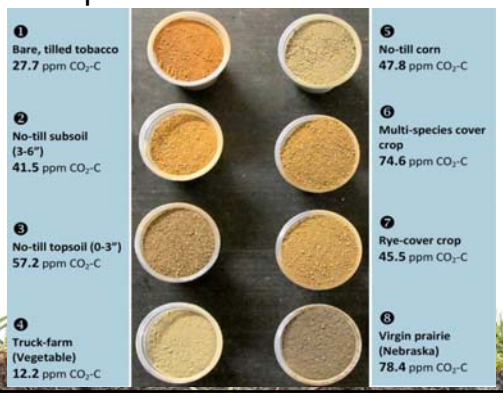
"CO_2-Burst" (drying-rewetting protocol)

40g soil pre-dried at 45C and water added at start of test



22

Soil respiration results



23

Soil Structure Challenge to Accurate Respiration Tests

PA soil, High aggregate stability (no-till, cover-cropped)

ID soil, structurally damaged, over-saturated (Proficiency test sample)

24

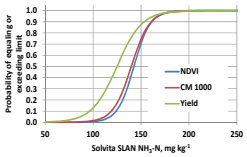
Labile Soil Humus-Amino-N Test

releases organic-N loosely held in humus

"SLAN" Test = Labile amino-nitrogen reserves

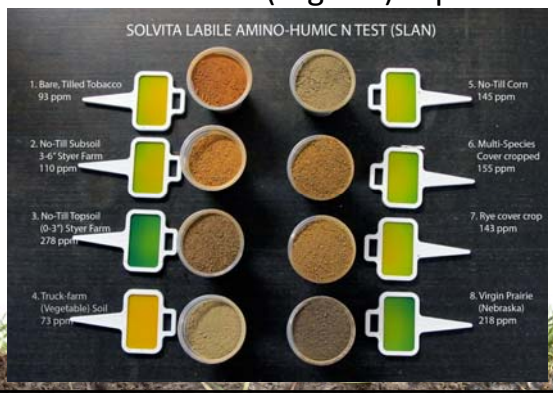
RESULTS

- Reveals accumulated organic nitrogen
- Correlates with ISNT and "likelihood of N-response"



Guillard et al (2014) Dept Plant Science, University of Connecticut

Humus-bound (organic) N pool



Winter cover crops

(improving soil biology, increase in soil organic-N)

Ways of reporting results

Ray Styer, No-Till Zero inorganic-N, Med-High CO2 rate; high SLAN

- Index of soil biological activity
- Monitor soil improvements
- Compare to yield/strip plot results
- Show field-level soil CO_2 output
- Integrate into "soil health" lab tests
- Indicate potential N-mineralization
- Responsive/non-responsive indice

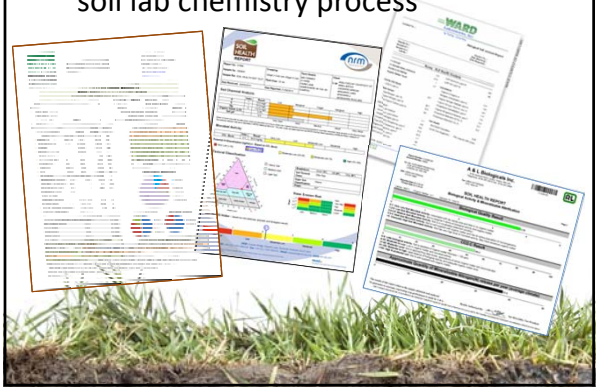
28

Examples of Interpretation

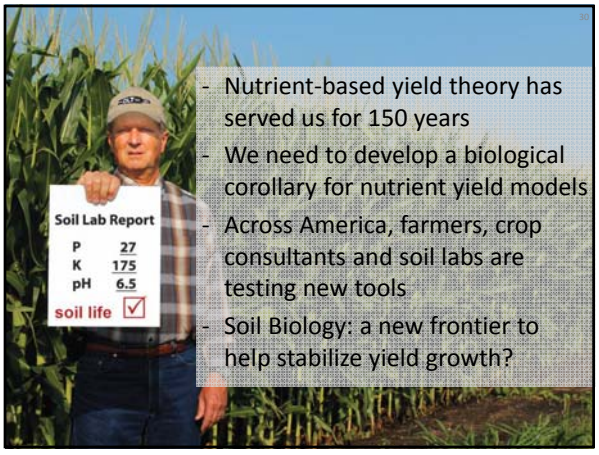
Suggested Soil Status	SLAN Labile Amino-N	Likely Response to Nitrogen?	CO_2-C Burst Respiration (24h hr)	Basal Soil CO_2 Respiration (field – 24hr)
Very Low Biology	<80 ppm	yes	0-20 ppm	0 – 15 lb/acre
Moderate Biology	100-200	possible	20-60	15 - 30
High Biology	>200	unlikely	60-175	30-100

Uses of results:
- Very low biology indicative of biologically exhausted soils
- Moderate category – soils at balance between depletion and improvement
- Very high results suggest reduced need for N (and other) fertilizers.

Biology integrated into routine soil lab chemistry process



30



- Nutrient-based yield theory has served us for 150 years
- We need to develop a biological corollary for nutrient yield models
- Across America, farmers, crop consultants and soil labs are testing new tools
- Soil Biology: a new frontier to help stabilize yield growth?

32

Q & A Session

Supplementary Material

contacts:
will.brinton @ woodsend.org
respiration website: solvita.com/soil