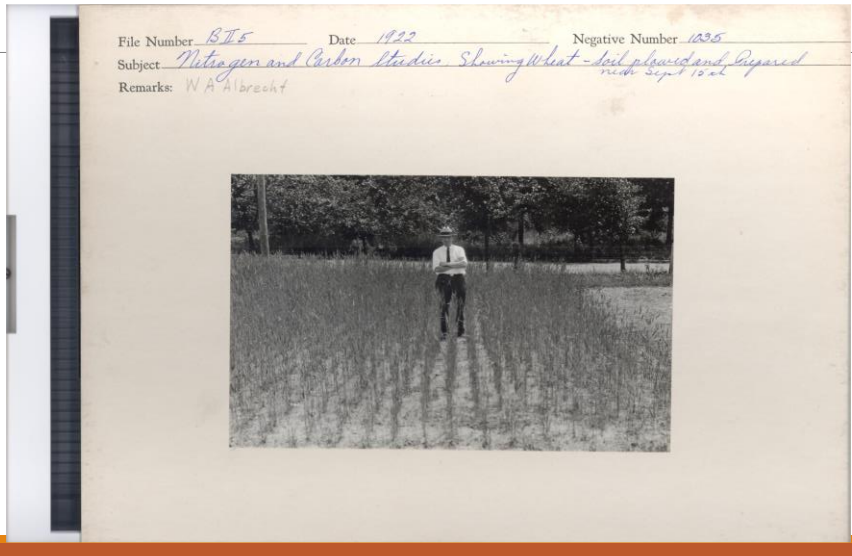
Connecting Soil Health and Human Health-Crop Management

TALK THREE-CODY WYOMING

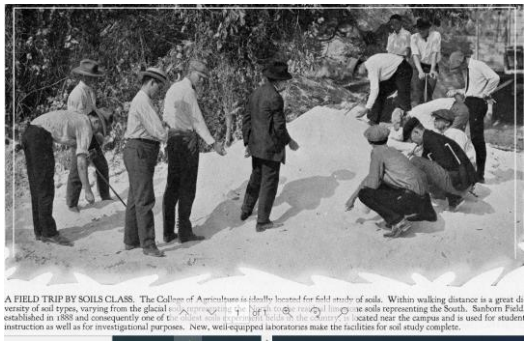
1

A little over 100 Years Ago MU Hired A Young Soil Scientist-Dr. William Albrecht to Study Soil Microbiology



2

Dr. Albrecht Taught Students Not Only In the Class But In the Field



A FIELD TRIP BY SOILS CLASS. The College of Agriculture is ideally located for field study of soils. Within walking distance is a great di
versity of soil types, varying from the glacial [illegible] soils representing the South. Sanborn Field
established in 1888 and consequently one of the oldest [illegible] in the country, is located near the campus and is used for student
instruction as well as for investigational purposes. New, well-equipped laboratories make the facilities for soil study complete.

3

Sanborn Field That Was Established in 1888 and Still Going! The Third Longest Continuous Research Station in the World

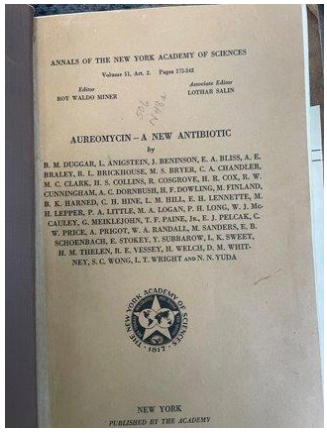
4

With Dr Albrecht's Help Aureomycin was Discovered on Plot 23. 2003 is the 75th Anniversary of the Discovery of Aureomycin at Sanborn Field

Fig. 7 Agricultural testing ground of the University of Missouri. The sample came from plot 23 of the test site, untreated since 1888, of the University of Missouri and was planted with timothy grass (*Phleum pratense*). The mycelium-building bacterium from this sample, initially A-377, later called *Streptomyces aureofaciens* (photograph), produces a potent compound against, for example, *Staphylococcus aureus* (© lwtwb8, PD Dr. Joachim M. Wink, Helmholtz-Zentrum für Infektionsforschung GmbH, Braunschweig)

5

75th Anniversary Aureomycin



ANNALS OF THE NEW YORK ACADEMY OF SCIENCES

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Editor ROY WALDO MINER

Associate Editor LOTHAR SALIN

AUREOMYCIN – A NEW ANTIBIOTIC

by

B. M. DUGGAR, L. ANIGSTEIN, J. BENINSON, E. A. BLISS, A. E. BRALEY, R. L. BRICKHOUSE, M. S. BRYER, C. A. CHANDLER, M. C. CLARK, H. S. COLLINS, R. COGROVE, H. R. COX, R. W. CUNNINGHAM, A. C. DORNBUSH, H. F. DOWLING, M. FINLAND, B. K. HARNED, C. B. HINE, L. M. HILL, E. B. LENNETTE, M. H. LEPPER, P. A. LITTLE, M. A. LOGAN, P. H. LONG, W. J. McCAULEY, C. MRIKLEJOHN, T. F. PAINE, Jr., E. J. PELCAK, C. W. PRICE, A. PRIGOT, W. A. RANDALL, M. SANDERS, E. B. SCHOENBACH, E. STOKEY, Y. SUBBAROW, I. K. SWEET, H. M. THELEN, R. E. VESSEY, H. WELCH, D. M. WHITNEY, S. C. WONG, L. T. WRIGHT AND N. N. YUDA

NEW YORK

PUBLISHED BY THE ACADEMY

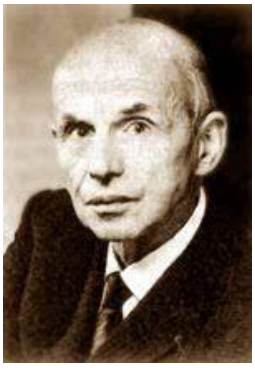
A soil sample from plot 23 is stored in the Smithsonian Institution.

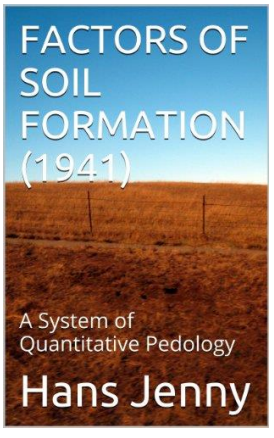
6

Dr. Albrecht Was At MU At A Very Special Time

7

Hans Jenny-Father of Soil Chemistry and a Colleague of Dr. Albrecht





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Hans Jenny work demonstrated the degradation of Soil Productivity Including Water Holding Capacity

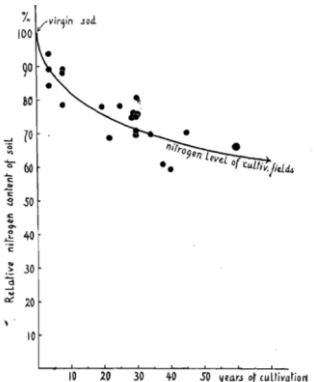

Fig. 6.—Decline of soil fertility with length of cultivation periods under average farming practices in the Middle West.

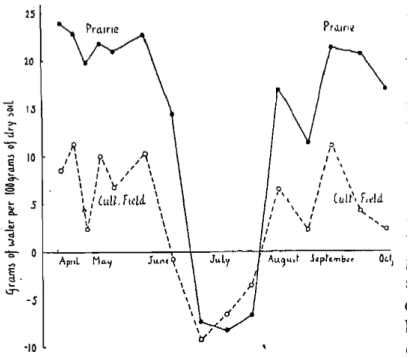

Fig. 3.—Cultivation Affects the Water Economy of the Soil. During most of the season the cultivated field contains less available growth water than the prairie.

*Prairie : 2.10±0.032% ; Cultivated field : 1.30±0.01

9

Drs. Bradfield and Baver Were Also Colleagues and Contributed To the Understanding of Base Saturation And Soil Fertility

10

Some of Their Groundbreaking Research

THE CHEMICAL NATURE OF A COLLOIDAL CLAY

RICHARD BRADFIELD

Abstract.—The fresh subsoil of Putnam silt loam, predominating prairie soil of Northeast Missouri, was suspended in five parts of water by churning, the coarser material settled by gravity and the finest colloidal material separated by means of a centrifugal force of about 30,000 times gravity. This fraction was unusually high in $AlPO^3$ and Fe^2O^3, almost all of which was soluble in hot HCl. This indicated that the colloidal fraction might be made up largely of the completely broken down end products of weathering; colloidal $AlPO^3$, Fe^2O^3 and SiO^2. A synthetic mixture of these colloids having a chemical composition similar to the natural colloid was prepared and their physico-chemical properties compared. Cataphoresis studies showed that the natural colloid was negative and that the synthetic mixture was positive. The migration velocity of the natural colloid was decreased by traces of acids and increased by traces of alkali; larger amounts of alkali caused flocculation. In no case was the direction of migration reversed. The synthetic colloid had a much stronger buffer action than the natural colloid due apparently to its high content of free $AlPO^3$. The natural colloid was flocculated most readily by polyvalent cations in an acid medium. The synthetic mixture was more sensitive to polyvalent anions and to alkalis. Analyses were made of the fractions of each colloid soluble in dilute acid, and in dilute alkali. The differences were marked throughout. All data obtained indicated that the natural colloid was a complex alumino-silicate, rather than a mixture of the separate colloidal oxides.

The Putnam silt loam, which is the predominating soil type on the level prairies of northeastern Missouri, is underlaid at a depth of 12 to 20 inches with a very heavy clay layer. This heavy layer is so compact that there is practically no water or air movement through it, except when it is cracked by drought. For this reason crops growing on it suffer severly in periods of wet weather, for the surface soil is kept saturated until the excess of water is removed by surface evaporation. Crop yields are probably reduced even more by the drought periods in the summer, because the sup-

Soil Erosion in Missouri

L. D. BAVER*

INTRODUCTION

The problem of soil erosion in Missouri is unusually serious as evidenced by data compiled in the recent reconnaissance erosion survey of the state. It is the purpose of this report to (1) present the picture of the seriousness of erosion in the state as it now exists, (2) to call attention to the factors that have contributed to soil losses by erosion, and (3) to suggest possible means of controlling erosion most effectively throughout the various sections of the state in accordance with the properties of the soils.

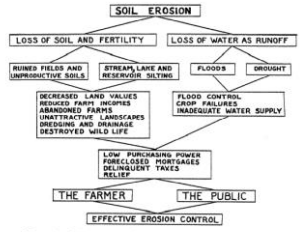

Chart 1.—Soil erosion affects the general public as well as the farmer.

11

Dr. Albrecht Started Putting Together All of These Different Disciplines Which Leads to How They Affect Soil Microbial Activity-June 22, 1922

12

In Annual Cropping Systems Even With Manure Applied There Was A Loss of Soil C and N. Only in a Perennial System With Manure Did Soil C and N Accumulate.

Table 2

TOTAL CARBON AND NITROGEN CONTENTS TOGETHER WITH THEIR RATIOS AT TWENTY-FIVE-YEAR INTERVALS ON SANBORN FIELD

Plot No.	Crop and Treatment	After 25 Years			After 50 Years			Changes in Carbon	Changes in Nitrogen
		Carbon %	Nitrogen %	C/N	Carbon %	Nitrogen %	C/N		
2	Wheat--Fertilizer	1.13	.107	10.5	1.02	.100	10.3	-.11	-.07
5	Wheat--Manure 6T, 25 yrs. Manure 3T, 25 yrs.	1.52	.140	10.8	1.27	.119	10.6	-.25	-.21
29	Wheat--Manure 6T, 25 yrs. Ammonium sulfate, 25 yrs.	1.38	.145	9.5	1.07	.081	13.2	-.31	-.64
30	Wheat--Manure 6T, 25 yrs. Sodium nitrate, 25 yrs.	1.61	.171	9.4	1.30	.094	13.8	-.31	-.77
23	Wheat--No treatment	1.33	.141	9.4	1.45	.135	10.7	+.12	-.06
22	Wheat--Manure 6T.	1.69	.177	9.5	2.04	.195	10.4	+.35	+.18

Timothy

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When Soils From Rotations Were Treated With Lime (Ca Source) then Nitrifying Activity Increased, Especially When Fertilizer Had Not Been Applied

Table 4

NITRATE NITROGEN LEVELS IN SOILS UNDER DIFFERENT LABORATORY TREATMENTS AS INFLUENCED BY THE PAST HISTORY OF CROPPING AND SOIL TREATMENTS. (SOILS FROM SANBORN FIELD)

Cropping History and Field Treatment		(Pounds Nitrogen per Acre) Laboratory Treatments					
		No Treatment	Limestone	Organic Matter	Lime and Organic Matter	Mean of All Treatment	Increase over Lowest Item
Continuous Crops	Corn	25	83	55	122	71	....
	Oats	30	26	121	190	92	21
	Wheat	59	102	52	172	96	25
	Timothy	48	104	110	183	111	40
Rotation	Six-year	34	52	74	176	84	....
	Four-year	56	75	109	206	112	28
	Three-year	44	97	182	219	135	51
Soil Treatments	None	40	61	92	179	93	....
	Manure	49	93	120	196	114	21
	Phosphate	50	106	184	282	155	62
	Fertilizers	43	94	149	222	127	34
	Ammonium Sulfate	60	113	150	193	129	36
	Sodium Nitrate	62	87	174	216	134	41
	Lime	36	74	223	267	150	57

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Dr. Albrecht's 1939 Manuscript Soil Science Society of America

VARIABLE LEVELS OF BIOLOGICAL ACTIVIT
SANBORN FIELD AFTER FIFTY YEARS OF
TREATMENT Wm. A. Albrecht

Concluded that soil microorganisms were dependent upon:

soil N, P, and Ca

15

Dr. Albrecht Didn't Have The Tools That We Have Today: What Does Today's Data Say?

Fertility	pH	TN	P	SOC	Microbes	Agg. Stab.
		g/kg	mg/kg	g/kg	pmols/g	%
No Fertility	5.5 a	1.15 a	5.2 a	10.7 a	72,334 a	15 a
Full Fertility	5.7 a	1.45 b	37.0 b	14.0 b	90,902 b	17 b
Manure	6.9 b	1.78 c	56.2 c	17.5 c	121,854 c	25 c

Different letters indicate significance at the 0.05 probability level

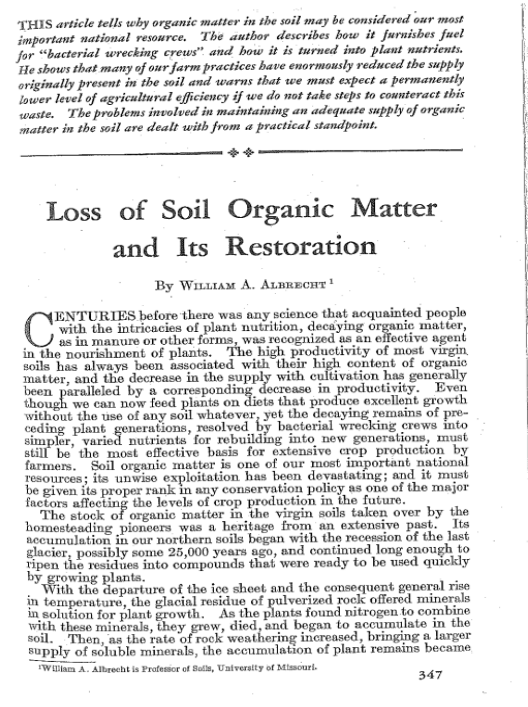
Norkaew, 2018

16

Dr. Albrecht Understood the Importance of Organic Matter

17

In 1938, Dr. Albrecht Wrote An Article on Soil Organic Matter For the Special Issue of the USDA Annual Yearbook of Agriculture



THIS *article tells why organic matter in the soil may be considered our most important national resource. The author describes how it furnishes fuel for "bacterial wrecking crews" and how it is turned into plant nutrients. He shows that many of our farm practices have enormously reduced the supply originally present in the soil and warns that we must expect a permanently lower level of agricultural efficiency if we do not take steps to counteract this waste. The problems involved in maintaining an adequate supply of organic matter in the soil are dealt with from a practical standpoint.*

Loss of Soil Organic Matter and Its Restoration

By William A. Albrecht [1]

CENTURIES before there was any science that acquainted people with the intricacies of plant nutrition, decaying organic matter, as in manure or other forms, was recognized as an effective agent in the nourishment of plants. The high productivity of most virgin soils has always been associated with their high content of organic matter, and the decrease in the supply with cultivation has generally been paralleled by a corresponding decrease in productivity. Even though we can now feed plants on diets that produce excellent growth without the use of any soil whatever, yet the decaying remains of preceding plant generations, resolved by bacterial wrecking crews into simpler, varied nutrients for rebuilding into new generations, must still be the most effective basis for extensive crop production by farmers. Soil organic matter is one of our most important national resources; its unwise exploitation has been devastating; and it must be given its proper rank in any conservation policy as one of the major factors affecting the levels of crop production in the future.

The stock of organic matter in the virgin soils taken over by the homesteading pioneers was a heritage from an extensive past. Its accumulation in our northern soils began with the recession of the last glacier, possibly some 25,000 years ago, and continued long enough to ripen the residues into compounds that were ready to be used quickly by growing plants.

With the departure of the ice sheet and the consequent general rise in temperature, the glacial residue of pulverized rock offered minerals in solution for plant growth. As the plants found nitrogen to combine with these minerals, they grew, died, and began to accumulate in the soil. Then, as the rate of rock weathering increased, bringing a larger supply of soluble minerals, the accumulation of plant remains became

[1] William A. Albrecht is Professor of Soils, University of Missouri.

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Albrecht and Organic Matter

NEW AWARENESS AND NEW RESPONSIBILITY

American citizens are becoming conscious of the fact that loss of fertility and the depletion of organic matter in the soil are partly responsible for the menace of erosion. The first step in remedying this situation is to restore fertility by the use of lime and fertilizer. The second step is to put some lands permanently into sod crops—legumes wherever possible, and the better grasses—and to use sod more regularly in rotations on tillable cropped lands. The conservation and use of such farm wastes as crop residues and manures should be included as the third step.

If these practices are recommended as proper soil management by all agricultural agencies, their adoption by individual farmers will become so common that the rate of soil depletion will be lessened. The need for long-time investments in materials that build up the soil in organic matter and fertility should be recognized in granting credit to farmers.

tion and work for it cooperatively. Unearned increment, the great wealth producer of the past, should be recognized as largely responsible for the mining of soil fertility and the burning up of soil organic matter until it has reached such a low level that this source of wealth has an extremely uncertain outlook in the future. The heritage of soil fertility and organic matter that we are handing on to the next generation is not large enough to be used lavishly. Careful conservation and thrifty management will be imperative if it is to yield even a moderate income.

19

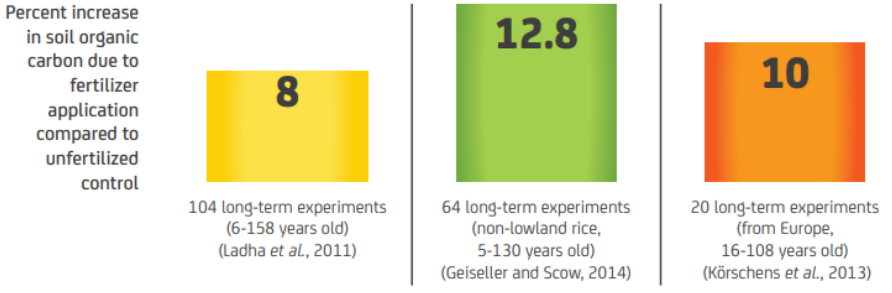
Charles Kellogg Chief Of USDA Soils, Was Not A Fan Of Dr. Albrecht and Noted So

938 yearbook *Soils & Men*, for which William Albrecht
hapter on the loss of soil organic matter and its restoration [33]. In 1933,
harles Kellogg, could have taken a position at the University of Missouri
hen William Albrecht took a leave of absence for a year, but at the time,
he considered the salary too low. Charles Kellogg gave a well-attended talk
and after the visit, he noted in his diary: "Albrecht had been furiously writing
a great deal of nonsense about the direct effects of liming on food quality. I
recall commenting on this in the speech and pointing out that if a diet were
made up from crops grown on the best soils in Missouri and a comparable
one on the poorest soils, the first would be somewhat more nutritious. But
by adding or subtracting a quart of milk a day the small differences would
be overwhelmed. Prof. M. F. Miller and the others were highly amused. It
is very difficult to understand how M. F. Miller, whom everyone respected,
and the others at the University let this quack stay on as Head of the Depart-
ment of Soils. He wrote bulletins and hundreds of papers, and all sorts of

20

Doe Better Fertility Increase Organic Matter? Yes!

Increase in soil organic carbon due to fertilizer application compared to unfertilized control in long-term experiments from all over the world.



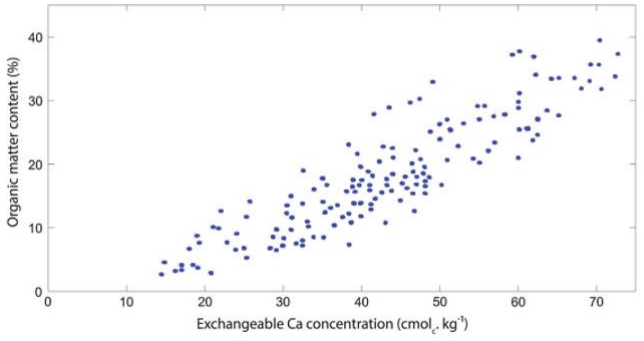
21

Improved Soil Fertility Had An Even Larger Impact On Organic Matter Than Manure!

Treatment		Mean yield of wheat over 9 years (t ha^{-1})	Soil organic carbon content in 0-15 cm top soil (t ha^{-1}) after 9 years
N-P-K (kg ha^{-1})	Farmyard manure (t ha^{-1})		
0-0-0	0	1.30	14.10
0-0-0	10	1.71	15.44
120-26-33	0	2.40	16.91
120-26-33	10	3.04	18.62
LSD (p = 0.05)		0.21	1.89

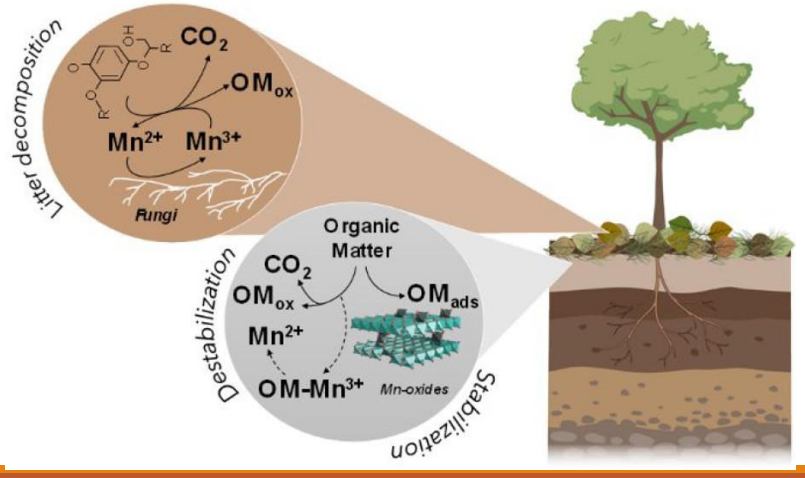
22

Increasing Ca Soil Availability Increases Soil Organic Matter



23

Manganese Is Important For Organic Matter Decomposition and Stabilization.



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Soil Organic Matter Is Involved In All Aspects Of Soil Health

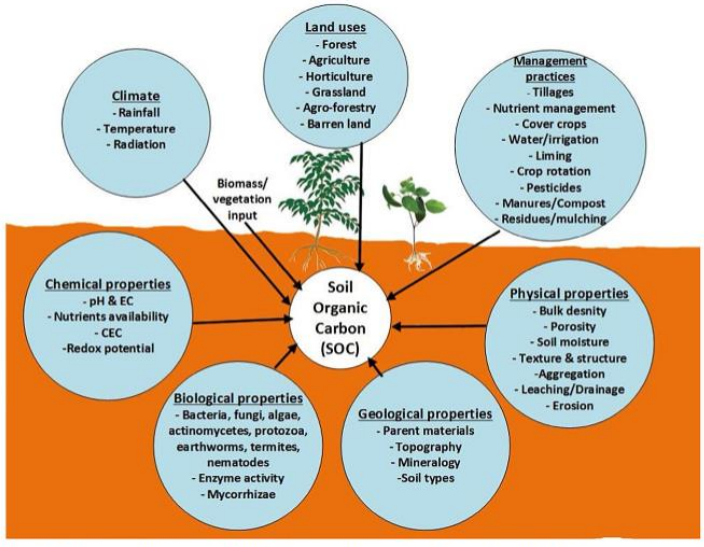
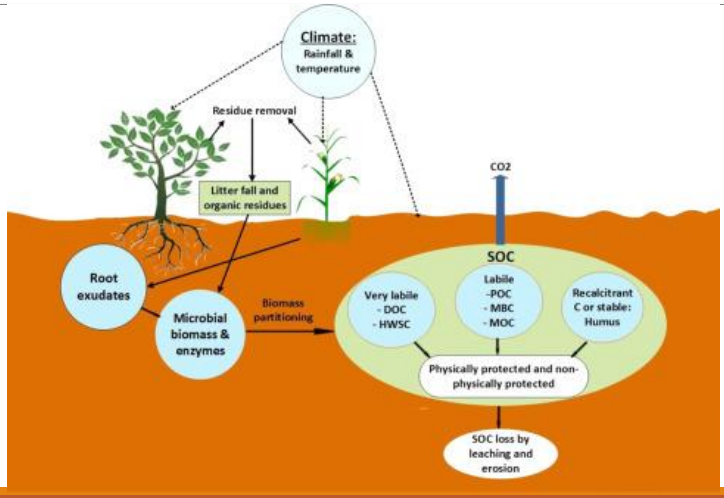


Fig. 2 Schematic diagram of the factors influencing organic carbon dynamics in soil.

25

Soil Organic Matter Is From Plant and Animal Materials That Is Broken Down By Soil Microbial Organisms.



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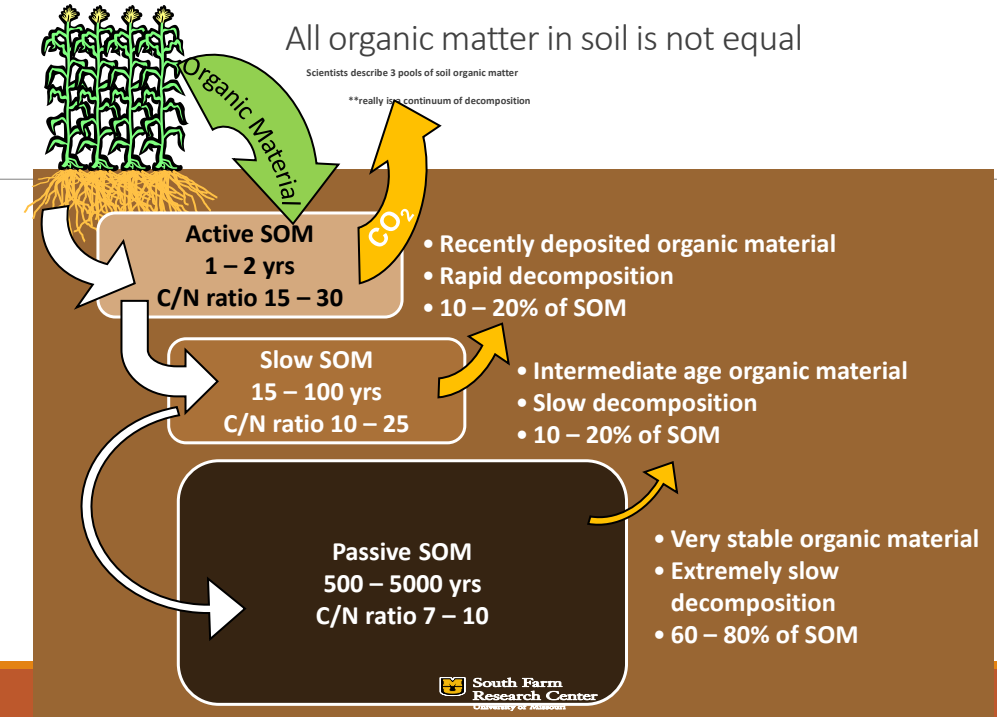

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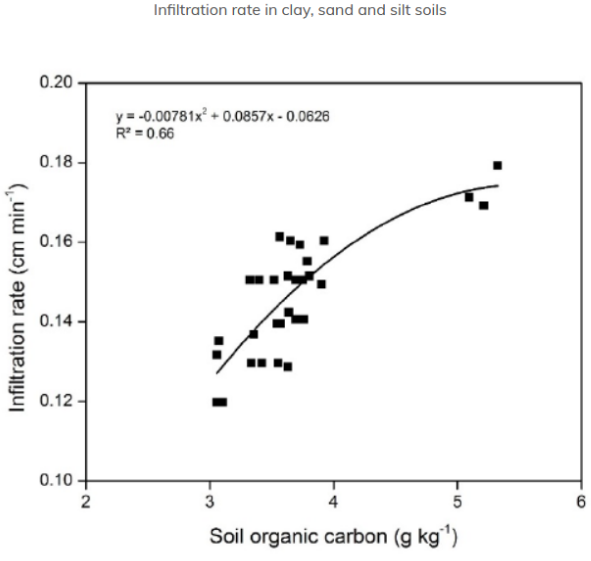


From Symbiosis

28

What is a Healthy Soil?

29

Hans Jenny work demonstrated the degradation of Soil Productivity Including Water Holding Capacity

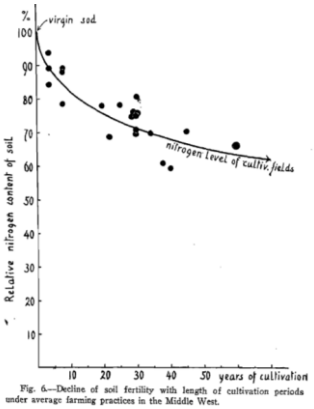


Fig. 6.—Decline of soil fertility with length of cultivation periods under average farming practices in the Middle West.

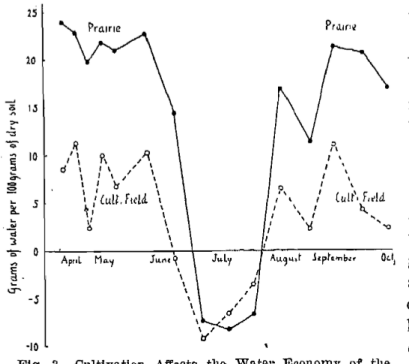


Fig. 3.—Cultivation Affects the Water Economy of the Soil. During most of the season the cultivated field contains less available growth water than the prairie.

*Prairie: 2.10±0.032%; Cultivated field: 1.30±0.01

30

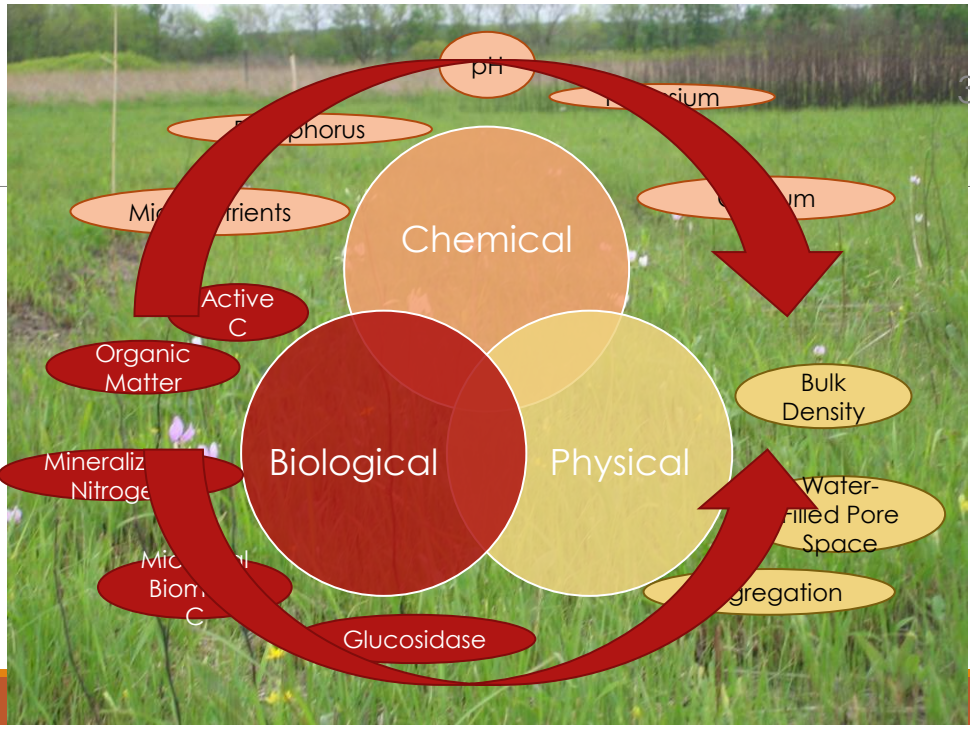
Tilled vs No-Till-We Have Destroyed Much of Our Soil Structure-Lets Talk About Regenerative Agriculture

LONG TERM PASTURE

TILLED IN AN ANNUAL CROP

31

32



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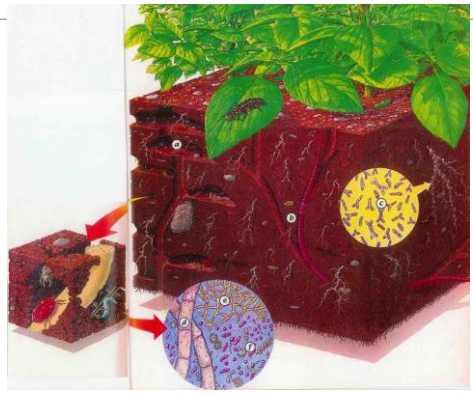
Soil Biology: Microorganisms:

Bacteria-100 million-1 Billion!

Fungal Filaments-Several Yards

Protoza-Several Thousand

Nematodes-10-20



South Farm Research Center
University of Missouri

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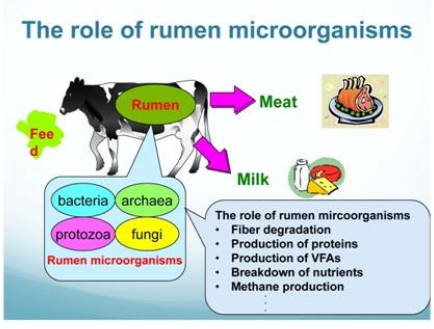
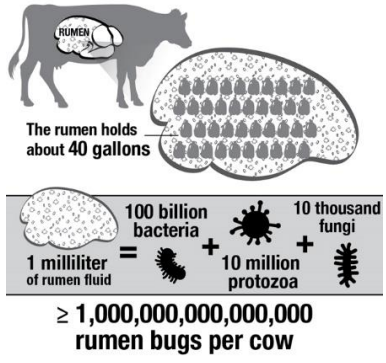
Cow's Stomach and The Soil-Feed The Microbes Fed The Cow and Plant





34

Annual Cover Crops and Perennial Crops Are a Way To Increase Soil Biology

35

Cover Crops Nothing New: Did This is the 1930's.

36

Often When You Plow Up a Pasture
You Have A Bumper Yield The First Year, Maybe the Second and Then It Goes Down. Why?

37

Example: Tilling Under a Perennial Cover

38

In the Short Term, You May Even Improve Yield When Killing and/or Tilling A Cover Under

39

Longer Rotations Using Cover Crops, Using Perennial Crops Can Also Improve Soil Health

40

Cover Crop (left) Larger and More Robust Than No Cover Crop (right)-Dry Year and Better Soil Health=More Water

41

Lengthening the Rotation Resulted In Greater Soybean Yield

Rotation	Cover Crop	Crop(s)	Soybean Yield
			Bu/acre
Continuous	none	Soybean	39
	Yes		46
Two-Year	none	Corn/soybean	42
	Yes		42
Three-Year	none	C/Soy/Wheat	42
	Yes		52
Four-Year	none	C/Soy/W/Red Clover	52
	Yes		52
Five Year	none	C/Soy/W/2 Alfalfa	54
	Yes		58
LSD (0.05)			9
LSD (0.10)			8

42

In Only Two Years A Perennial Cover Crop Can Make Huge Differences In Soil Health

Treatment	Aggregate Stability	Active Carbon	B-Glucosidase	Soil Organic Carbon	Total Nitrogen
	g/kg	g C/kg soil	µg PNP/g soil/hr	g/kg	g/kg
Alfalfa	33.0	0.39	65.8	1.53	0.15
Tilled annual	13.3*	0.33*	45.6*	1.33*	0.12*

- Indicates significant difference at the 0.05 probablity level

43

What About Soil Chemistry-Nutrients?

IS THERE AN INTERACTION WITH SOIL BIOLOGY?

44

What Does Recent Data From Sanborn Tell Us About the Interaction of Soil Chemistry and Biology?

	Chemical				Biological
Fertility	**pH**	**TN**	**P**	**SOC**	**Microbes**
		g/kg	**mg/kg**	**g/kg**	**pmols/g**
No Fertility	**5.5 a**	**1.15 a**	**5.2 a**	**10.7 a**	**72,334 a**
Full Fertility	**5.7 a**	**1.45 b**	**37.0 b**	**14.0 b**	**90,902 b**
Manure	**6.9 b**	**1.78 c**	**56.2 c**	**17.5 c**	**121,854 c**

Different letters indicate significance at the 0.05 probability level

45

Table 1. Soil health indicators from the upper soil horizon from four soil cores taken in November 2020. Saturated hydraulic conductivity (Infiltration) 2023 Rotations species include corn (C), wheat (W), red clover (RC), grain sorghum (GS), Timothy, tall fescue or in restored prairie. Soil fertility include no fertility, full (fertility: N,P,K, lime), manure (13.5 Mg dairy manure ha^{-1}).

Plot, Rotation, Fertility	2020 crop	OC	POXC	TN	PMN	WSA	Respiration	Infiltration	PLFA Wt
		mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg CO_2 kg^{-1}	cm $hour^{-1}$	pmols $mols^{-1}$
4-C-W-RC-Full Fertility	C	1.50	383	0.165	64.4	19.3	628	7.4	79,406
6-Cont. Corn-Full Fert. tilled	C	1.25	270	0.133	33.9	12.8	474	7.8	54,514
7-Cont. Corn-Full Fert. notill	C	1.33	423	0.144	52.4	19.3	413	4.3	43,109
9-Cont. Wheat-no fert	W	1.18	333	0.127	52.8	33.3	523	10.4	57,826
10-Cont. Wheat-manure	W	2.08	588	0.210	90.8	32.5	794	14.4	74,064
17-Cont. Corn-no fert	C	0.85	222	0.092	16.8	11.0	293	4.0	51,331
18-Cont. Corn-manure	C	1.58	498	0.162	67.0	27.0	575	14.4	104,922
22-Cont. Timothy-manure	T	2.30	733	0.236	84.6	54.5	879	6.8	114,261
23-Cont. Timothy-no Fert	T	1.70	330	0.173	81.6	77.5	1007	8.1	101,869
45 Restored Prairie	P	2.00	463	0.181	73.6	50.8	1156	8.8	97,717
Tucker Prairie	P	3.30	585	0.319	162	83.0			345,700
LSD (0.05)		0.19	110	0.016	13.9	12.0	248	ns	20,257
LSD (0.10)		0.16	92	0.014	11.7	10.0	208	4.5	16,959

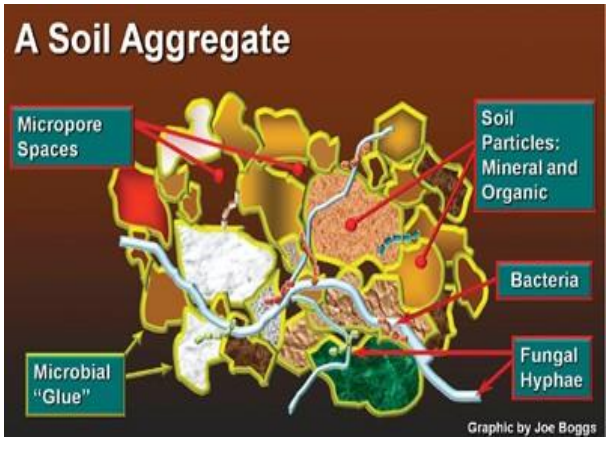
46

What About Our Study? After Five Years of Albrecht Recommendations?

Treatment	Cover Crop	Mycorrhizae	Total Microbes
		pmols/mol	pmols/mol
Control	no	2957	103,374
64/14	Yes	3813	119,222
Recommendations	no	3388	109,809
68/12	Yes	4225	124,127
Rec+Magnesium	no	2445	94,118
54/20	Yes	3544	118,691
LSD (0.05)		522	9,960

47

The End Product of the Interaction of Soil Chemistry and Biology is Good Physical Soil Properties=Aggregate Stability



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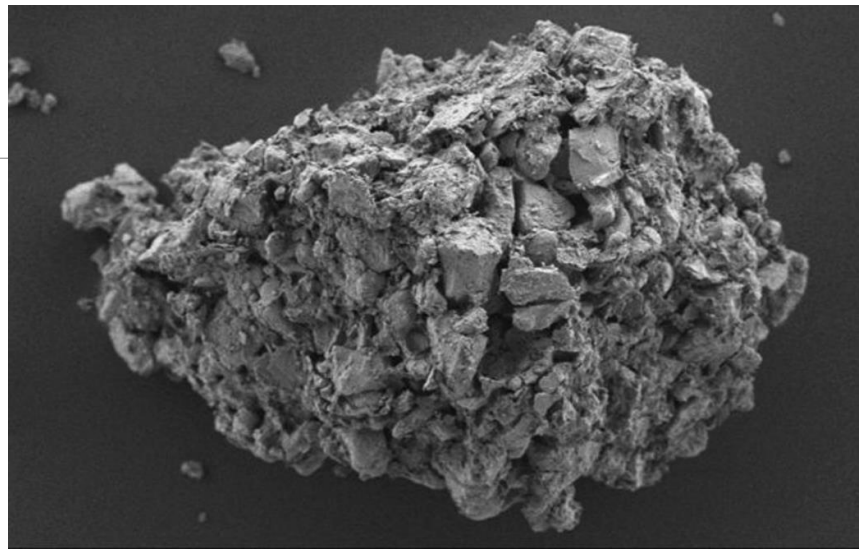
A Soil Aggregate

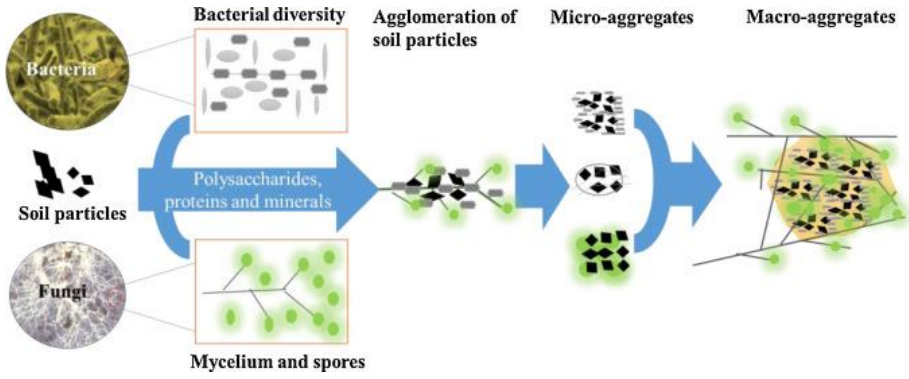


49

Longer Rotations Using Cover Crops, Using Perennial Crops Can Also Improve Soil Health

50

How Are Aggregates Formed? Microorganisms



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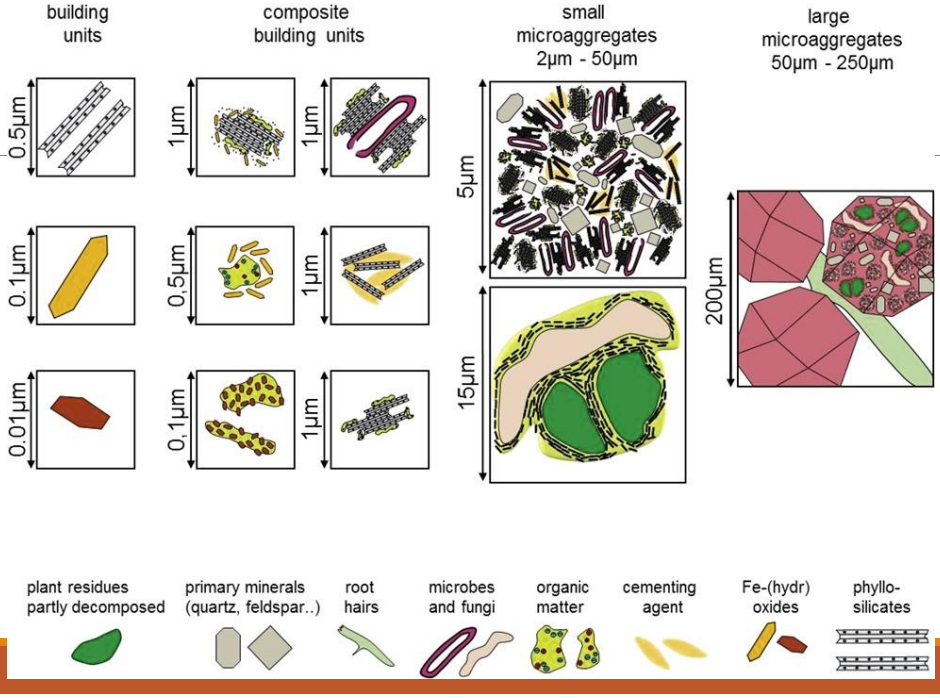


52

Aggregates Formed By The Attraction of Cations to Clay and Organic Compounds

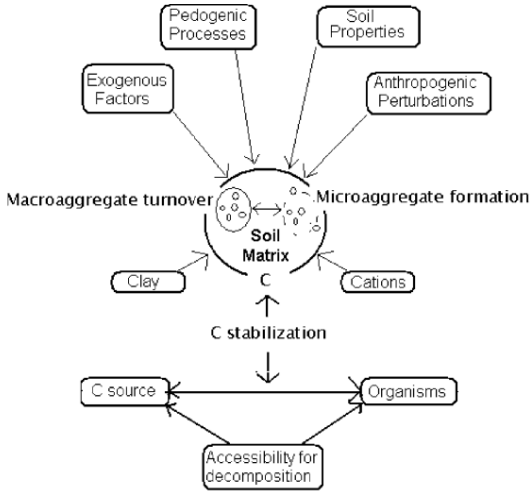
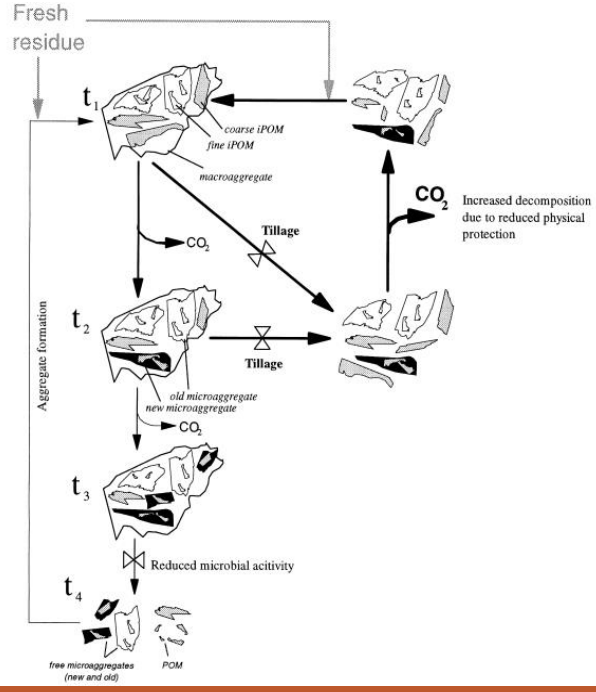


Fig. 2. Factors affecting soil aggregation.

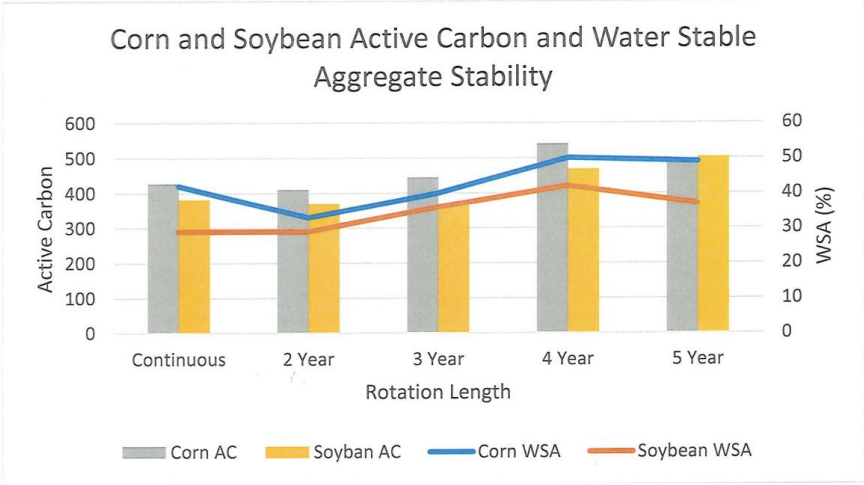
53

Macroaggregates Are Constantly Being Broken Down to Microaggregates. Tillage Speed This Up



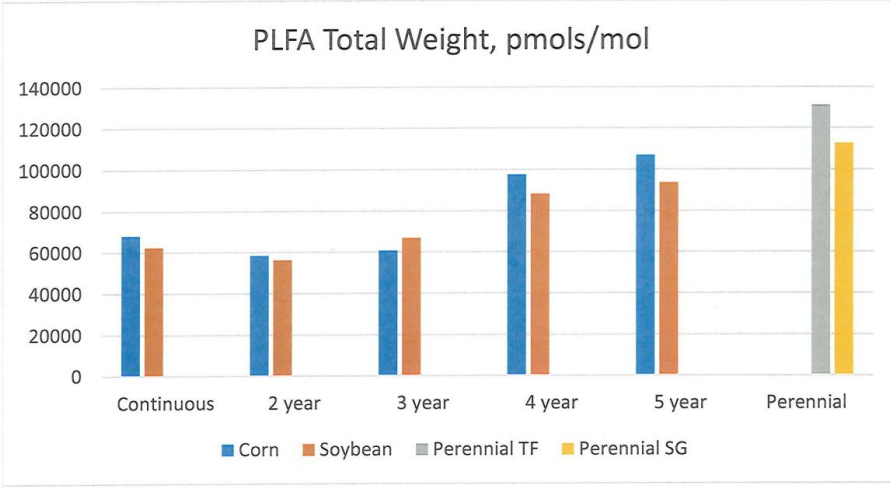
54

Lengthen Rotation Increase Active C and Aggregate Stability



55

Longer Rotation More Soil Biology



56

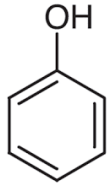
Different Crops Affect Soil Aggregation Differently: Cereal Crops and Corn Much Better Than Soybeans-Why?

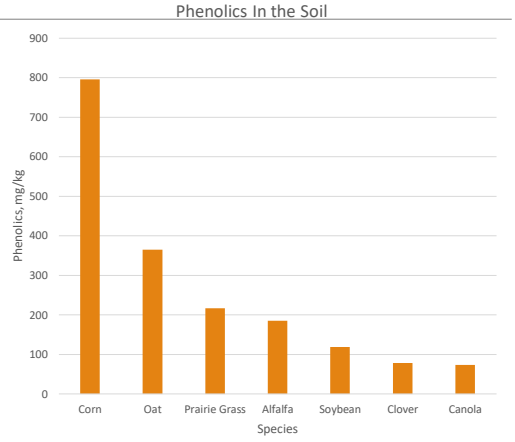
Corn and Cereals Produce A lot of Phenolic Compounds

Soybeans Produce Very Little Phenolic Compounds

Phenolic Compound Help Bind Soil Aggregates

- **-Phenolic Synthesis Manganese Dependent**
- Produce Aromatic Amino Acids





57

How Does Soil Aggregate Stability Relate Back To Organic Matter and The Calcium/Magnesium Base Saturation?

58

The Interaction of Chemical, Biological and Physical Properties at Sanborn Field

	Chemical				Biological	Physical
Fertility	**pH**	**TN**	**P**	**SOC**	**Microbes**	**Agg. Stab.**
		g/kg	**mg/kg**	**g/kg**	**pmols/g**	**%**
No Fertility	**5.5 a**	**1.15 a**	**5.2 a**	**10.7 a**	**72,334 a**	**15 a**
Full Fertility	**5.7 a**	**1.45 b**	**37.0 b**	**14.0 b**	**90,902 b**	**17 b**
Manure	**6.9 b**	**1.78 c**	**56.2 c**	**17.5 c**	**121,854 c**	**25 c**

Different letters indicate significance at the 0.05 probability level

59

What is the Difference? Better Aggregation Better Drought Tolerance

60

Change In Active Carbon and Aggregate Stability After 5 Years of Albrecht Treatments

Treatment	Cover Crop	Active Carbon	Total Agg. Stab.
		mg/kg	%
Control	no	458	15
64/14	Yes	458	23
Recommendations	no	523	21
68/12	Yes	490	28
Rec+Magnesium	no	516	15
54/20	Yes	491	27
LSD (0.05)		63	6

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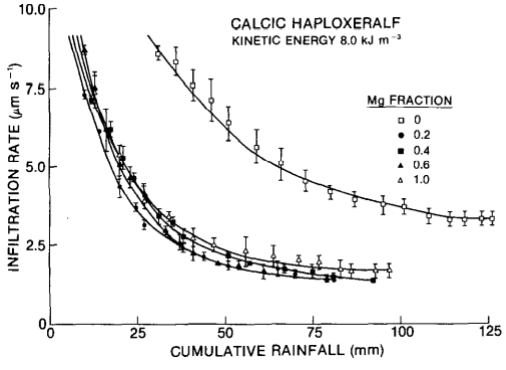
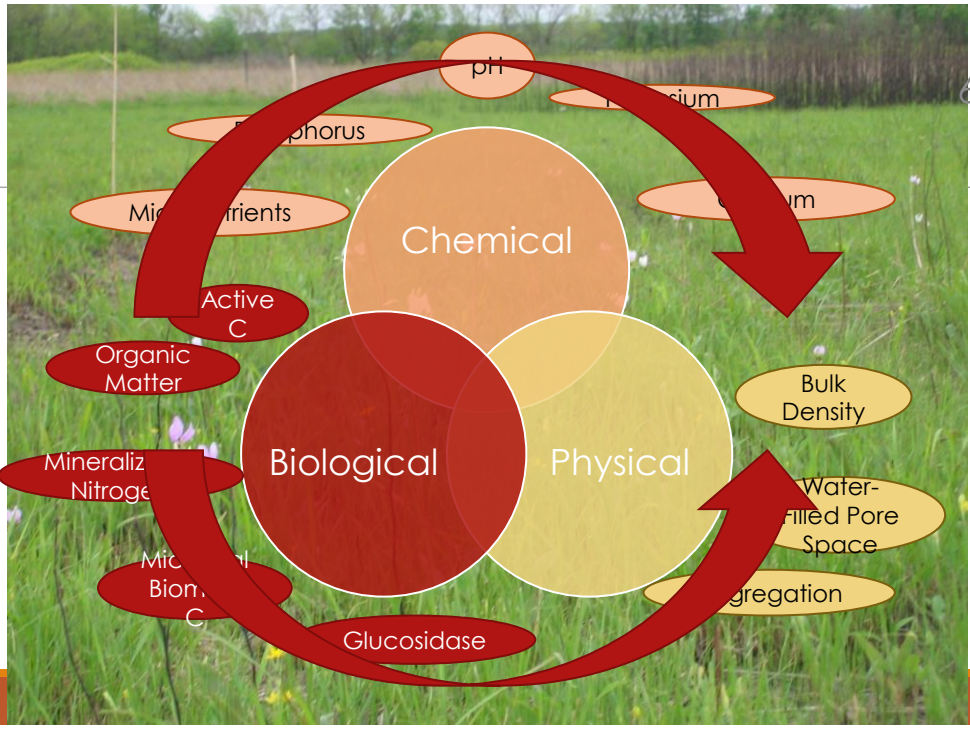
Remember, High Soil Mg or Na, Then Water Infiltration Decreased



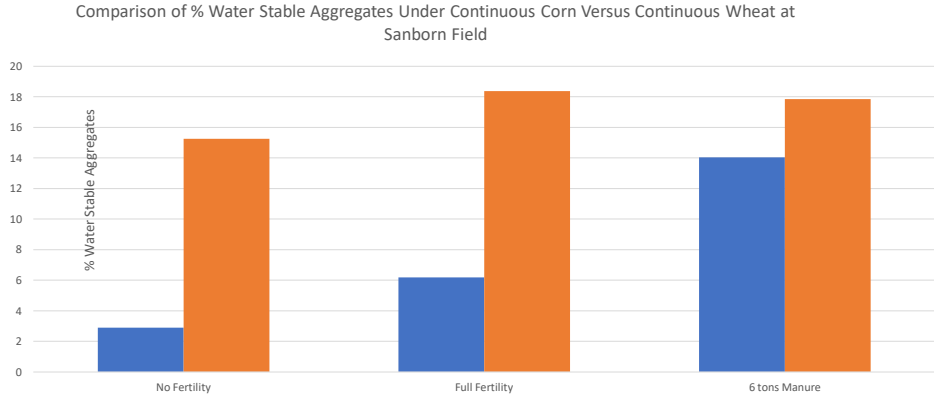
62



63

63

Sanborn Field Study-Higher Fertility and Wheat Has Greater Aggregate Stability: Why?



Norkaew, 2018

64

Why More Yield Response In a Dry Year Than A Wet Year?

Treatment	Wet Year Yield bu/acre	Dry Year Yield bu/acre
Control	178	161 c
Recommendations	190*	203 a
Recom. Without Pell Lime	193*	183 a
Recom.+Mg and Lime	179	174 bc
Recom+Mg no lime	173	185 ab
Micros Only	179	178 bc
P and K	175	-

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Conclusions:

All Factors of Soil Health Are Changed By the Albrecht System

Soil Biology-more soil Microorganisms

Soil Chemistry-balanced Ca and Mg and available P, K, S and micronutrients

Soil Physical –greater Aggregate Stability=better soil water infiltration, water availability and soil aeration

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Soil Health Leads To Healthy People (and animals)

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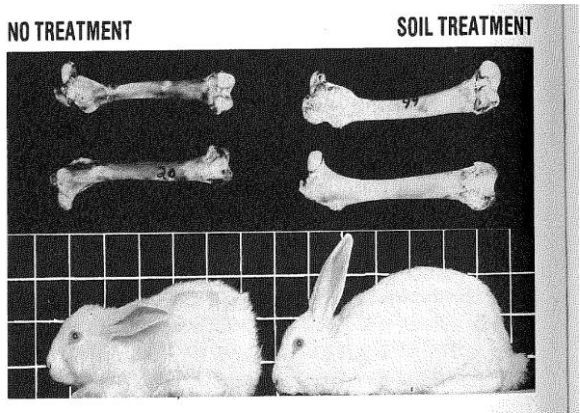
Dr. Albrecht Put Together The Concept of Healthy Soil, Healthy Plants, Healthy Animals (People).



The weanling rabbits had the same pedigree, so did the crop plants making up the hay, but treatment of the soil with some extra fertility to grow better feed made the rabbit on the right different in appearance and body structure as the bones also illustrate.

68

Inductees Correlated To The Soil Fertility of Their Home

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
J. H. LONGWELL, *Director*

CIRCULAR 333 DECEMBER, 1948

Our Teeth and Our Soils

WM. A. ALBRECHT, A.B., B.S., M.S., Ph.D.
Department of Soils, College of Agriculture, University of Missouri

The knowledge about the human body and its many functions has been accumulating seemingly very slowly. The additions to our information have awaited the coming of each new science and the contributions by them in their respective fields. Dentistry as well as the medical profession has been ready and quick to accept and use any new knowledge that might alleviate human suffering.

Very probably the twentieth century will be credited with the addition of the science of nutrition as a major contribution to the better life of our people. Better nutrition is leading us to think less about medicine as cures and less about fighting microbes with drugs. In a more positive way it is helping us to think more about helping the body defend itself by being well-fed and therefore healthy.

For such defense, the science of the soil and its fertility, by which alone high quality foods can be provided, may well be a present century addition to our knowledge of the better functions and better health of our bodies. It is proposed therefore in this discussion to lead you to think about the health condition of only one part of our body, namely, our teeth as they are related to the fertility of our soils.

Some Basic Facts Involved

In dealing with the subject of soil fertility and its implications for our teeth, or for any other part of our anatomy and our physiology, it is essential that one establish certain facts and principles at the outset and then follow through as these seem to have causal connections with the phenomena under consideration.

The first fact that may well be considered is the observation that under moderate temperatures the increase in annual rainfall from zero to 60 inches, for example—as is the range in going across the United States from near the Coast Range eastward—gives first an increased weathering of the rocks. That change represents increased soil *construction*. Going east from zero rainfall means increasingly more productive soils until one reaches about the mid-continental area. Then with still more rainfall, there comes excessive soil development under the higher rainfall which means increased soil *destruction* in terms of soil fertility considered both in quantity and in quality.

Reprinted from ANNALS OF DENTISTRY, Vol. 6, No. 4, December, 1947

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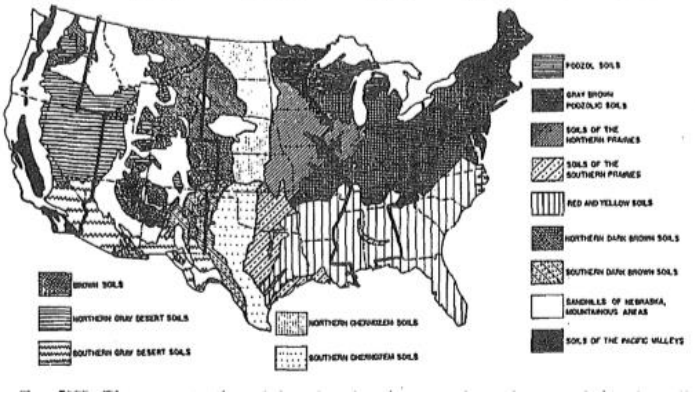
Albrecht's Dental Records

9.10	8.80	8.38	10.06	11.45	Cavities
6.40	4.30	3.70	4.89	6.10	Fillings
15.50	13.10	12.08	14.95	17.55	Total Caries



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Worn Out Soil And Childhood Ailments

Photo by Post

FIG. XIII. Human health goes with the soil and its fertility. Courtesy F.S.A. Scene from Wadesboro, N. C.

cattle market. That honor now rests on Kansas City. Even the hog market

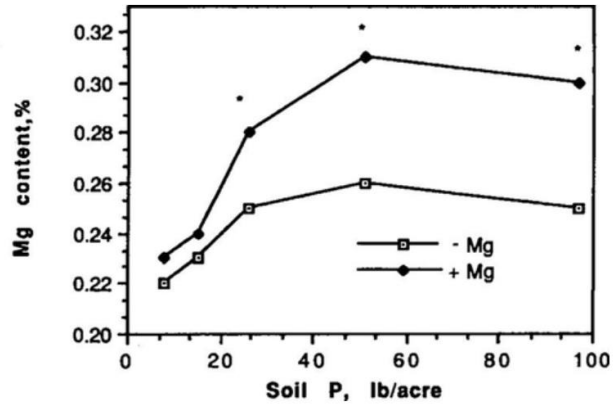
71

Connecting Ca/Mg, Soil Heath, and Wheat Quality-Sanborn Field

Plot	Ca	Mg	CP	Lysine	Methon.	Ca	Mg	K	P	S	Agg. Stab
	%	%					%				
3	71	11	13.8	0.39	0.33	0.06	0.14	0.46	0.39	0.14	20
25	78	13	13.3	0.37	0.21	0.05	0.14	0.43	0.35	0.14	29
26	63	9	11.9	0.33	0.19	0.05	0.14	0.44	0.35	0.13	13
28	70	8	11.7	0.33	0.19	0.05	0.13	0.46	0.36	0.13	16

72

Nutrients Are Often Tied To One Another-Mg Uptake is Dependent Upon P



73

How Soil P Affects Blood Serum of Lactating Cows

Treatment	Mg	Ca	K	P
		mg/dl		
Control-no P Fertilizer	1.47	7.52	26.4	4.90
Mineral Block-no P fertilizer	1.72*	7.63	26.6	6.05*
P Fertilizer Treatment-	1.72*	7.35	26.9	6.24*

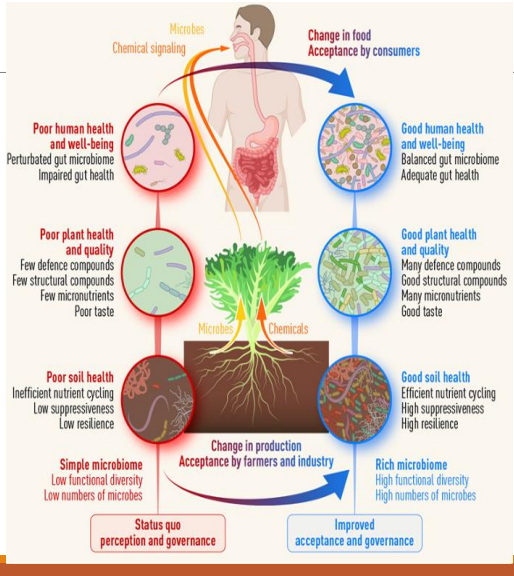
- **Indicates significant differences at the 0.05 level**

74

How Does Soil Biology Affect Human Health?

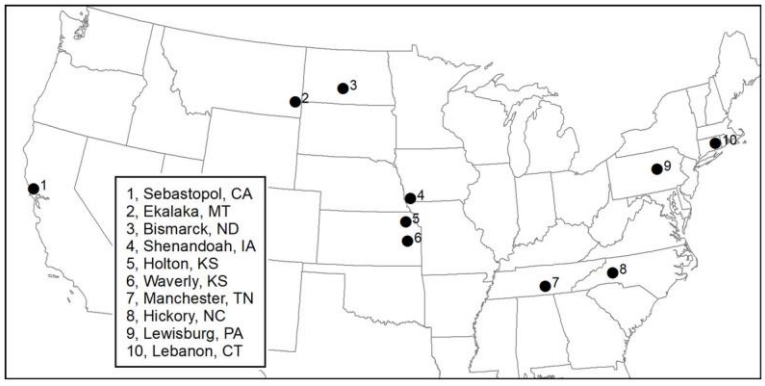
75

Improved Soil Biology Improves Human Health



76

A Study To Compare Regenerative Management Such As Cover Crops Vs Conventional Crops-David Montgomery and Ray Archuleta



Montgomery et al, 2022

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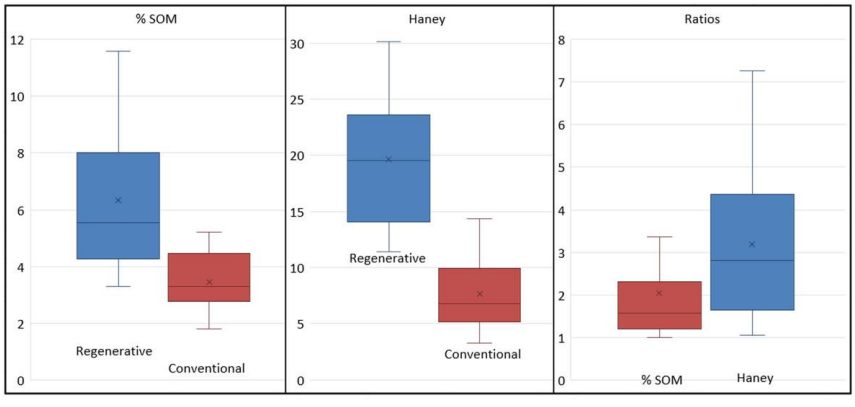
Comparison of Soil Organic Matter and the Haney Soil Health Index In Conventional and Regenerative Systems



Montgomery et al, 2022

78

Wheat: Cover Crop vs No Cover Crop after Several Years

Nutrient	Regenerative Cover Crop	No Cover Crop
	ppm	ppm
B	0.90*	0.64
Mg	1439*	1112
K	7219*	5750
Mn	50.96*	37.66
Fe	40.78	34.10
Cu	2.56	2.17
Zn	18.99*	12.21
Mo	0.220*	0.053

*significantly different from the no cover crop at the 0.05 level

Montgomery et al, 2022

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Beef Fatty Acid Composition

Fatty Acid	Regenerative	Conventional	Ratio
	g/100 g	g/100 g	
Total Omega-3	0.1056	0.0358	2.9
Total Omega-6	0.1416	0.2216	0.6
Omega-6/Omega-3	1.3140	6.1933	0.2

Montgomery et al, 2022

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Conclusions

Soil Nutrients Levels Affects Soil Microorganisms and Soil Structure

The Albrecht System Improves Soil Microorganisms and the Soil Structure-Soil Health

This Improves Water Infiltration and Reduces Soil Runoff

Improving Soil Health Results In Better Nutrient Density of Food

A Healthy Soil=A Healthy Plant=Healthy Animal (People) Just Like Dr. Albrecht Said that it Would.