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Humic Contents of US Topsoils

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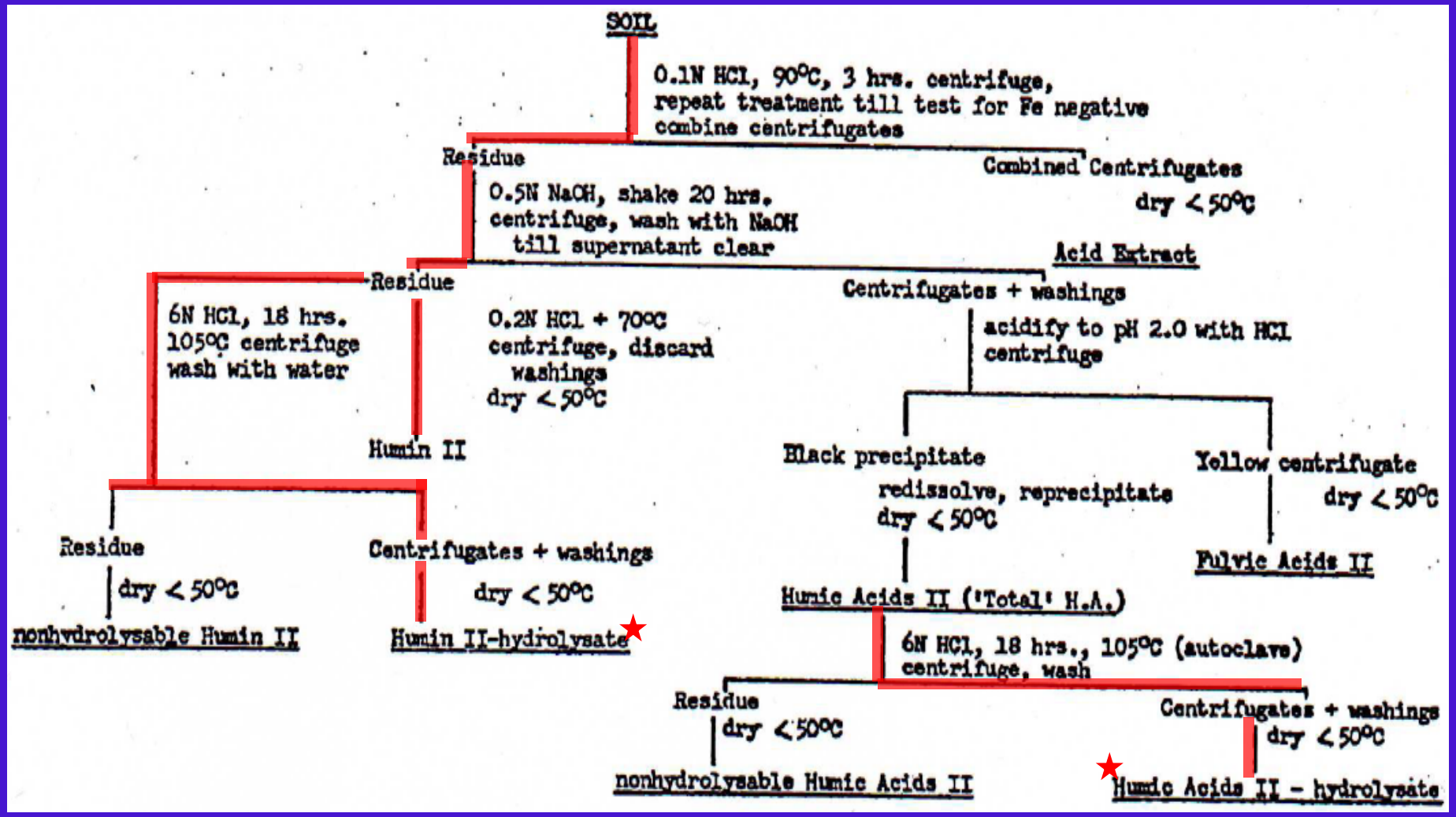
Applicability of the Carbon-dating Method of Analysis to Soil Humus Studies
Campbell et al, Soil Sci., 1967, 104, 217-224.



Applicability of the Carbon-dating Method of Analysis to Soil Humus Studies

Campbell et al, Soil Sci., 1967, 104, 217-224.

Mean residence time (m.r.t.) and distribution of carbon among the fractions resulting from the hydrolysis of Humic Acids II and Humin II of the Melfort soil

Fraction	% of Total Carbon	m.r.t. (yr.)
Humin II	30.8	1140 ± 50
Nonhydrolyzable Humin II	23.5	1230 ± 60
Humin II-hydrolysate	7.3	465 ± 50
Humic Acids II (“total”)	40.3	1235 ± 60
Nonhydrolyzable Humic Acids II	33.2	1400 ± 60
Humic Acids II-hydrolysate	7.1	25 ± 50

SOM

Two SOM pools

1. Labile crop waste – energy source for microbes – short-lived
2. Humic acids and fulvic acids – long-lived

Baseline of SOM and of CO_2 sequestration

% Loss on ignition is 1 + 2, a temporary number

LOI

Slow Metal Release

Metal-HS (M = Fe(III), Cu(II), Ni(II), Eu(III)) Complexes

Dissociation rates are low, increase with decreasing pH

Lavigne JA, Langford CH. Mak MKS. *Anal. Chem.* 59: 2616-2620 (1987)

Hering JG, Morel FMM. *Environ. Sci Technol.* 24: 242-252 (1990)

Cabaniss SE. *Environ. Sci Technol.* 24: 583-588 (1990)

Rate AW, McClaren RG, Swift RS. *Environ. Sci Technol.* 27: 1408-1414 (1993)

King SJ, Warwick P, Hall A, Bryan ND. *Phys. Chem. Chem. Phys.* 3: 2080-2085 (2001)

Analytical Protocol

Av 4 g soil sample dried at 110°C overnight.

1) Four 24-hr treatments with 125 mL of 0.1 M HCl
Shake in horizontal 250 mL centrifuge bottle @ 100 rpm and 20°C
Centrifuge @ 11,000 rpm for 30 min.

2) Two 24-hr washes with 125 mL of water. Centrifuge @ 11,000 rpm for 30 min.

3) Two 24-hr extractions with 100 mL of 0.1 M NaOH
Centrifuge @ 11,000 rpm for 30 min, **double bottle technique**.
Lower supernatant pH to 1.6

4) Let stand for 24 hr, decant FA, analyze from spectrum.

5) Wash HA gel two times with water (centrifuge 20 min @ 2,000 rpm).
Dry gel at 110°C overnight. Weigh solid HA on microbalance.

Recovery

3 highly purified HAs stored for > 10 years

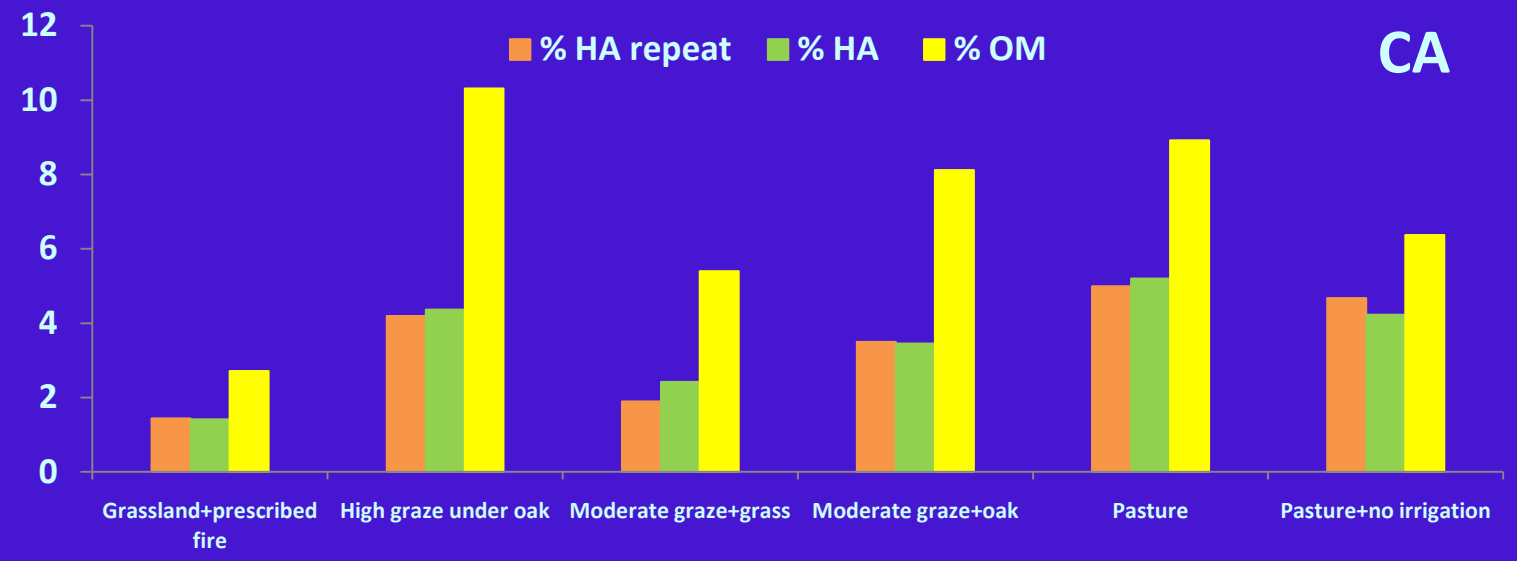
GHA NHA NYHA

Recovery

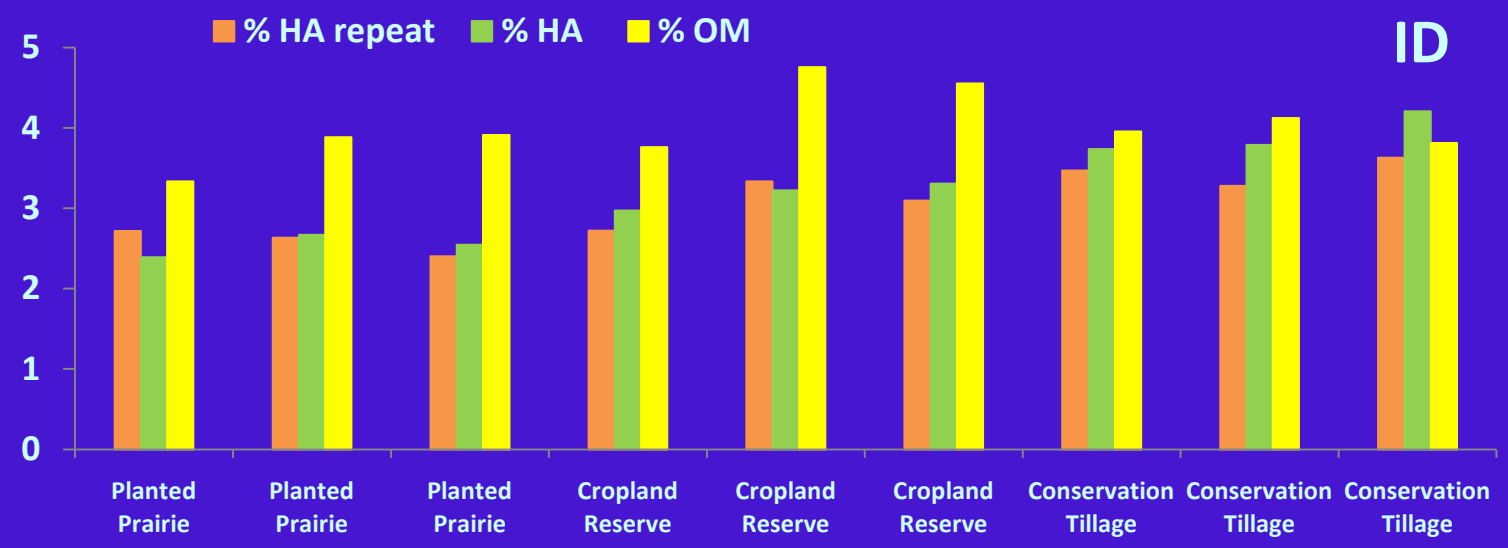
At end of protocol, av 75% soluble, rest is polymerized.

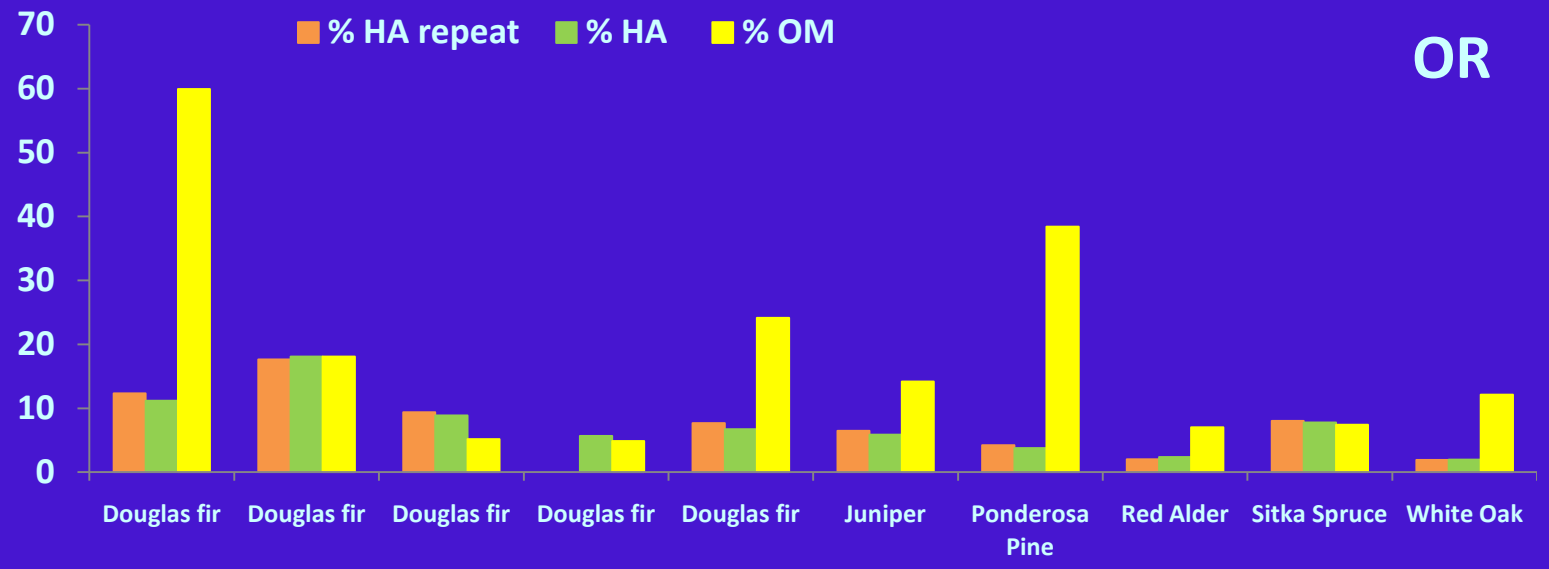
Average recovery 12 replicates is 98 ± 4%.

250mL
PYREX
2
5
6
13
14
17
No. 1000
PARAFILM
H 7

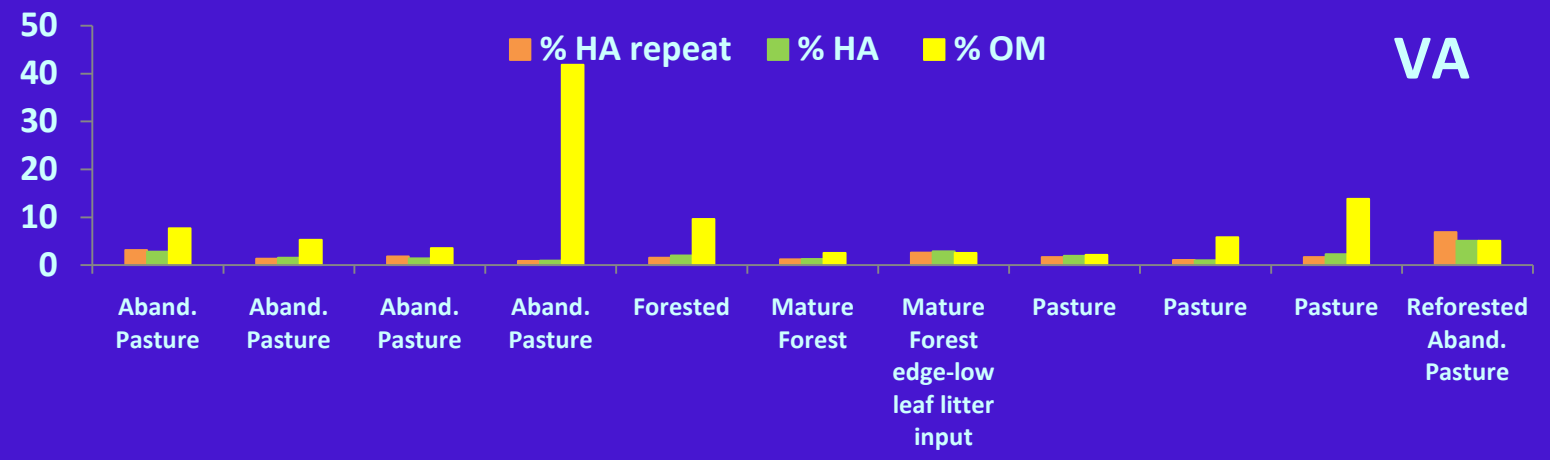

CA
% HA repeat
% HA
% OM
12
10
8
6
4
2
0
Grassland+prescribed fire
High graze under oak
Moderate graze+grass
Moderate graze+oak
Pasture
Pasture+no irrigation

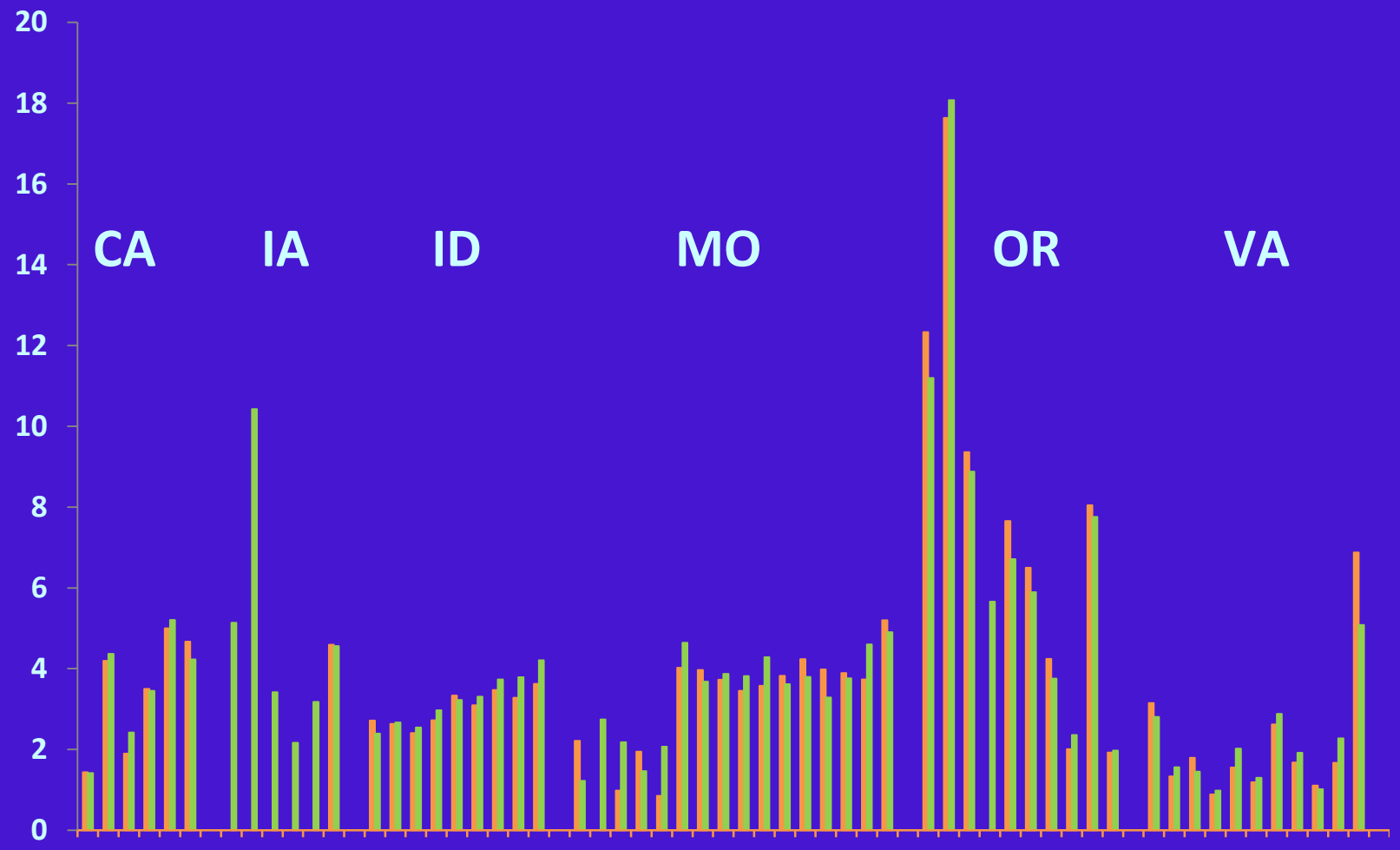
IA
% HA repeat
% HA
% OM
12
10
8
6
4
2
0
Prairie
Prairie
Tilled Corn
Grass
Grass
Grass


% HA repeat
% HA
% OM
ID
5
4
3
2
1
0
Planted Prairie
Planted Prairie
Planted Prairie
Cropland Reserve
Cropland Reserve
Cropland Reserve
Conservation Tillage
Conservation Tillage
Conservation Tillage

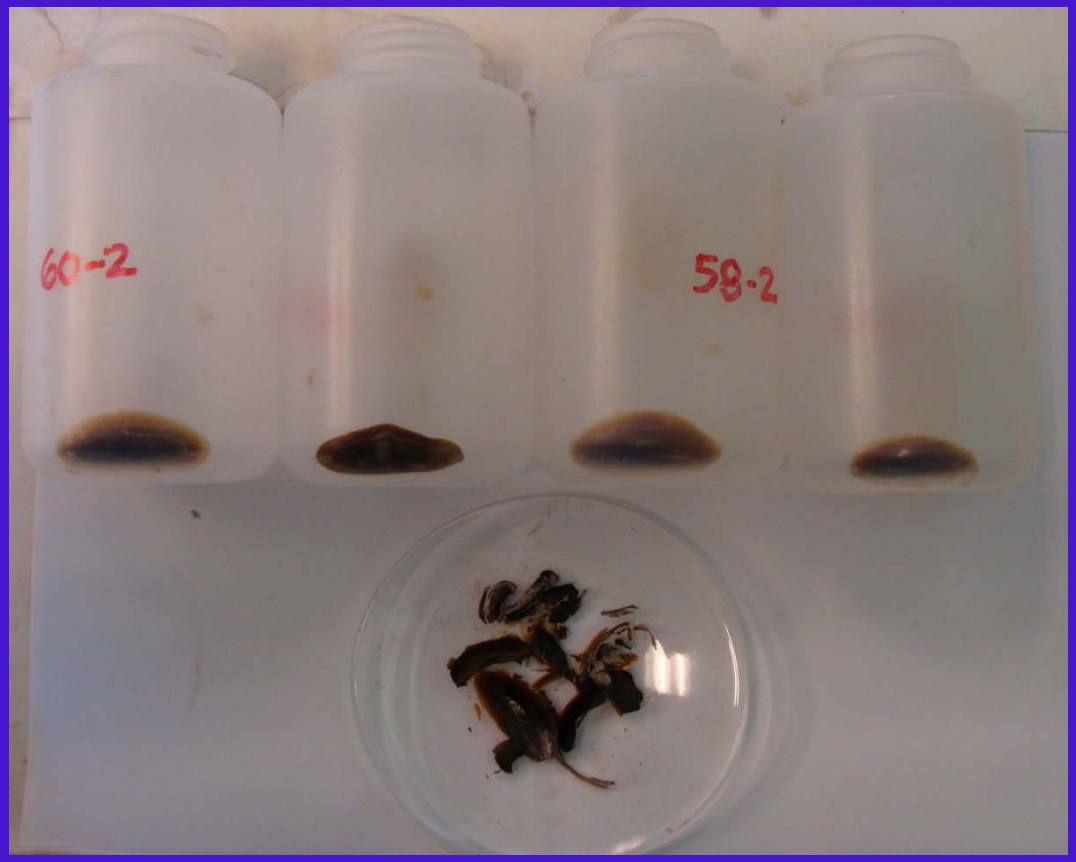

% HA repeat
% HA
% OM
OR
70
60
50
40
30
20
10
0
Douglas fir
Douglas fir
Douglas fir
Douglas fir
Douglas fir
Juniper
Ponderosa Pine
Red Alder
Sitka Spruce
White Oak

MO
% HA repeat
% HA
% OM
6
5
4
3
2
1
0
Tilled
No-till
Tilled
Tilled
Tilled
No-till
No-till
No-till
Tilled
Tilled
Tilled
Tilled
Tilled
Tilled
Tilled
No-till

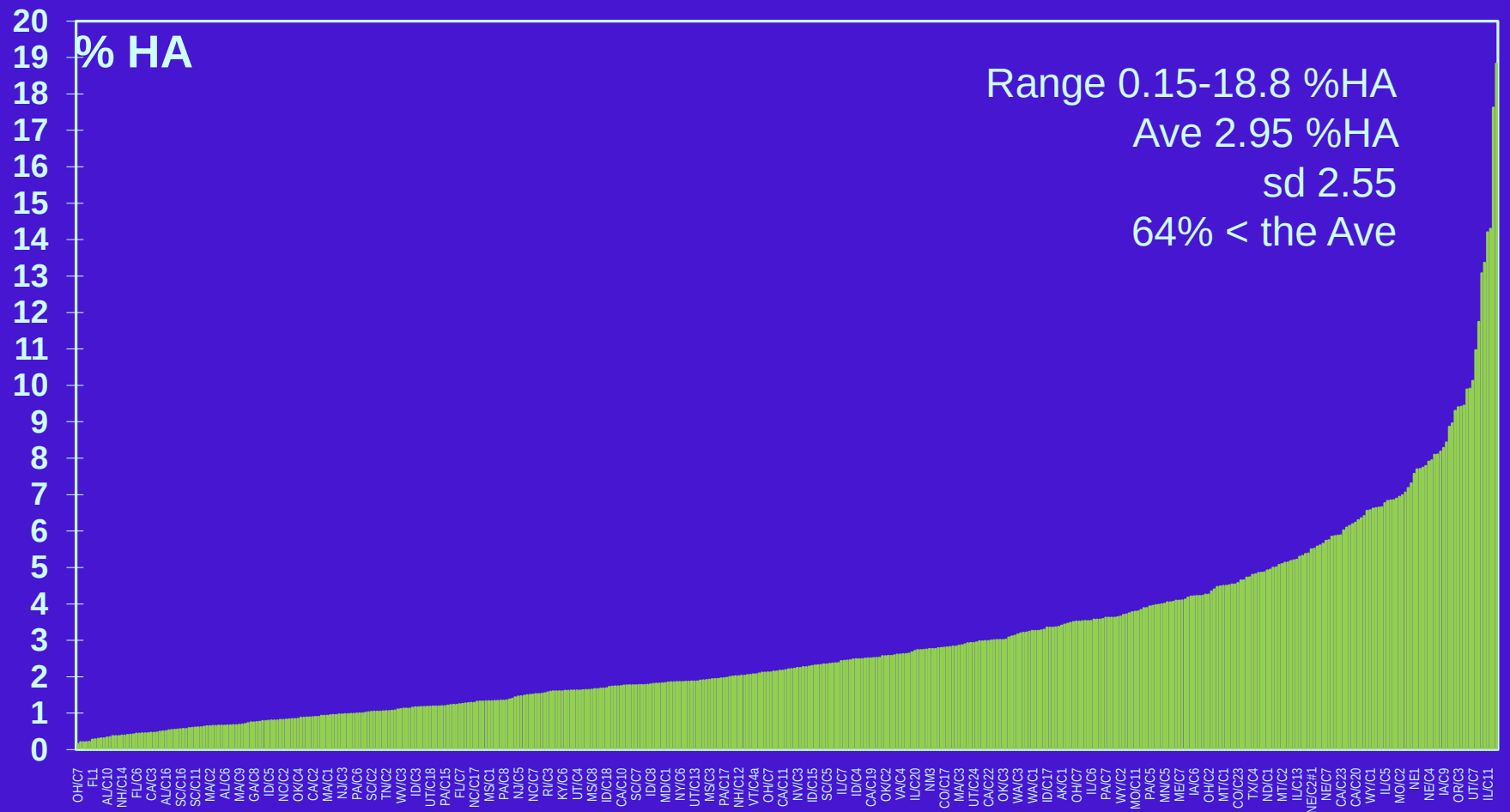

VA
% HA repeat
% HA
% OM
50
40
30
20
10
0
Aband. Pasture
Aband. Pasture
Aband. Pasture
Aband. Pasture
Forested
Mature Forest
Mature Forest edge-low leaf litter input
Pasture
Pasture
Pasture
Reforested Aband. Pasture


20
18
16
14
12
10
8
6
4
2
0
CA
IA
ID
MO
OR
VA

Humin Yields from Missouri Soils



Sample	%HU
44-4	4.0
48-4	3.8
49-1, 49-4	4.2, 4.1
51-3	1.0
53-1, 53-3	2.2, 2.6
54-1, 54-2	2.4, 3.0
55-2	1.1
56-2	1.1
57-1, 57-2	2.0, 2.1
58-1, 58-2, 58-3	2.6, 2.4, 2.5
59-3	2.5
60-1, 60-2	2.9, 2.5


% HA
Range 0.15-18.8 %HA
Ave 2.95 %HA
sd 2.55
64% < the Ave
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
OH/C7
FL1
AL/C10
NH/C14
FL/C6
CA/C3
AL/C16
SC/C16
SC/C11
MA/C2
AL/C6
MA/C9
GA/C8
ID/C5
NC/C2
OK/C4
CA/C2
MA/C1
NJ/C3
PA/C6
SC/C2
TN/C2
WV/C3
ID/C3
UT/C18
PA/C15
FL/C7
NC/C17
MS/C1
PA/C8
NJ/C5
NC/C7
RI/C3
KY/C6
UT/C4
MS/C8
ID/C18
CA/C10
SC/C7
ID/C8
MD/C1
NY/C6
UT/C13
MS/C3
PA/C17
NH/C12
VT/C4a
OH/C7
CA/C11
NV/C3
ID/C15
SC/C5
IL/C7
ID/C4
CA/C19
OK/C2
VA/C4
IL/C20
NM3
CO/C17
MA/C3
UT/C24
CA/C22
OK/C3
WA/C3
WA/C1
ID/C17
AK/C1
OH/C7
IL/C6
PA/C7
WY/C2
MO/C11
PA/C5
MN/C5
ME/C7
IA/C6
OH/C2
MT/C1
CO/C23
TX/C4
ND/C1
MT/C2
IL/C13
NE/C2#1
NE/C7
CA/C23
CA/C20
WY/C1
IL/C5
MO/C2
NE1
NE/C4
IA/C9
OR/C3
UT/C7
IL/C11

Conclusions

- The analytical methods are potential standards
- The baseline HA and FA contents of soils need to be built up
- Need more samples (577 to date)
- 3140 Counties

Acknowledgements

Donors from 50 US States
Maxine Levin
Chris Smith
Cindy Stiles
Larry West