Residue quality does not influence C and N stabilization.

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Introduction

- Soil fertility degradation and restricted availability of affordable inputs in sub-Saharan Africa requires optimization of all available organic and mineral fertilizers.
- Residue quality influences short-term C and N dynamics, but effects on long-term fates of C and N are unknown.
- Long-term C and N stabilization is affected by soil structure and aggregation, with new C preferentially stabilized in macroaggregates (M) and microaggregates within macroaggregates (mM).
- Soil aggregate dynamics are controlled by various factors including soil texture and plant growth, and may be influenced by input quality.
- To manage diverse inputs for long-term soil organic matter stabilization, the link between input quality and soil structural dynamics needs to be understood.

Hypothesis

Input quality influences soil aggregation and hence controls C and N stabilization.

Methods

Study Sites

- Embu: clay soil (3% sand, 75% clay, 2.9% total C, 0.3% total N)
- Machanga: loamy sand (80% sand, 13% clay, 0.3% total C, 0.02% total N)
- Bimodal rainfall with 2 cropping seasons per year

Field Design

- Split-split plot design with 3 blocks
- Main plot: Residue application at 4 Mg C ha^{-1} yr^{-1} (no input control, maize stover, *Calliandra* or *Tithonia*; see Table 1)
- Sub plot: N Fertilizer (0 or 120 kg N ha^{-1} $season^{-1}$)
- Sub plot: Cropping (bare, or cropped with maize)
- Trials initiated in March 2002, soil samples collected March 2005 from 0-15 cm

Sample Fractionation

- 100 g of air-dried soil was wet-sieved to isolate stable physical aggregate fractions and macroaggregates were further separated as indicated in Figure 1
- Subsamples of each soil fraction were ground and analyzed for C and N

Table 1. Quality parameters of organic residues.

Organic residue	C	N	C:N	Lignin	Polyphenol	Quality Class[a]
	%			%		
Tithonia diversifolia	38	3.2	13	8.9	1.7	I
Calliandra calothyrsus	44	3.3	13	13.0	9.4	II
Zea mays - Embu	40	0.7	59	5.4	1.2	III
Zea mays - Machanga	40	0.8	59	5.7	1.2	III

[a]Quality classes according to the Organic Resource Database of Palm et al. (2001).

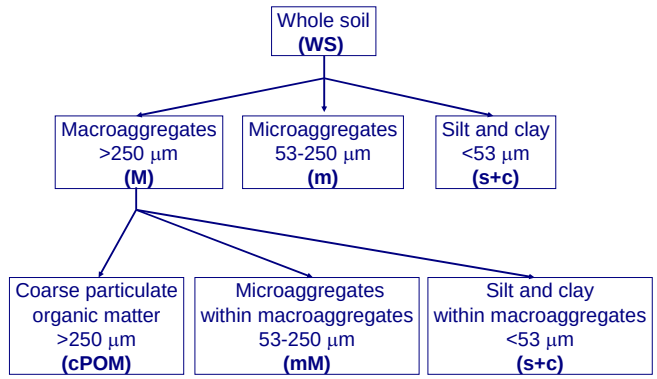

Figure 1. Diagram of isolated soil aggregate fractions.

Key Findings

Table 2. Aggregate size distribution response to residue inputs and cropping at Embu and Machanga.

Main effect	Embu			Machanga		
	M	m	s+c	M	m	s+c
	% of whole soil					
Residue						
Control	63.6b	30.8a	5.6	24.5	66.2	9.3
Maize	71.0a	24.3b	4.6	25.4	65.8	8.8
Calliandra	70.4a	24.7b	4.9	23.9	67.2	8.9
Tithonia	70.5a	24.7b	4.8	27.1	63.6	9.4
Cropping						
Bare	68.8	25.8	5.5a	24.7b	65.1b	10.2
Cropped	69.0	26.5	4.6b	25.7a	66.3b	8.0

a-b Within each soil, main effect and size fraction, means followed by a different letter are significantly different (P<0.05).

Table 3. Carbon content of aggregate size fractions response to residue inputs and cropping at Embu and Machanga.

Main effect	Whole soil fractions				Macroaggregate fractions		
	WS	M	m	s+c	cPOM	mM	s+cM
	g C kg^{-1} soil						
Embu							
Residue							
Control	26.0b	17.4b	8.1	1.7	0.6	12.9b	5.7
Maize	31.7a	23.7a	7.5	1.7	1.0	16.1a	8.2
Calliandra	32.3a	22.9a	7.7	1.7	1.0	15.7a	7.4
Tithonia	32.6a	23.6a	8.0	1.8	1.0	16.9a	7.9
Cropping							
Bare	29.7b	21.6	7.6	1.8a	0.8	15.1	7.1
Cropped	31.0a	22.2	8.1	1.6b	0.9	15.7	7.4
Machanga							
Residue							
Control	5.8	1.5	3.1	1.2	0.5b	0.4	0.3
Maize	5.0	1.3	2.6	1.1	0.4b	0.3	0.3
Calliandra	5.6	1.7	2.8	1.3	0.8b	0.3	0.3
Tithonia	7.8	2.9	3.6	1.1	1.2a	0.6	0.4
Cropping							
Bare	6.4	2.1	3.1	1.2	0.8	0.4	0.3
Cropped	5.7	1.6	3.0	1.2	0.7	0.4	0.3

a-b Within each soil, main effect and size fraction, means followed by a different letter are significantly different (P<0.05).

Summary of Results

- Patterns of N stabilization of aggregate size fractions were the same as C contents

Residue quality

- Adding residue increased formation of macroaggregates at Embu with no difference between qualities.
- Adding residue increased soil C and N in M and mM at Embu regardless of quality.

Nitrogen fertilizer

- Did not influence aggregation or C and N contents at either site, except to increase N content of the s+c (data not shown).

Cropping

- Cropping resulted in a small increase in aggregation at both sites.
- Cropping increased whole soil C at Embu.

Treatment interactions

- There were no consistent interactions between the residue, fertilizer or cropping treatments for soil aggregation or C and N contents at either site.

Conclusions

- Input quality does not affect long-term stabilization of soil organic C and N, only increased C inputs lead to long-term stabilization.
- To manage inputs for the long-term maintenance of soil organic matter, organic residues should be applied regardless of their quality.
- From a residue management standpoint, we recommend the use of the best residue quality and fertilizer combination to enhance short-term N release benefits. Less consideration is needed for long-term benefits of residue management as these are not affected by residue quality.

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