Mitigation options through manure management?

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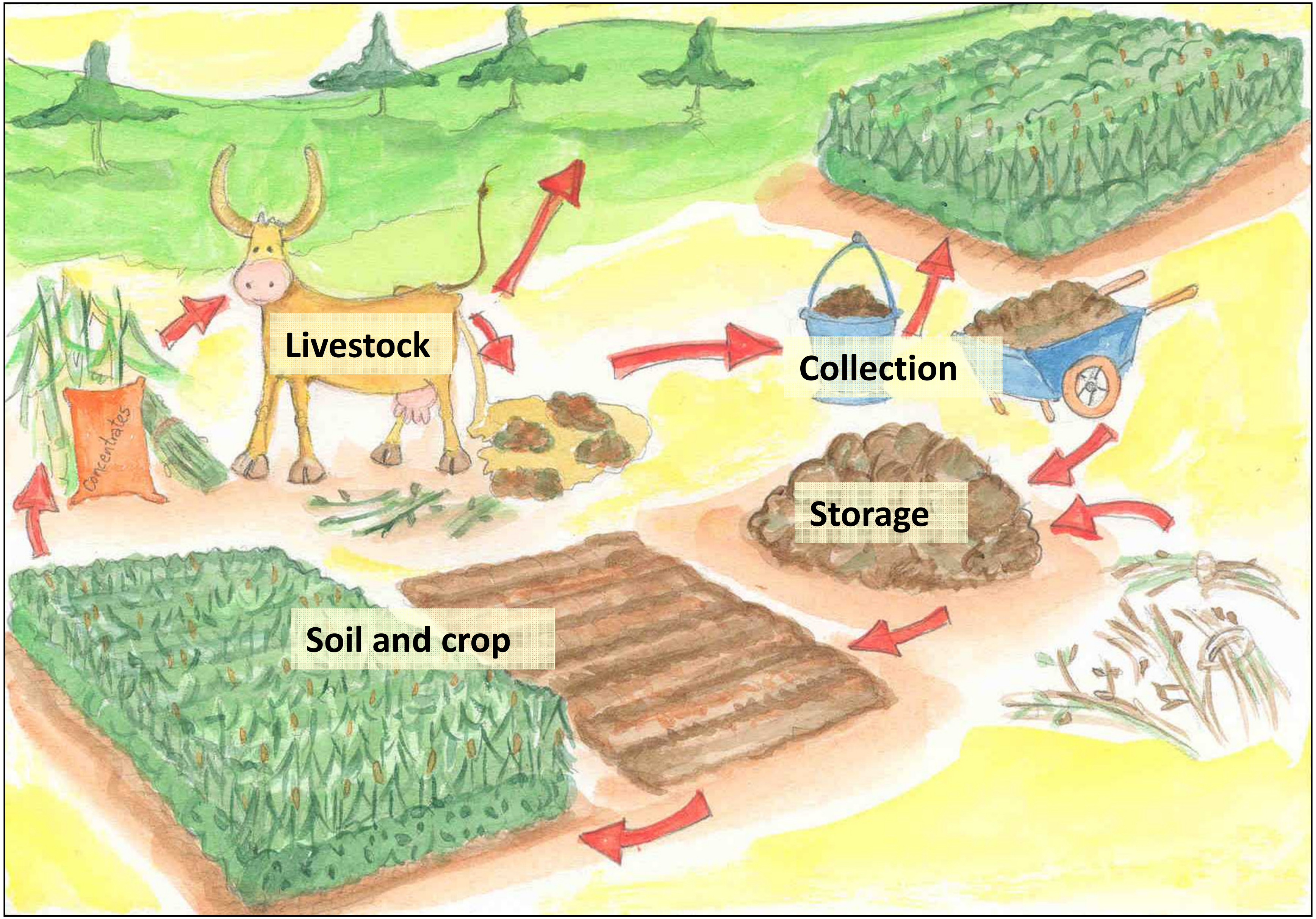
Conclusions:

Yes, there are *opportunities for mitigation* through manure management

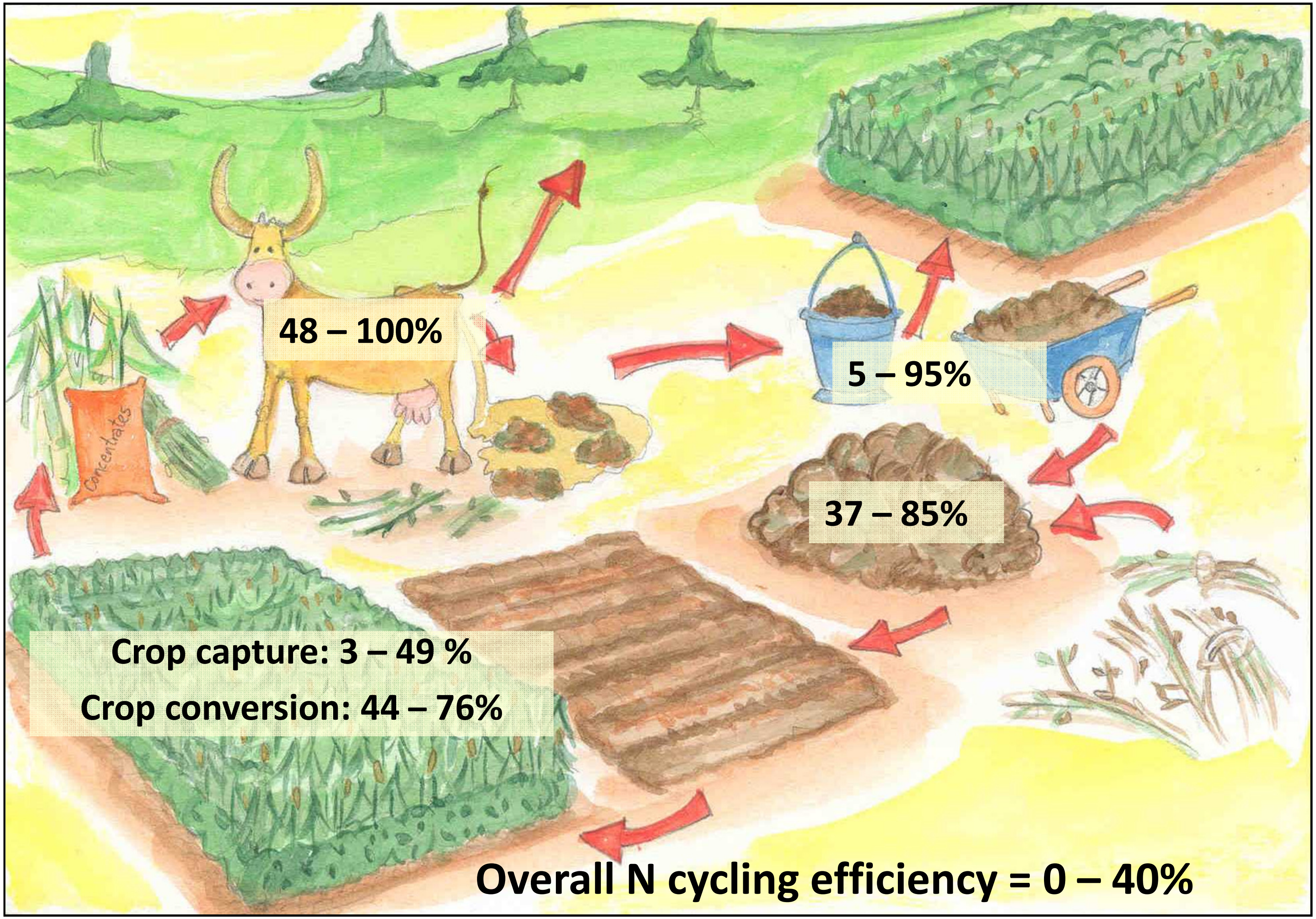
Farmers might not be interested in improving manure management because there is *no added value*

Incentives may be needed so that manure management practices become *mitigation options*



Crop-livestock integration: farm scale

Nitrogen cycling efficiencies = output/input



Rufino et al. 2006 AAE 112, 261-282

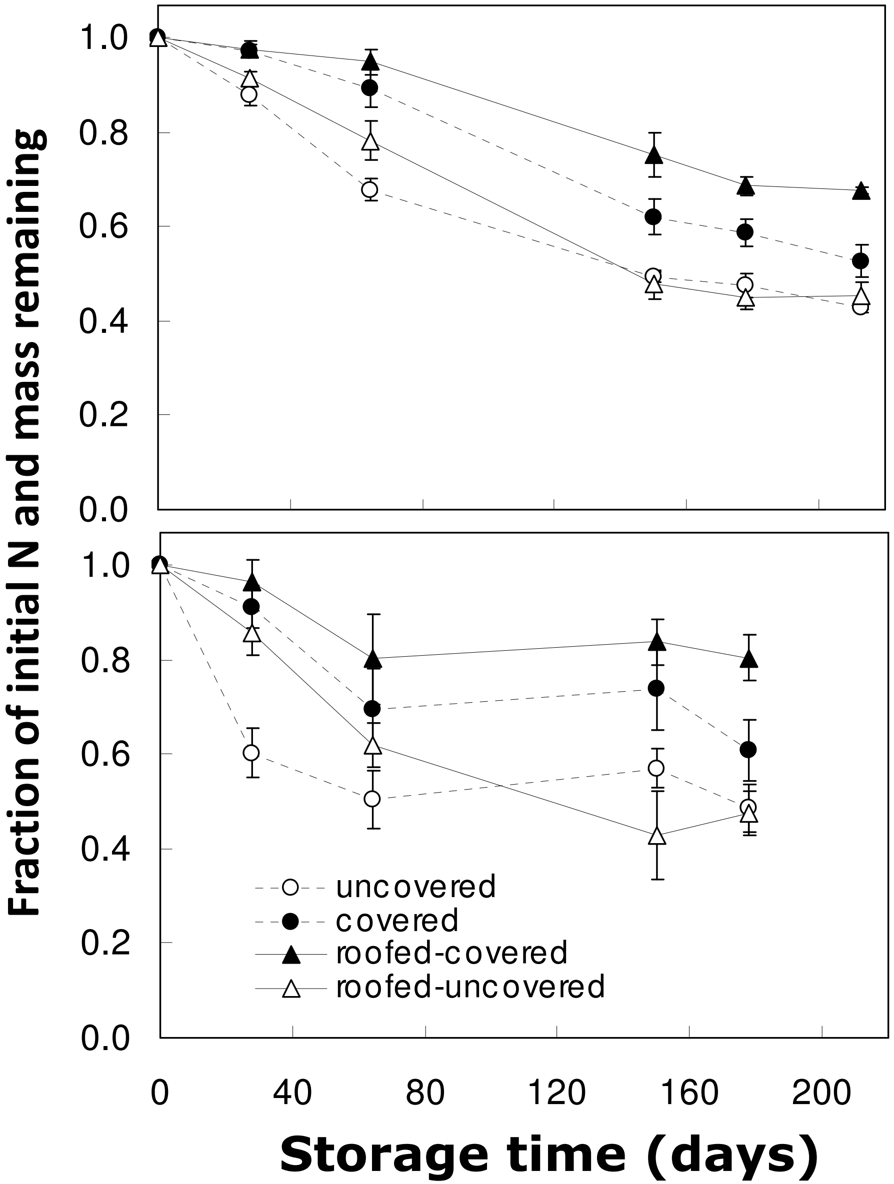
Table 4: N recovery efficiencies during handling and composting of N from manure (faeces with or without addition of straw, urine or feed refusals) from Friesian steers in Central Kenya. After Lekasi et al. (2001).

Manure type	N fresh manure[a] (kg)	N after storage[b] (kg)	Handling efficiency	Compost N[c] (kg)	Composting efficiency	Overall efficiency
Faeces, urine + straw (1:0.6)	3.73	3.65	0.98	3.18	0.87	0.85
Faeces + straw (1:1)	2.93	2.50	0.85	1.85	0.74	0.63
Faeces	1.90	1.45	0.76	1.13	0.79	0.59
Faeces, urine	2.88	1.83	0.63	1.55	0.85	0.54
Faeces + feed refusals	2.48	2.45	0.99	1.63	0.67	0.66
Faeces, urine + feed refusals (mixed manually)	3.60	2.28	0.63	1.40	0.61	0.39
Faeces, urine + feed refusals (mixed by cattle)	3.73	2.25	0.60	1.38	0.61	0.37

[a] Manure N contained in a heap as produced by 61 steers per day.
[b] Manure N as produced daily by one steer and accumulated over 61 days in a roofed concrete floored barn.
[c] Manure N after composting for 90 days.

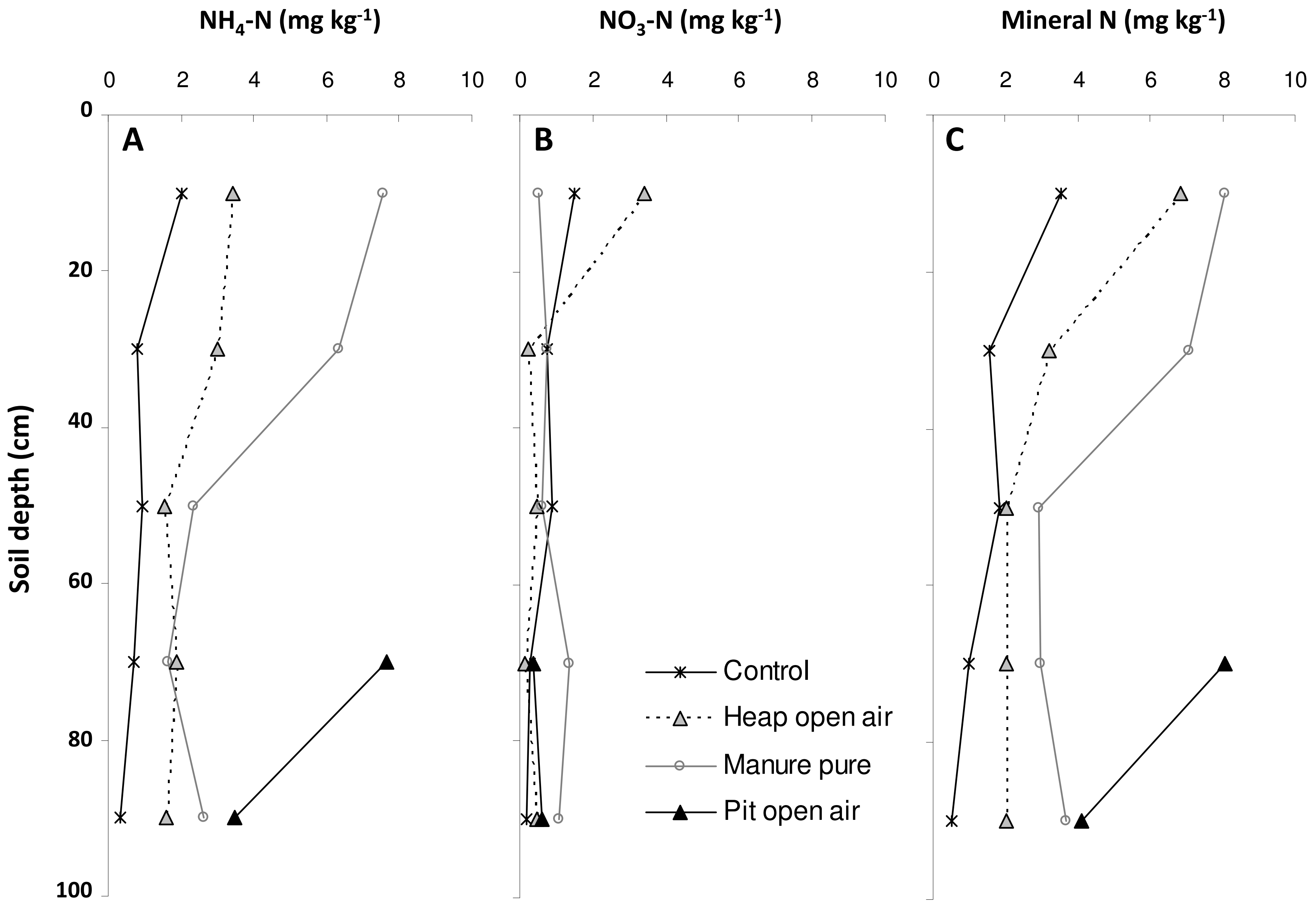
Central Kenya

Manure management is poor, especially during collection

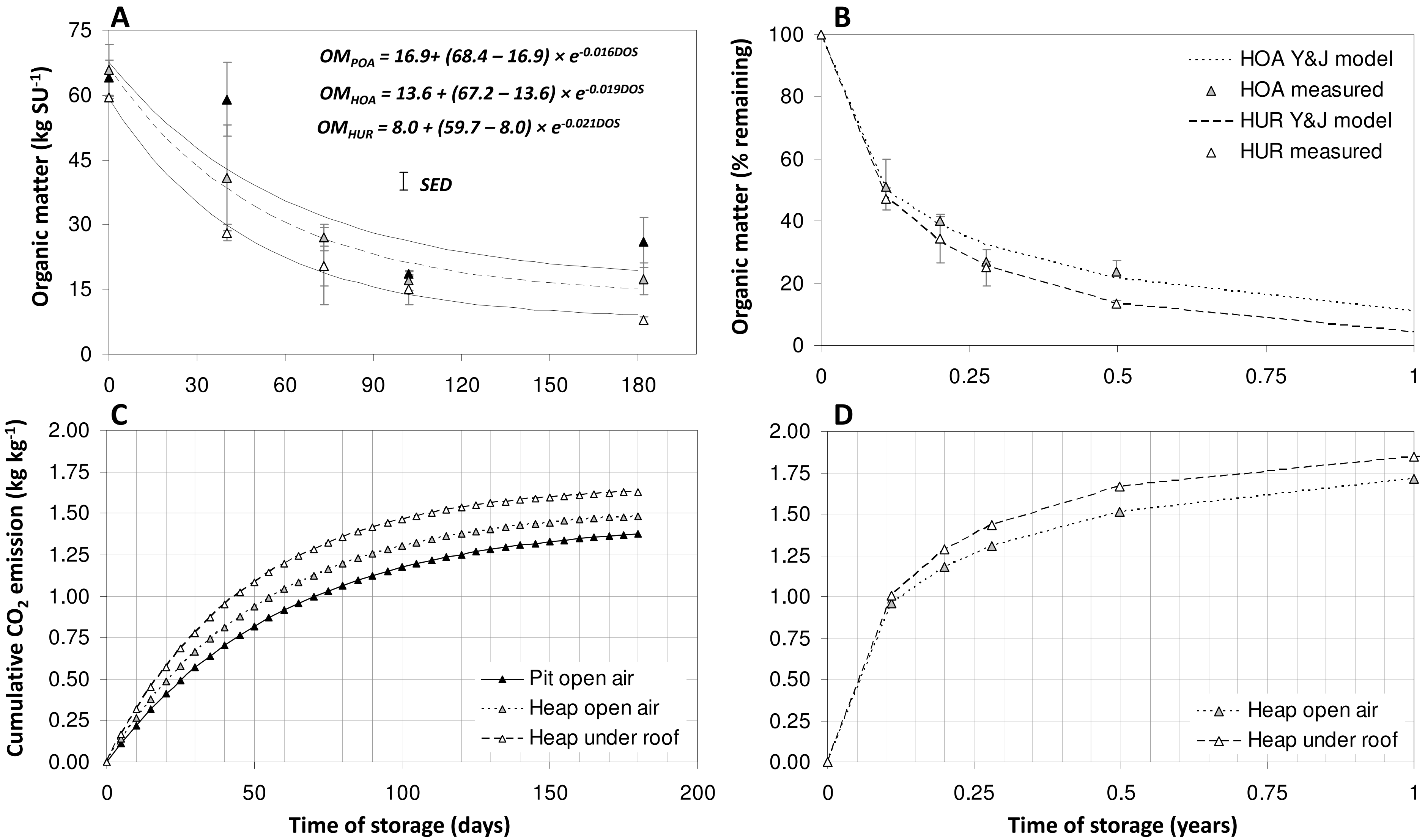


Rufino et al. 2007 Liv Sci 112, 273-287

Simple practices may reduce considerably mass and N losses



Tittonell, Rufino, Janssen, Giller, 2009 Plant & Soil 328: 253-269

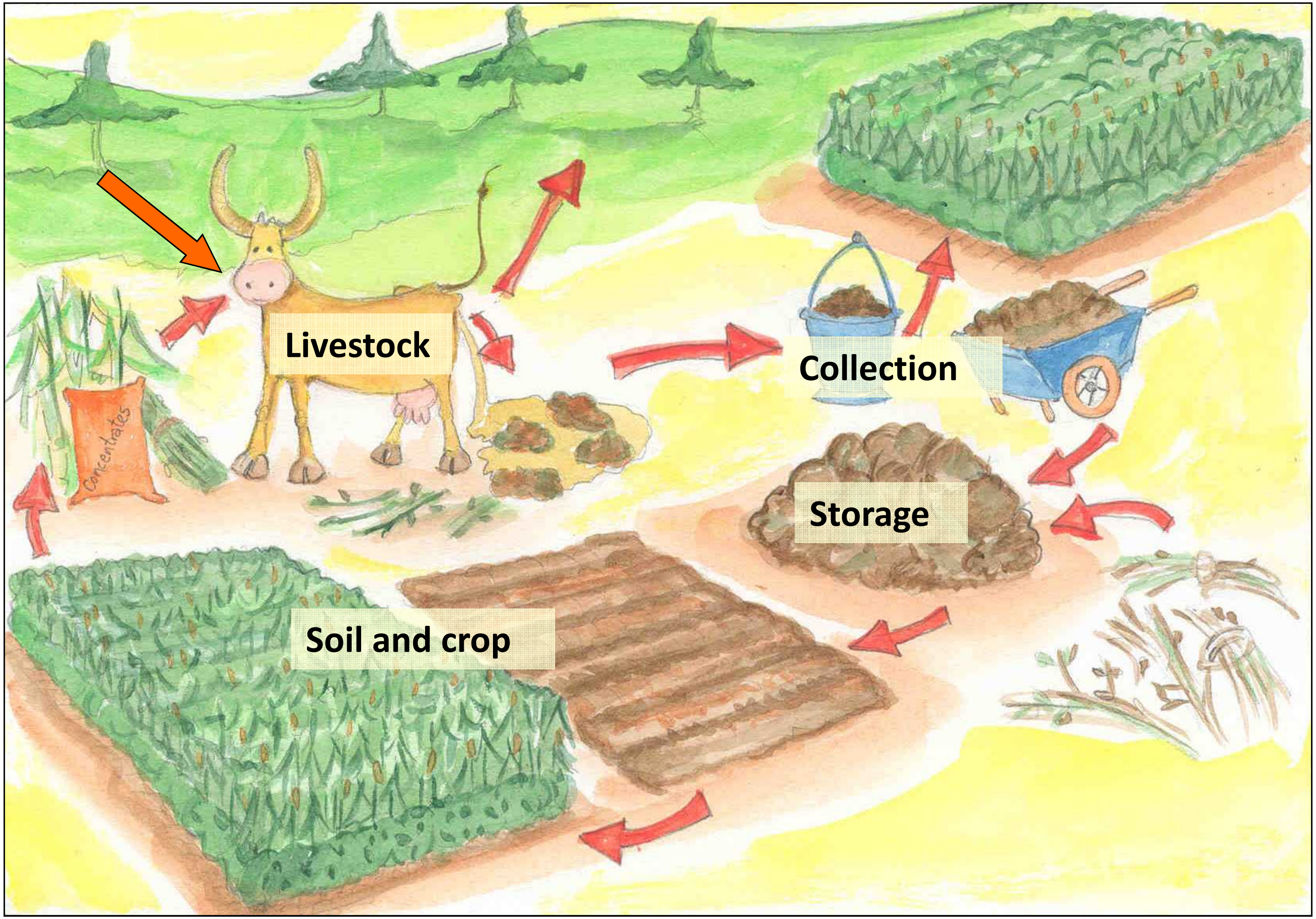


Tittonell, Rufino, Janssen, Giller, 2009 Plant & Soil 328: 253-269

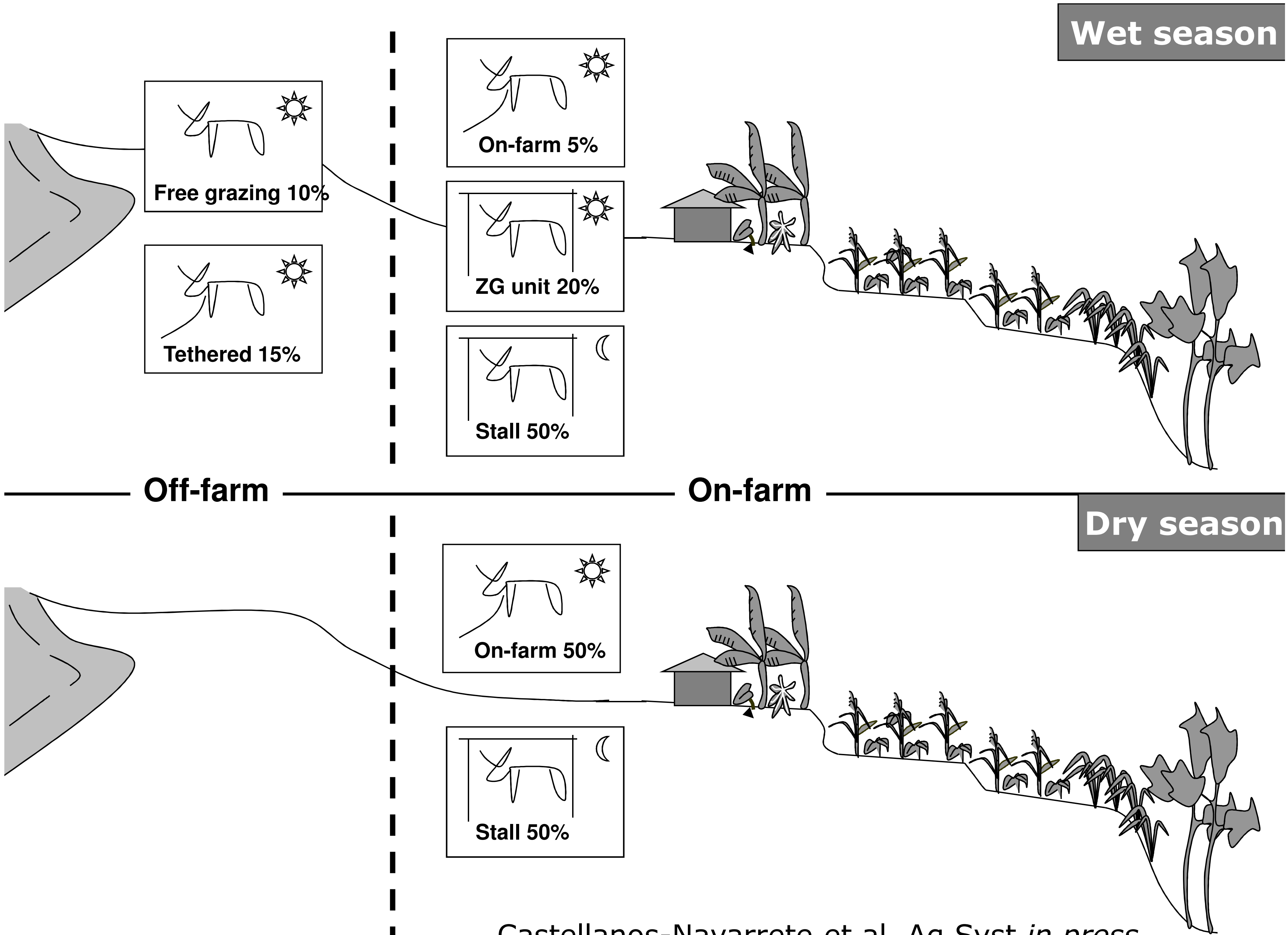
Wealthier farmer, Central Kenya

Western Kenya

Tethering and cut-and-carry feeding



Crop-livestock integration: not only farm scale



Castellanos-Navarrete et al. Ag Syst *in press*

Table 3. Cattle feeding system (percentage of days per year that cattle graze on grasslands or are fed by cut-and-carry systems per case study), cattle location (expressed as percentage of daily time spend by the cattle in a particular system per year), and diet composition per tropical livestock unit (TLU[a]) in order of importance. Name of the farmer and type within the cattle subsystem typology (I, II and III) are also included.

Farmer	Livestock subsystem typology[a]	Cattle feeding system		Cattle location				Diet composition						
		Grazing	Cut & carry	Free-ranging	Tethered off-farm	Tethered on-farm	ZG unit	DM input (cut & carry)	Maize stover	Napier grass	Collected grassland species	Maize thinnings	Other feeds[c]	Dairy meal
		(% year)	(% year)	(% year)	(% year)	(% year)	(% year)	(kg DM TLU^{-1} s^{-1})	(% diet)	(% diet)	(% diet)	(% diet)	(% diet)	(% diet)
RUT	I	10	90	0	10	90	0	674	28	34	28	3	6	0
WIL	I	36	64	14	21	36	29	647	71	14	7	1	7	0
DOR	I	35	65	35	0	65	0	1097	59	9	24	5	3	0
JOA	I	16	84	16	0	84	0	2030	56	28	12	4	1	0
NAA	II	50	50	0	0	50	50	1149	76	13	5	5	1	0
RAP	II	47	53	11	29	7	53	1078	46	34	11	4	4	0
THO	II	0	100	0	0	100	0	714	47	30	14	4	6	0
VCT	II	22	78	0	4	43	53	768	11	51	23	10	6	0
SAR	III	20	80	0	0	20	80	1803	16	61	18	2	2	0
IUL	III	0	100	0	0	0	100	737	23	65	6	1	0	6

[a] TLU= Tropical livestock unit, animal of 250 kg body mass.
[b] Types are: Type I: low labour capital livestock subsystem; Type II: intermediate labour capital livestock subsystem; and, Type III: high labour capital livestock subsystem.
[c] Other feeds are constituted mainly by banana leaves (*Musa spp.*) but include other crop residues (e.g. *Saccharum spp.*, *Phaselous vulgaris*, *Vigna unguiculata*, *ipomea batata*,etc.) and tree prunings (e.g. *Sesbania sesban*, *Calliandra calothyrsus*).

Diversity across farms

Castellanos-Navarrete et al. Ag Syst *in press*

Table 4. Nitrogen cycling efficiencies (NCE) per season (s) for manure collection and storage, as well as for maize residue retention for case studies. Stall management, manure storage practices, name of the farmer and type within the cattle subsystem typology (I, II and III) are also included.

Farmer	Livestock subsystem typology[a]	Residues	Manure			Stall management					Manure storage					
		NCE_{res}[b]	$NCE_{collection}$[c]	$NCE_{storage}$[d]	$NCE_{overall}$[e]	Collection frequency	Stall type	Roof	Soil	Bedding	System type	Floor	Shadow	Cover	Turns	Period
	(type)					(days)	(type)	(type)	(type)	(Y/N)	(heap/pit/both)	(sand-solid /solid)	(Y/N/Partial)	(type)	(no.)	(months)
RUT	I	0.00	0.65	0.05	0.04	1	None	-	-	-	Heap	Sand-solid	N	Uncovered	0	12
WIL	I	0.00	0.20	0.44	0.09	7	Semi-open ZG	Metal	Soil	Y	Heap	Solid	Partial	Uncovered	0	6
DOR	I	0.15	0.42	0.14	0.06	3	None	-	-	-	Heap	Solid	Partial	Uncovered	0	12
JOA	I	0.00	0.74	0.35	0.26	3	None	-	-	-	Pit	Sand-solid	Partial	Branches	0	12
NAA	II	0.00	0.42	0.04	0.02	90	Semi-open ZG	Metal	Soil	Y	Pit	Sand-solid	Partial	Branches	1	12
RAP	II	0.10	0.57	0.13	0.07	1	Semi-open ZG	Wood	Soil	N	Heap	Sand-solid	Partial	Branches	1	12
THO	II	0.25	0.31	0.44	0.14	1	None	-	-	-	Heap	Solid	Y	Uncovered	1	6
VCT	II	0.93	0.53	0.58	0.31	1	Semi-open ZG	Metal	Wood	N	Heap	Sand-solid	N	Uncovered	0	6
SAR	III	0.24	0.44	0.16	0.07	1	Enclosed ZG	Metal	Wood	N	Heap	Solid	Y	Uncovered	1	12
IUL	III	0.55	0.84	0.19	0.16	1	Enclosed ZG	Metal	Concrete	N	Both	Solid	N	Uncovered	0	6

[a] Types are: Type I: low labour capital livestock subsystem; Type II: intermediate labour capital livestock subsystem; and, Type III: high labour capital livestock subsystem.

[b] NCE_{res} = mulched N/ harvested N.

[c] $NCE_{collection}$ = collected N/(Faecal N + Urinary-N).

[d] $NCE_{storage}$ = stored N/ collected N.

[e] $NCE_{overall}$ = NCE collection * NCE storage.

Manure management a consequence of feeding management

Castellanos-Navarrete et al. Ag Syst *in press*


North East
Zimbabwe

North East Zimbabwe

Rainy season

Dry season

North East Zimbabwe

Manure accumulates in the corrals for long periods, exposed to losses of nutrients and carbon

North East
Zimbabwe

Manure stored is a small
% of manure excreted!

In poor soils, addition of organic matter is key to produce grain

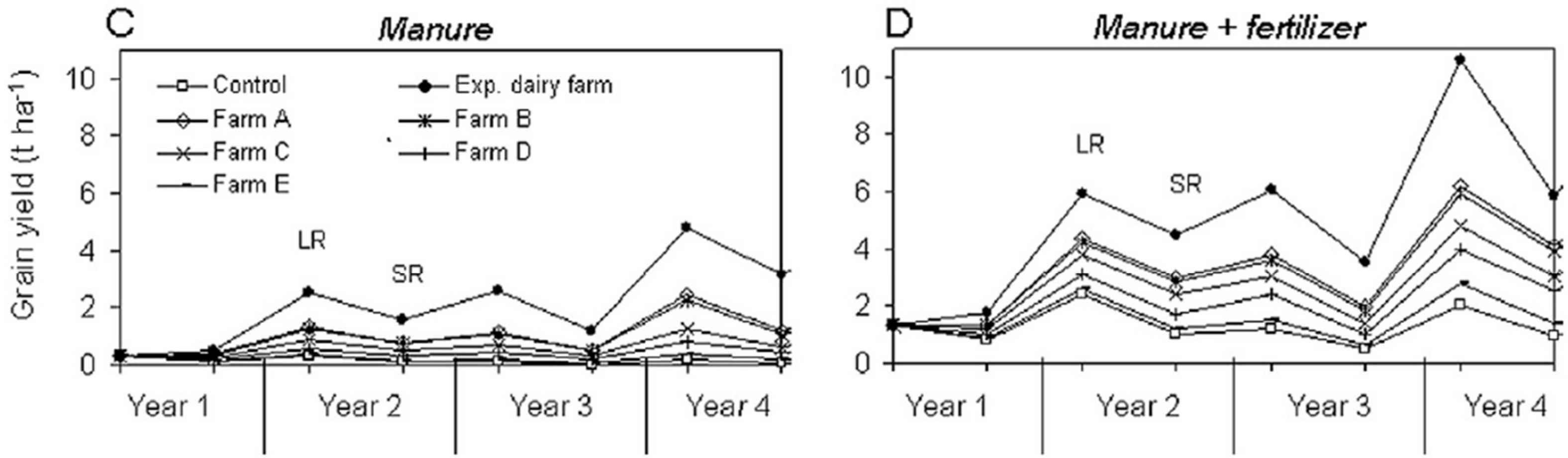


Fig. 7. Rehabilitation of nonresponsive fields (outfield at Aludeka) with application of 1.8 t dm ha^{-1} manure of different qualities (Table 3). Simulated aboveground maize biomass (A) and soil organic carbon (B) during a 12-yr period. Zooming-in on the first 4 yr of the simulation, grain yield increase with application of different manure types (C) and with manure plus a minimum fertilizer rate (32 kg N ha^{-1} and 23 kg P ha^{-1}) (D).

It takes a number of years to see response to manure applications

Tittonell et al. 2008 Agronomy Journal 100: 1511-1526

Challenges to study mitigation options:

Where do we measure emissions from manure management?

How do we report emissions from manure? Per head, per ha?

How do we promote manure managament practices with low emissions?

Good practices are not necessarily mitigation options!

Conclusions:

Yes, there are *opportunities for mitigation* through manure management

Farmers might not be interested in improving manure management because there is *no added value*

Incentives may be needed so that manure management practices become *mitigation options*

Thanks for your attention

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