GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

Current knowledge and challenges for measurement and estimation of nitrous oxide and methane emissions from manure

Todd Rosenstock | World Agroforestry Centre (ICRAF)

24.9.2012

Nairobi, Kenya

New Zealand Government

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Overview of emissions processes

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Emission	Process	Substrates	Controlling factors
Methane	Methanogenesis	H, C	O(-), pH, temperature
Nitrous oxide	Nitrification	NH_4^+	O(+)
	Denitrification	NO_3^-	O(-), C

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Manure emissions are a relatively small fraction of the total annual emissions

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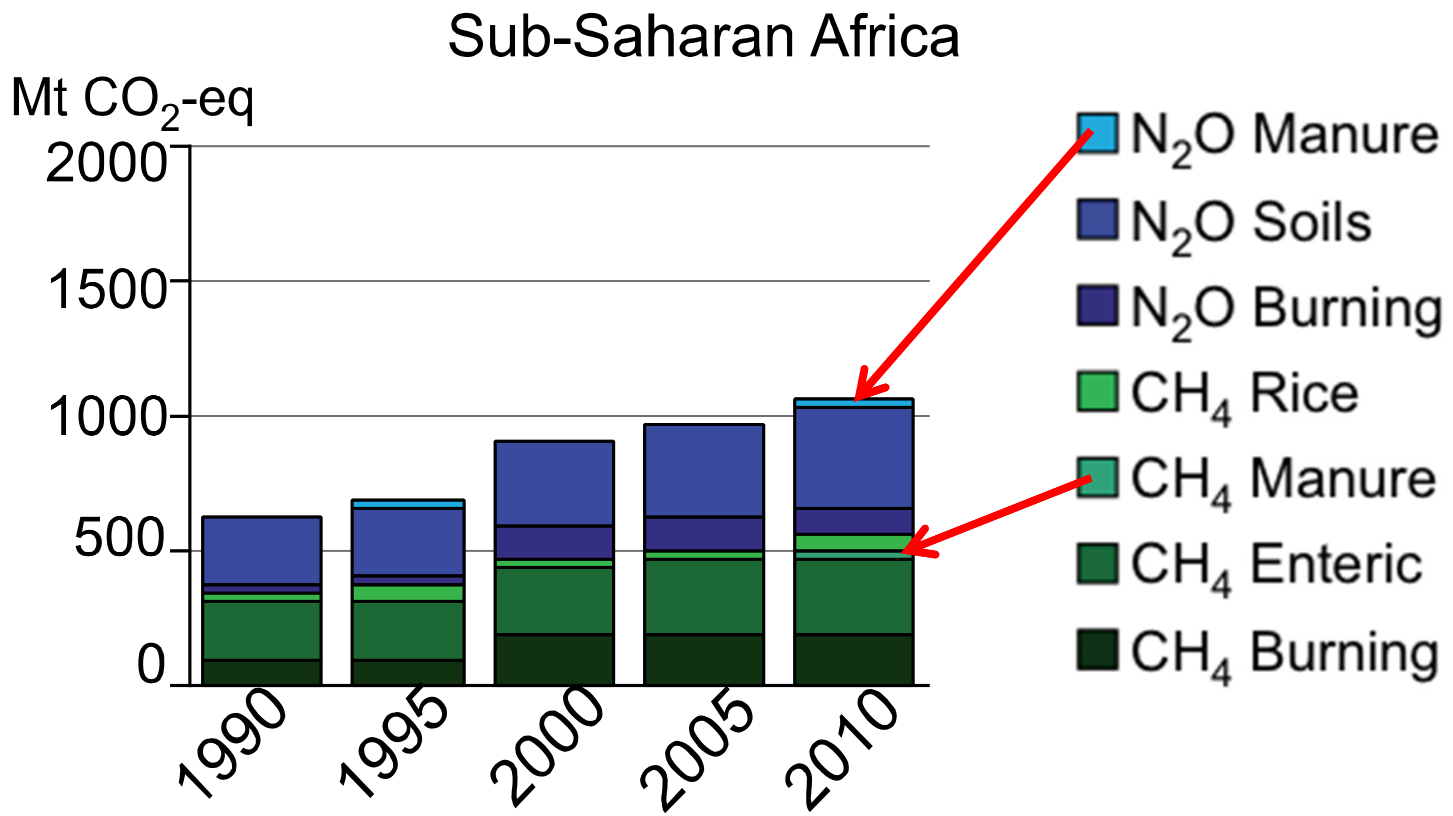

Adapted, Smith et al. 2007

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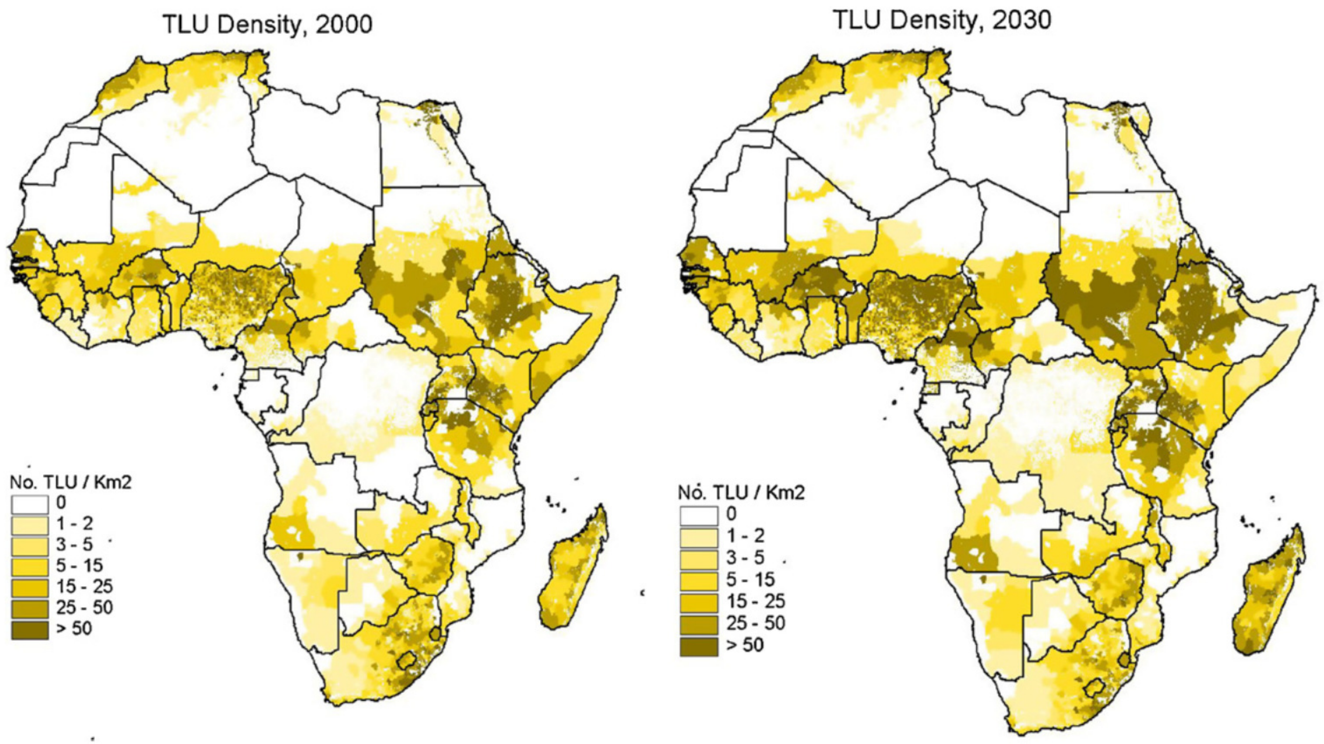
There will be more manure in the future than today



Herrero et al. 2008

What do we know about emissions from manure in Africa?

What do we know about emissions from manure in Africa?

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- **Very few studies**
  - Short duration
  - Uncoordinated
- **Infer from other regions**
  - Different agroecologies
  - Different production systems
- **Relevant or appropriate?**

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When thinking about manure most people start here

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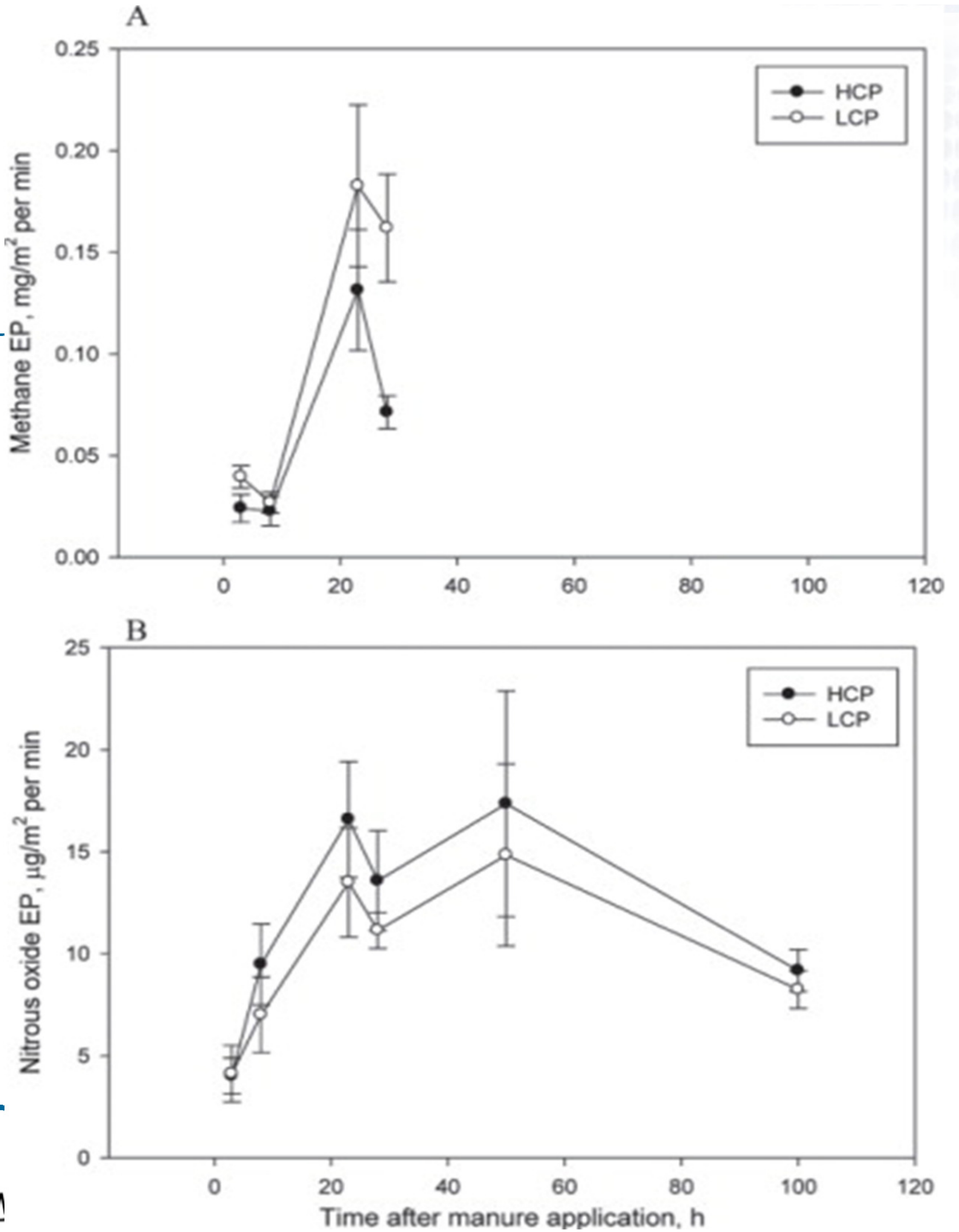
But really they should start here…

…manure emissions start with feed

Diet affects emissions potential of manure

Animals fed higher rates of crude protein have greater potential emissions of both gases



Lee et al. 2012

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Feedstock heterogeneity

Feeds vary in properties

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Characteristics of select dairy feeds in Kenya

Constituents	Feeds						
	Pastures	Napier	Lucerne	Vetch	Desmodium	Stover	Dairy meal
DM	294	175	189	157	172	889	913
CP	65	69	186	223	165	49	169
NDF	704	684	437	320	492	724	483
ADF	342	339	361	341	342	366	236
LIGNIN	42	443	66	52	62	54	38.5

DM= dry matter; CP= Crude protein; NDF= neutral detergent fibre; ADF= acid detergent fibres, ADL= acid detergent fibre,

Kiragu et al. 2003

Characteristics of manure in Africa

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Manure type	% N (range)	% P (range)	% K (range)	% C	C/N	Reference
Cattle manure	1.4 (0.5-2)	0.6 (0.2-1.6)	1.3 (0.5-2.7)	35	25	Lekasi et al., 2001a, Kenya
Manure/compost	1.12 (0.3-1.9)	0.3 (0.1-0.8)	2.4 (0.4-7)	24	23	Lekasi et al., 2003, Kenya
Farm yard manure	1.62	0.5	1.43			Kimani and Lekasi, 2004, Kenya
Cattle manure	1.41 (1.1-1.9)	0.53 (0.4-1)	1.54 (0.9-2.1)			Onduru et al., 2008, Kenya
Cattle manure	1.22 (0.6-1.8)	0.29	2.14			Onduru et al., 2008, Kenya
Cattle slurry	2.1 (1.9-2.2)	0.53 (0.4-0.7)	3.9 (2.7-4.3)	33	16	Snijders et al., 1992, Kenya
Manure solid	0.89 (0.1-2.8)			13	14	Nhamo, 2004, Zimbabwe
Indoor manure	1.96	0.36	1.75		10	Jackson and Mtengeti, 2005, Tanzania
Kraal manure	1.13	0.19	1.16		19	
Earthen pit	1.58	0.27	0.94		11	
FYM	0.3-2.2	0.04-0.92	0.4-1.2			Harris, 2002, W. Africa
Cattle manure fresh	1.4-2.8	0.5-1.01	0.5-0.6			FAO, 2001
Cattle kraal + litter	0.5-2.3	0.22-0.81	0.77-5.44			
Cattle kraal – litter	1.5-2.5	0.2-0.6	1.5-2.0			
Cattle slurry	4.9	0.84	5.6	32.7	7	Anon., 1997, the Netherlands
FYM average	2.94	0.72	2.61	35.8	12	

Significant ranges within and among manure

Snjider et al. 2009

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Manure

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Relative emissions potential depending on management

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Manure Management System	Description	Relative emissions CH_4	Relative emissions N_2O
Pasture	Direct deposition on soil	Low	High
Daily spread	No storage	Low	Low
Solid storage (dung heaps)	Long-term storage	Low	High
Liquid/slurry	Collected and stored as liquid	Moderate to high	Low
Pit storage	Storage in pits below confinements	Moderate to high	Low
Poultry with litter	Use of bedding in houses	Low	High
Poultry without litter	Passive composting below animals	Low	Low

Adapted from USDA 2006

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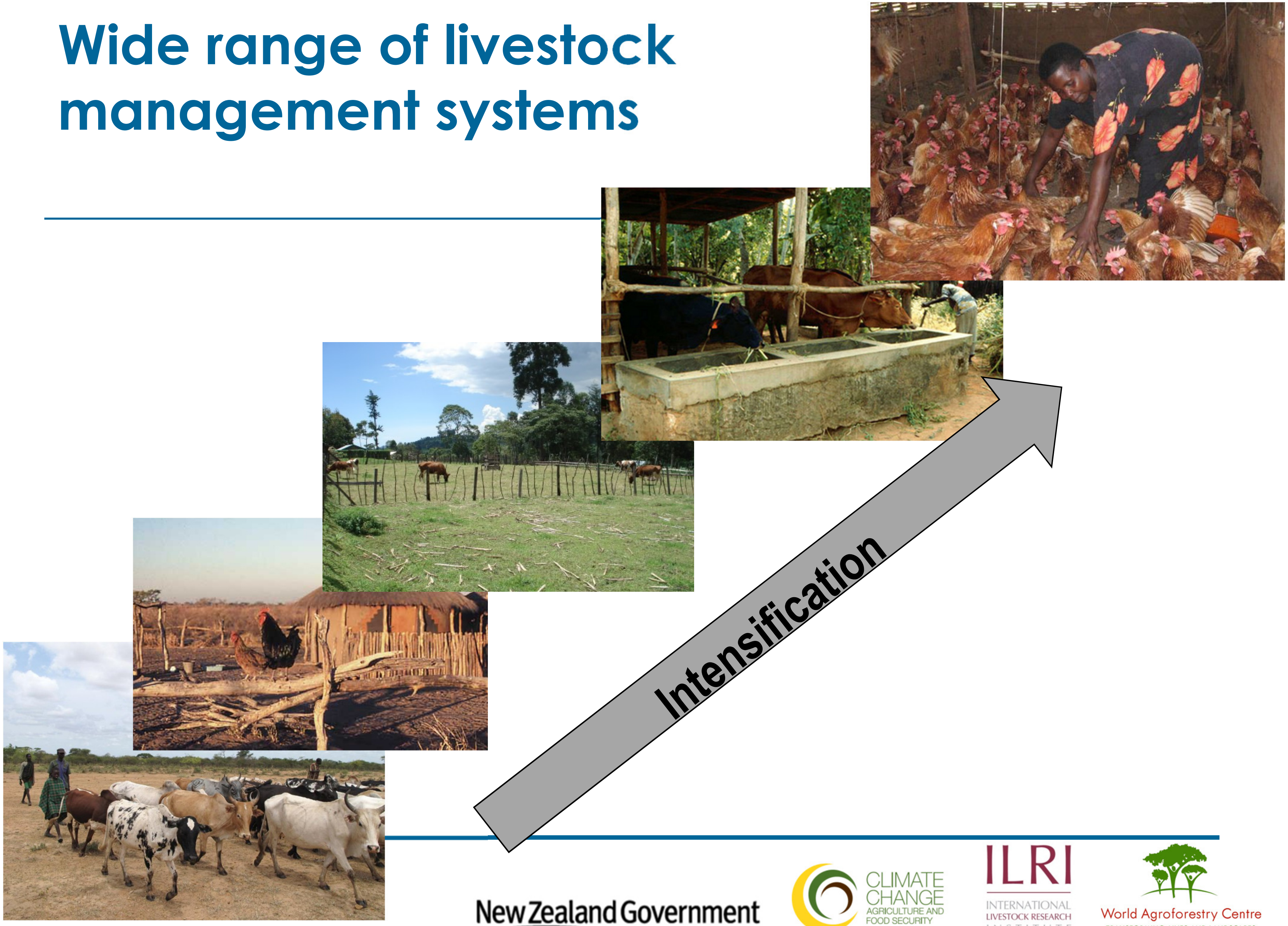
Wide range of livestock management systems



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Methods

Method	Advantages	Disadvantages
Lab-based incubations	-Controlled conditions	-May not represent environmental conditions well
Chambers	-Relatively cheap and easy	-May miss hot moments and hotspots -Chamber design, analysis, and calculations affect results
Micrometeorologial	-High temporal resolution -Non-distructive	-Expense limits sites -Requires uniform source area -No source attribution

Methodological tradeoffs

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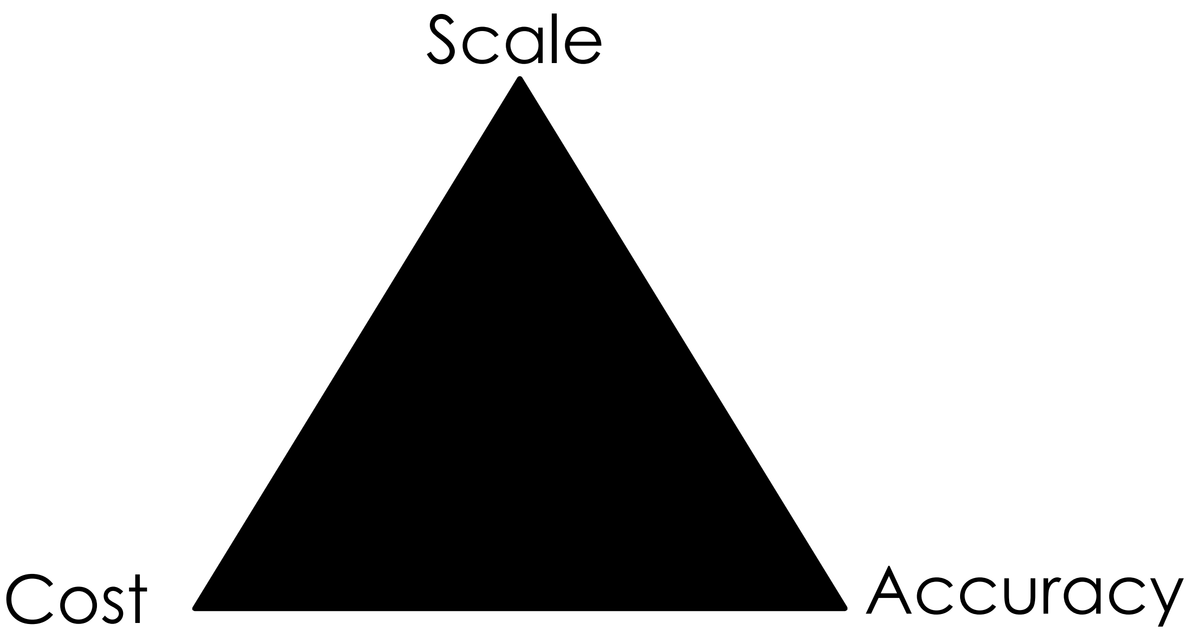
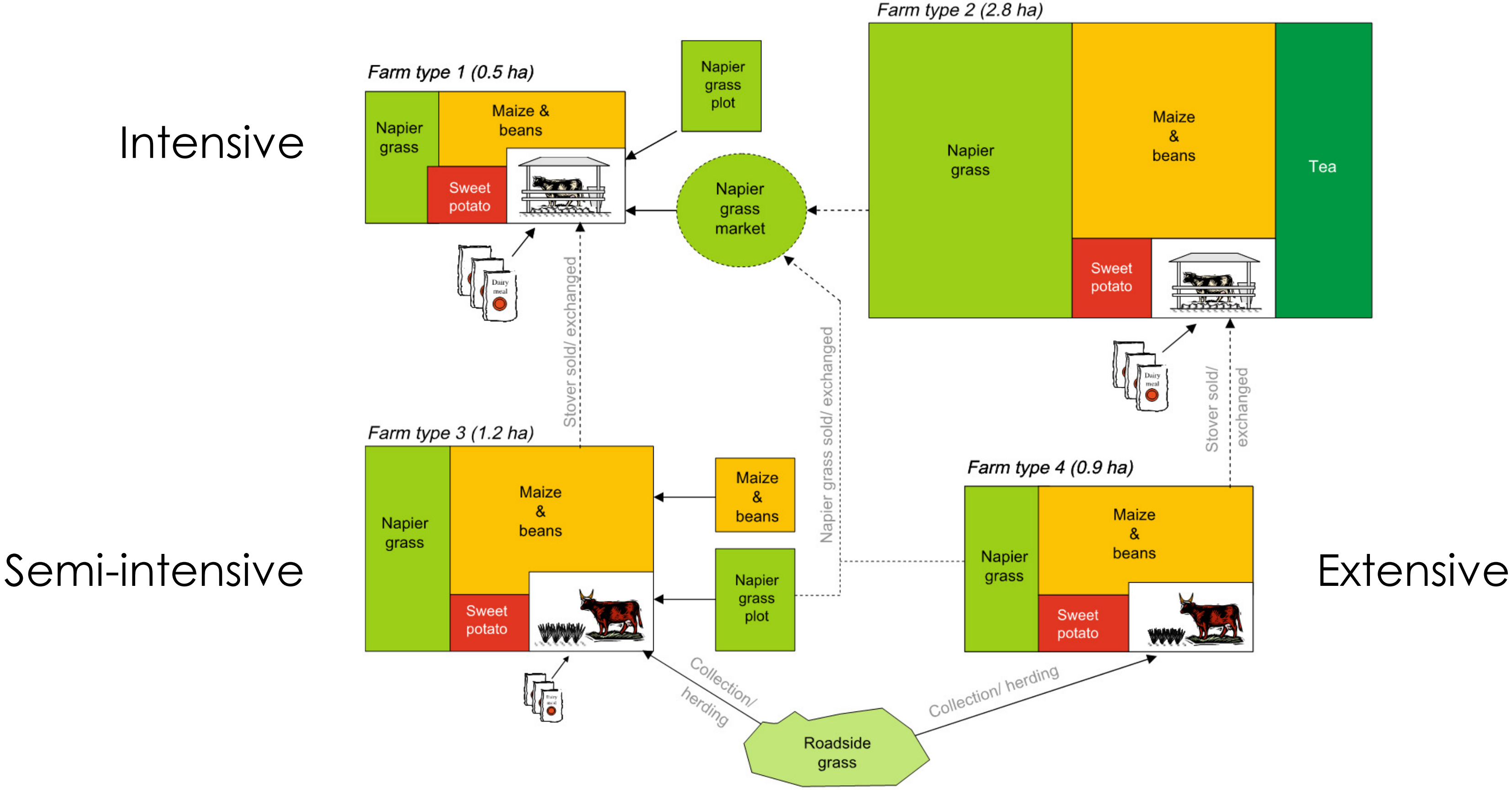
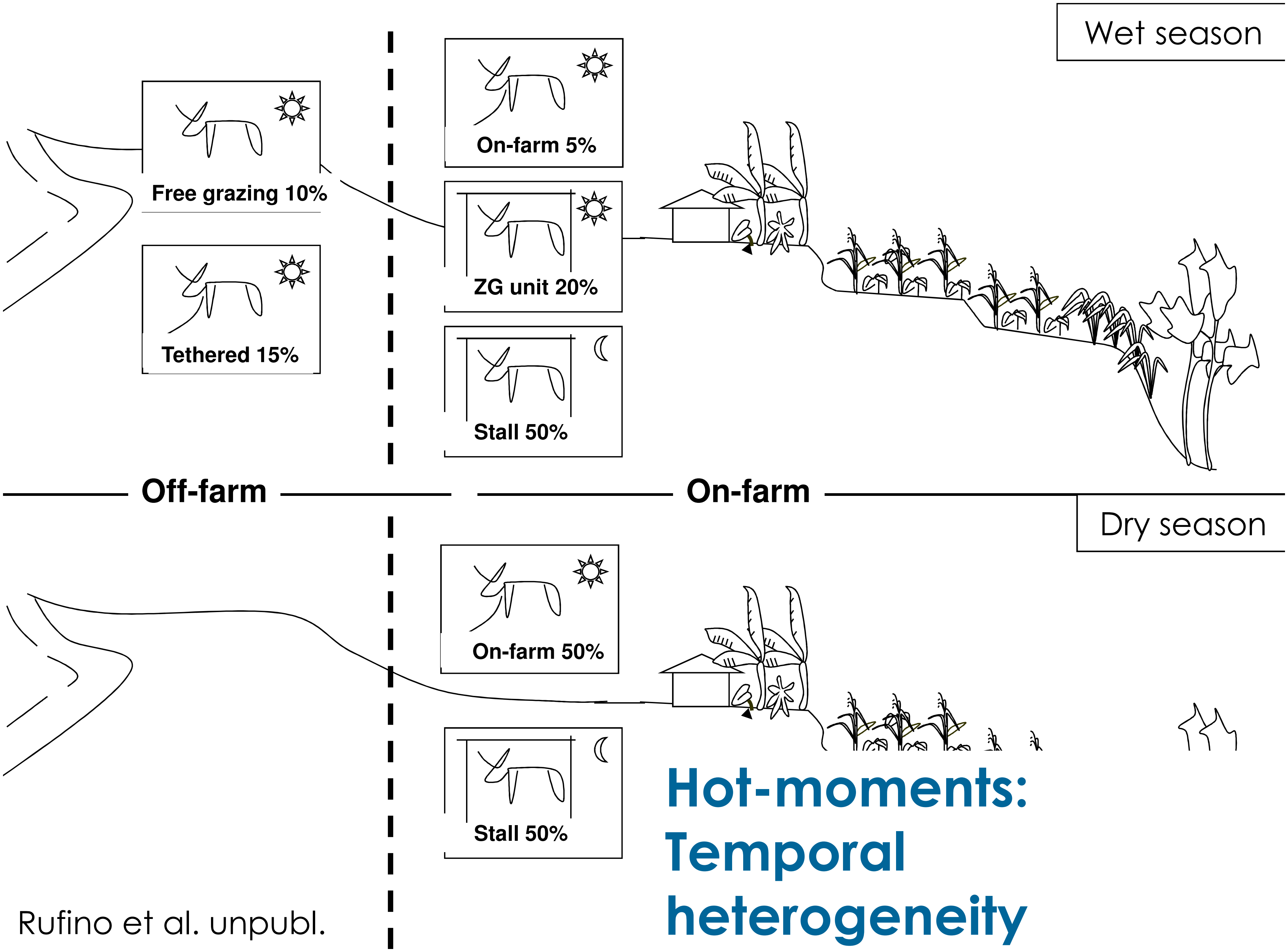


Hotspots: Spatial heterogeneity



Tittonell et al. 2009

Hot-moments: Temporal heterogeneity



Rufino et al. unpubl.

How to measure emissions of unit, farms, and landscapes?

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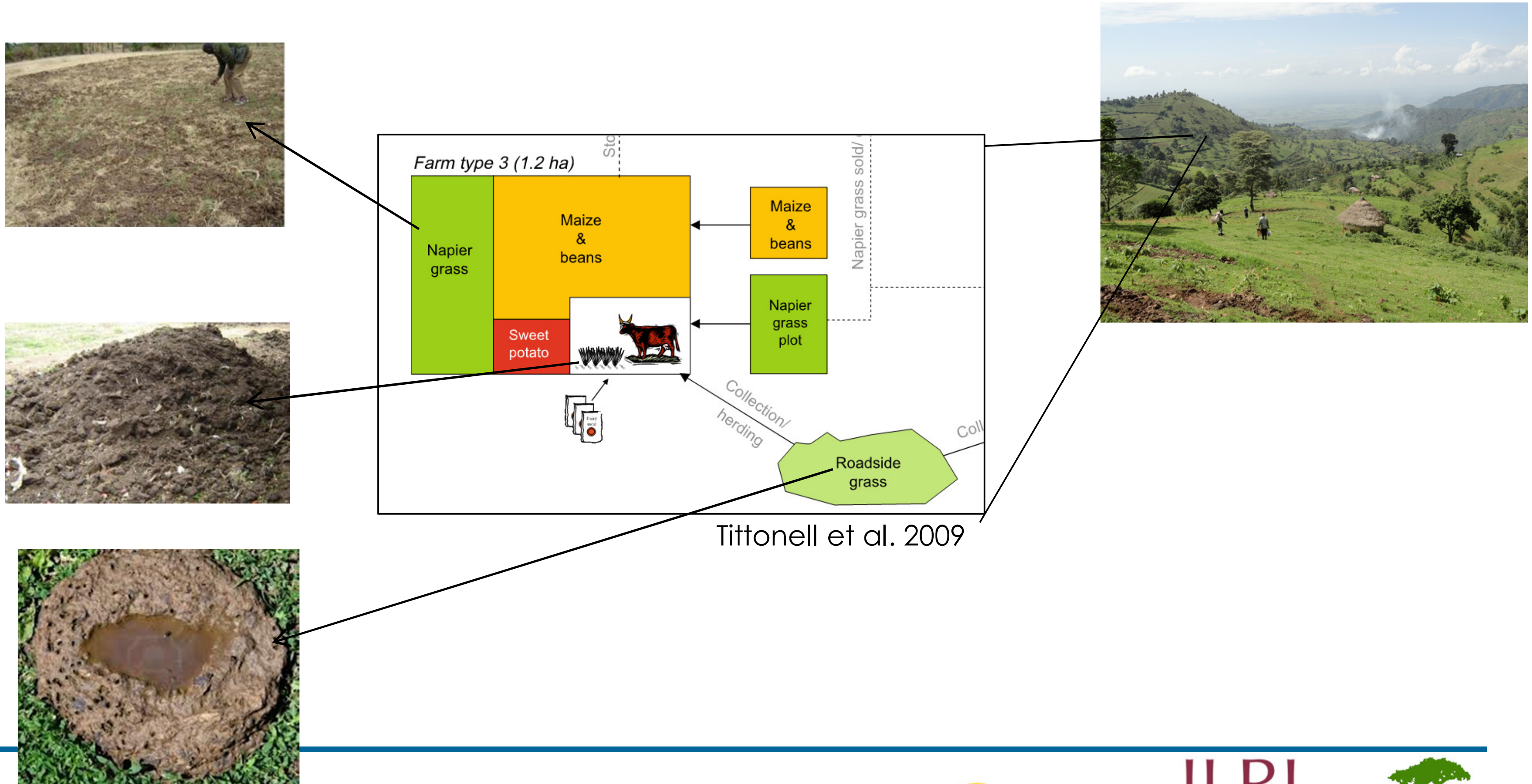

Tittonell et al. 2009

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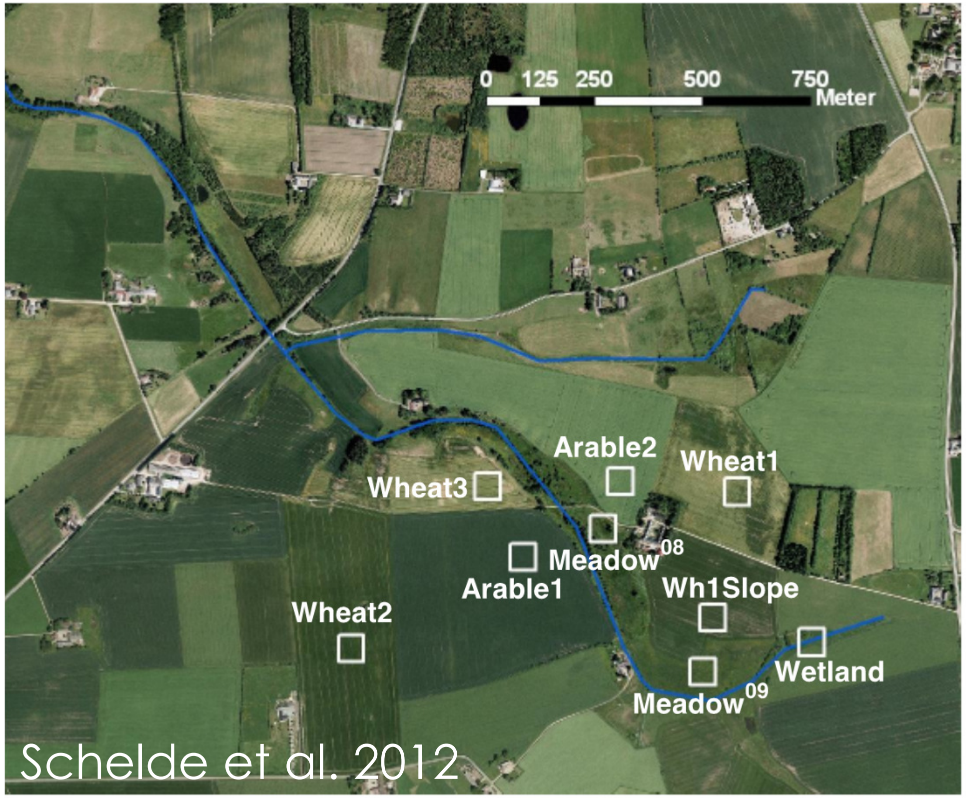
Activity data does not support measurement design

A lack of baseline data limits ability to target efficiently or effectively sampling at every scale



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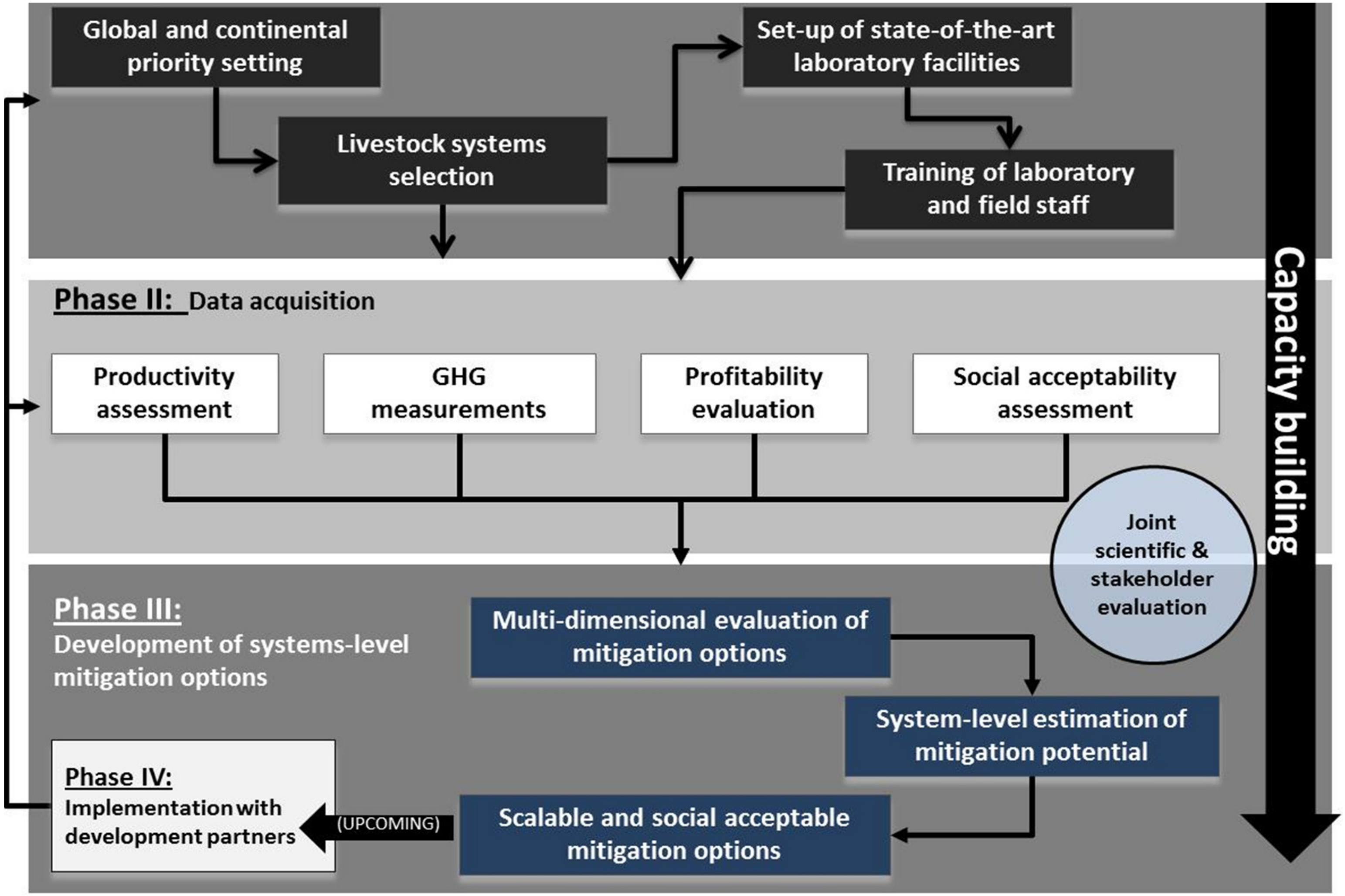
Standard Assessment of Mitigation Potential and Livelihoods in Smallholder Systems (SAMPLES)

A multi-dimensional assessment of mitigation options



Take home messages:

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- **Limited** data on N_2O or CH_4 from manure from African experiments
- Large variability in feeds, production systems, and management systems suggest **at least equal** variability in emissions
- Methods are sufficient but there are **tradeoffs**
- Need to develop basic background data to **target** future research
- Measurements of emissions should be **coupled** with measures of livelihood impact

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Thank you

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