Livestock Systems and Nutrient Cycling

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Outline

- Introduction
- Nutrient cycling in livestock production systems in the tropics
- Feed resources and soil fertility management: key mediating factors in the evolution of livestock systems
- Opportunities for future improvement

Annual meat and milk consumption (kg p. c.)

	Meat		Milk	
	1993	2020	1993	2020
Developed countries	76	83	192	189
Developing countries	21	30	40	62

Livestock to 2020: The Next Food Revolution, a joint IFPRI, FAO, ILRI study.

Total meat and milk production (10^6 MT)

	Meat		Milk	
	1993	2020	1993	2020
Developed countries	100	121	348	371
Developing countries	88	183	164	401

Livestock to 2020: The Next Food Revolution, a joint IFPRI, FAO, ILRI study.

Livestock issues in developed and developing countries

	Developed countries	Developing countries
Social and economic issues	Small proportion of population involved. Small contribution to gross domestic product.	Large proportion of population and GDP. Avenue for poverty reduction.
Human health and nutrition	Increasing concerns on health and excessive consumption of calories.	Enhanced nutrition and cognitive development through protein and micronutrients.
Nutrient cycling	Near-nutrient-balanced or nutrient surplus in most intensive systems. Manure, a pollutant in these systems.	Mostly nutrient deficient systems. Manure, key component of nutrient use efficiency and management strategies.

Millet-livestock system in the Sahel

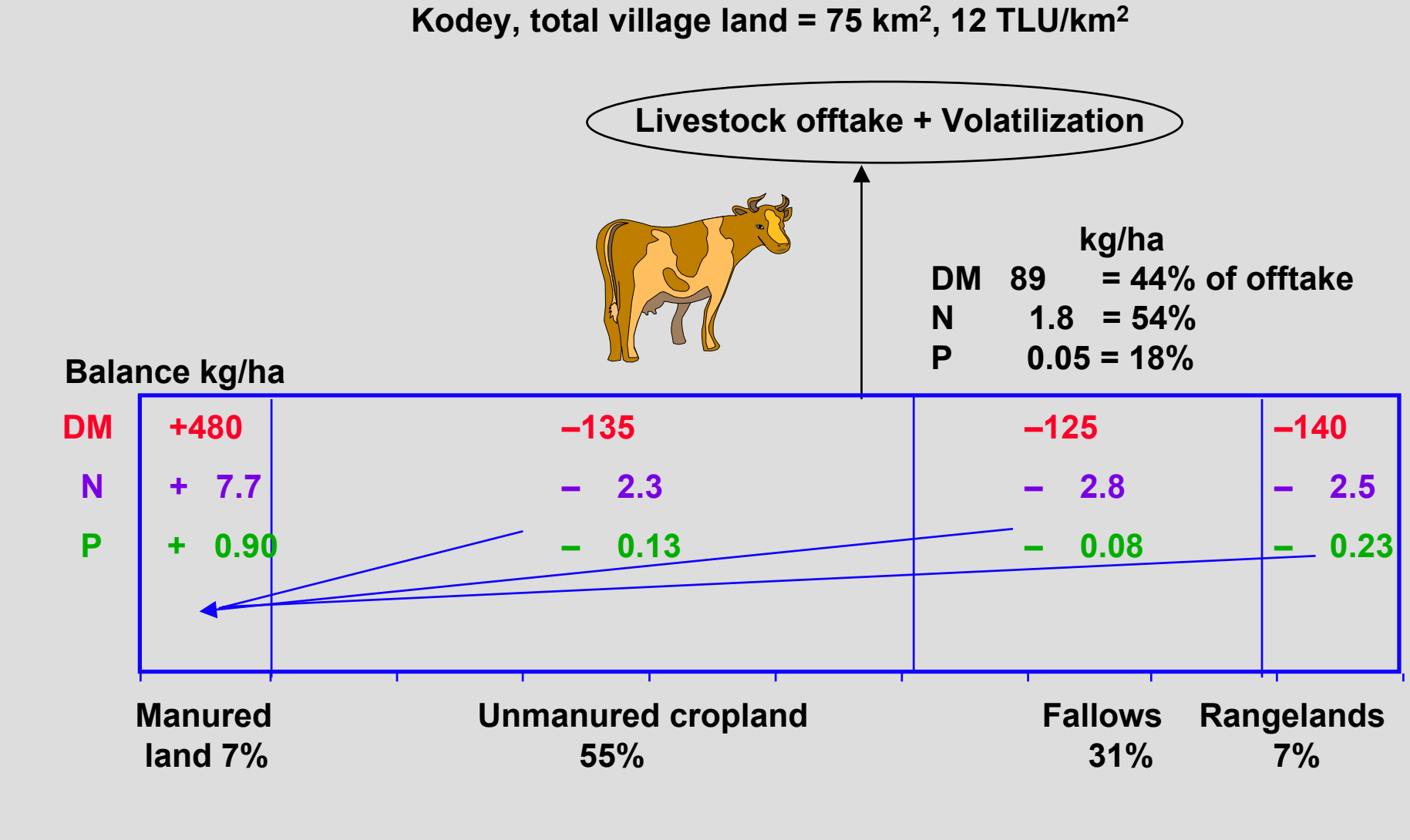
(Hiernaux et al., 1998; Schlecht et al., 2001)

- Low agricultural potential (530 mm/yr, poor soil fertility).
- 15-20 people per km^2.
- Three study sites with 30, 36, 62 % of village lands under cultivation.
- Farm size (land, herd) depend on farming community.
- Millet (staple), some cowpea.
- Animals graze during the day and are tethered the night.
- 4-8 % of land manured by corralling animals or manually.
- Most cattle sent on transhumance during rainy season.
- Very small amounts of fertilizer and feed supplements.

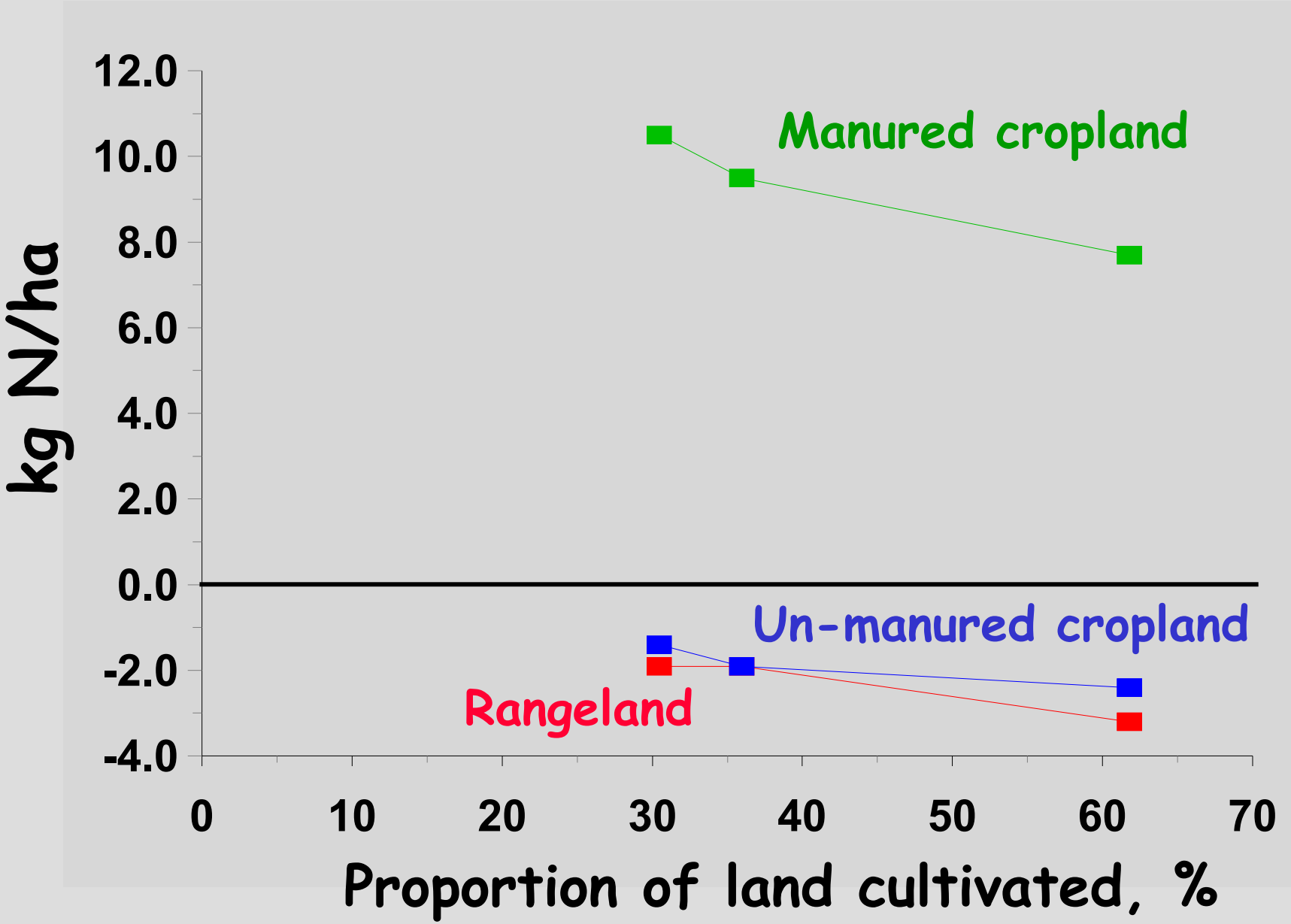
Millet-livestock system Western Niger

	Village farmers	Hamlet agro-pastoralists
Farms, no.	366	166
Persons/household	9.1	9.6
Land cropped, ha	14.5	10.5
Land manured, ha	1.4	4.7
Herd size, no:		
Sheep	2.2	19.2
Goats	2.3	36.4
Cattle	3.4	27.6
Dairy cows	0.6	5.8

Organic Matter and nutrient transfers mediated by livestock within village lands



Livestock transfers of Nitrogen



“Close-settled-zone” system, Northern Nigeria

(Mortimore, 1991; Harris, 1998)

- High agricultural potential (750-1000 mm/yr, fertile soils).
- More than 300 people per km^2.
- 86.4 % of land already under cultivation in 1971.
- Land holding per farm, 3.3 ha.
- Millet, sorghum (staple), cowpea, groundnut (cash, feed).
- Livestock, mostly small ruminants (13 SR/hh)
- No rangeland, high farming intensity
- Manure from own animals, transported to fields

"Close-settled-zone" system, N farm balances, kg/ha
(Harris, 1998)

	1993	1994
N balance	-11 to 1	-28 to 3
P balance	0 to -2	-3 to 3
Fertilizer N	6.0	8.9
Sold N as food	9.8	25.0
Feed N	10.7	15.4
Manure N	10.2	14.2

Maize-Livestock, semi-arid Eastern Kenya

(Okwell et al., 1991; McCown et al., 1992; Probert et al., 1995)

- Medium agricultural potential (725-975 mm/yr).
- 21-50 persons/km^2 .
- 3 ha cropland and 5 ha range / farm.
- Maize (staple), pigeonpea and cowpea
- Herd , 9 TLU (oxen, other cattle, small ruminants).
- “Boma” system: animals enclosed for 12-16 h/d and fed on cowpea, pigeon pea.
- At end of dry season (Aug-Sep) manure is dug out, conserved in heaps and applied to fields when land is ploughed.
- Manure applied: Maximum, 50 kg N/ha and 9 kg P/ha
  - Probert et al., 5 villages, excessive applications lead to large losses

Maize-coffee-dairy system, Kenya Highlands

(Ramson et al., 1995; Lekasi et al., 1998)

- High agricultural potential (1000-1800 mm/yr, fertile soils).
- 350 – 800 persons/km^2 .
- 1.8 (0.4 – 12.5) ha/farm.
- Maize (staple), beans, coffee, vegetables.
- Dairy cattle (1.9 – 3.2 cows, 2.7 – 3.4 other cattle), 1.5 – 4.6 small ruminants.
- Almost 100% farms use zero-grazing.
- 70-100% of farmers produce feed all year.
- 62-86% farms use supplements (dairy meal, maize germ, brans).

Maize-coffee-dairy system, Kenya Highlands

(Ramson et al., 1995; Lekasi et al., 1998)

- Maize yield 4-5.6 ton/ha.
- N removed through maize grain and stover, 59-75 kg/ha.
- Manure, feed refusals collected in “bomas” and applied to maize fields.
- Intense use of manure. Quality and factors affecting it recognized by farmers.
- Estimated N applied through manure: 114 kg/ha in small farms, 50 kg/ha for medium size farms and 30 kg/ha in large farms.
- Manure supplied 82-98% of N used in the system.
- Inorganic fertilizer supplied 37-56% of P.

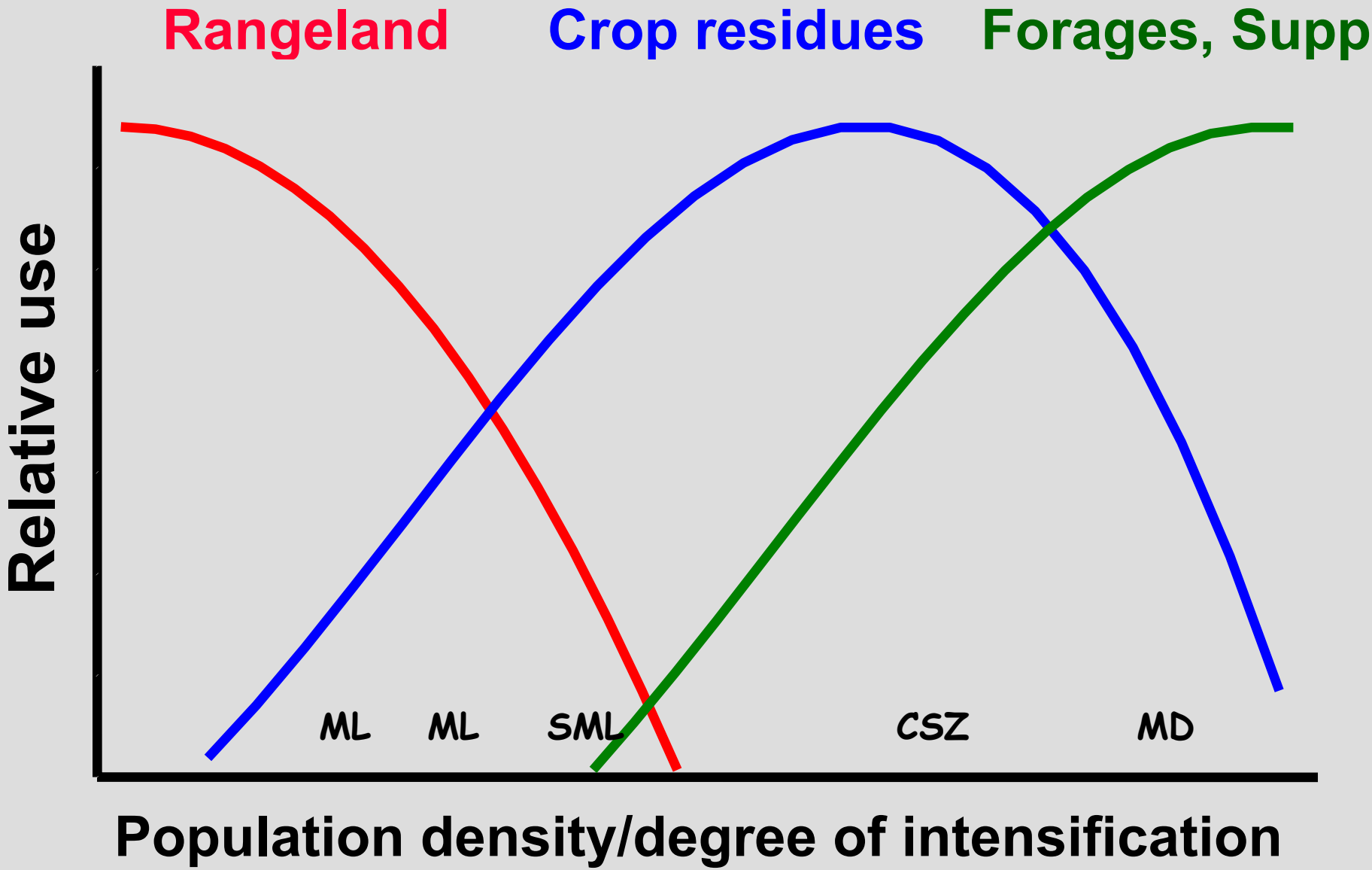
Livestock systems and nutrient use

	Millet-Livestock	Millet-Livestock	CSZ N Nigeria	SA Maize-Livestock	Maize-Dairy HL
Population	Low	Low	High	Medium	Very High
Market	Weak	Weak	Medium (Grain)	Medium (Milk)	High (Milk)
Rangeland	XXX	X	0	X	0
Crop Res	XXX	XXX	XXX	XX	X
Forage	0	X	XX	X	XXX
Supplement	0	X	XX	XX	XXX
Fallow	XX	X	0	X	0
Manure	X	XX	XXX	XX	XXX
Fertilizer	0	X	XX	X	XX

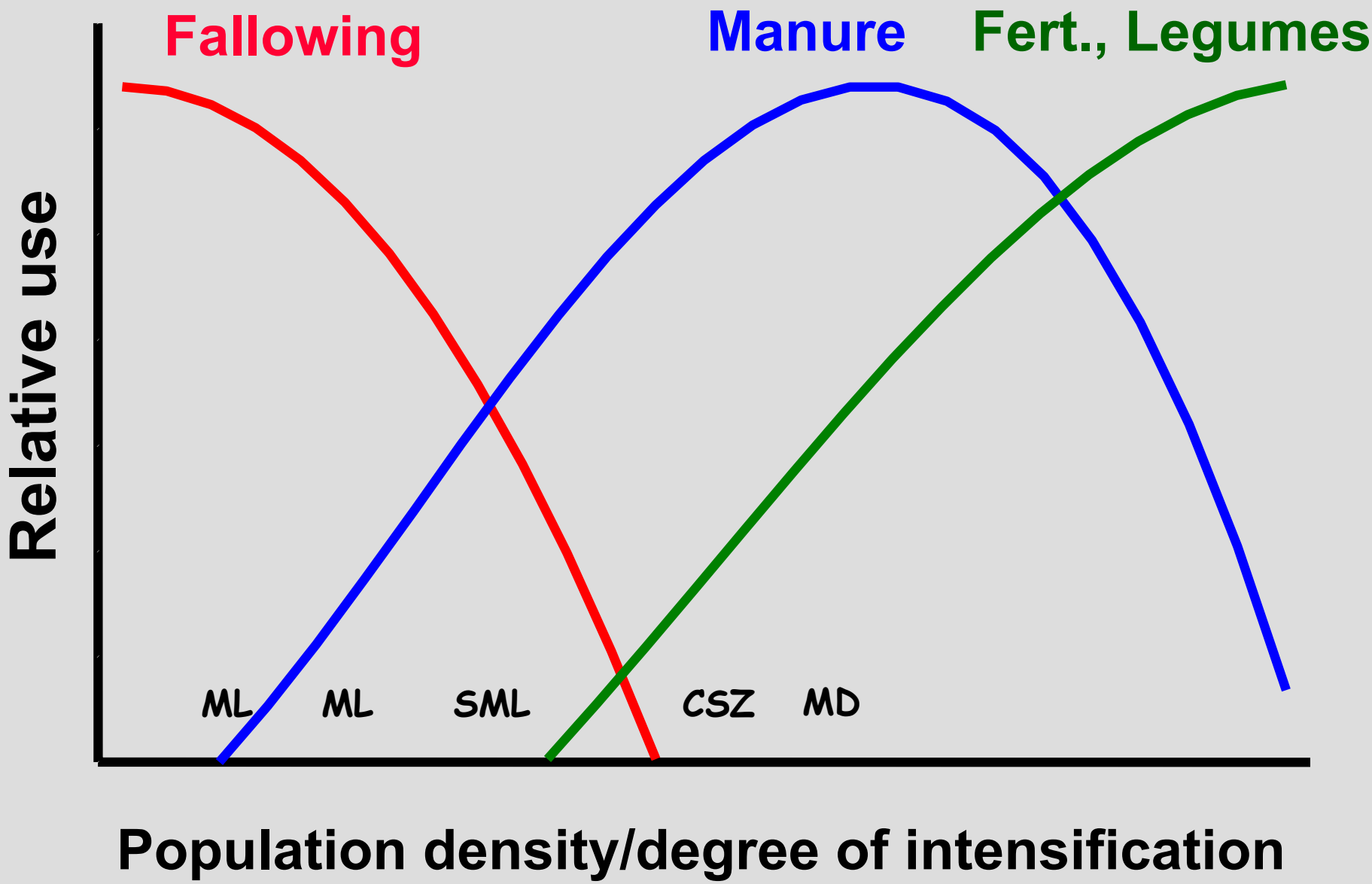
Intensification of livestock systems

- Livestock systems evolve toward intensification in response to demographic growth and demand for agricultural products.
- Mixed (crop-livestock) farming, a common path for intensification.
- Intensification is mediated by:
  - Social, institutional factors
  - Labour
  - Capital
  - Nutrients (soil and animal)

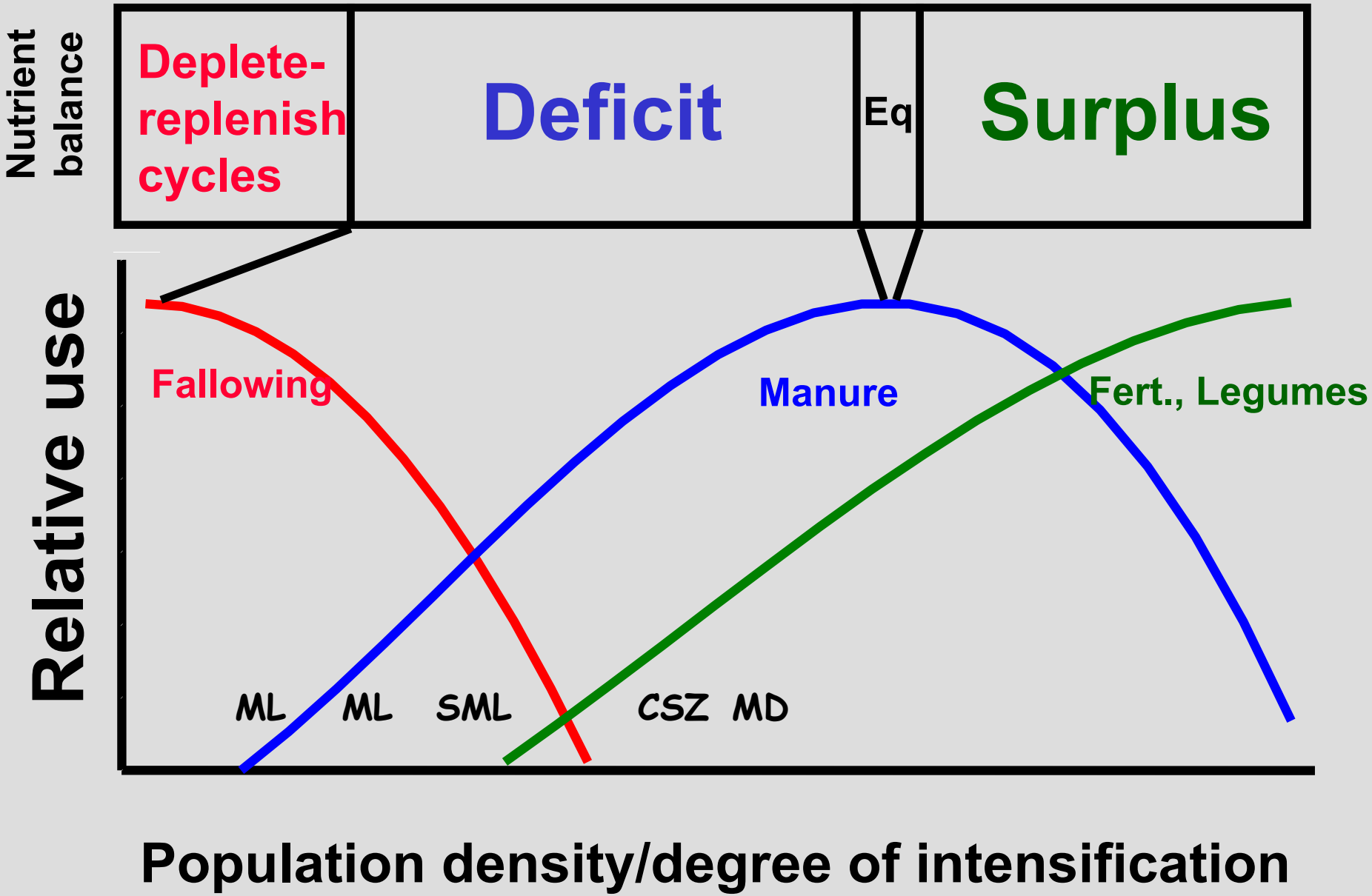
Livestock feeding strategies



Soil nutrient management strategies



Livestock systems and nutrients balances



Opportunities for future improvement

- External inputs:
  - Fertilizers
  - Feed supplements
  - Legumes
- Increasing efficiency of available nutrients:
  - Reducing nutrient losses
  - Improving manure quality, composting
  - “Precision” application in space and time
- Approaches:
  - Cross-system, cross-regional analyses
  - Socio-economic realities, participatory
  - Build upon lessons learnt
  - Modelling
  - Access to inputs and outputs markets

Thank you !