What are the system changes required to reduce environmental impacts of Tanzanian livestock farms?

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Status in Tanzania

Tanzania vision 2025 – transform to a middle income country

National Climate Change Strategy – participate in global efforts

Most animal products produced in the country

Livestock low input-use and low yield system

Smallholders are most vulnerable

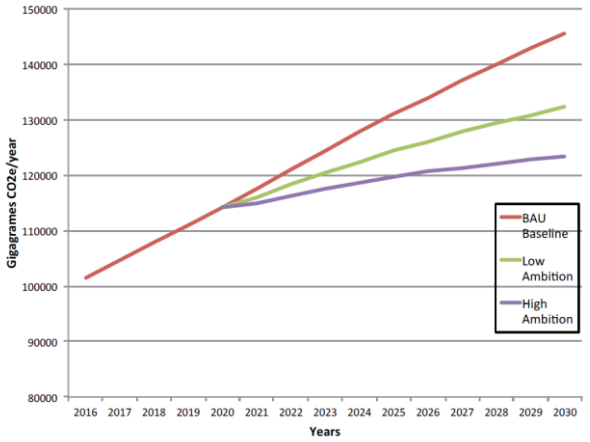
What system changes are needed to fulfill the growing demand for human-edible protein & reduce GHG emissions?

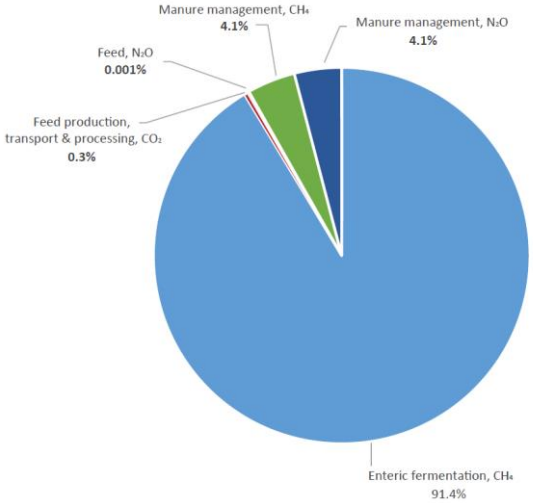
GHG emissions

Tanzania will reduce GHG emissions 10-20% by 2030 relative to the BAU scenario of 138 - 153 $MtCO_2e$ – INDC

Dairy sector emits 28.8 Mt CO_2e emissions, 91% enteric methane

Emissions intensity: 20 kg CO_2e/kg FPCM





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Objective

Evaluate the environmental impacts of three different livestock production systems transitioning from traditional to improved (various types of intervention)

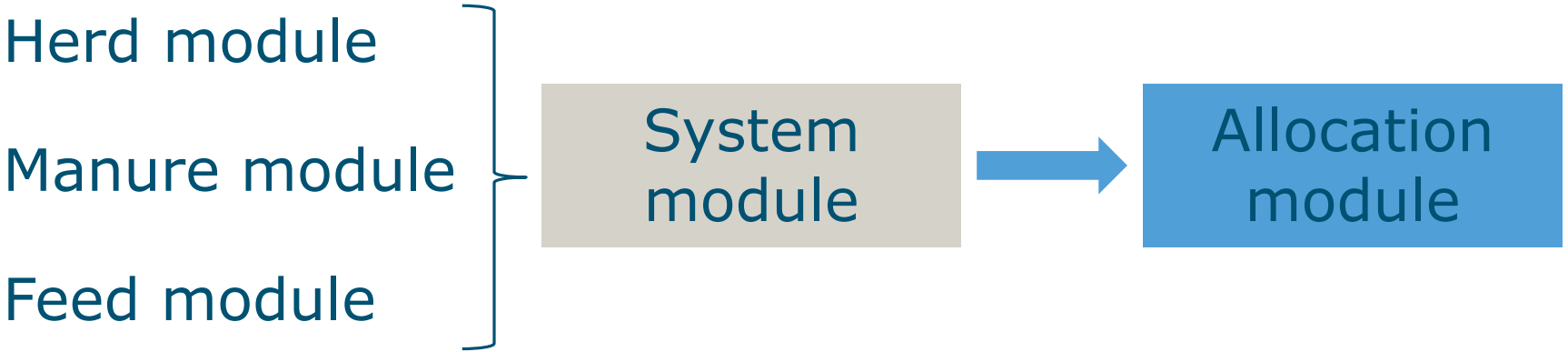
Systems:

- Pastoralist cattle system (Maasai)
- Backyard poultry system
- Smallholder dairy system

Approach – modelling GLEAM

- Global Livestock Environmental Assessment Model - GLEAM
- Based on the modules representing the structure and elements of livestock supply chains
- Covers three major GHGs: methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2)
- Range of inputs & EFs mainly sourced from IPCC

Built on five modules



GLEAM

- Emissions associated with manure management, enteric fermentation and feed production are estimated.
- Energy use on farm is added to the total emissions, which are then allocated to co-products and services in the allocation module.
- Allocation here based on protein content.
- Emissions intensity i.e. emissions produced per unit of product are reported as a final output.

Data sources in GLEAM

- Vary greatly
- Some of the data on production herd structure were inputs from a complementary study.
- National databases,
- literature,
- expert opinion and
- life cycle inventory package e.g. Ecoinvent

Data – smallholder dairy

Data	Unit	Baseline	Improved scenario 1	Improved scenario 2
Production and herd data				
Dairy cows	heads	5	Same as baseline	Same as Improved scenario 1
Number of animals in the herd[1]	heads	15	8	
Number of animals leaving the farm alive	heads	2	3	
Adult female weight	kg live weight/head	320	Same as baseline	
Adult male weight	kg live weight/head	450	Same as baseline	
Birth weight	kg live weight/calf	20	Same as baseline	
Death rate female calves	%	20	**15**	
Death rate male calves	%	20	**15**	
Death rate adult females	%	7	**5**	
Age at first calving	year	4	**3**	
Slaughter weight female	kg	310	Same as baseline	
Slaughter weight male	kg	430	Same as baseline	
Fertility rate[2]	%	75	**80**	
Replacement rate female[3]	%	10	Same as baseline	
Bull to cow ratio	ratio	0.69	**0.1**	
Labour (adult males)	hours/day/animal	1.2	Same as baseline	
Milk yield	kg raw milk/cow/year	240	**288**	**2400**

Feeding[4]				
Grazed grass	% ration	24	48	0
Fresh cut grass	% ration	0	0	48
Crop residues	% ration	70	46	46
Maize*	% ration	2	Same as baseline	Same as baseline
Meal oilseeds*	% ration	3	Same as baseline	Same as baseline
Grain by-products*	% ration	1	Same as baseline	Same as baseline

[1]Herd consisting of adult females, replacement females, adult males, replacement males

[2]Fertility rate: % probability a pregnancy will result in birth of a calf

[3]Replacement rate female: % adult females replaced due to diseases or fertility problems

[4]Source of feed is on- and off-farm, those marked with * are off-farm

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Data - pastoralist

Data	Unit	Baseline	Improved scenario
Production and herd data			
Beef cows (adult female)	heads	111	119
Number of animals in the herd[1]	heads	300	300
Number of animals leaving the farm alive	heads	48	72
Adult female weight	kg live weight/head	320	Same as baseline
Adult male weight	kg live weight/head	416	Same as baseline
Birth weight	kg live weight/calf	25	Same as baseline
Death rate female calves	%	21	**15**
Death rate male calves	%	21	**15**
Death rate adult females	%	7	**5**
Age at first calving	year	4	**3**
Slaughter weight female	kg	200	Same as baseline
Slaughter weight male	kg	260	Same as baseline
Fertility rate[1]	%	75	**80**
Replacement rate female[2]	%	10	Same as baseline
Bull to cow ratio	ratio	0.1	Same as baseline
Labour	Hours/day	1.2	Same as baseline

[1]Herd consisting of adult females, replacement females, adult males, replacement males, beef females and beef males.
[2]Fertility rate: % probability a pregnancy will result in birth of a calf
[3]Replacement rate female: % adult females replaced due to diseases or fertility problems
[4]Source of feed is on-farm, those marked with * are off-farm

Feeding[3]			
Fresh grass	% ration	90	95
Crop residues	% ration	10	2
Meal oilseeds*	% ration	-	2
Grain by-products*	% ration	-	1

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Data – backyard chicken

Data	Unit	Baseline	Improved scenario
Production and herd data			
Chickens (adult female)	heads	2.4	1.5
Number of animals in the herd[1]	heads	29	29
Number of animals leaving the farm alive	heads	27	27
Adult female weight / Adult female weight fattening	kg live weight/head	1.35 / 1.35	Same as baseline
Adult male weight / Adult male weight fattening	kg live weight/head	1.92 / 1.85	Same as baseline
Birth weight	kg live weight	0.025	Same as baseline
Hatchability[1]	%	80	Same as baseline
Death rate pullets	%	50	**30**
Death rate adult females	%	20	**10**
Egg productivity	number of eggs/year	50	**70**
Clutches	number/year	3	**4**
Eggs per clutch	number/clutch	13	Same as baseline
Age at first parturition	days	168	Same as baseline
Egg weight	kg/egg	0.041	Same as baseline
Age at slaughter laying hens/fattening females	days	926/250	Same as baseline
Lay time	year/adult life	3	Same as baseline
Rooster: Hen ratio	ratio	0.19	Same as baseline

Feeding[2]			
Swill	% ration	39	**33**
Pulses*	% ration	2	**3**
Cassava*	% ration	8	Same as baseline
Wheat	% ration	1	**2**
Maize	% ration	11	**13**
Millet	% ration	3	Same as baseline
Rice	% ration	3	Same as baseline
Sorghum	% ration	3	Same as baseline
Soybean meal*	% ration	2	**4**
Meal oilseeds*	% ration	11	Same as baseline
Meal cottonseed*	% ration	6	Same as baseline
Grain by-products*	% ration	11	Same as baseline

[1]Herd consisting of reproduction hens, reproduction replacement hens, reproduction roosters, fattening young females, fattening adult females, fattening males.
[2]Hatchability: % probability chicks will be produced from eggs
[3]Source of feed is on- and off-farm, those marked with * are off-farm

Results - *adult females reported here*

	Dairy	Pastoralist	Backyard chicken
Emissions intensity ($kgCO_2e$/kg product)			
Meat			
Baseline	78	60.4	12.2
Improved case	29	40.4	11
Improved case 2 (dairy only)	22		
Milk or egg	*Milk*		*Egg*
Baseline	24		8.1
Improved case	17		7.2
Improved case 2 (dairy only)	3		

Notes

- Feed inventory: on- and off-farm, inputs N, P, K, lime, field work, processing and transport, energy use FOR EACH and EVERY FEED INGREDIENT
- Are all feed ingredients in?
- Feed inventory being prepared for Kenya
- Land use change, C sequestration or water not here!
- System boundary and allocation

Take home messages

- Improved quality and quantity – functioning markets
- Improved animal health
- Improved breeding – AI services
- Herd size could be reduced – consider multifunctionality & access to finance
- A ‘package’ of ‘no regret’ scenarios -> modest but realistic achievements
- Prioritisation for intervention? Mitigation alone is not the priority PLUS production efficiency PLUS return on assets

Further reading

Baltussen W, van Berkum S, Dijkxhoorn Y, Helmes R, Özkan Gülzari Ş, Vellinga T, Massawe GD, Galgani P, Borniotto D, vd Elzen F and Smith T. 2019. Traditional livestock systems in Tanzania; An application of the TEEB Framework. Report under review.

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Thank you

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