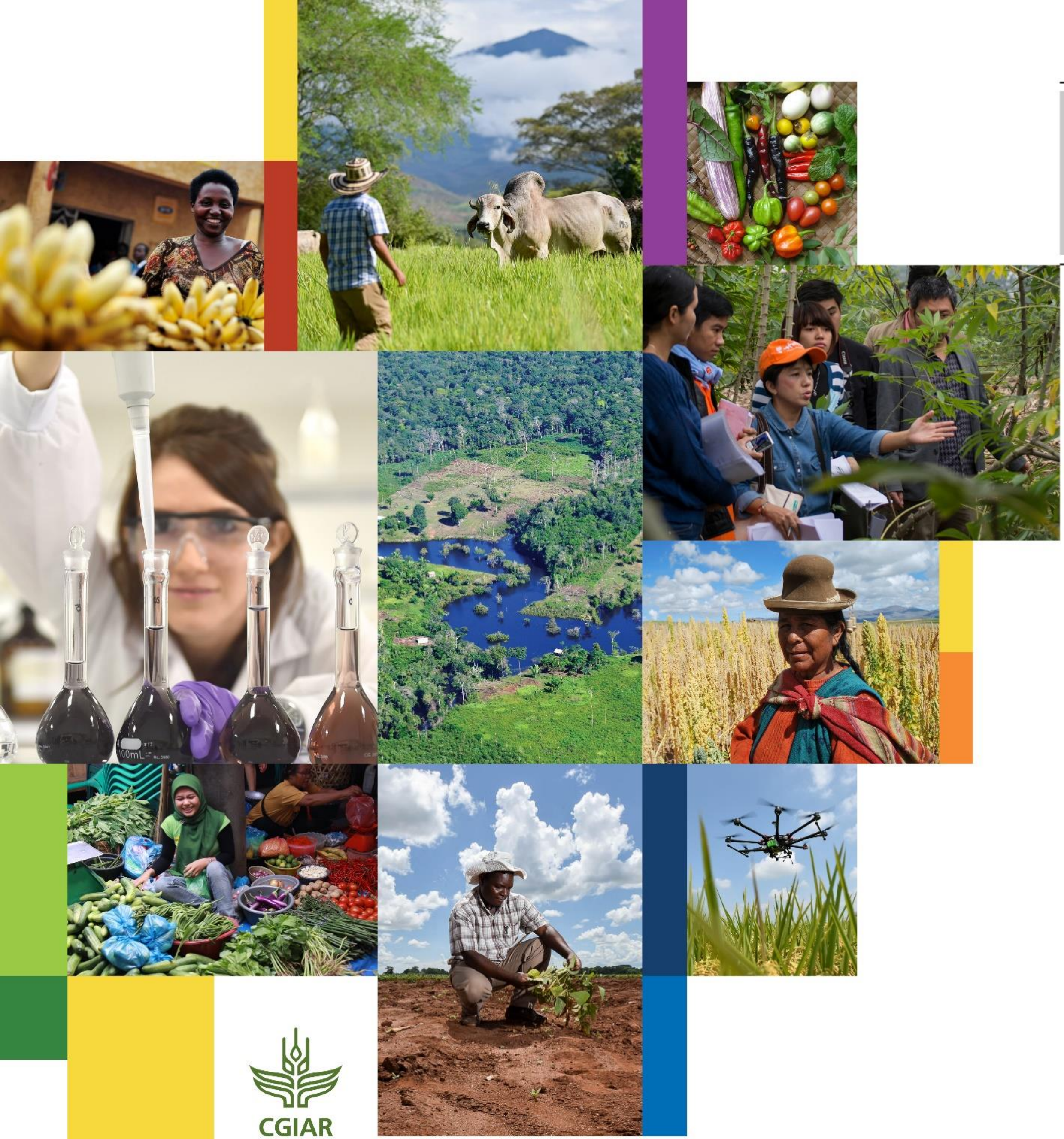

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CLEANED Awareness Training for Kenya Climate Smart Agriculture Program (KCSAP) Digital Dairy Project Team

19th of August, Nairobi, Kenya (online)

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Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
CGIAR is a global research partnership for a food-secure future.

Welcome to training

Opening remarks + Introduction

Maneuvering Teams + Housekeeping rules

Objectives of the training

- Participants to understand the basic functioning of the CLEANED model including outputs and input requirements
- At the end of the training, participants can decide whether CLEANED model is suitable to be deployed in KCSAP digital dairy project under Objective 3

Agenda

CLEANED AWARENESS TRAINING: 19TH AUGUST 2021

Time	Activity	Responsible
8:30am - 9:00am	Microsoft Teams testing + solving participants' connection problems	Emmanuel Mwema
9:00am - 9:10am	Welcome to training, opening remarks, self-introduction of participants	Emmanuel Mwema, Birthe Paul, Boniface Akuku, participants
9:10am - 9:20am	Objectives of the training, agenda	Emmanuel
9:20am - 9:40am	**Background: KCSAP - progress with Digital Dairy Project** **Objective 3:** Quantifying the contribution of forage technology adoption to reaching policy targets under the Kenya Climate Smart Agriculture Strategy - what have you implemented on the current status of 30% ? Have you collected the data needed for quantification? - What are your plans for the remaining 70%?	Boniface Akuku - general project overview Objective 3: Robert Oboko assisted by Dr John Kinyuru and Dr Evans Ouma
9:40am - 10:00am	**CLEANED overview** **-** Importance of livestock and environment - What is CLEANED? - CLEANED architecture (two-step process) - Data requirements Q&A	Emmanuel Mwema
10:00am - 10:15am	Coffee/restroom break	Participants
10:15am - 11:00am	**Deep dive: sections of the CLEANED model** -Inputs sheet -Results sheets -Calculations sheets -Parameters sheets Q&A	Emmanuel Mwema
11:00am - 12:00pm	**Group work/exercise (breaking up in two groups of five participants)** 1. Familiarizing with benchmark farm 2. Modifying benchmark farm to your own farm 3. Summarizing results	Participants
12:00pm - 12:45pm	Reporting back from both groups, Q&A	Group representatives
12:45pm - 1:00pm	**Quiz**: recap of CLEANED model understanding	Participants
1:00pm - 2:00pm	LUNCH BREAK	All
2:00pm - 3:00pm	**Showcasing a CLEANED assessment case study**, including scaling to regional level, Q&A	Emmanuel Mwema
3:00pm - 3:20pm	**Group discussion**: Application of CLEANED to KCSAP digital dairy project	Participants
3:20pm - 4:00pm	**Reporting back from groups**, discussion	Participants
4:00pm - 4:30pm	Feedback, closing, next steps	Emmanuel Mwema, Birthe Paul, Boniface Akuku

Background: KCSAP digital dairy overview

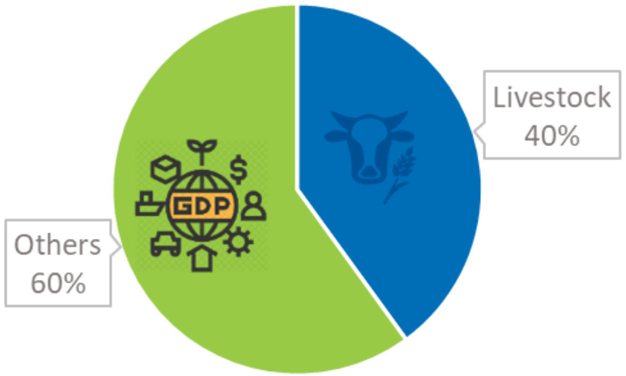
CLEANED overview

What are the benefits of livestock?

Manure

Draught power

Global agricultural GDP



Milk & meat

Herrero et al., (2013)

Current environmental impacts

Negative environmental impacts:

EMISSIONS

of greenhouse gases

LAND

degradation and deforestation

WATER

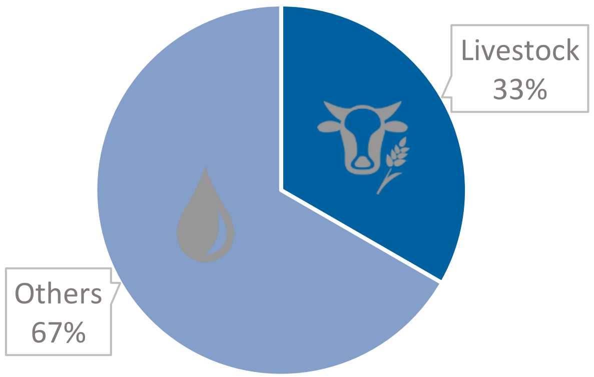
pollution and depletion

DEFORESTATION

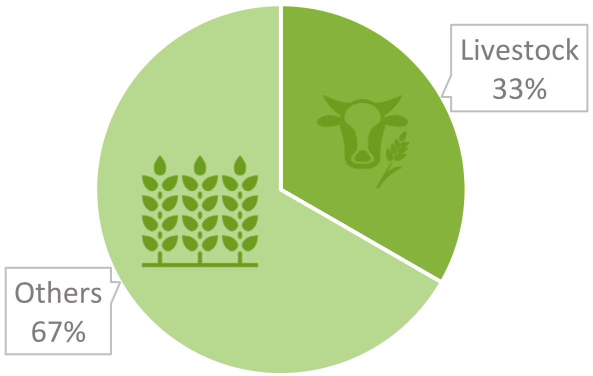
BIODIVERSITY

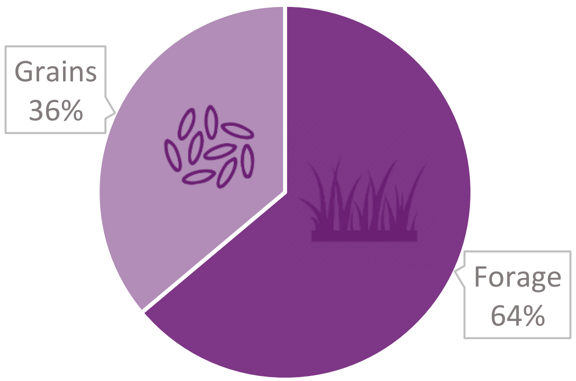
threatened

Global fresh water use



Global crop land





What is CLEANED?

C omprehensive
L ivestock
E nvironmental
A ssessment for improved
N utrition, a secured
E nvironment and sustainable
D evelopment along livestock
value chains.

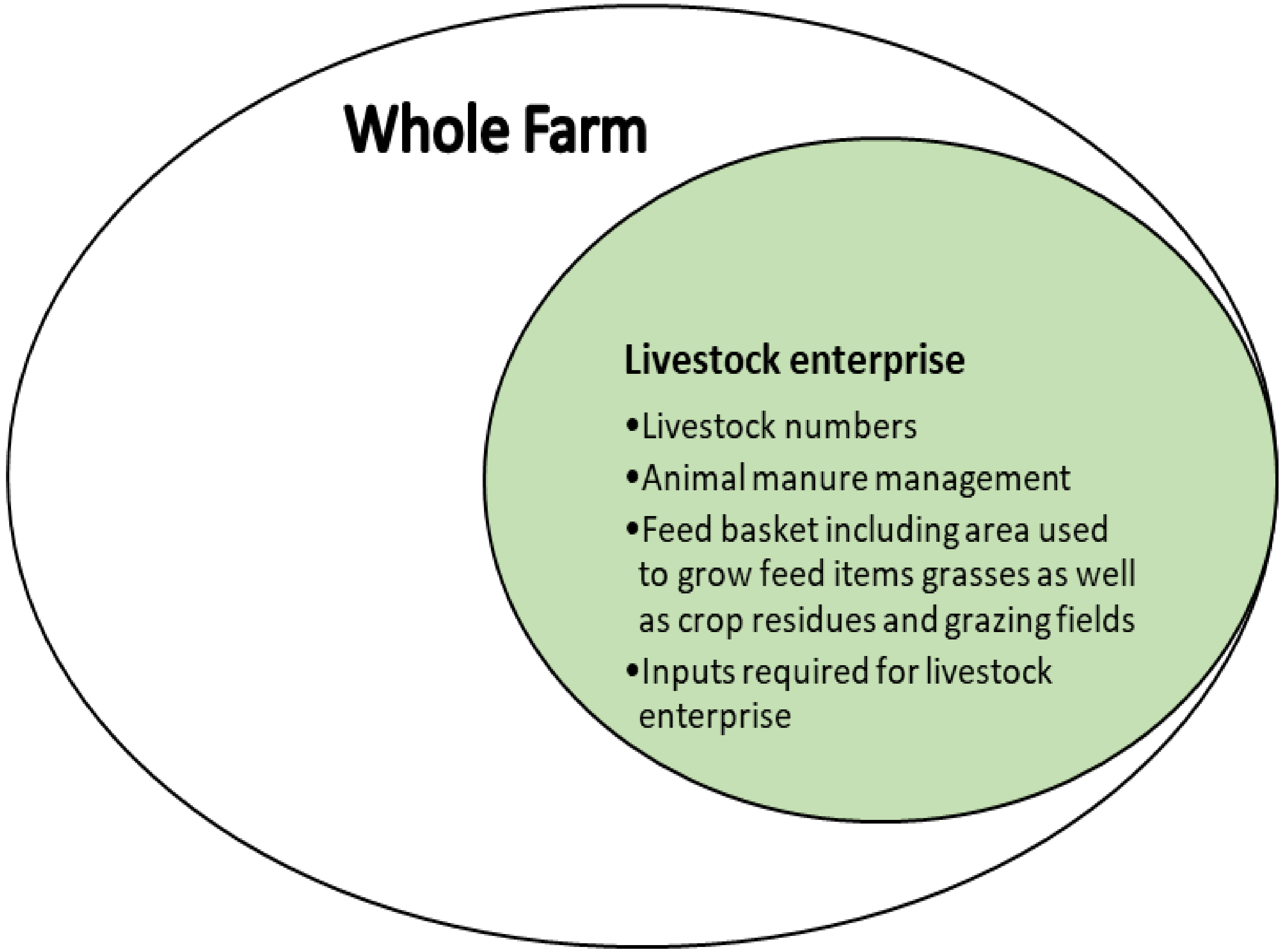
"A rapid ex-ante environmental impact assessment tool that allows users to explore multiple impacts of developing livestock value chains."

Dimensions assessed by CLEANED

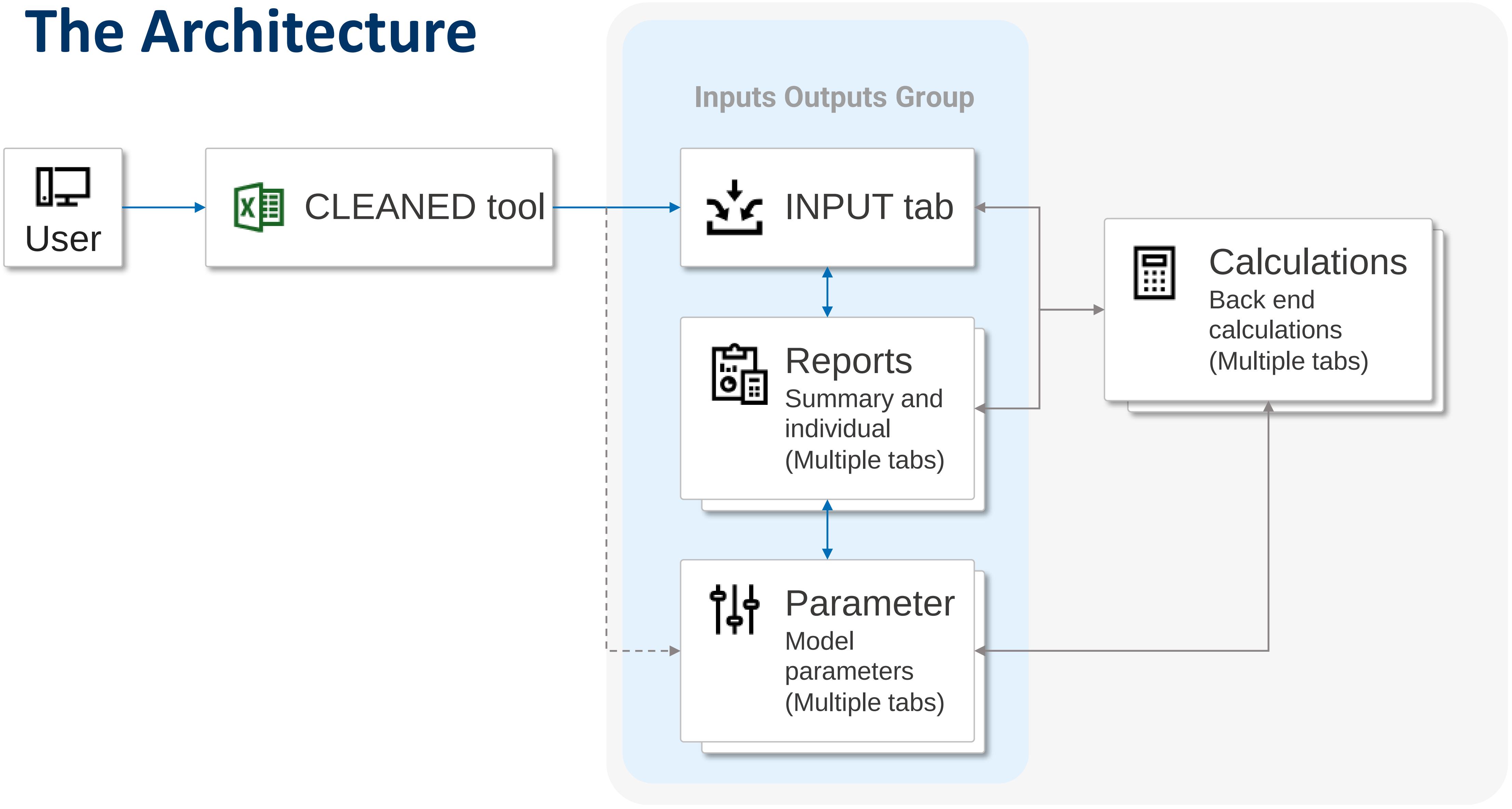
The CLEANED tool lets users explore **multiple** impacts of developing livestock value chains in explicit ways. It models the impact of intensifying livestock along multiple pathways:

- Land requirements
- Productivity
- Economics
- Soil Impacts
- Water impacts
- GHG emissions

Livestock enterprise



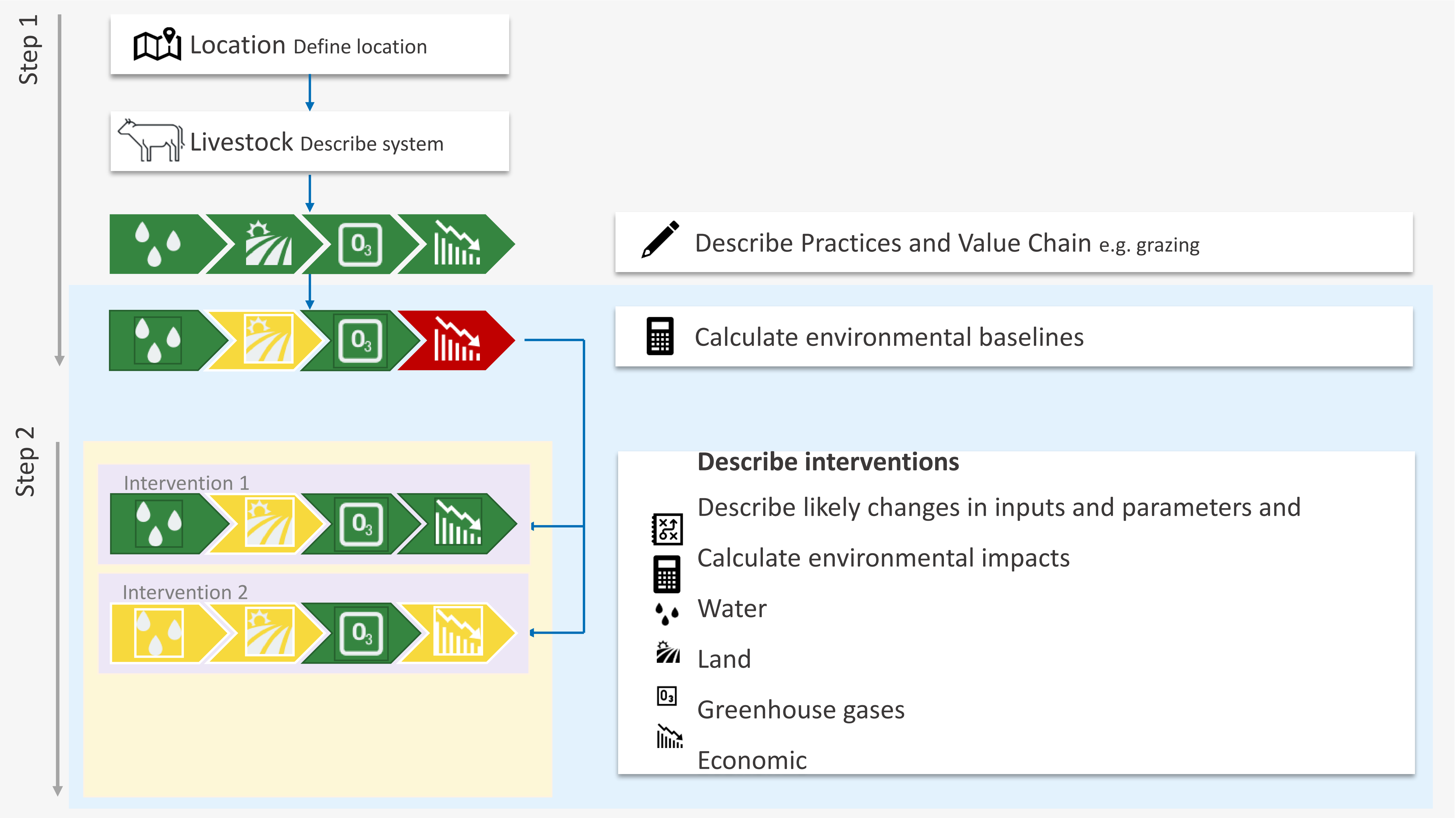
The Architecture



The process

The CLEANED tool process comprises of 2 stages:

1. Collect and input the baseline data
2. Generate reports for different scenarios of how the livestock production systems might change



Step 1
Location Define location
Livestock Describe system
Describe Practices and Value Chain e.g. grazing
Calculate environmental baselines
Step 2
Intervention 1
Intervention 2
Describe interventions
Describe likely changes in inputs and parameters and
Calculate environmental impacts
Water
Land
Greenhouse gases
Economic

Data requirements

Livestock

- Animal body weight
- Annual milk production
- Calving interval
- Herd composition
- Annual growth rates
- Daily management

annual_evapo_transpiration
aridity_index_ETO
precipitation
soil Organic Carbon
bulk_density_.kg_per_cubic_meter.
soil clay_content
soil total_nitrogen_.ppm.
Soil_Depth
Soil Type
Rainy season

Area

- SOC
- Bulk density
- Clay content (%)
- ETo
- Soil N
- Soil depth & type
-Annual precipitation
- Rainy season

Crop

- Crop yields
- Harvest index
- N content
- cover factor
- Kc factor
- crop areas & residue mgt
- Crop inputs

Feed

- Feed basket quality (DM, CP, ME, DE)
- Feed basket composition

Coffee/restroom break

Deep dive: sections of the CLEANED model

Sections of the CLEANED model

- Input sheet -> model
- Results sheet -> model
- Calculations sheets -> slides
- Parameter sheets -> model

Switch between model & slides

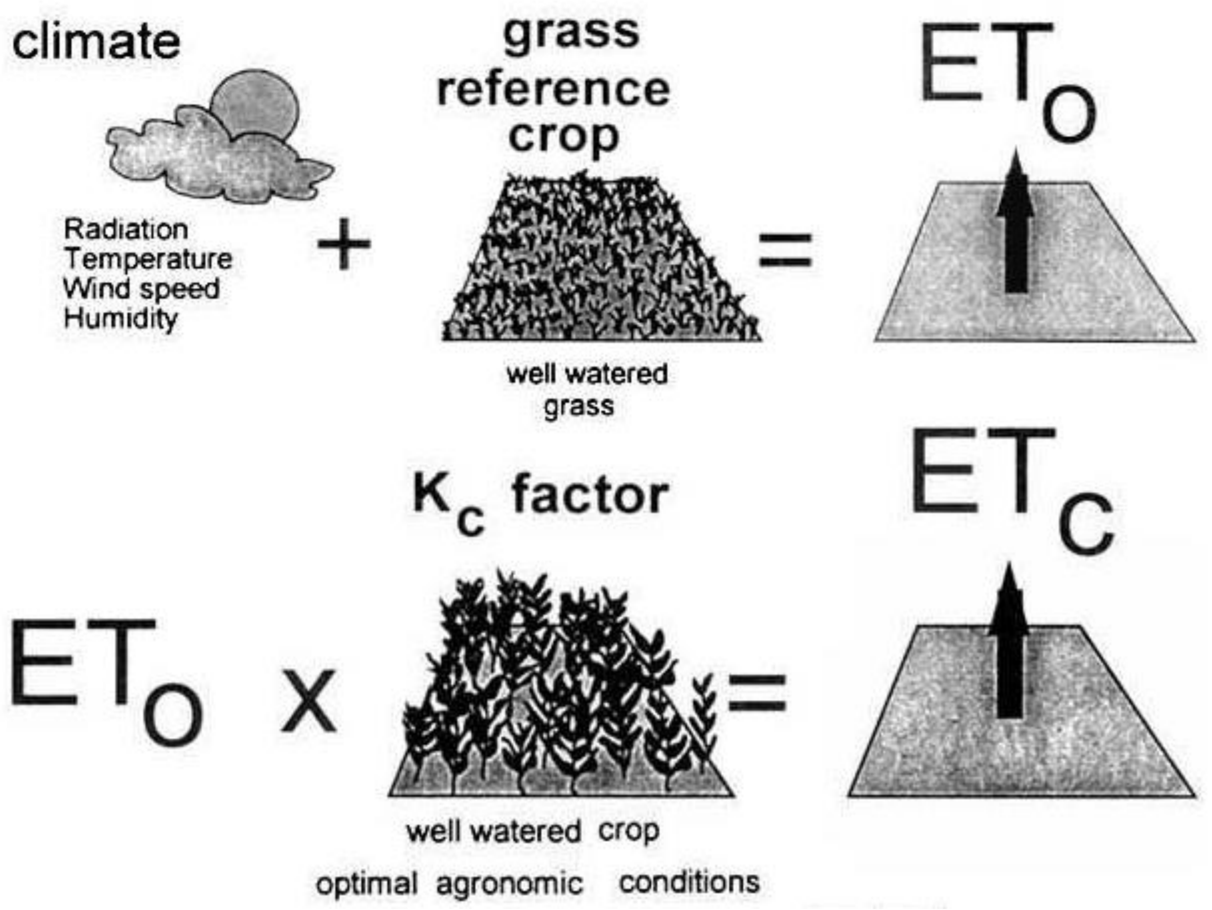
CLEANED calculations

Land Requirement =

Feed requirement + Feed quality ==> feed amount

Feed amount + crop yields ==> land size

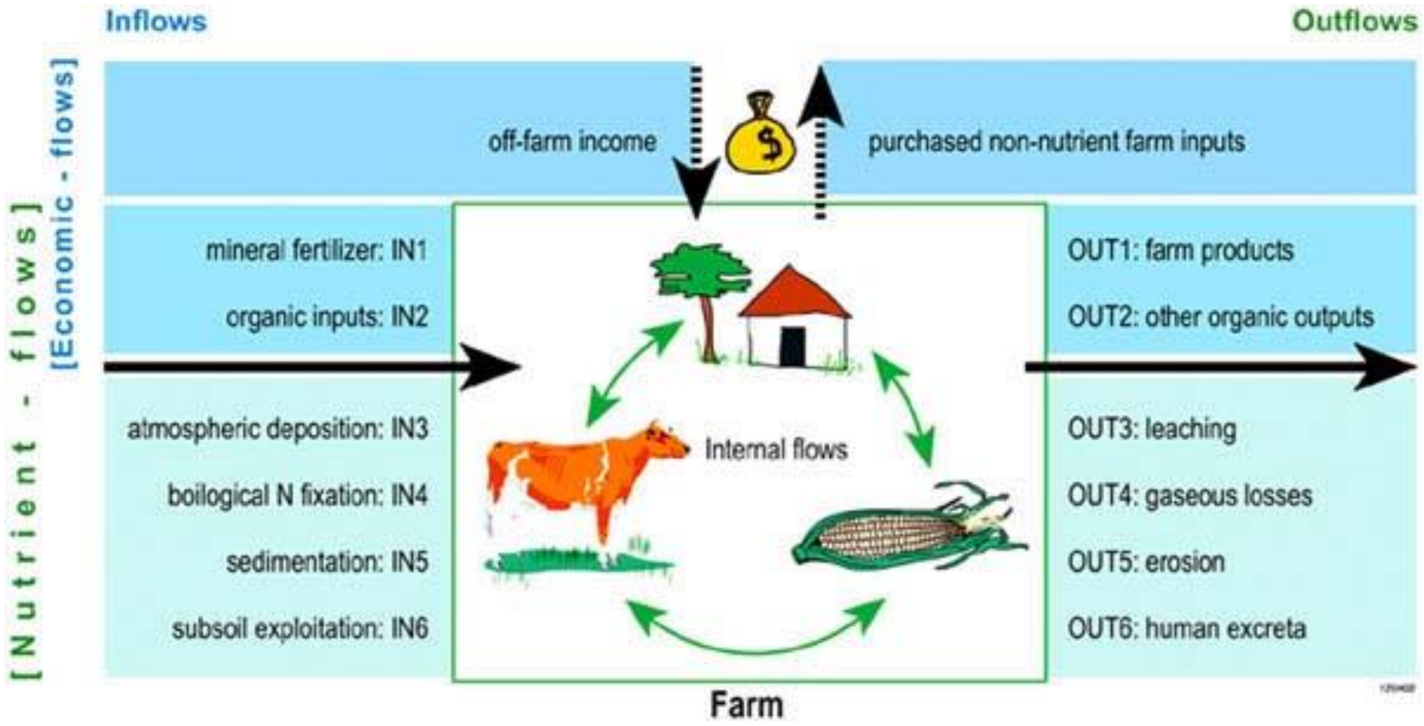
Water Using -> Evapotranspiration (ET)



Soil health (N balance ⟶ NUTMON)

CLEANED

IN1	→	OUT1
IN2	→	OUT2
IN3	→	OUT3
IN4	→	OUT4



Soil health (soil erosion ⟶ RUSLE)

RUSLE (Revised Universal Soil Loss Equation) is widely used for estimating the rate of soil loss by **water**.

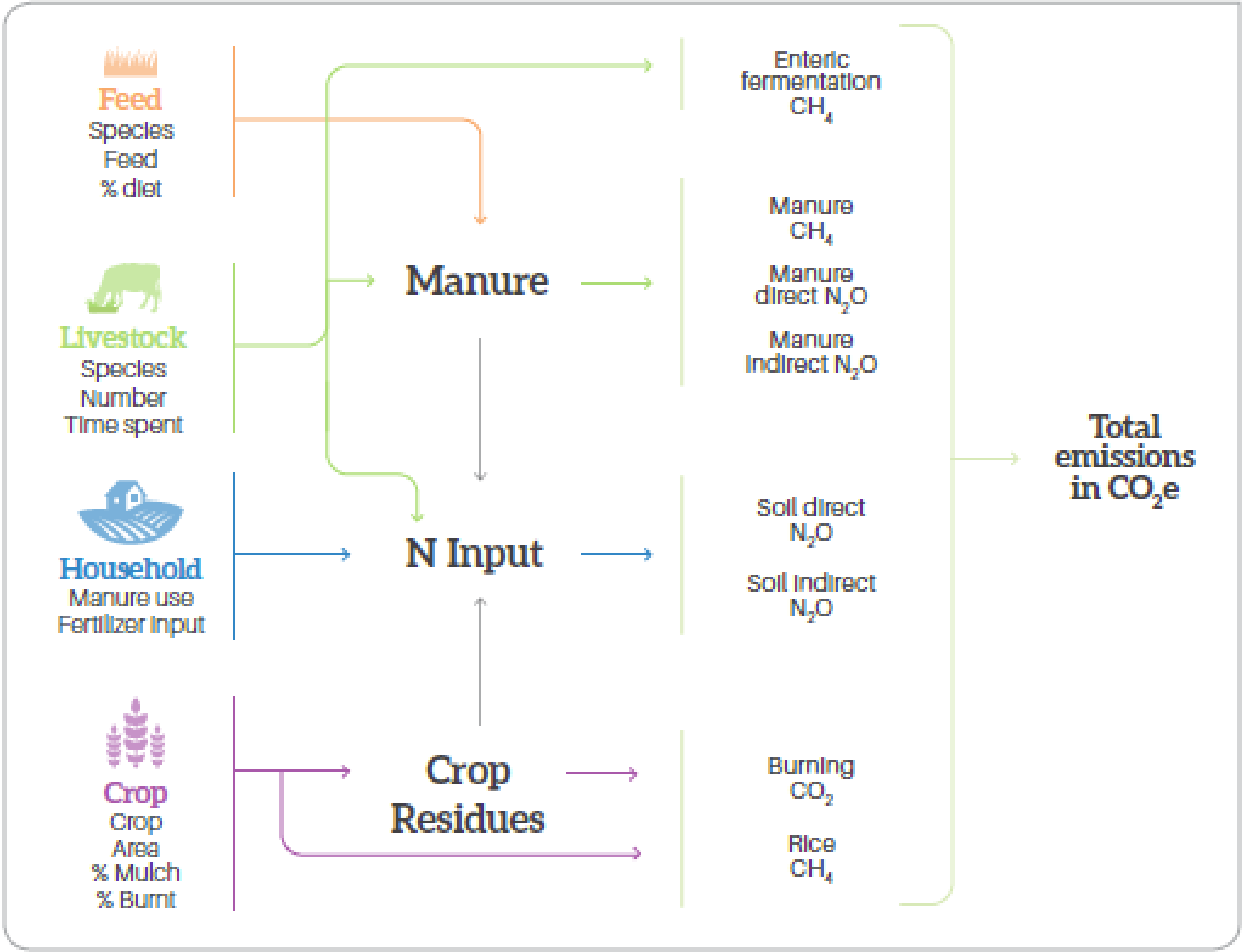
$$A = R \times K \times L \times S \times C \times P$$

A: annual soil loss per acre
R: **rainfall erosivity**
K: **soil erodibility**
L: **slope length**
S: **slope steepness**
C: **vegetative cover**
P: **erosion control practices**

GHG

2006 IPPC Guidelines for National Greenhouse Gas Inventories.

Tier 1 and 2



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Group work/exercise

Modifying benchmark farm

1. Get familiar with benchmark farm (provided) - individual (10 mins)
2. Change the following inputs and save as your own farm (20 mins)

- Livestock numbers
- Livestock and manure management
- Feed basket (% intake)
- Crop inputs

3. Transfer your results to summary sheet (provided) (30 mins)

Quiz/recap

- https://forms.office.com/Pages/ResponsePage.aspx?id=AA76ahT6t0CKLiKn-MNX1UBiR8YfYv5HrV7QaOgq9zBUNThGMVZVTjRLSldXS1lFNkRUSzhUNU9UNy4u

Lunch break

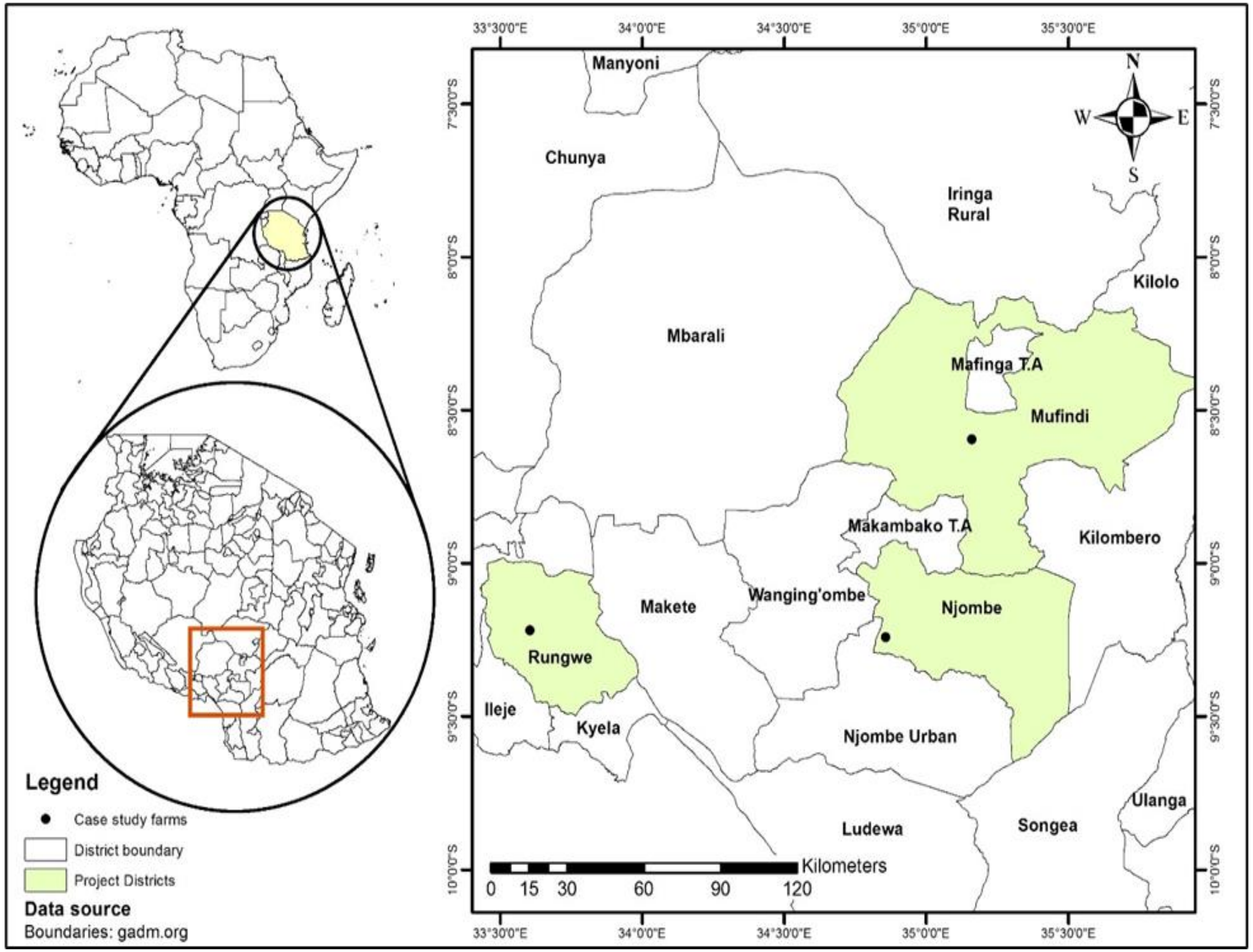
Showcasing CLEANED assessment

Introducing a dairy livestock enterprise

Southern Highlands Tanzania

- Research project - **'Climate-smart dairy systems in East Africa through improved forages and feeding strategies: enhancing productivity and adaptive capacity while mitigating GHG emissions**.'
- Focus on Rungwe, Mufindi, and Njombe Districts.

https://cgspace.cgiar.org/handle/10568/104046



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Objective of the study

- To assess the environmental impacts of increasing productivity through improved feeding as a livestock intensification pathway in smallholder dairy farming in the Southern Highlands of Tanzania.

An overview of the case study farms

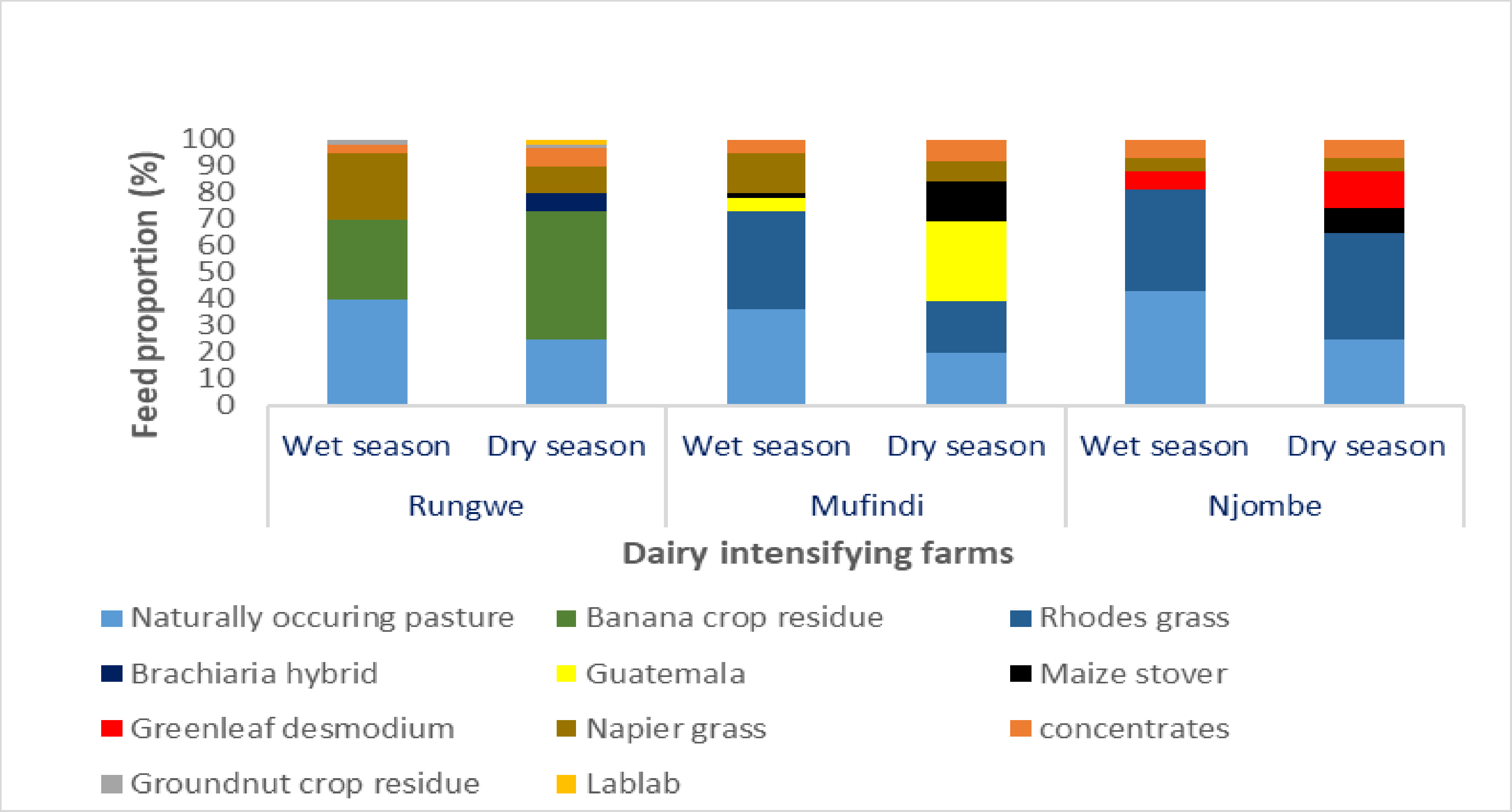
Case study farms	District	Population density (pp/km2)	Precipitation (mm/yr)	Altitude (meter above sea level)	Topography	Number of animals (Tropical Livestock Units/ha)	Productive animals	Milk/ lactating cow (kg/yr)	Fertilizer (Kg N/yr)
Rungwe	Rungwe	45	1100	1303	Hilly	4.87	1	2135	64
Mufindi	Mufindi	27	1400	1934	Steep	6.53	1	1525	5
Njombe	Njombe	33	1160	1826	Flat	4.63	1	2440	40

Inputs and parameterization

Data sources:

- ❑FEAST- Livestock production systems, feed management, agro-climatic conditions, and season lengths.
- ❑FGA - Current feed baskets ,livestock numbers, daily milk yields, and heart girth circumference.
- ❑IFAD Socio-economic household survey- farm inputs, crop residue uses and management
- ❑Parameterization - Experimental data, literature, and expert opinion.

Annual feed basket



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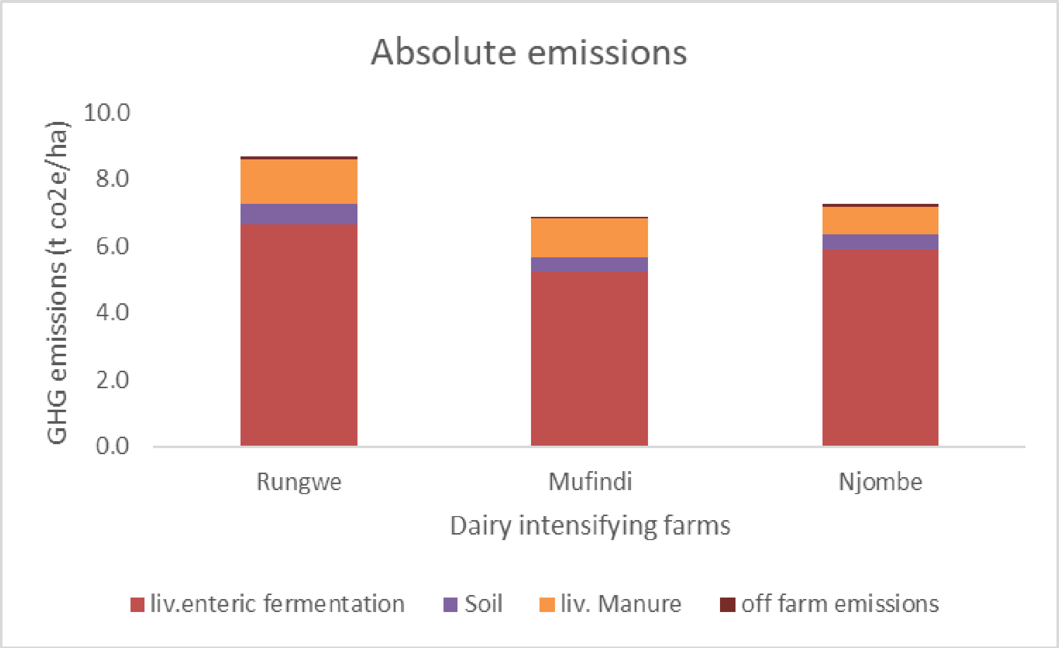
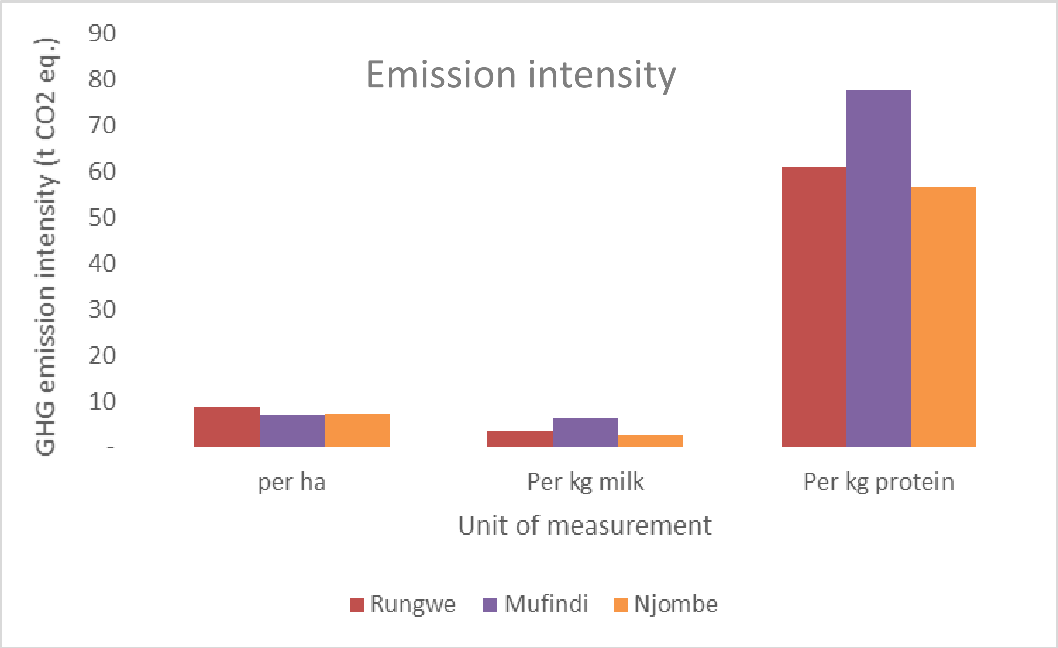
Baseline results





- ✓ Enteric fermentation main source of GHG emissions - low-quality feeding, livestock size
- ✓ Manure emissions- resulting from farm inputs
- ✓ Similar off-farm emissions

- ✓ Similar absolute GHG emissions
- ✓ Mufindi requires more emission intensity to produce kg Protein
- ✓ Global average is 2.8 kg of CO2eq per kg of FPCM
- ✓ Only Njombe is below this- showing reduced emission at lowest unit of production.
- ✓ Farming practices in Rungwe & Mufindi are contributing to more GHG emissions.

Formulating scenarios - improved feeding

Scenario	Explanation
Improved wet season feeding	This scenario involved replacing food crop residues such as groundnut and maize stover with Brachiaria, so that Brachiaria was taking up 15% of the feed basket.
Improved dry season feeding	Low-quality feed such as maize crop residue was replaced with Rhodes and Brachiaria hay, with the hay taking up 40% of the feed basket.
Improved wet and dry season feeding	A combination of the first two scenarios, comprising of a high-quality feed intake in the wet season and high-quality hay in the dry season to maintain a constant supply of quality forage.

Formulating scenarios – productivity

- Assessed milk productivity increases of 10%, 15%, 20%, 25%, and 30% through improved feeding
- A total of 15 separate analyses/scenarios done (three feeding practices x 5 production levels)

Scenario results

Case study farms and improved feeding scenarios		GHG emissions														
		10%			15%			20%			25%			30%		
		GHG/ha (t CO2eq/ha)	GHG/milk (kg CO2eq/kg milk)	GHG/protein (kg CO2eq/kg protein)	GHG/ha (t CO2eq/ha)	GHG/milk (kg CO2eq/kg milk)	GHG/protein (kg CO2eq/kg protein)	GHG/ha (t CO2eq/ha)	GHG/milk (kg CO2eq/kg milk)	GHG/protein (kg CO2eq/kg protein)	GHG/ha (t CO2eq/ha)	GHG/milk (kg CO2eq/kg milk)	GHG/protein (kg CO2eq/kg protein)	GHG/ha (t CO2eq/ha)	GHG/milk (kg CO2eq/kg milk)	GHG/protein (kg CO2eq/kg protein)
Rungwe	Improved wet season feeding		++	+		++	++		+++	++		+++	++		+++	+++
	Improved dry season feeding		++	+		++	++		+++	++		+++	++		+++	+++
	Improved wet and dry season feeding		++	+		++	++		+++	++		+++	++		+++	+++
Mufindi	Improved wet season feeding		++	+		++	+		+++	++		+++	++		+++	++
	Improved dry season feeding		++	+		+++	+		+++	++		+++	++		+++	++
	Improved wet and dry season feeding		++	+		+++	+		+++	++		+++	++		+++	++
Njombe	Improved wet season feeding		++	+		++	++		+++	++		+++	++		+++	+++
	Improved dry season feeding		++	+		++	++		+++	++		+++	+++		+++	+++
	Improved wet and dry season feeding		++	+		++	++		+++	++		+++	+++		+++	+++

Regional level scaling

From farm to national-level milk production and environmental impact assessment

$$National\ environmental\ footprints\ of\ changing\ feeding\ systems = Farm\ scale\ impacts \times Herd\ composition$$

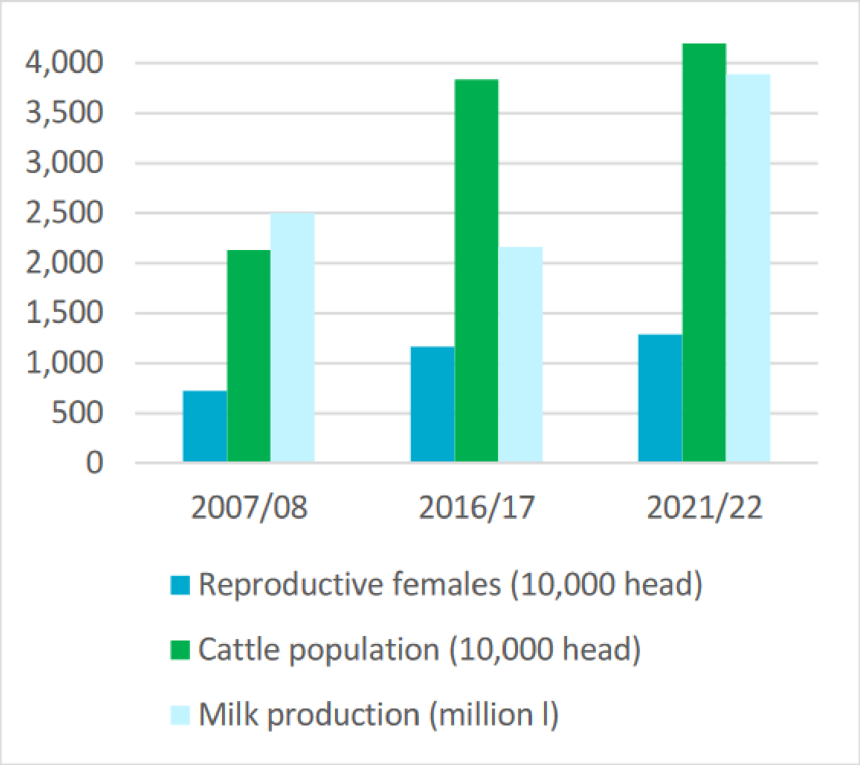
- Individuals per herd estimated from national cattle pop. Statistics

A case study of Tanzania and Rwanda

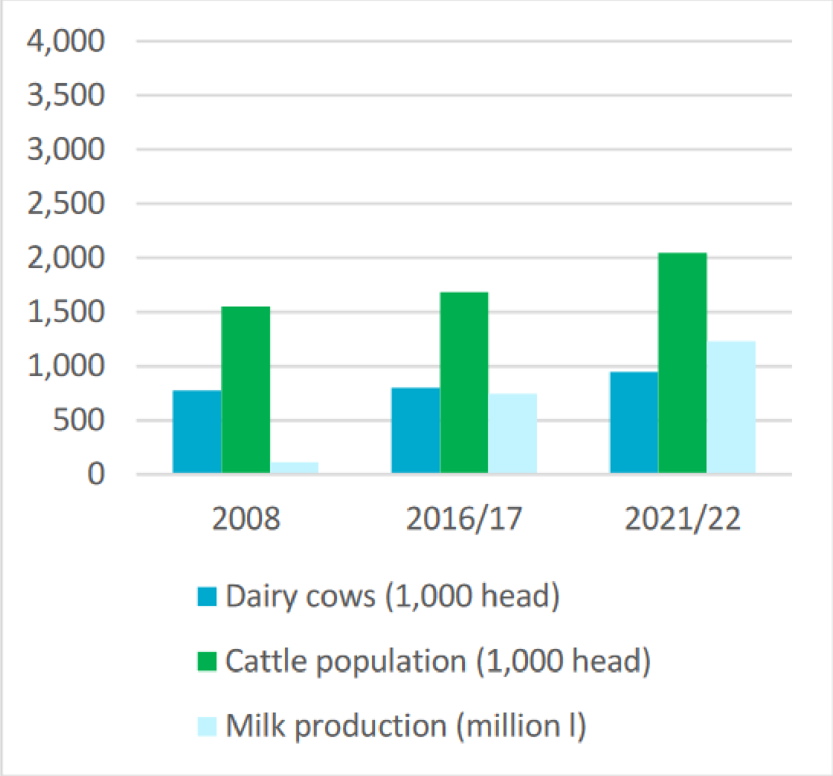
- Individuals per herd ,local breeds TZ = 3.3, Rwanda = 1.8.
- Individuals per herd, improved breeds TZ = 2.5, Rwanda = 2.3

Waha, K. (2020) Feed-based dairy system intensification scenario development and national-level biophysical impact assessment. Canberra (Australia): Commonwealth Scientific and Industrial Research Organization. 23 p. https://hdl.handle.net/10568/111512

Projected increases in milk, dairy cows and cattle pop.



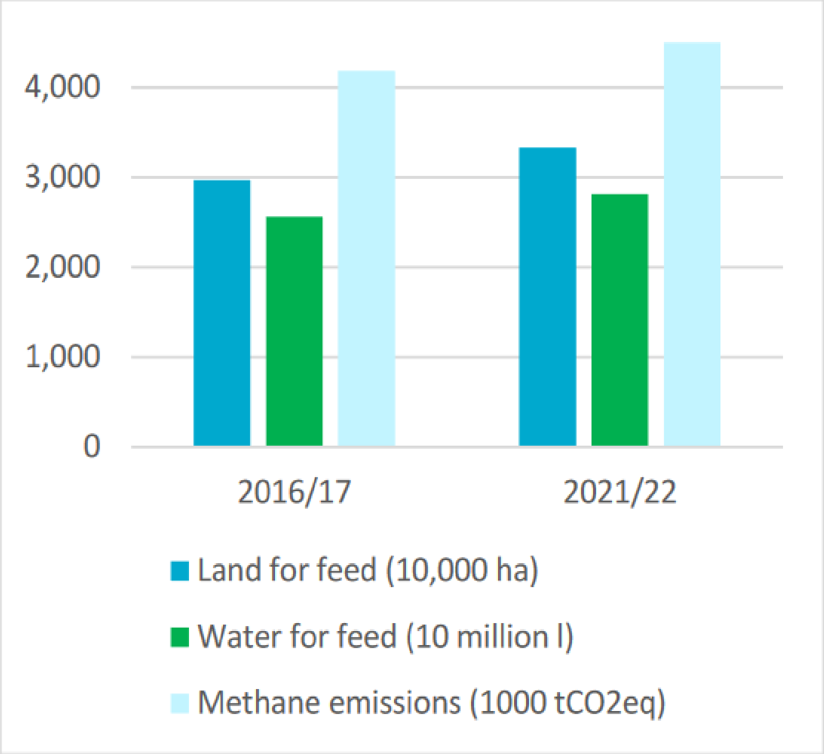
Tanzania



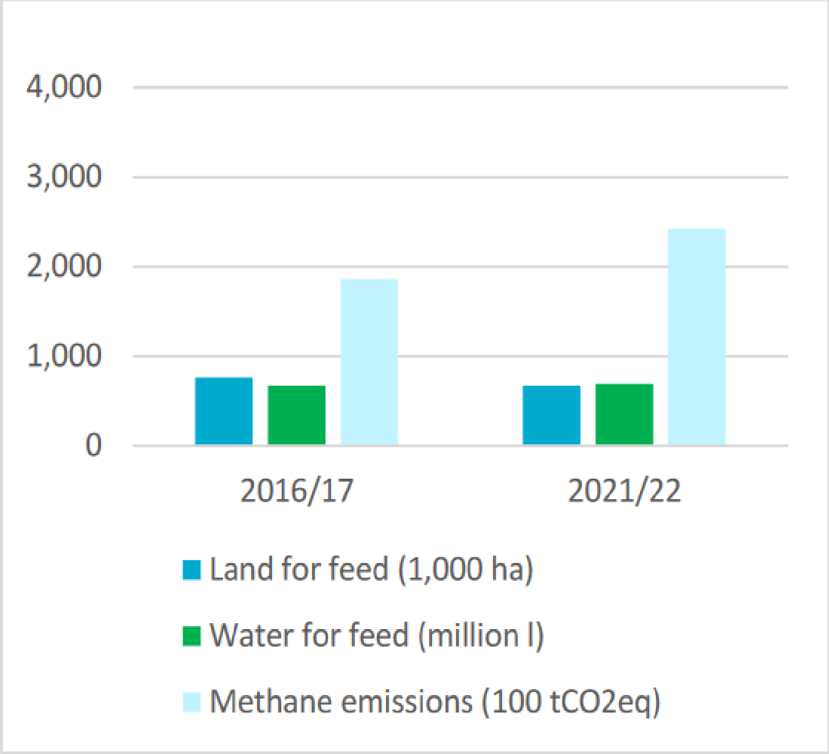
Rwanda

- ✓ 5-year plan milk increases of 80% and 65% in TZ and Rwanda respectively – LMPs
- ✓ Dairy cows increase by 10% and 7% in TZ and Rwanda respectively.
- ✓ Assumed same increase for the rest of cattle pop.

Projected environmental impacts



Tanzania



Rwanda

- ✓ Increased cattle pop. Is projected to increase methane emissions (enteric fermentation & manure mgt) by 11% (4.6Mt CO_2 eq) and 30% (0.24Mt CO_2 eq) in TZ and Rwanda respectively.

What conclusions can we make from the results?

TZ goal: **To reduce GHGe economy wide between 10-20% (INDCs) by 2030.**

- Increased methane emissions in TZ represent a very small fraction of the pledged reduction to limiting global average temperature increase to < 2^o Celsius so should not influence this goal.
- Rwanda goal: **To reduce GHGe from enteric fermentation by increasing fodder supply (Napier and Desmodium legume)**
- This goal won't be achieved if at the same time milk increases by 65%.
- Overall increase in cattle pop. needed to produce this additional milk leads to gross increase in emissions from enteric fermentation.

Group discussion: application of CLEANED in KCSAP digital dairy

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More reading

CLEANED workbook:

Mukiri, J.; Notenbaert, A.; Paul, B.; Mwema, E.; van der Hoek, R. (2020) CLEANED Workbook [Web site]. International Center for Tropical Agriculture (CIAT). Nairobi, Kenya. Retrieved from: https://cleanedtraining.netlify.app/

Journal paper:

Notenbaert et al. (2020). Towards environmentally-sound intensification pathways for dairy development in the Tanga region of Tanzania. *Regional Environmental Change*. https://doi.org/10.1007/s10113-020-01723-5

Policy brief:

Birnholz, C., Paul, B. and Notenbaert, A.M.O. 2016. The CLEANED Excel tool to assess the environmental impacts of livestock production. Livestock and Fish Brief 19. Nairobi handle: 10568/78472 https://hdl.handle.net/10568/78472

Website:https://ciat.cgiar.org/ciat-projects/environmental-assessments-of-livestock-systems-using/

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Thank you!

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This research was conducted as part of the CGIAR Research Program on Livestock and is supported by contributors to the CGIAR Trust Fund. Research used for this brief was also funded by the International Fund for Agricultural Development (IFAD) through the project ''Climate-smart dairy systems in East Africa through improved forages and feeding strategies: enhancing productivity and adaptive capacity while mitigating GHG emissions”.

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