

# Evaluating potential environmental co-benefits of perennial grass-legume mixtures in Ethiopia

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# The context



Ethiopia suffers from some of the highest rates of soil erosion and land degradation worldwide (with high contribution by livestock's overgrazing of natural pastures)



Climate change is projected to exacerbate this  
Livestock contribute >60% of agricultural GHGe



Livestock is crucial for  
livelihoods and the economy

70 million cattle, 43 million sheep, 52 million goats  
(+ horses, donkeys, mules, camel and poultry)  
18.9 million livestock keeping households  
4.7 billion litre cattle milk, 2.4 billion litre camel milk,  
370 billion eggs, honey, beef, mutton, goat

# EthiopiaGRASS: a multi-disciplinary project

The ETHIOPIAGRASS project aims to develop **integrated grassland-cropping systems** to address this challenge by enhancing livestock feed provision, simultaneously improving soil quality and subsequent food crop production, and reducing livestock's overall environmental footprint.

- **Greenhouse experiment:** Microbial functions and soil nutrient turnover
- **On-station trials:** yields, effects on soil quality, carbon storage, and nutrient cycling.
- **Participatory farmer-led testing:** smallholders' preferences and adoption patterns
- **Literature review:** forages and land restoration
- **CLEANED modeling:** environmental co-benefits
- **Suitability mapping:** scaling potential
- **Multi-stakeholder engagement:** validation and scaling



# Three major Livestock Production Systems in Ethiopia

- ▶ Mixed crop-livestock - 55 million cattle

- ▶ Crop-livestock interactions

- LIVESTOCK → CROP ~ manure, draught power*

- LIVESTOCK ← CROP ~ feed*

- ▶ Emphasis on crop cultivation

- ▶ Relatively low livestock numbers/household

- ▶ (agro-)pastoral - 13.4 million cattle

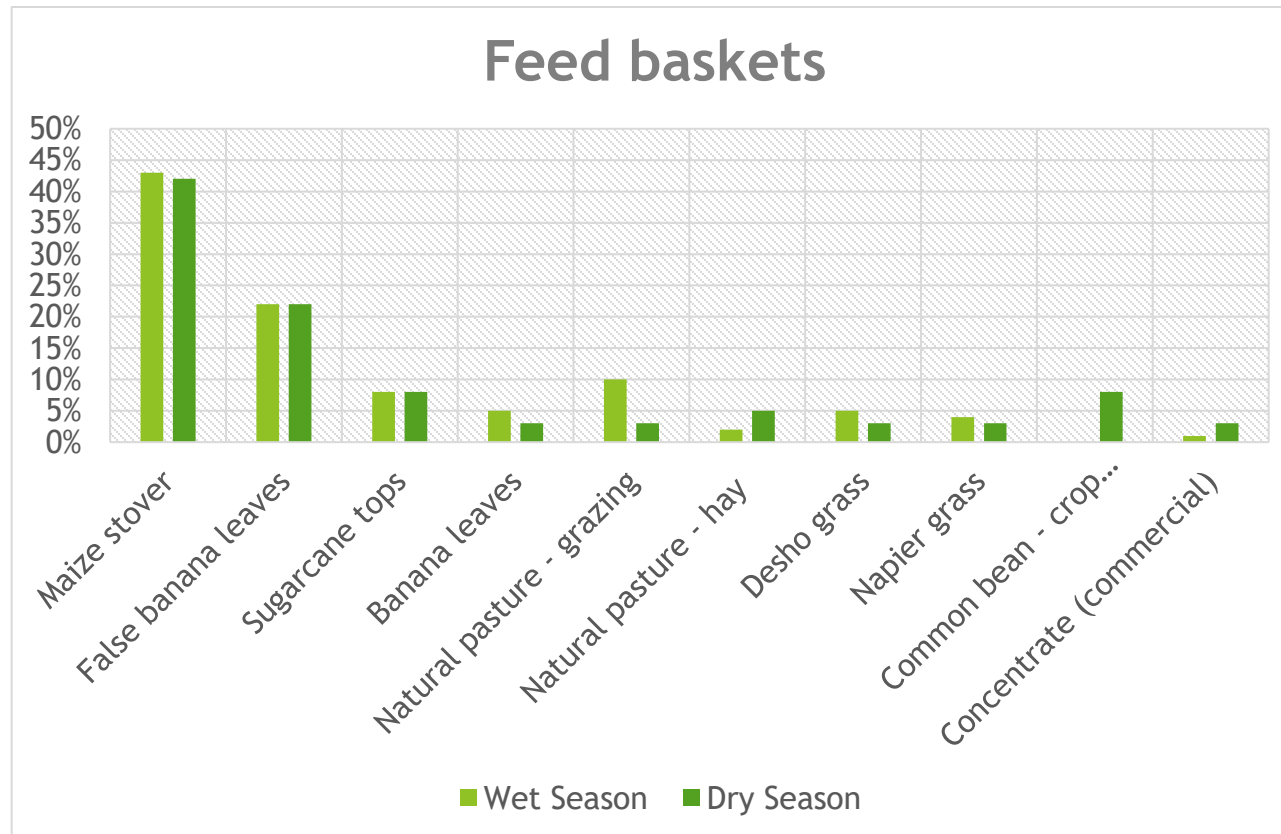
- ▶ No (or limited) crop production

- ▶ Specialised dairy - 1.8 million cattle

- ▶ Mostly (peri-) urban

# Livestock at a typical crop-livestock farm in Bilate District

- ▶ 2 cows, 1 adult male, 2 heifers/steers, 2 calves



- Annual milk production:
  - 325 liter/year/cow
- Annual live weight gain:
  - Heifers/steers: 80 kg
  - Calves: 80 kg
- Manure used for false banana
- DAP for maize and beans

# Feed crops at a typical crop-livestock farm in Bilate District

Feed item	Yield (MT DM/ha)	ME content (MJ/kg DM)	CP content (% DM)
Maize stover	7.31	18.20	5.35
False banana leaves	7.64	17.30	14.10
Sugarcane tops	2.50	18.00	4.90
Banana leaves	4.83	18.10	9.50
Natural pasture	6.40	18.00	10.00
Desho grass	18.28	18.10	6.50
Napier grass	20.00	17.40	9.70
Common bean - crop residue	15.05	17.90	7.10
Concentrate (commercial)	N/A	18.90	17.30
<i>Mombasa, Mulato II, Desmodium &amp; Vetch</i>	22.00	18.47	14.47

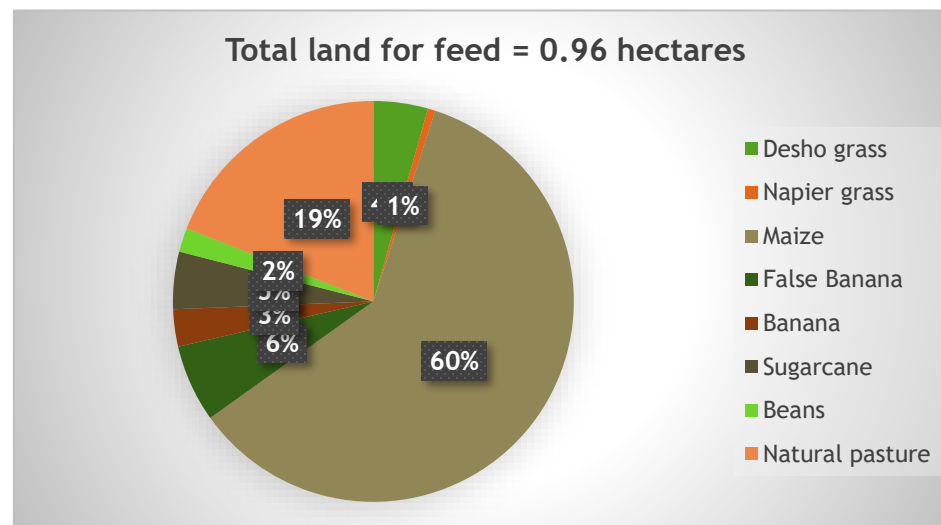
# The environmental performance of the livestock enterprise in Bilate District

## ► Production:

- 781 liter FPCM, 327 kg increase in live weight  $\sim$  66 kg protein and 443 AME days
- 4.7 tons of manure

## ► Land for feed production:

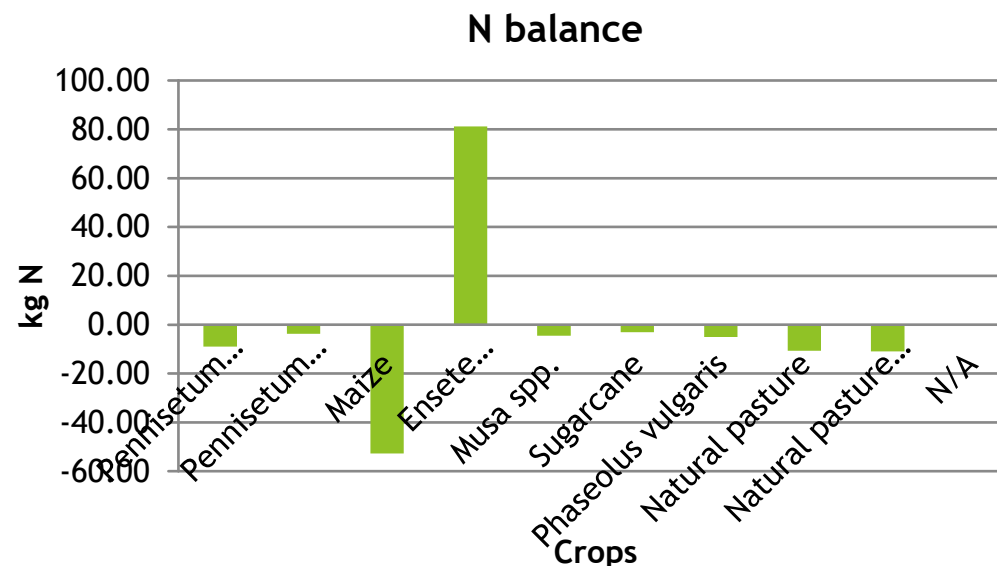
- Total: 0.96 ha
- Maize > pasture



# The environmental performance of the livestock enterprise in Bilate District

## ► N Balance:

- Mostly mining
- Maize!

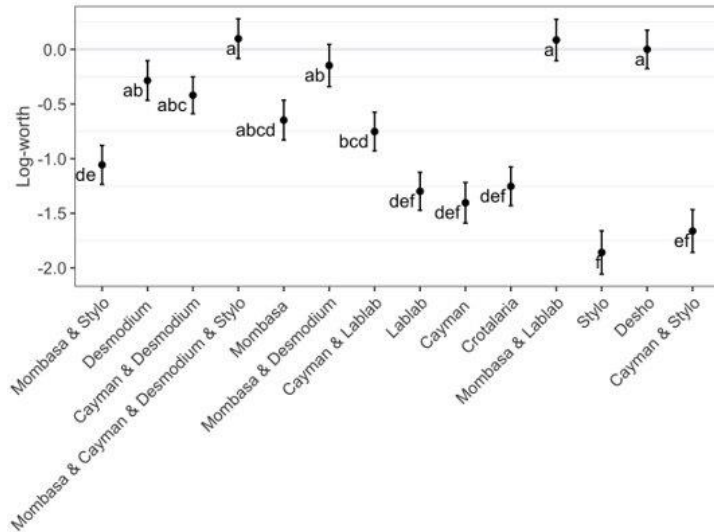


## ► GHG emissions

- Total: 5,923 kg CO<sub>2</sub>eq
- Intensity: 7.58 kg CO<sub>2</sub>eq/kg FPCM

# Introduction of grass-legume mix

- Replace 50% of the grasses (Desho, Napier, natural grassland) by a farmer-preferred grass-legume mix



## Farmer-led testing:

Farmers prefer *Panicum-Brachiaria* grass mixed with *Desmodium* and *Vetch* or *Stylosanthes*.



## On-station trial (simplex design):

Mixing legumes and grass gave significantly more yields than would be expected from the yields of monocultures



# Results

	Total Milk (kg FPCM)	Total Meat (kg)	Total area used for feed production (ha)	Area per milk unit (ha / MT FPCM)	Total GHG emissions (kg CO <sub>2</sub> eq)	GHGe intensity (kg CO <sub>2</sub> eq/MT FPCM)
Baseline	781	327	0.96	1.23	5,923	7.58
Limited mixtures	820	343	0.91	1.11	5,829	7.11
% change	5%	5%	-5%	-10%	-2%	-7%
A lot of mixtures	859	360	0.81	0.94	5,716	6.65
% change	9%	9%	-19%	-31%	-4%	-14%

- ▶ The results demonstrate significant environmental co-benefits of productivity increasing forage grass-legume mixes
- ▶ This presents opportunities to reduce livestock numbers, freeing up land for food or cash crops, reforestation, or conservation efforts.

# Next steps

- Out-scaling environmental assessment
- Cost-benefit analysis
- Gender analysis
- Synthesis
- Outreach and dissemination



# Conclusion

- ▶ To achieve sustainable farming in Ethiopia, **substantial changes** in livestock and land management are imperative.
- ▶ Several farmer-acceptable **grass-legume mixtures** were identified as more productive and multipurpose than monocultures, with an indication of positive legacy effects on soil health and subsequent food crops is observed.
- ▶ The replacement of 50% of collected fodder by the grass-legume mixtures **increases feed quality** and consequently decreased GHG emission intensity and water and land footprints.
- ▶ Transitioning to more intensive feeding systems including production of integrated grass-legume mixes or improved forage rotations with food crops could be beneficial.
- ▶ However, **further research is needed** to assess gendered labor and socio-economic implications.

# THANK YOU

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# The 2-sided contributions of livestock



## For PEOPLE

- Employment, income
- Economy
- Food and nutrition
- Transport, cultural value
- Resilience and risk management



## And the PLANET

- Biggest land user →
- Natural resources:
  - Manure, soil carbon, energy...
  - Water use/pollution, degradation, GHGe...

Opportunity cost!  
e.g. carbon storage, food production, biodiversity, ...

**Sustainability is a big issue and needs to be**

Optimize the environmental footprint

↑ “Good” & “Bad” ↓

**Without compromising the good!**