BRIDGE+
Practice Brief 02


Chopper technology to improve feed efficiency

GHG Emissions Reduction Potential From Improved Dairy Practices

May **2026**

Background

In Ethiopia, the dairy sector is a cornerstone of rural economic resilience and a primary source of essential nutrition. However, the industry is currently defined by a low-input, low-output system with large cattle numbers and very low productivity, fostering a significant environmental footprint. Within the Ethiopian landscape, greenhouse gas (GHG) emissions are primarily driven by the country's mixed crop-livestock systems and the pastoral/agropastoral systems, accounting for 56% and 43% of total milk-related emissions, respectively (FAO and NZAGRC, 2017). These emissions stem largely from enteric fermentation and traditional manure management. While the dairy sector is a global contributor to climate change, the pressure in Ethiopia is localised; the conversion of forests to fodder and the heavy reliance on traditional grazing contribute to a high emission intensity compared to the burgeoning commercial sector, which accounts for only 1% of the country's dairy-related emissions (FAO and NZAGRC, 2017).

Summary

While Ethiopia's dairy sector is vital for nutrition and rural economies, it faces low productivity and high greenhouse gas (GHG) emissions. Research into the BRIDGE+ interventions shows that, while total farm emissions rose due to larger herds, emission intensity (GHG per unit of milk) dropped significantly as productivity improved. Key mitigation strategies include enhancing feed efficiency, improving manure management, and expanding market access.


bio slurry application

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bio slurry application

Problem statement

While the dairy sector is vital to Ethiopia's food security and rural livelihoods, its expansion is currently conflicting with environmental sustainability.

The sector suffers from low animal productivity and high climate impact at the same time. As Ethiopia experiences a surge in demand for dairy products due to urbanisation and population growth, the environmental cost, specifically direct methane from enteric fermentation and indirect CO_2 from feed transportation, threatens to escalate. Ethiopia's main challenge is finding a way to grow the dairy industry without increasing GHG emissions. Without targeted interventions in feed efficiency and modern farming practices, the anticipated rise in production will exacerbate land degradation and climate vulnerability. Thus, transforming the dairy value chain into a high-productivity, low-carbon system is not just an environmental necessity, but a critical economic opportunity for the nation.

Objective

The study aimed to determine the effect of dairy practices on GHG emissions in the main dairy farming systems, and the emission reduction potential of interventions promoted by the BRIDGE and BRIDGE+ projects.

BRIDGE+

Building Rural Income through inclusive Dairy Business Growth in Ethiopia (BRIDGE+) is a five-year (2023-2027) project financed by the Embassy of the Kingdom of the Netherlands, Addis Ababa and implemented by a consortium of SNV, Agriterra and Wageningen University & Research.

The project aims to foster a dairy value chain that creates inclusive and sustainable benefits for all participants, including the wider society, with a particular focus on smallholder farmers in mixed farming systems. It works across all functions of the dairy value chain, from production to end markets.

R&D Component:

Research and Development (R&D) is one of the ten components of the BRIDGE+ project. The component aims to generate evidence to inform project implementation and influence dairy related policy. It is jointly implemented by SNV and WUR. The component collaborates with more than 14 local implementing partners, including federal and regional agricultural research institutes, universities, and professional associations.

Methods

The present study evaluated the impacts of the applied BRIDGE and BRIDGE+ intervention strategies by quantifying the GHG emissions and emission intensity of dairy farming in Mekelle, North Shoa, and Sidama milk sheds in Ethiopia, considering these strategies. The research project was implemented by BRIDGE+ project by Holeta Agricultural Research Centre and four universities: Mekelle, Hawassa, Debre Berhan, and Wageningen University & Research.

The GHG emissions and emission intensity of the farms with the BRIDGE/BRIDGE+ project interventions were determined using both primary and secondary data collected. Primary data on herd composition, feed composition, manure management and milk production, etc., were collected through a household survey conducted in 2024/25.

The household survey involved 216 dairy farms split into two groups:

i) 78 farms not participating in BRIDGE and BRIDGE+ interventions (Without Project; **WOP**) and

ii) 166 farms benefiting from these interventions (With Project; **WP**).

The GHG emission sources assessed included enteric CH_4, CH_4 from manure management systems, CO_2 emissions from feed production and transportation, and direct and indirect N_2O emissions from manure management and pasture deposition. GHG emissions were estimated using the IPCC Tier 2 methodology, while emission intensity and emission reduction were calculated using the Initiative for Sustainable Forest Landscape (ISFL) method.

The IPCC (2019) tier 2 methodology was used to estimate methane from enteric fermintation, Methane and Nitrous oxide emission from manure mangement practices and N2O and CO2 emission from feed production and transportation. While emission intensity approach was used to investigate the GHG emission reduction potental of BRIDGE and BRIDGE+ project interventions. Emission intensity refers to GHG emissions per unit of product (in this case, per unit of FPCM) from the dairy cattle for the two scenarios (WP and WOP).

Key Findings

The GHG emissions per farm in t CO_2eq were 70% higher for WP farms compared with WOP farms in the same milk sheds (69 vs. 41 tCO_2eq/farm/year).

- The average GHG emission intensity for WOP farms was 16.22, 9.92, and 15.19 tCO_2eq/t-FPCM for Mekelle, North Shoa, and Sidama milk sheds, respectively, whereas the emission intensity for WP farms in the same locations was 7.36, 10.54, and 8.79 t CO_2eq/t-FPCM, respectively (Table 1)

- Emission intensity of intervention farms (WP) decreased by 54% and 42% compared with WOP farms in Mekelle and Sidama milk sheds, respectively, while the emission intensity of WP farms in North Shoa was higher by 6% compared with WOP farms in the same location.

- Overall, Sidama consistently exhibited the highest total GHG emissions under WP scenarios, primarily driven by higher enteric CH_4 and N_2O emissions. North Shoa showed the lowest emissions under WP conditions, suggesting potential benefits of project support in reducing GHG intensity.

- The higher emission factor in North Shoa for WOP farms could be attributed to a higher proportion of brewery waste in the diet composition which resulted in higher CO2 emission compared with WP farms, and also a possible selection bias on the WOP farms.

Milk shed		Unit	WOP	WP
Mekelle	GHG emissions	tCO2e/farm/yr	22.08	69.64
	Emission intensity	tCO2eq/t-FPCM	16.22	7.36
N/Showa	GHG emissions	tCO2eq/farm/yr	53.95	67.48
	Emission intensity	tCO2eq/t-FPCM	9.92	10.54
Sidama	GHG emissions	tCO2eq/farm/yr	46.52	71.21
	Emission intensity	tCO2eq/t-FPCM	15.19	8.79
Average	GHG emissions	tCO2eq/farm/yr	122.55	208.33
	Emission intensity	tCO2eq/t-FPCM	12.43	8.69

Table 1: Average GHG emissions and emission intensity per dairy farm with and without project support

The difference in enteric CH4 emission factor between WOP and WP farms in the three milk sheds is related to the difference in gross energy intake as a result of the difference in the digestible energy required for lactation and work and mainly in the average daily milk yield, shown in Figure 1.



Figure 1 (a): Number of dairy animals owned (b) Average daily milk yield per cow

Drivers for Emissions Intensity

The total emissions per farm are driven by the total number of animals on the farm and the average milk yield per cow. Cows with higher milk yield tend to be more efficient in converting feed into milk and hence usually have lower emissions per kg of milk compared to low-yielding cows.

Figure 1 shows the number of animals per farm and the average milk yield calculated separately for WOP and WP farms per milk shed.

The WP farms in all three milk sheds had more animals per farm, which was a major contributor to the higher emissions per farm in this group, compared to the WOP farms. Looking at the milk yield, cows from the WP farms produced more milk per day in Mekelle and Sidama, hence the lower GHG emissions per litre of milk in these milk sheds for WP farms, compared to the WOP farms. However, in North Shoa, the WOP farms had a higher milk yield, leading to lower GHG emissions of the WOP farms compared to the WP farms.



Sistema Bio Pre-fabricated Bio digester.

Recommendations

The best way to measure GHG emission reduction is to use an emission intensity measure, which is GHG emission per unit of product. Cows with higher milk yield have lower GHG emissions intensity; therefore, strategies leading to improved productivity in dairy cattle have a high potential to reduce GHG emissions.

There is no single pathway to achieving a low-carbon dairy sector; emission intensity can be further reduced by:

- Increasing dairy cattle productivity mainly by improving feeding strategies to increase the feed conversion efficiency of cows
- Enhancing crop residues, commonly fed to cows, for example, by using urea treatment and supplementing them with high-protein feeds.
- Managing reproduction to increase the proportion of productive animals in the herd by reducing the calving interval and the age at first calving, and by culling less productive animals.
- Strengthening the Farmer Field Schools to systematically support low-carbon dairy production systems, ensuring increased productivity, improved manure management, including the use of biogas digesters to capture manure methane and provide farmers with clean energy and fertiliser.

Lessons Learned

We have learned that changes in emission intensity are attributed to factors at the individual animal and or at the herd level:

- At the individual animal level, we confirmed that increasing productivity reduces the GHG emission intensity of livestock production (GHG emissions per unit of livestock product output).
- From the household level, GHG emission intensity can be decreased by a change in herd structure (e.g. growth in the relative share of more productive animals, change in herd composition) or by increasing marketed output.
- The selection of the right control farms for North Shoa was a challenge, and more robust criteria should be put in place when selecting control farms for subsequent studies.

Implications for Practice

- Transition from increasing herd size to maximising milk per cow to lower emission intensity, not just increasing animal numbers.
- Prioritise Interventions that enhance feed quality, encourage the use of high-yielding crossbreds, and improve manure management

References

FAO and NZAGRC (2017): Supporting Low Emissions Development in the Ethiopian Dairy Cattle Sector. Food and Agriculture Organization of the United Nations (FAO) and the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC)



Improved forage production.



Feeding Management

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