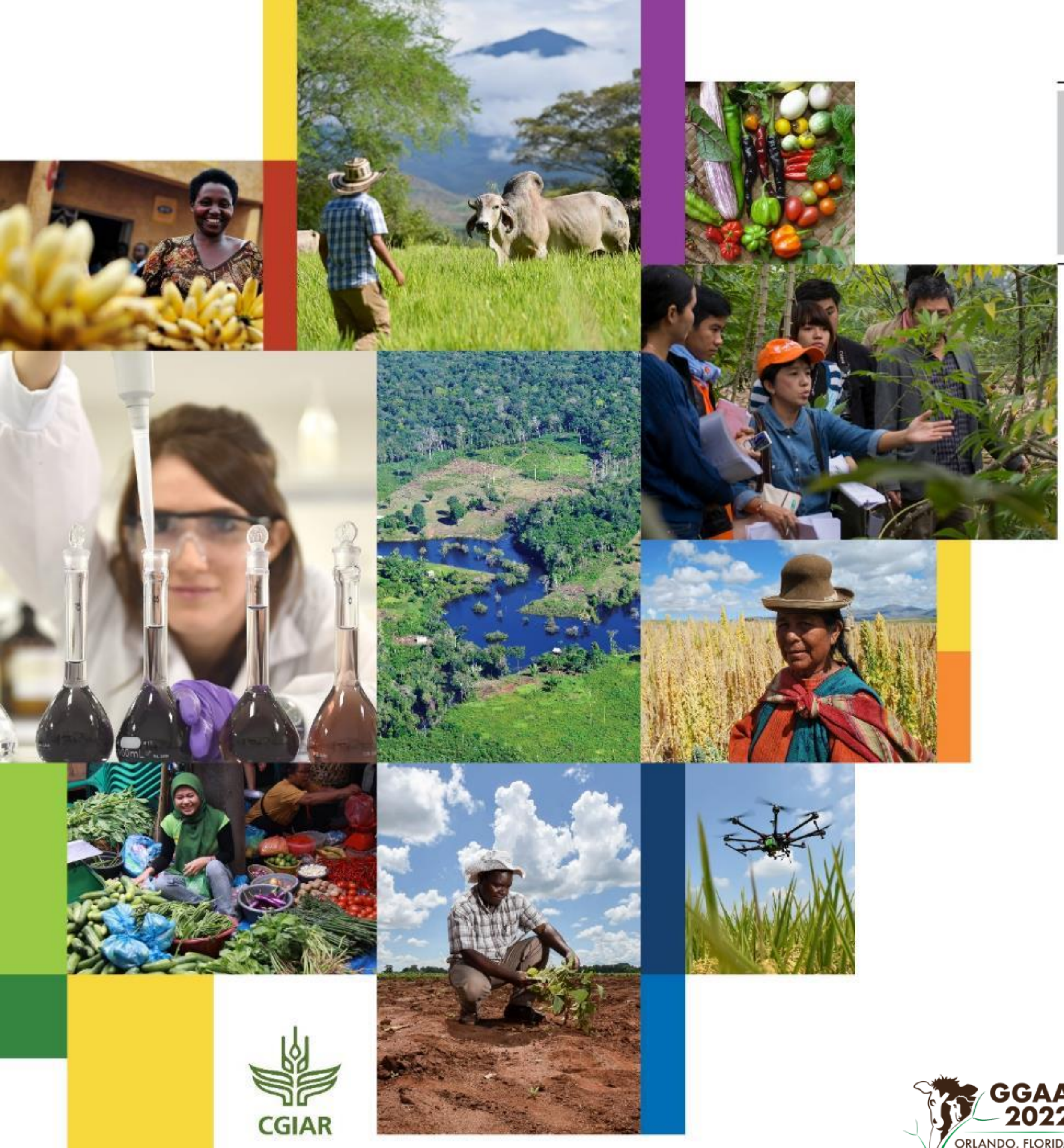

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Climate impact of improved genetic resources from a novel beef production system in the Colombian Orinoquia

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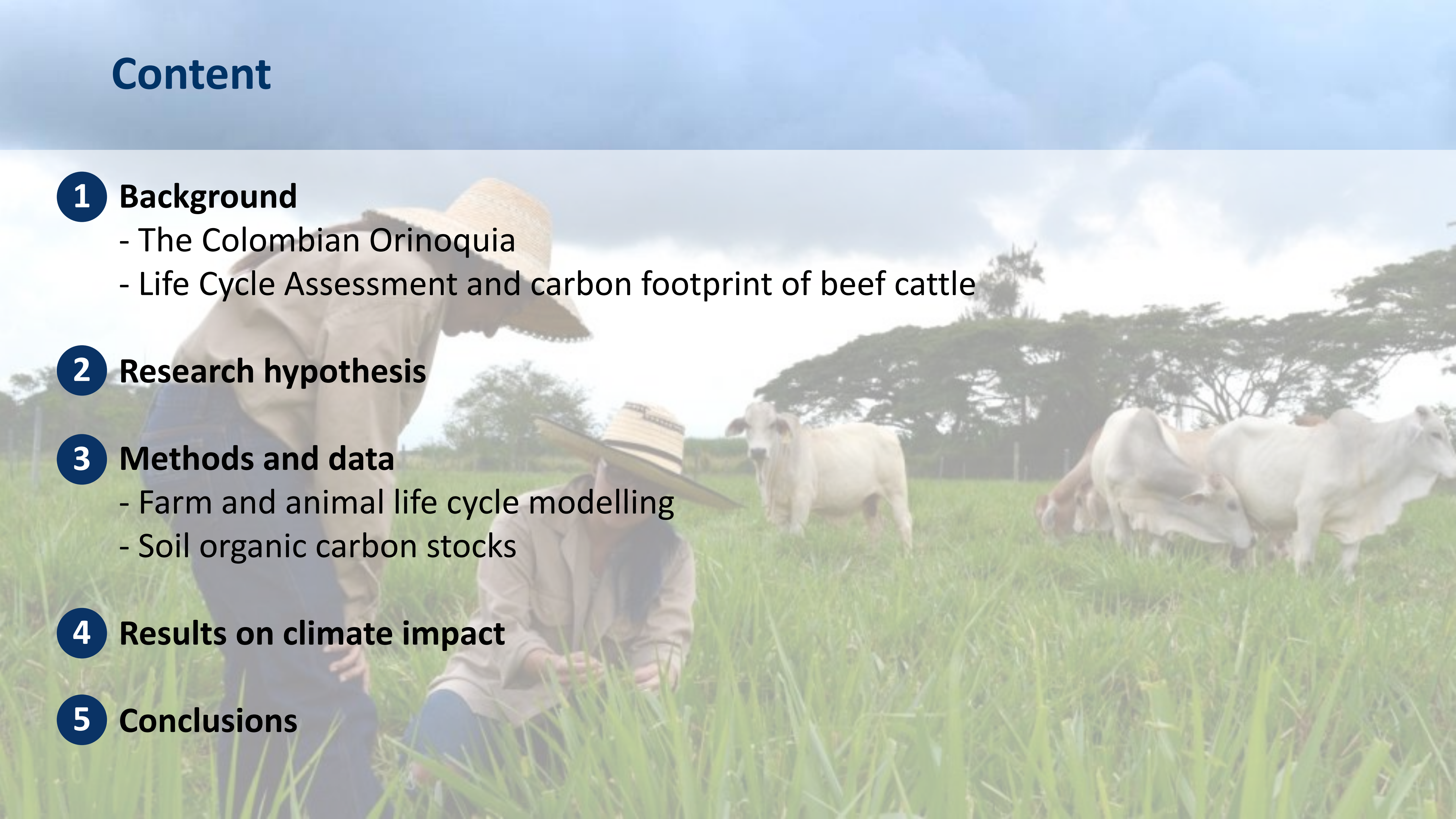
GGAA 2022
ORLANDO, FLORIDA USA
Hybrid Event

8th International Greenhouse Gas & Animal Agriculture Conference June 09, 2022

Content



1. **Background**
   - The Colombian Orinoquia
   - Life Cycle Assessment and carbon footprint of beef cattle
2. **Research hypothesis**
3. **Methods and data**
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   - Soil organic carbon stocks
4. **Results on climate impact**
5. **Conclusions**

❶ The Colombian Orinoquia

- AFOLU sector in Colombia: 55% of national GHG emissions in 2014[1] → Thereof 51% from livestock related activities.
- **Livestock activities could become key in the achievement of the NDCs in the context of the Paris Agreement.**

★ Location of the case study.

- Beef farms in Colombia: 11.6 million heads (43% of total cattle) → Thereof 34% in the Orinoquia, extensive systems.
- Annual grassland burns to provide animals with grass sprouts, ashes' minerals and control unpalatable grasses[2].

Vichada:

- 10 million ha (6% of national territory).
- Degraded permanent grasslands.
- Average annual rainfall: approx. 2.200 mm[3].
- Average temperature: 27.3°C[3].
- Soils: low activity clay[4], acid soils.
- Undeveloped infrastructure, scarce workforce.

[1]IDEAM, UNDP 2018; [2]Peñuela et al. 2014; [3]IDEAM 2021; [4]Neira et al. 2017.

Matiz-Rubio et al. (under review), Climate impact of producing genetic resources for more efficient beef cattle.

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1 Life Cycle Assessment and carbon footprint of beef cattle

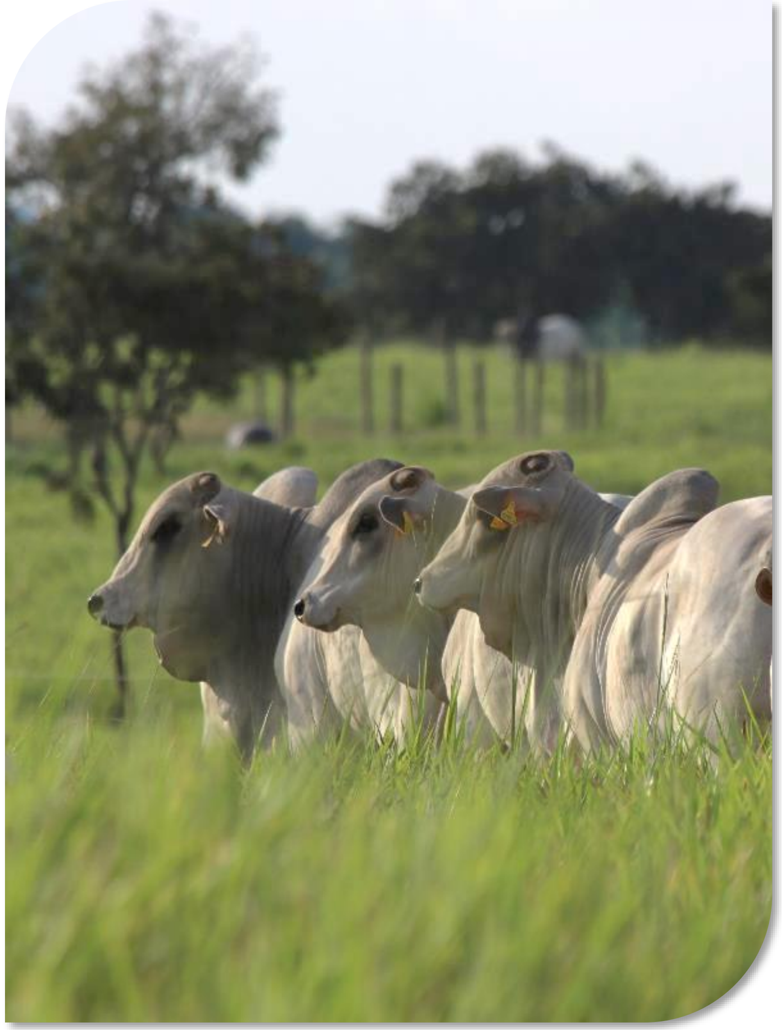


Photo: Hacienda San José

- Some studies claim to calculate the carbon footprint but focus only on GHG emissions.
- Soil carbon fluxes are rarely assessed[1].
- GHG intensities of embryo, semen and breeding stock are inputs missing in the systems.
- Biophysical allocation to distribute the burdens among the co-products is recommended for LCA studies, yet there is no standardized method available for beef cattle (unlike dairy).

[1]Cusack et al. 2021; [2]FAO 2016

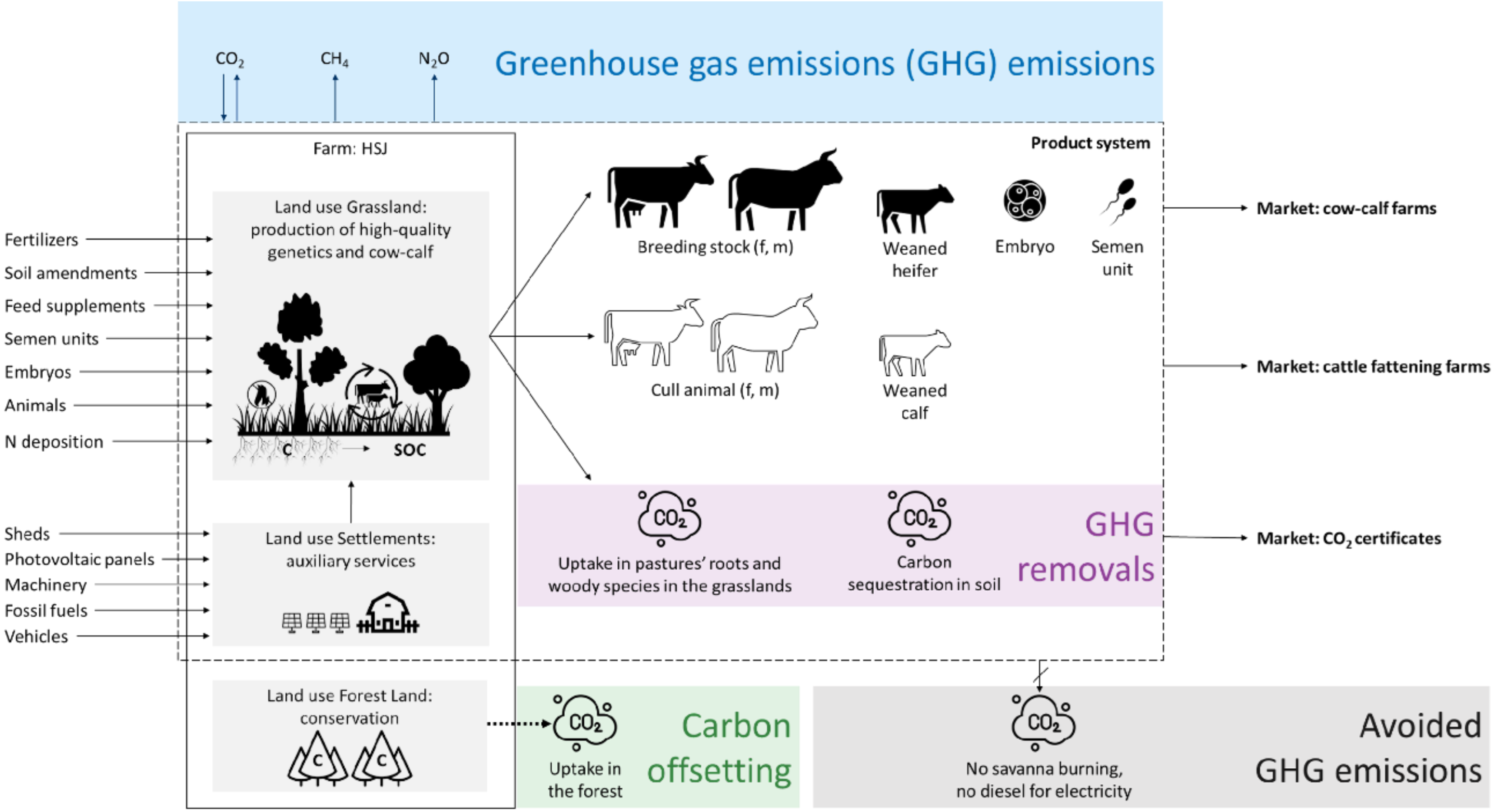
❷ Research hypothesis

Photo: Hacienda San José

- **Cattle of high genetic merit have considerable potential to reduce GHG intensities** in the beef sector, especially in regions characterized by low animal productivity like Latin America.
- The introduction of **improved pastures** as part of a rotational grazing system without grassland burns enhances carbon capture in the soil.
- A methodological framework combining the life cycle at the farm and animal level is needed to calculate the climate impact of producing genetic resources.

❸ Farm life cycle modelling

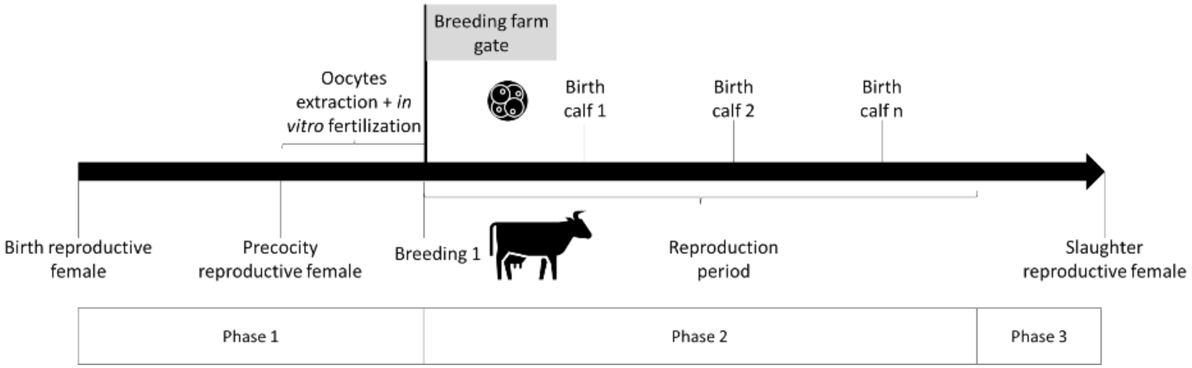
- **System boundary:** cradle to farm-gate.
- **Functional unit:** annual production of exported animal LW during 2017–2023.



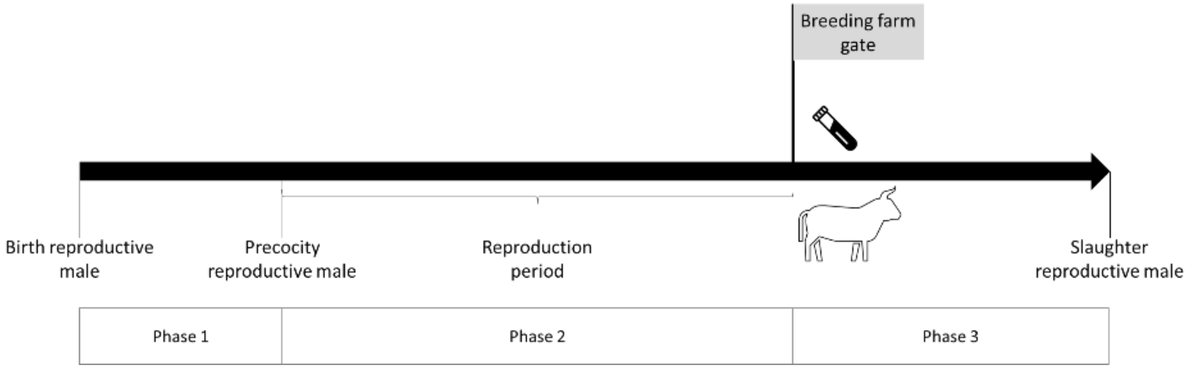
- ISO standards: Carbon footprint of products (14067:2018) and LCA (14040 and 14044:2006).
- IPCC Guidelines for National GHG Inventories and Emission Factors (2006, 2019).
- Colombian National Inventory Report (IDEAM and PNUD 2018).
- Background model: life cycle inventory database ecoinvent 3.6 (2019).

❸ Animal life cycle modelling

- Multifunctional life cycle Embryo – Bred cow



- Multifunctional life cycle Semen – Cull bull



Scheme for biophysical allocation of burdens

	Phase 1		Phase 2		Phase 3	
NE	**GR**	**RA**	**GR**	**RA**	**GR**	**RA**
NEm		X	X			X
NEa		X	X			X
NEg	X		X			X
NEp			X			
NEl			X			

NE: net energy, m: maintenance, a: activity, g: growing, p: pregnancy, l: lactation
GR: genetic resource, RA: reproductive animal

- GHG emissions from the NEg of the reproductive animal in phase 1 are allocated to the embryos and semen (genetic resources).
- **NEg is used as proxy measure of NE for reproductive functions.**

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❸ Soil organic carbon stocks - Experimental design

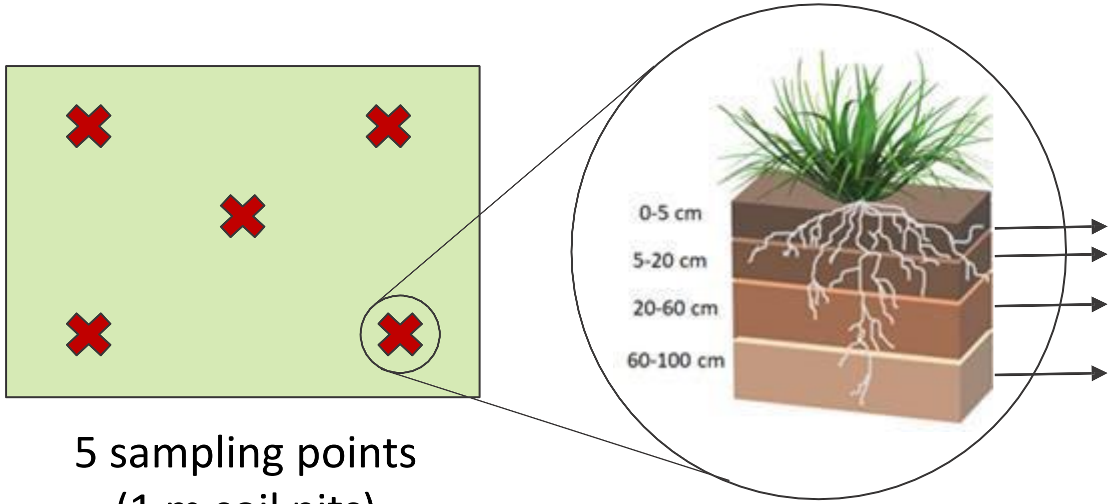
3 land use types:

Permanent grassland

Improved pasture
U. Humidicola (Est. 2016-2017)

Forest

In each land use type
(June 2021)



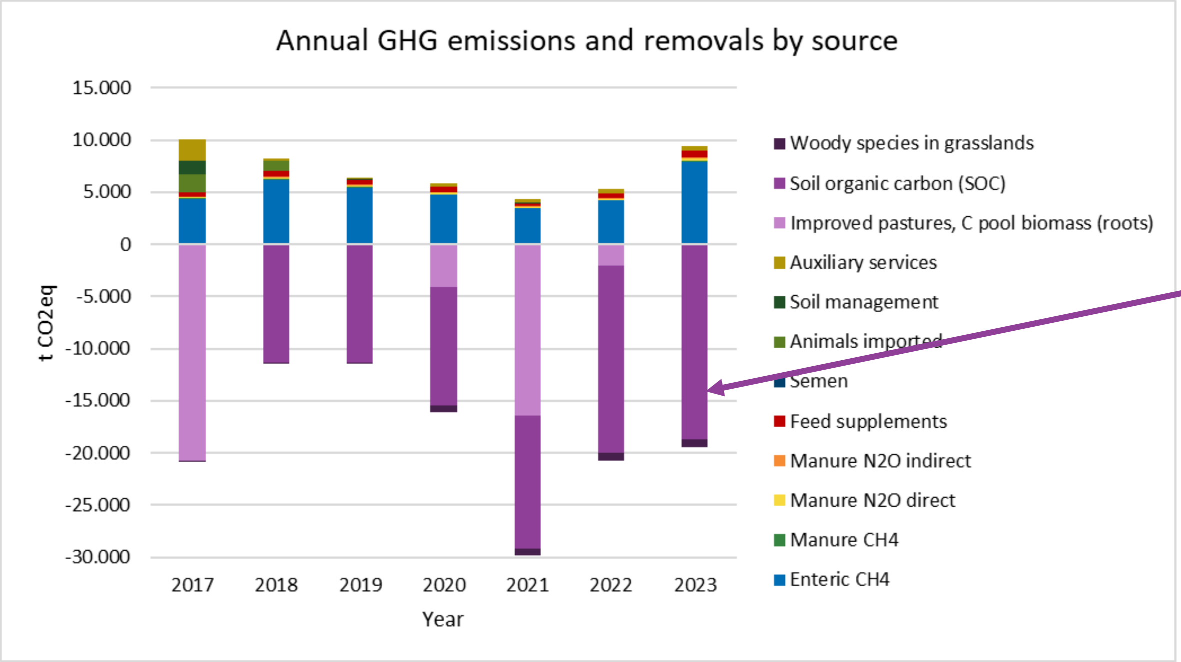
5 sampling points
(1 m soil pits)

2 soil samples per depth

Analysis of:

- Organic carbon
- $\delta^{15}N$ and $\delta^{13}C$
- Bulk density
- Macronutrients (N, P, K, Mg, Ca, S)
- Texture
- pH

❹ GHG emissions and removals, carbon footprint, and avoided GHGe 2017–2023



GHG intensity: 8.7 kg CO_2eq kg^{-1} LW

44% lower than cow-calf farms in the region (projects Sustainable Colombian Livestock and LivestockPlus).

Potential annual removal in soil:
2.5 t CO_2 ha^{-1} yr^{-1}

Roots turnover during 20 years of improved grazing with *U. Humidicola* pasture.

Carbon Footprint: -17 kg CO_2eq kg^{-1} LW

Carbon removals are higher than GHG emissions

Avoided GHG emissions: 0.4 t CO_2 ha^{-1} yr^{-1}

Due to no grassland burning.

Exported LW 2017–2023: 5,732 t

Grazing area: 4,553 ha in 2017; 7,500 ha in 2023

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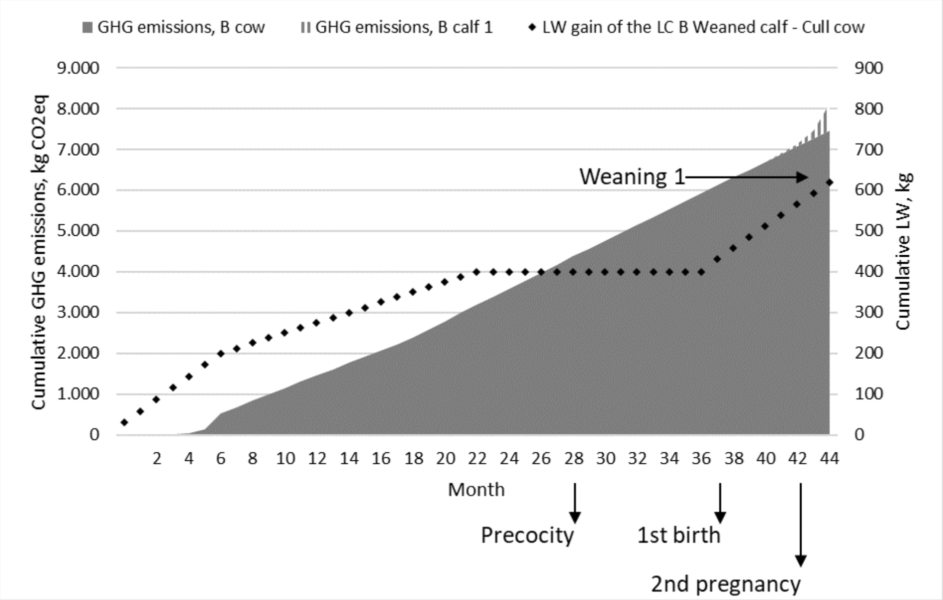
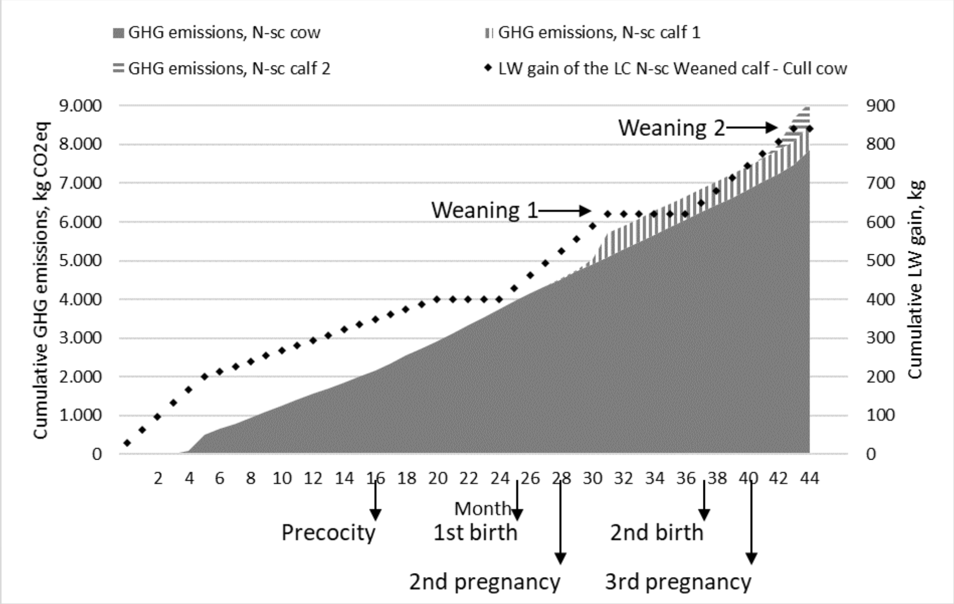
Costa Jr. et al. (under review), Soil carbon stocks and nitrous oxide emissions of pasture systems in Orinoquia Region of Colombia: Potential for developing land-based greenhouse gas removal projects.

4 Life cycle Weaned calf – Cull cow

Brahman, 1 calf



Short-cycle Nelore, 2 calves



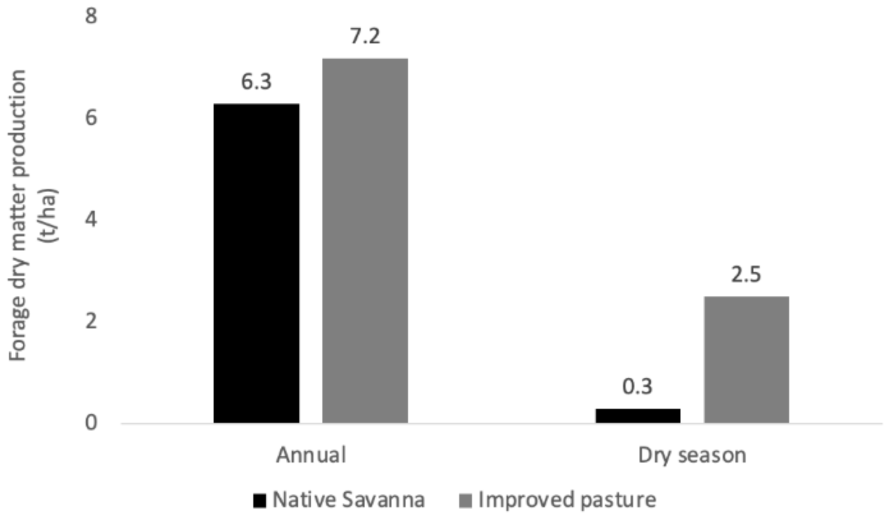
Co-product	Brahman	Short-cycle Nelore
LW gain, kg	620	840 (↑35%)
GHG emissions, kg CO_2eq LC^{-1}	8,112	9,088 (↑12%)
GHG emissions, kg CO_2eq $calf^{-1}$	8,112	4,544 (↓44%)
GHG intensity, kg CO_2eq kg^{-1} LW	13.1	10.8 (↓17%)

Cattle of high-quality genetics showed reduced GHG intensities due to improved productive and reproductive performance.

Matiz-Rubio et al. (under review), Climate impact of producing genetic resources for more efficient beef cattle.

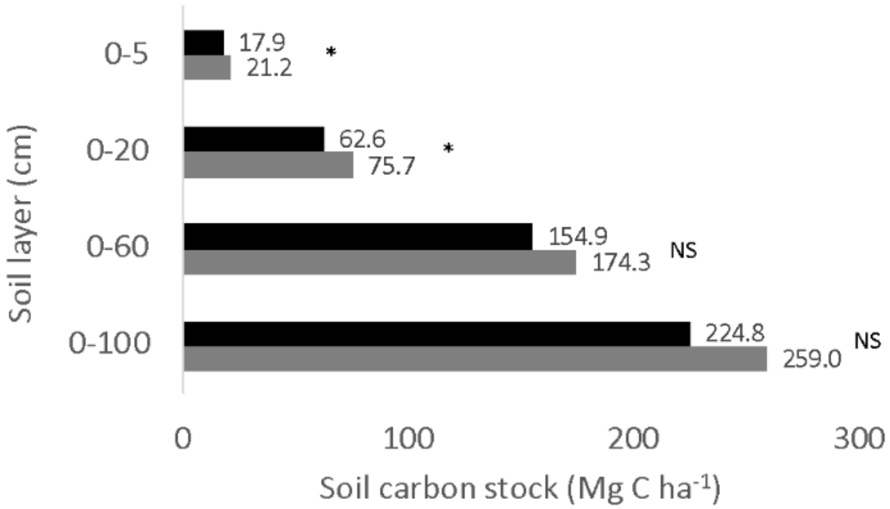
❹ Performance of improved pastures

Forage dry matter (DM) of *U. humidicola*



- Higher DM production of improved pasture (IP) compared to native savanna (NS)/permanent grassland:
- Year: 14%.
- Dry season: approx.. 8 times.

Soil organic carbon (SOC) stocks of soil layers



SOC stock (0-100 cm): 15% higher in the IP.

Significant differences (*) in the upper soil layers, 0–5 and 0-20 cm.

SOC stock in the NS: approx.. 40% higher than the default value for this climate zone and soil type (IPCC 2019).

79.9 t C ha^{-1} vs. 52 ±6% t C ha^{-1} for the 0-30 cm soil depth.

Costa Jr. et al. (under review), Soil carbon stocks and nitrous oxide emissions of pasture systems in Orinoquia Region of Colombia: Potential for developing land-based greenhouse gas removal projects.

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4 GHG emission intensities of the co-products from the Life cycles Embryo – Bred cow and Semen – Cull bull

Model	Farm level	Animal level
Co-product	**Average per kg exported LW**	**Biophysical allocation**
Embryo, kg CO_2eq unit^{-1}	0	13.4
Bred cow, kg CO_2eq kg^{-1} $LW_{genetics}$	8.7	4.6
Semen, kg CO_2eq unit^{-1}	0	1.2
Cull bull, kg CO_2eq kg^{-1} LW_{beef}	8.7	5.2

LW: live weight

The embryos and semen are attributed zero GHG emissions, which is physically incorrect.

No difference in GHG intensity of animals.

The developed scheme for biophysical allocation reflects physical reality more accurately:

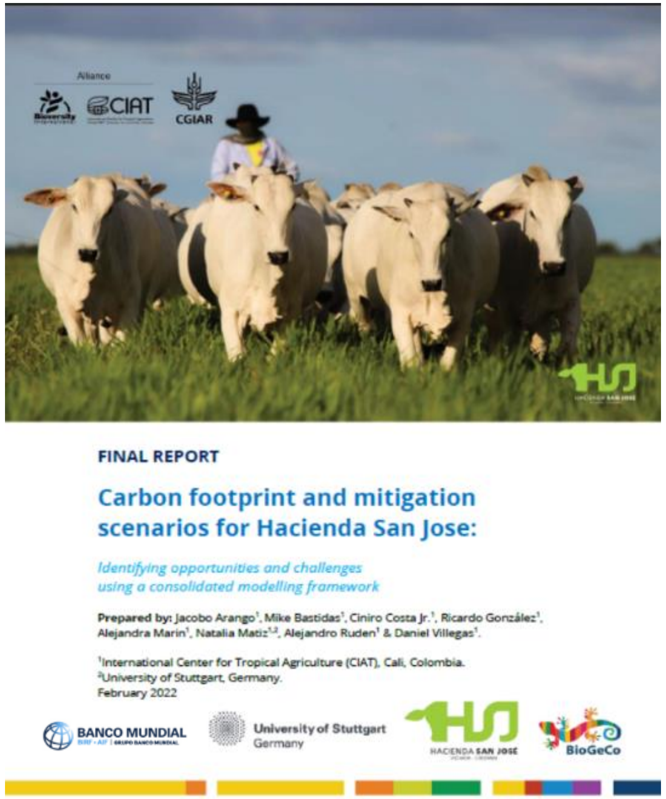
- Correction of the “zero” GHG emissions of genetic resources.
- Evidence of different GHG intensities of animals according to different metabolism.

✓ **GHG emission intensities can be used as emission factors in LCA-models.**

Matiz-Rubio et al. (under review), Climate impact of producing genetic resources for more efficient beef cattle.

❹ Conclusions

- Cattle of high-quality genetics showed **GHG intensities up to 44% lower** than conventional breeds due to better productive and reproductive performance.
- The introduction of *U. humidicola* and rotational grazing **influenced the SOC storage** probably through its more abundant and recalcitrant root system.
- The GHG intensities of cattle embryo, semen and breeding stock (i.e., genetic resources) were **quantified for the first time**.
- Animal life cycle accounting enables biophysical allocation to breeding functions.


FINAL REPORT

Carbon footprint and mitigation scenarios for Hacienda San Jose:

Identifying opportunities and challenges using a consolidated modelling framework

Prepared by: Jacobo Arango[1], Mike Bastidas[1], Ciniro Costa Jr.[1], Ricardo González[1], Alejandra Marin[1], Natalia Matiz[1,2], Alejandro Ruden[1] & Daniel Villegas[1].

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VICHADA - COLOMBIA

Thank you!

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