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Insights into the Alliance's research on livestock and the environment

Dr. Stefan Burkart

November 5, 2024

Conferencia Regional para la Transformación Sostenible de la Ganadería
Punta del Este, Uruguay

Session: Livestock Solutions for a Better Environment – Innovations in Livestock Production for Environmental Improvement

Future Seeds: The Alliance's Germplasm Bank

Conserving the world's largest collections of beans, cassava, and tropical forages

37,987
Bean accessions

6,643
Cassava accessions

44,000
Tropical forage accessions

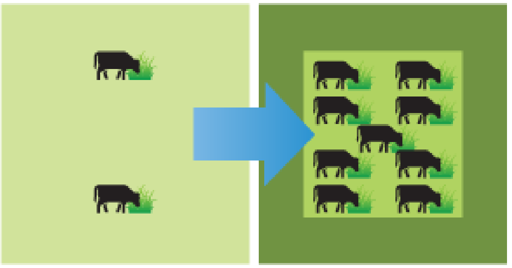
Agrobiodiversity is **key** to maintaining ecosystems and providing adequate supplies of **healthy**, **nutritious food** in the face of climate change & environmental degradation.

Breeding and germplasm selection of tropical forages

Develop **improved pastures** resistant to extreme conditions…

…that contribute to **increase animal (and crop) productivity**

and reduce **environmental impacts**…



…by **reducing the areas** required to respond to livestock demand

as well as reducing the **GHG emissions** and increasing **C captures**

Forages for Climate and the Environment:

METHANE MITIGATION CH_4

Livestock enteric fermentation is the biggest from Ag emissions.

Tropical forages high in anti-methanogenic compounds optimize rumen efficiency and reduce CH_4 emissions.

BEZOS EARTH FUND | BILL & MELINDA GATES foundation | ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE | ICARDA Science for resilient livelihoods in dry areas

Montoya et al 2020. Animals

SOIL CARBON SEQUESTRATION CO_2

Low SOC levels diminish soil health and its ability to sequester C, reducing productivity, and contributing to GHG emissions.

Deep-rooted forages can sequester CO_2 from the atmosphere, increase SOC stocks and improve soil health.

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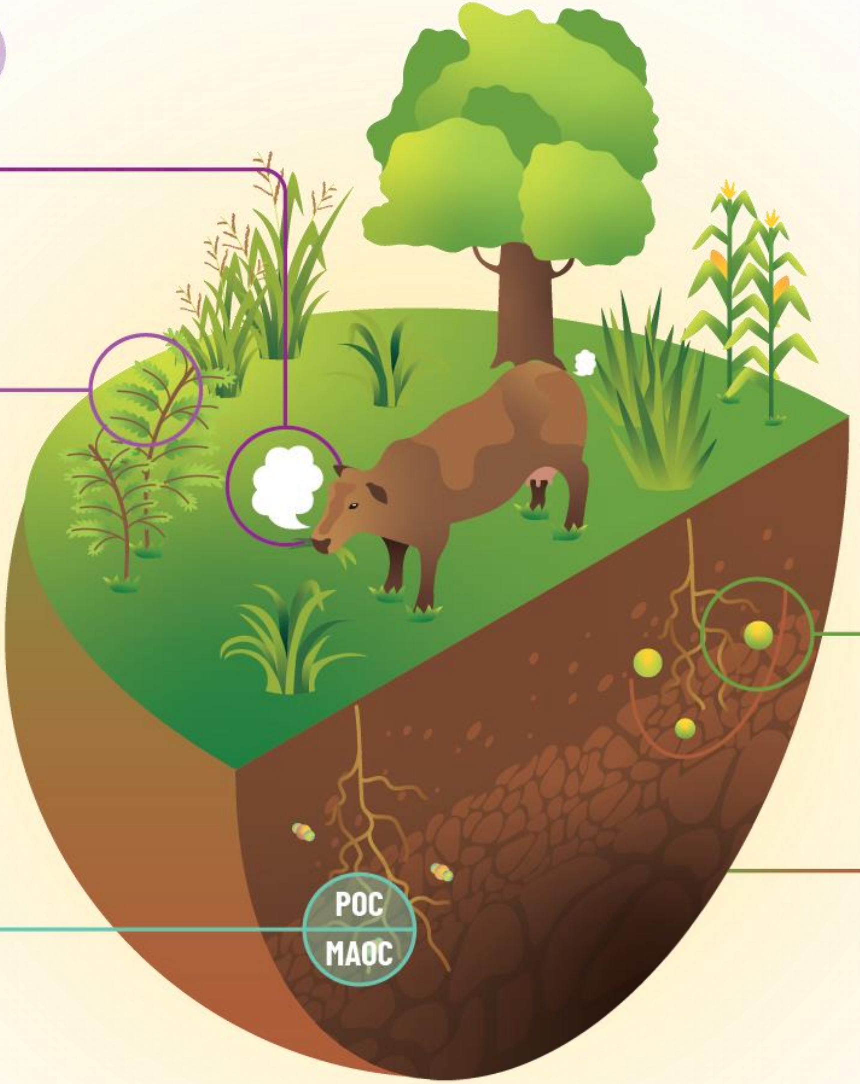

Fisher et al 1994. Letters to Nature

NITROUS OXIDE MITIGATION N_2O

N_2O emissions in livestock systems arise from the microbial breakdown of N of manure, urine and fertilizers.

Some pastures release compounds that suppress soil microorganisms, reducing N_2O emission . This is called Biological Nitrification Inhibition (BNI)

JIRCAS | agresearch | ETH zürich

Subbarao et al 2009. PNAS

Nitrification

$NH_4^+ > NO_3^-$

LEGEND

- O Oxygen
- C Carbon
- N Nitrogen
- H Hidrogen
- POC Particulate Organic Carbon
- MAOC Mineral-Associated Organic Carbon
- Partners

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FUTURE SEEDS

Using genetic diversity to capture carbon through deep root systems in tropical soils

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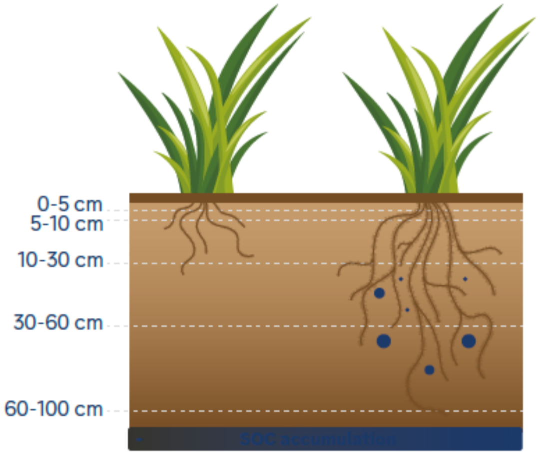
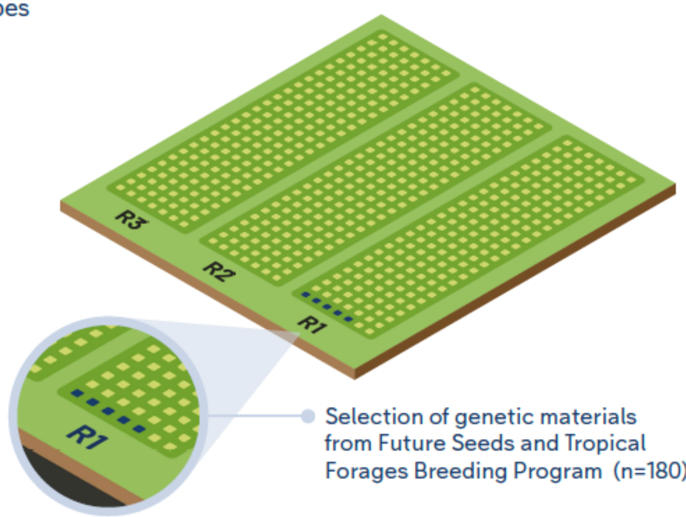
Forage grass field trials

Exploring the genetic diversity of tropical forages for soil organic carbon accumulation in deep soil layers

Study of 180 tropical forage grass genotypes for the identification of root ideotypes that promote greater Soil Organic Carbon (SOC) accumulation based on:



- Root morphology and architecture
- Root biomass
- Root exudation
- Root composition
  - Lignin
  - Suberin
  - C:N
- Root decomposition and turnover
- Interaction between roots and rhizospheric microorganisms



Selection of genetic materials from Future Seeds and Tropical Forages Breeding Program (n=180)

Field trial locations

	MEAN TEMP.	SOIL	RAINFALL (mm annual)
① Palmira	24°	Vertisol, high fertility	870
② Puerto López	26.5°	Oxisol, low fertility	2,900
③ Hacienda San José	27.3°	Oxisol and ultisol, low fertility	2,220

Tropical Forages Materials

Urochloa humidicola
22 accessions
26 hybrids

Megathyrsus maximus
42 accessions
24 hybrids

U. decumbens × *U. brizantha* × *U. ruziziensis*
24 accessions
32 hybrids

Cenchrus ciliaris
2 accessions

Chrysopogon zizanioides
8 accessions

Selection Criteria

Used by the Tropical Forages Program

- Resistance and adaptation to
  - Spittlebug
  - Drought
  - Acid soils
  - Waterlogging
  - Aluminum toxicity
- Nutritional quality
- Biological Nitrification Inhibition (BNI)
- Deep rooting ability

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For more information scan the QR code or visit carbonsequestration.co/

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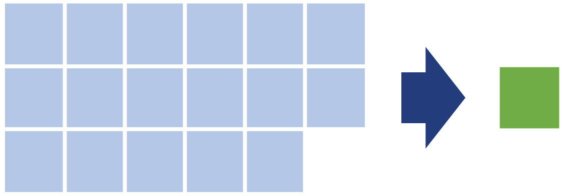
Urochloa humidicola, an eco-efficient forage grass for the Orinoquia region (Llanos)

Ecosystem services from the adoption of *Urochloa humidicola* grass

Sustainable intensification

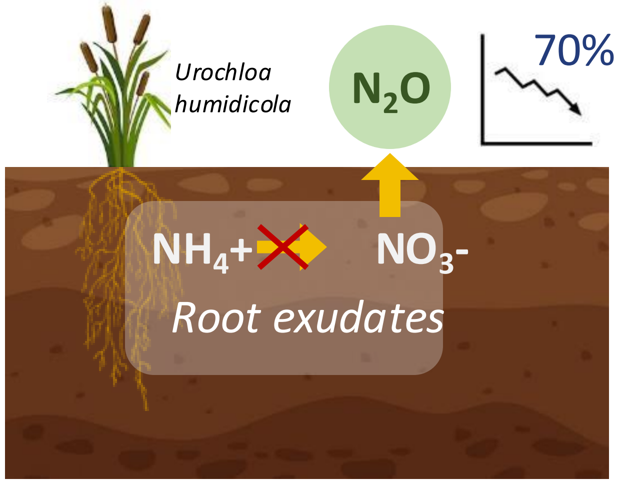


17 ha / 1 cow → **1** ha / cow

Production efficiency
Land use efficiency

Mitigation of N_2O emissions

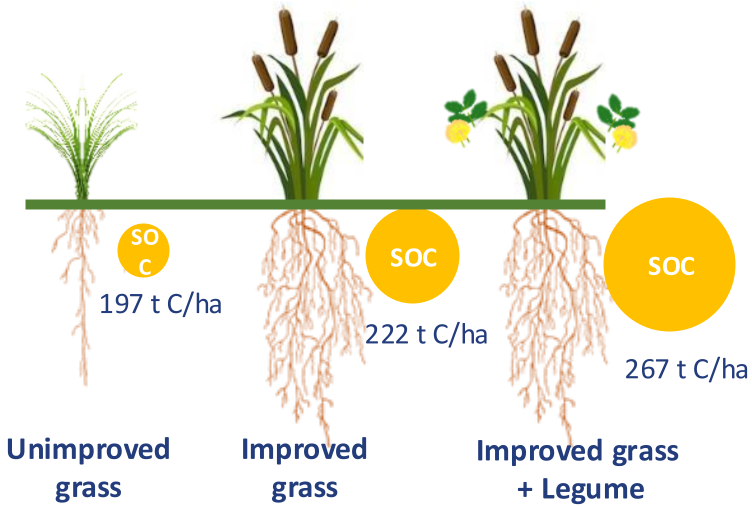
Biological nitrification inhibition (BNI)



Subbarao et al 2009. PNAS

JIRCAS

Soil carbon capture



Fisher et al 1994. Nature

LOW-METHANE FORAGES

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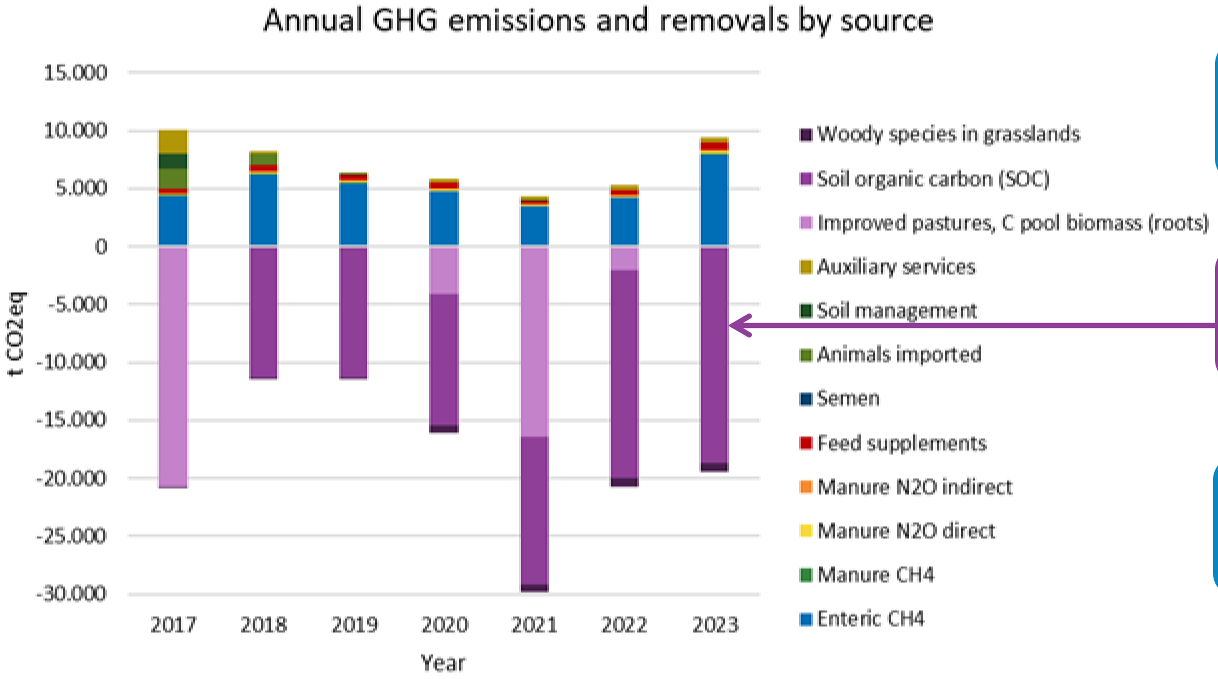
Negative carbon footprint of HSJ from the use of *Urochola humidicola* CIAT679 cv. Tully pasture

Functional unit, annual production of exported animal live weight (LW) during 2017-2023: **5.840 t**



Carbon-intensity
8.4 kg CO_2eq kg^{-1} LW

46% lower than breeding farms in the region.

Soil carbon sequestration potential
2.5 t CO_2 ha^{-1} yr^{-1}

Deep root systems and high root turnover for 20 years with improved grazing.

Negative carbon footprint
-17.0 kg CO_2eq kg^{-1} LW

Carbon capture in soil is higher than GHG emissions.
Opportunity for C projects to access C market and expand to a 150k ha in this project.

Additional avoided emissions
0.4 t CO_2eq ha^{-1} yr^{-1}

No savanna burning.

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FUTURE SEEDS

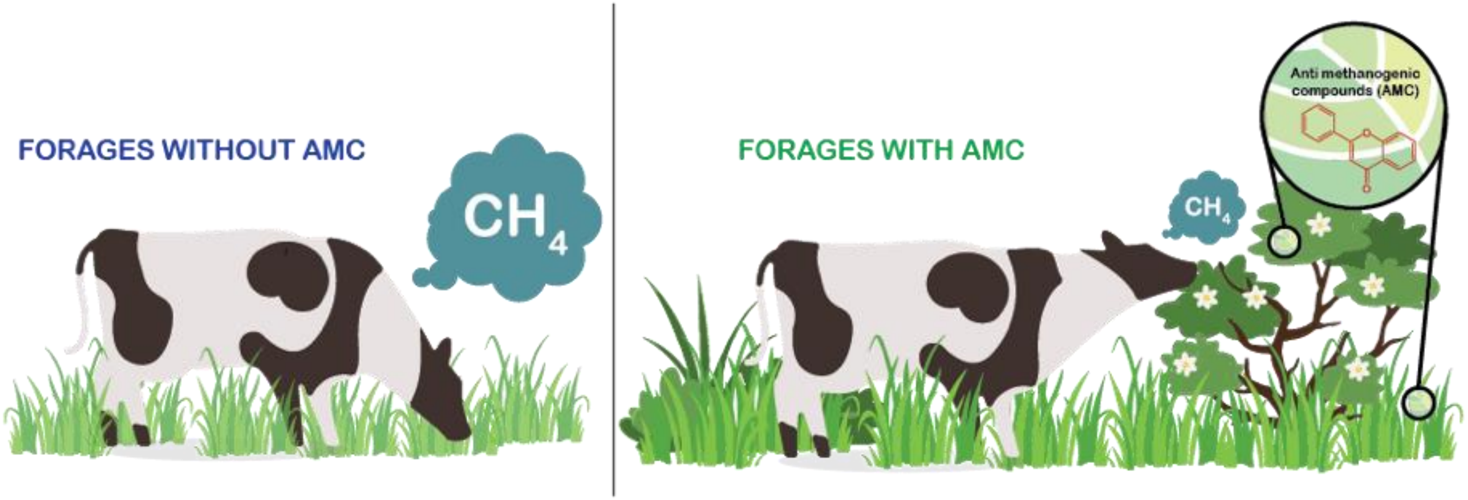
Screening, developing, and deploying preparation of anti-methanogenic feedstock into livestock systems in the Global South (Low-Methane Forages)

BEZOS EARTH FUND
BILL & MELINDA GATES foundation

Project Summary

Reduce methane (CH_4) emissions from the **single largest emitter in the agricultural sector: livestock**.

Screen, develop, and deploy **forages with anti-methanogenic compounds (AMC) into cattle production systems in the Global South** to achieve an outsized reduction of greenhouse gas (GHG) emission per dollar invested, equivalent to taking 7 million internal combustion engine cars off the road each year.



LOW-METHANE FORAGES

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LOW-METHANE FORAGES

ANTI-METHANOGENIC FEEDSTOCK INTO LIVESTOCK SYSTEMS IN THE GLOBAL SOUTH

Sponsored by: Bill & Melinda Gates foundation; Bezos Earth Fund

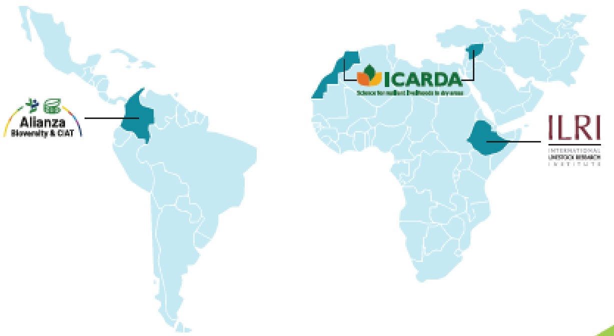
Implemented by: Alianza Bioversity & CIAT; ILRI International Livestock Research Institute; ICARDA Science for resilient livelihoods in dry areas; Global Methane Hub; Pontificia Universidad Javeriana Cali; agresearch āta mātai, mātai whetū

DISCOVERY

Low Methane Forages (LMF) can come in different vegetation forms

Grasses | Herbaceous legumes | Shrub legumes | Climbing legumes | Trees

The forage materials are selected from our **genebanks and breeding programs**



Forage selection criteria for screening

- High-yielding, nutritious, drought-tolerant forages
- Rich in anti-methanogenic compounds (AMC)
- Benefiting livestock farmers and pastoralists in the Global South

In vitro screening

Materials with low methane production identified under *in vitro* conditions are selected for **metabolomic profiling** and *in vivo* trials

In vivo validation

Respiration chambers "gold standard"

Promising forages that reduce methane emissions are evaluated using *in vivo* methodologies with respiration chambers (The Alliance, ICARDA, and ILRI) and SF6 (ILRI), ensuring animal welfare.

DEVELOPMENT

Legumes

Low methane legumes seeds are multiplied and tested agronomically to reduce methane emissions

Grasses

Forage-grass breeding pipelines incorporate AMC trait as one of the selection criteria

AMC — Gene editing methods are applied to develop LMF grasses

PREPARATION FOR DEPLOYMENT

Seeds

Seed production and market demand are assessed to ensure high-quality seed availability and accessibility

Monitoring

Cost-effective methods for monitoring LMF emission reductions are developed

Climate finance

Financial mechanisms aimed at overcoming financial barriers and promoting climate and sustainability goals are utilized

For more information scan the QR code or visit https://bit.ly/3WqJw7q

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FUTURE SEEDS

Use and impacts of CIAT's *Urochloa* hybrids, 2001-2023

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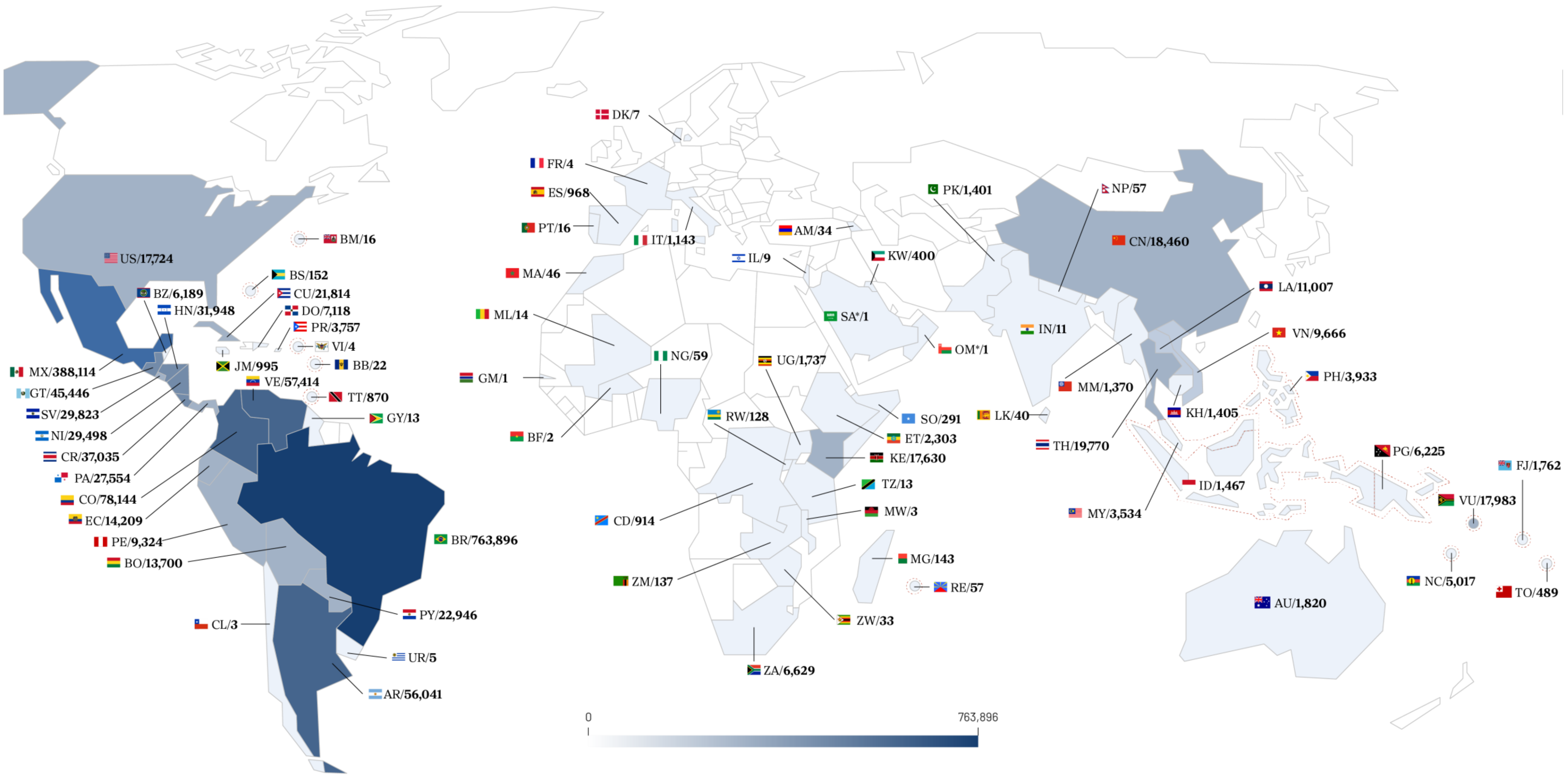
Hectares cultivated with CIAT *Urochloa* hybrids



The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

*SOURCE: Burkart, Stefan (2023). *Kuwait indicators used. Seed rate*

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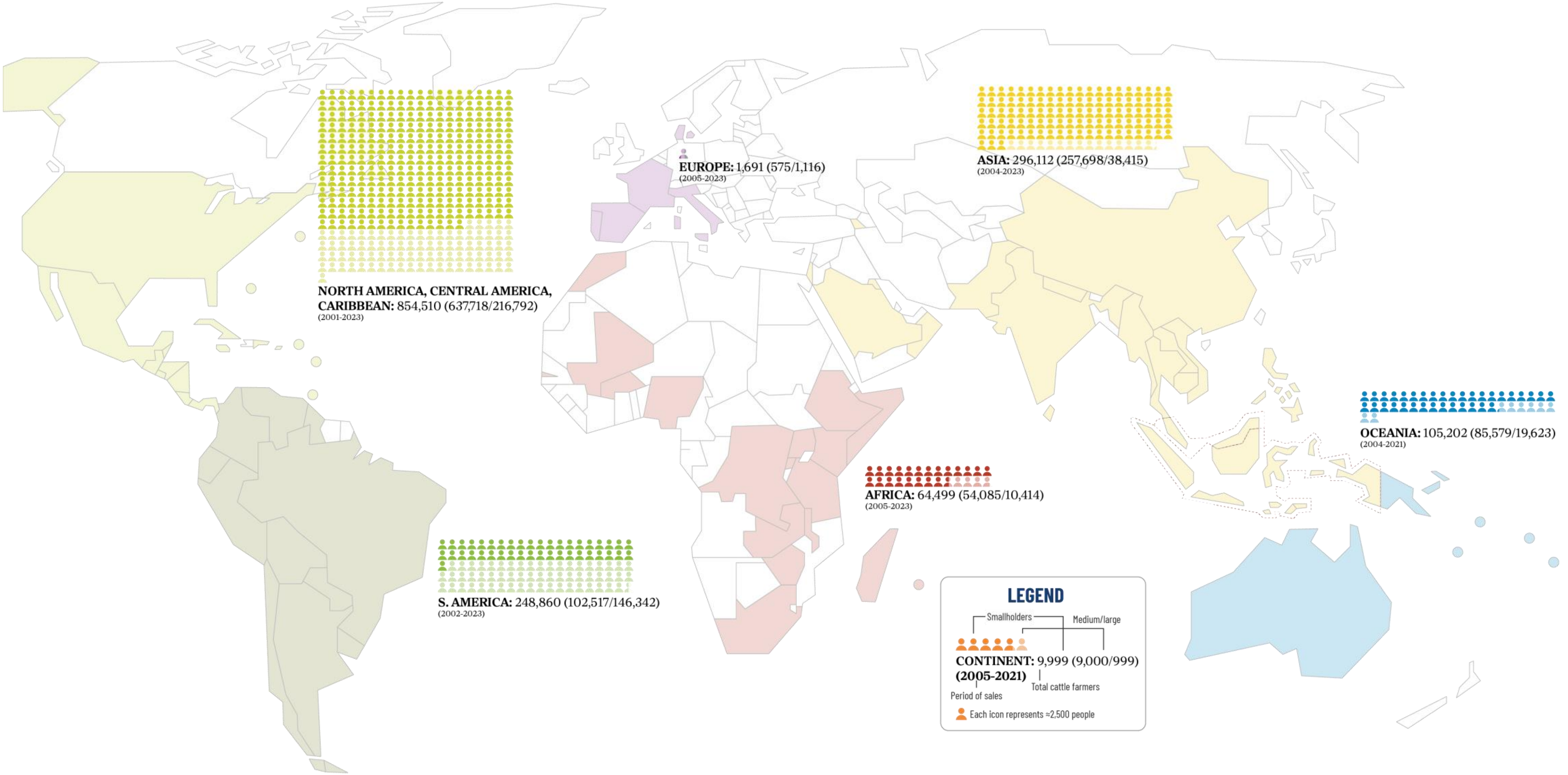
CIAT *Urochloa* hybrid adopters (cattle farmers)



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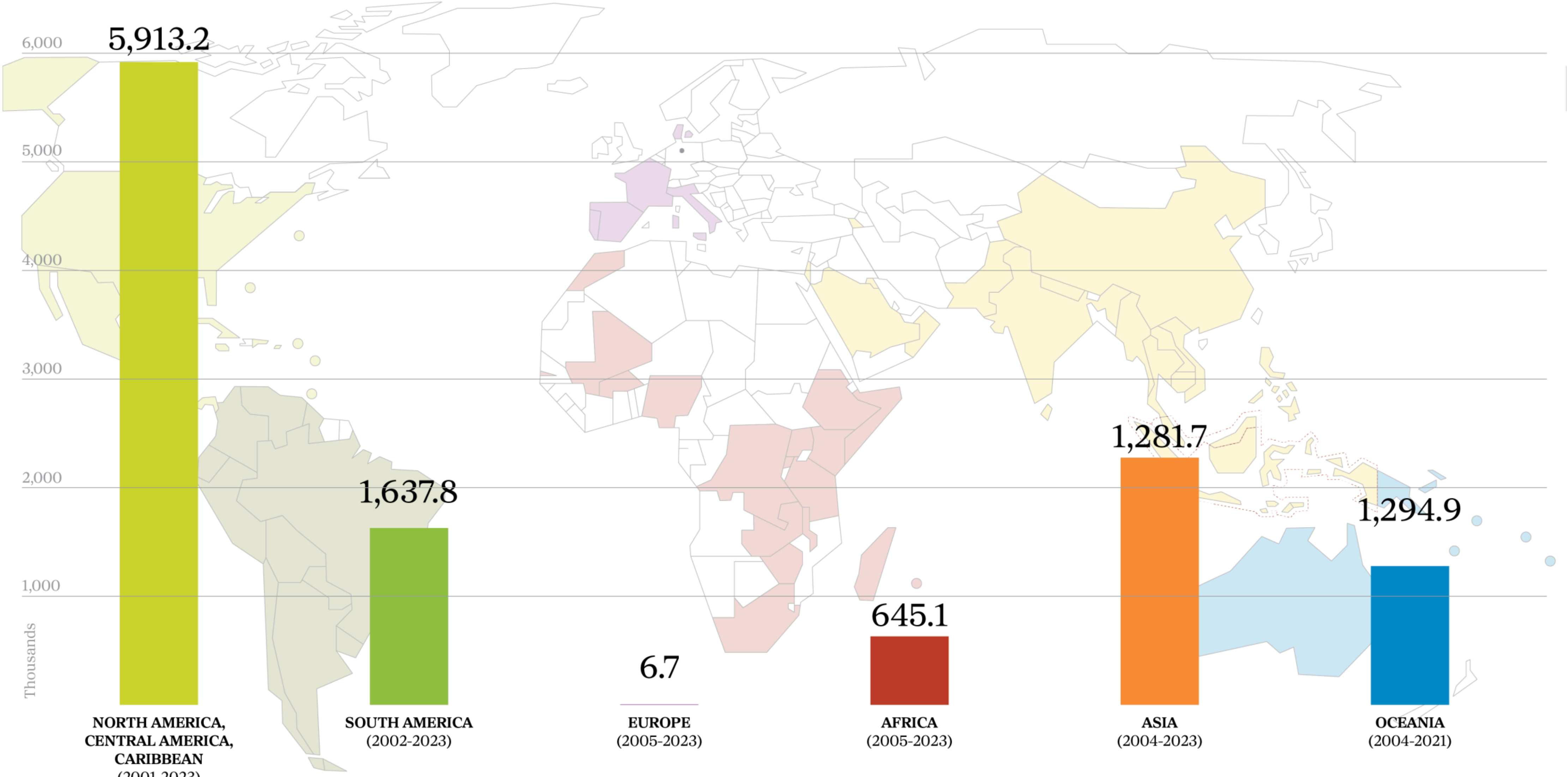
SOURCE: Burkart, Stefan (2023). Seed rate: 7 kg/ha.

CIAT *Urochloa* hybrid beneficiaries

Seed rate: 7 kg/ha. Values in thousands



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SOURCE: Burkart, Stefan (2023). Seed rate 7 kg/ha

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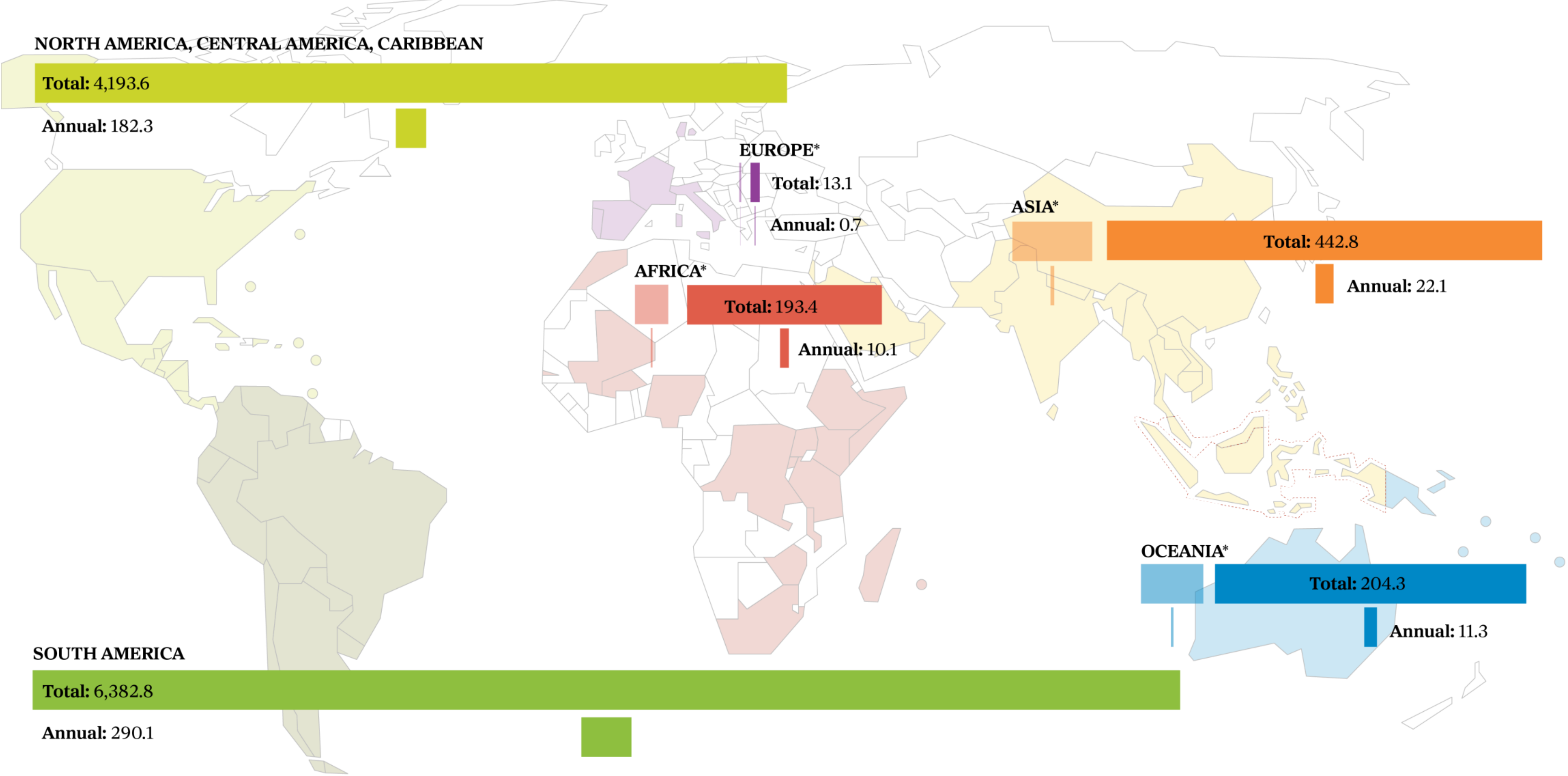
CIAT *Urochloa* forage hybrid value

Values in millions US$ (2015)



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*SOURCE: Burkart, Stefan (2023). Seed rate: 7 kg/ha. * Graphics scaled 5x.*

Potential GHG emission reductions and spared land from *Urochloa* hybrid adoption in the Americas, 2001-2023

	Area (ha)	Total LWG (Mt)	Total $CO_{2eq.}$ (Mt)	GHG reduction (Mt $CO_{2eq.}$)	Spared land (ha)
Scenario A – 100% replacement (unrealistic)					
Dichantium aristatum	7,867,798*	23.60	262.71	n.a.	n.a.
Urochloa hybrid cv. Cayman	1,663,773**	23.60	178.44	84.26	6,204,025
Scenario B – 70% replacement					
Dichantium aristatum	5,507,458*	16.52	183.89	n.a.	n.a.
Urochloa hybrid cv. Cayman	1,164,641**	16.52	124.91	58.98	4,342,817
Scenario C – 50% replacement					
Dichantium aristatum	3,933,899*	11.80	131.35	n.a.	n.a.
Urochloa hybrid cv. Cayman	831,887**	11.80	89.22	42.13	3,102,012
Scenario D – 30% replacement					
Dichantium aristatum	2,360,339*	7.08	78.81	n.a.	n.a.
Urochloa hybrid cv. Cayman	499,132**	7.08	53.53	25.28	1,861,207

Scenario A – Replacement rate 100 % (unrealistic scenario): All adopted hybrids have replaced a native/naturalized pasture (such as *Dichantium aristatum*).
Scenarios B, C, D – Replacement rates 70 %, 50 %, 30%: The adopted hybrids have only partially replaced a native/naturalized pasture and the rest have replaced another improved pasture (no GHG emission reduction).
*Area required with *Dichantium aristatum* to produce the same LWG as with the adopted *Urochloa* hybrids; **Area with *Urochloa* hybrids in the Americas that replaced native/naturalized pastures.

Source: based on Gaviria-Uribe et al. (2020)

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Thanks!

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