Innovations for Sustainable Intensification of Pasture-based Livestock Systems in the Tropics

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Workshop: "Tropical pastures in a changing environment: development of an international research collaboration in Latin America and the Caribbean"

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The sustainable intensification of forage-based livestock systens should be aimed at:

- ❑ Enhancing livestock productivity, with minimum impacts on biodiversity
- ❑ Increasing resilience to CC
- ❑ Reducing GHG emissions
- ❑ Improving net family income of livestock families
- ❑ Improving nutrition and health of the whole population.

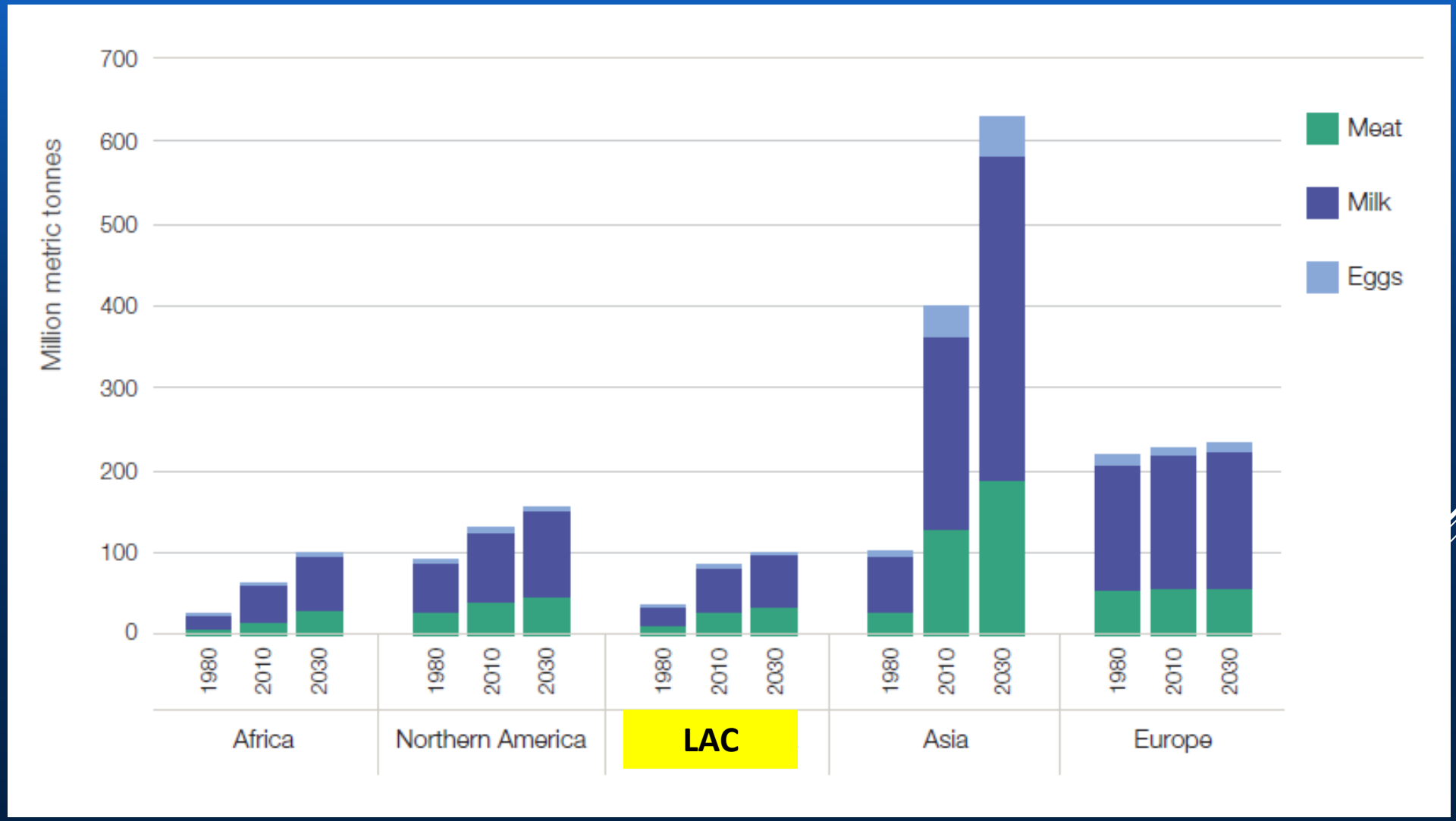
THE LIVESTOCK REVOLUTION

(Delgado *et al*, 1999)

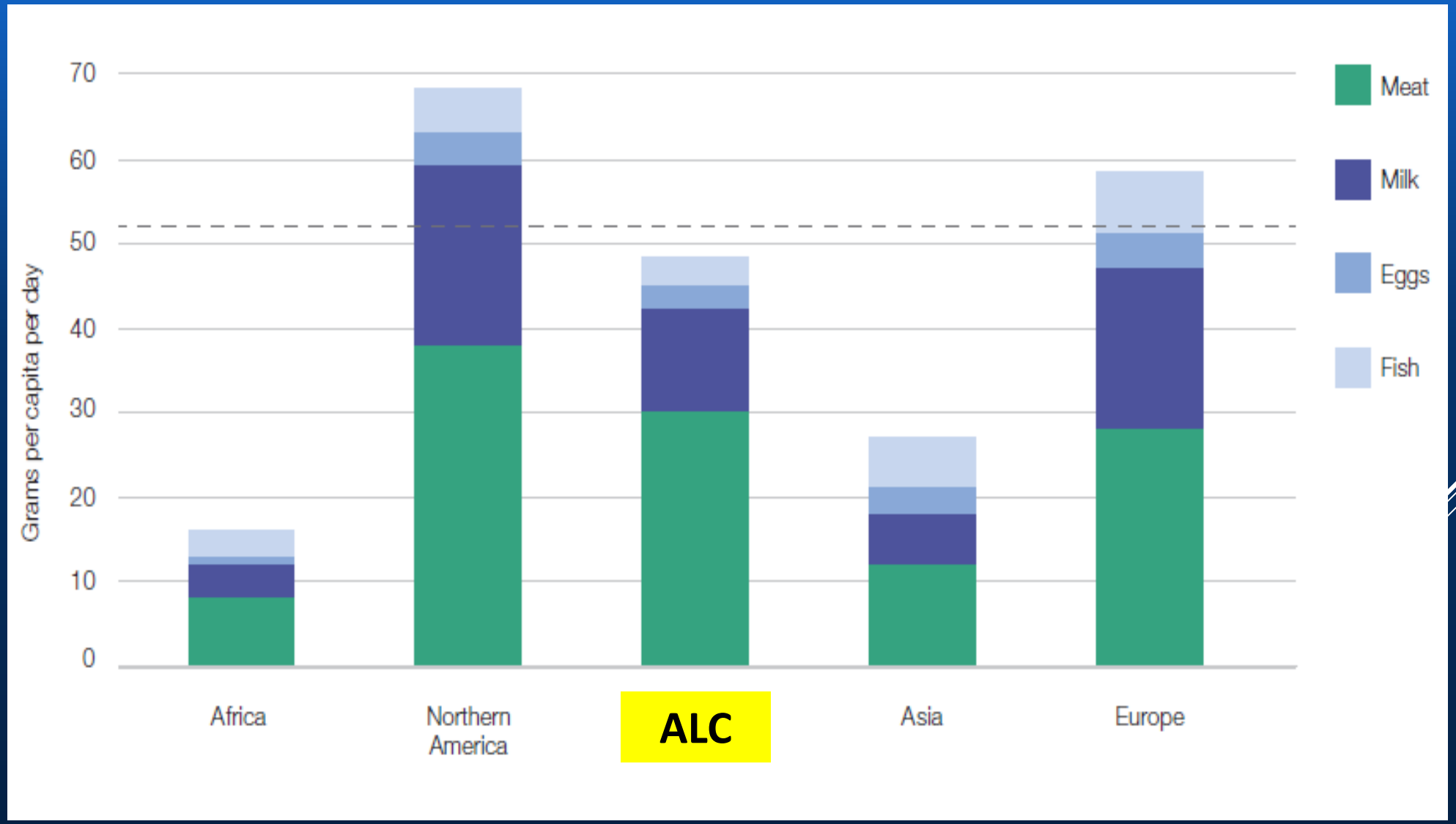
The demand for animal protein sources in low income countries is increasing due to:

- **Population growth**
- **Improve in income**
- **Movement of people from rural to urban areas**

PROJECTED DEMAND OF ANIMAL PROTEINS BY 2030 IN DIFFERENT REGIONS OF THE WORLD (ILRI/WEF, 2019)



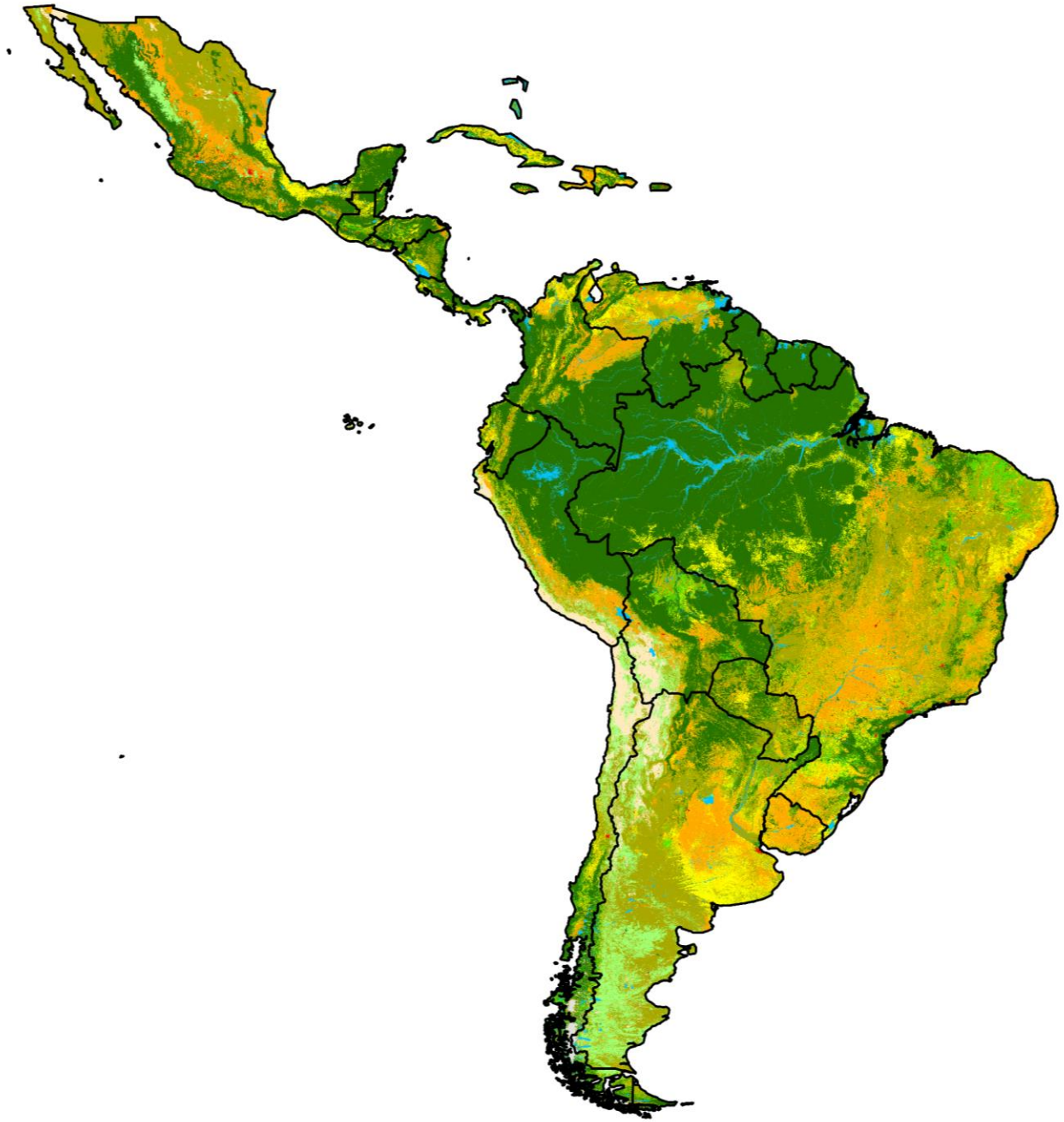
Per capita Consumption of Animal Proteins by Regions in 2013 (ILRI/WEF, 2019)



Environmental Impacts of Traditional Livestock Systems in LAC

- Deforestation
- Pasture Degradation
- Soil and water resources degradation
- Biodiversity losses
- Higher GHG emissions

Deforestation in LAC



2015

Landcover

- Bare areas
- Cropland
- Forest
- Grassland
- Permanent snow and ice
- Shrubland
- Tree cover high density
- Tree cover low density
- Urban areas
- Water bodies

PASTURE DEGRADATION IN LAC

- 50 - 80% of grazing are degraded (in Central America ca. 7 million ha)
- The problem increases with time, because the rate of degradation (12%) is greater than rehabilitation (5%).
- Under current pasture management practices is accepted that pastures las no more than 5-7 years.
- Pasture degradation is one of the main causes of expansion of the agricultural frontier in livestock dominated landscapes.

Impacts of pasture degradation on milk productivity and income in dual-purpose Systems in Petén, Guatemala (Betancourt et al, 2007)

Degradation Level	SR (AU ha^{-1})	Milk production (kg cow^{-1} yr^{-1})	Reduction in kg of milk cow^{-1} year^{-1} (%)	Reduction in incomeo[1] (US$ ha^{-1} year^{-1})
None	2.0	1582 ± 78	--	--
Slight	1.7	1474 ± 27	7 ± 3	184.30
Medium	1.3	1395 ± 90	12 ± 8	378.14
Severe	1.0	1245 ± 118	21 ± 8	537.32
Very severe	0.5	1060 ± 300	34 ± 19	737.52

[1] Milk price @ farm gate US$ 0.28/kg

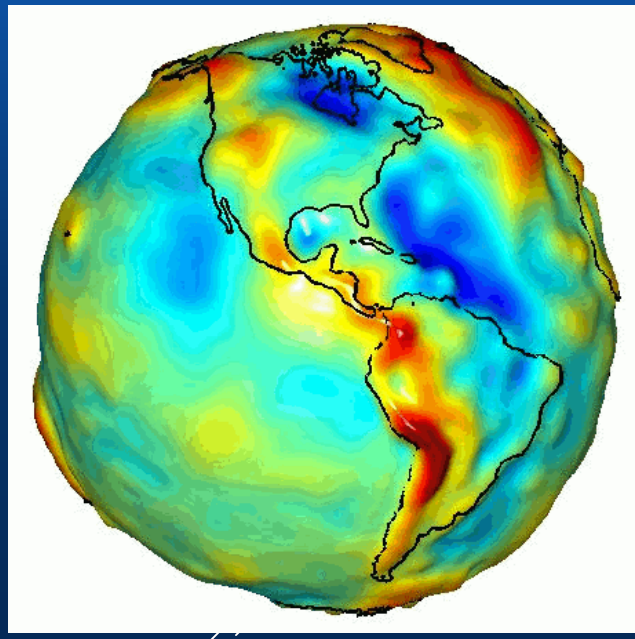
Pasture Degradation Impacts

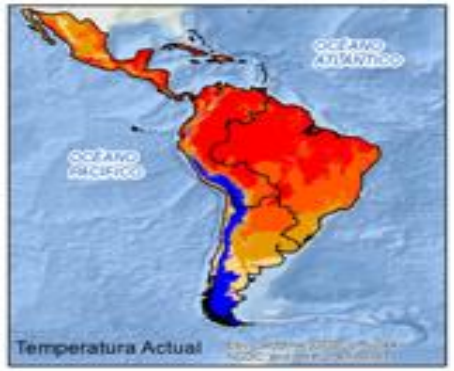
- **Environmental:**
  - Lower C-sequestration capacity
  - Higher GHG emisión intensity
  - Greater soil erosion and compaction
  - Biodiversity losses
- **Socioeconomic:**
  - Lower income affects food security
  - Less risk managment capacity
  - Seasonal separation of family members, because herders move with animals to distant grazing areas (in the case of pastoral systems.

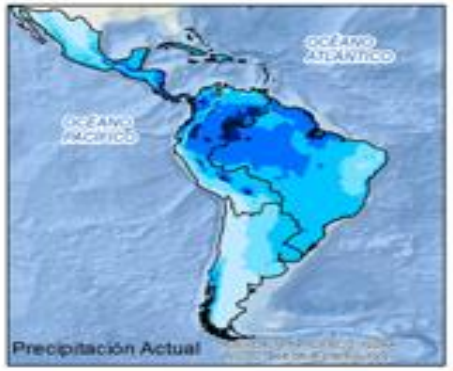
Climate Change in LAC (BID, 2014)

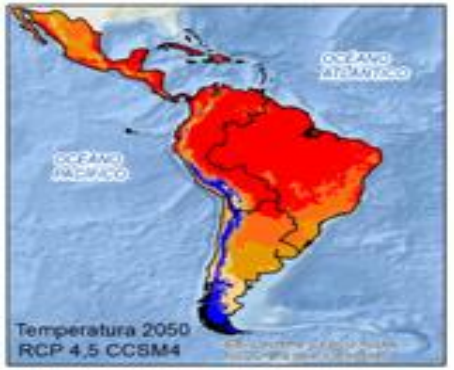
In the last 50 years:

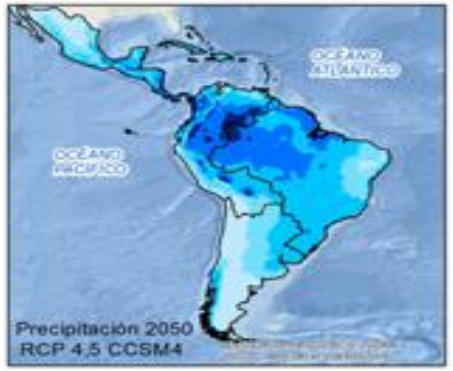
- Tempº increased by 1.0 - 1.5ºC. It is expected that in 2100 it will reach 2.6 - 4.7ºC more.
- Slight variation in anual rainfall, because the rainy season is shortenin, and rains are every time more intense.
- > Variability between and within years.

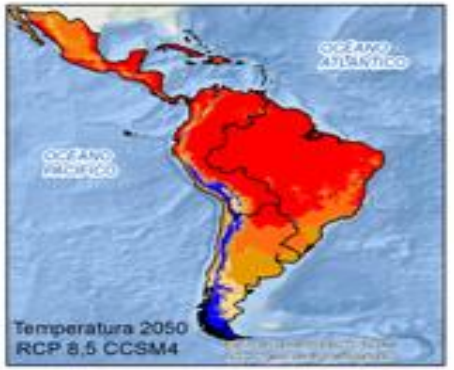


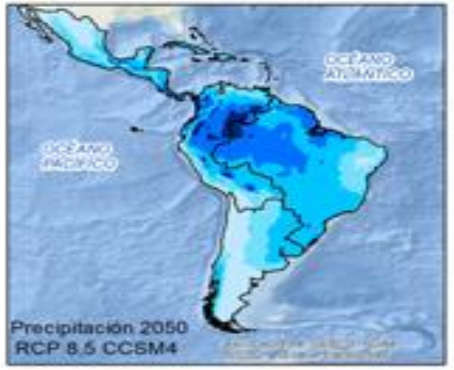












Temperatura media	Área Porcentaje (%)		
Rango ºC	Actual	RCP 4,5	RCP 8,5
< 10	10.77	8.16	7.34
10 - 15	7.98	7.03	7.14
15 - 20	16.41	14.23	13.14
20 - 25	28.43	20.34	18.41
> 25	36.41	50.24	53.97

Precipitación media	Área porcentaje (%)		
Rango mm	Actual	RCP 4,5	RCP 8,5
0 - 500	18.55	18.84	19.24
500 - 1.000	18.71	19.21	19.88
1.000 - 2.000	37.77	38.44	38.79
2.000 - 3.000	20.90	19.70	18.45
> 3.000	4.08	3.81	3.64

Área total (Km²): 23.590.066

Proyecto: Innovaciones para fomentar la adaptación al cambio climático del sistema productivo agrícola y ganadero en América Latina y el Caribe

FONTAGRO

CATIE

Información de Referencia

Projected Coordinate System: WGS_1984_World_Mercator
Projection: Mercator
False_Easting: 0.00000000
False_Northing: 0.00000000
Central_Meridian: 0.00000000
Standard_Parallel_1: 0.00000000
Linear Unit: Meter

Geographic Coordinate System: GCS_WGS_1984
Datum: D_WGS_1984
Prime Meridian: Greenwich
Angular Unit: Degree

Fuente: Worldclim Version 1.4

Changes in tempº and rainfall in LAC ALC, under two CC scenarios : RCP4.5 – 8.5 (Pezo *et al.* 2018)

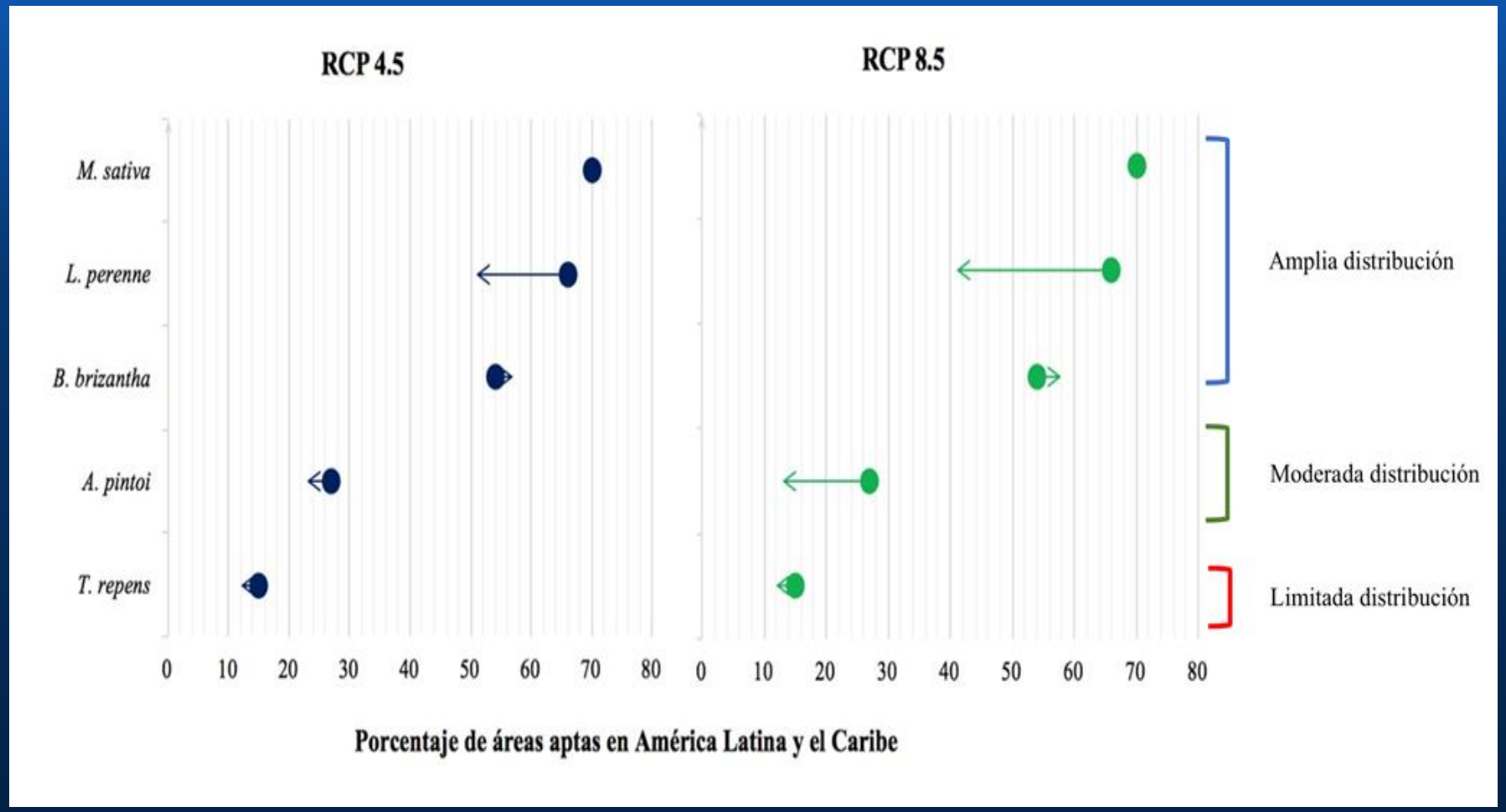
CC Impacts on Crop Production (Prasad et al., 2017)

- > EPT; < H_2O availability
- Soil m.o. interactions interfered
- Changes in soil nutrient dynamics
- < Soil fertility
- Changes in plants : pest relationships

<u>Consequently</u>:

- Productivity declines

CC IMPACTS ON THE DISTRIBUTIOIN OF PASTURE SPECIES IN LAC (Pezo *et al*, 2018)



Tropical Pastures and CC Adaptation

Increases in tempº:

- Tropical grasses (C_4) growing at higher altitudes and latitudes.
- Need for tolerant/resistant species to pest (i.e., *Urochloa brizantha* cv. Marandú & Urochloa hybrids such as Mulato, Mulato 2 and Cayman resistant to "spittlebugs").

More intensive rains:

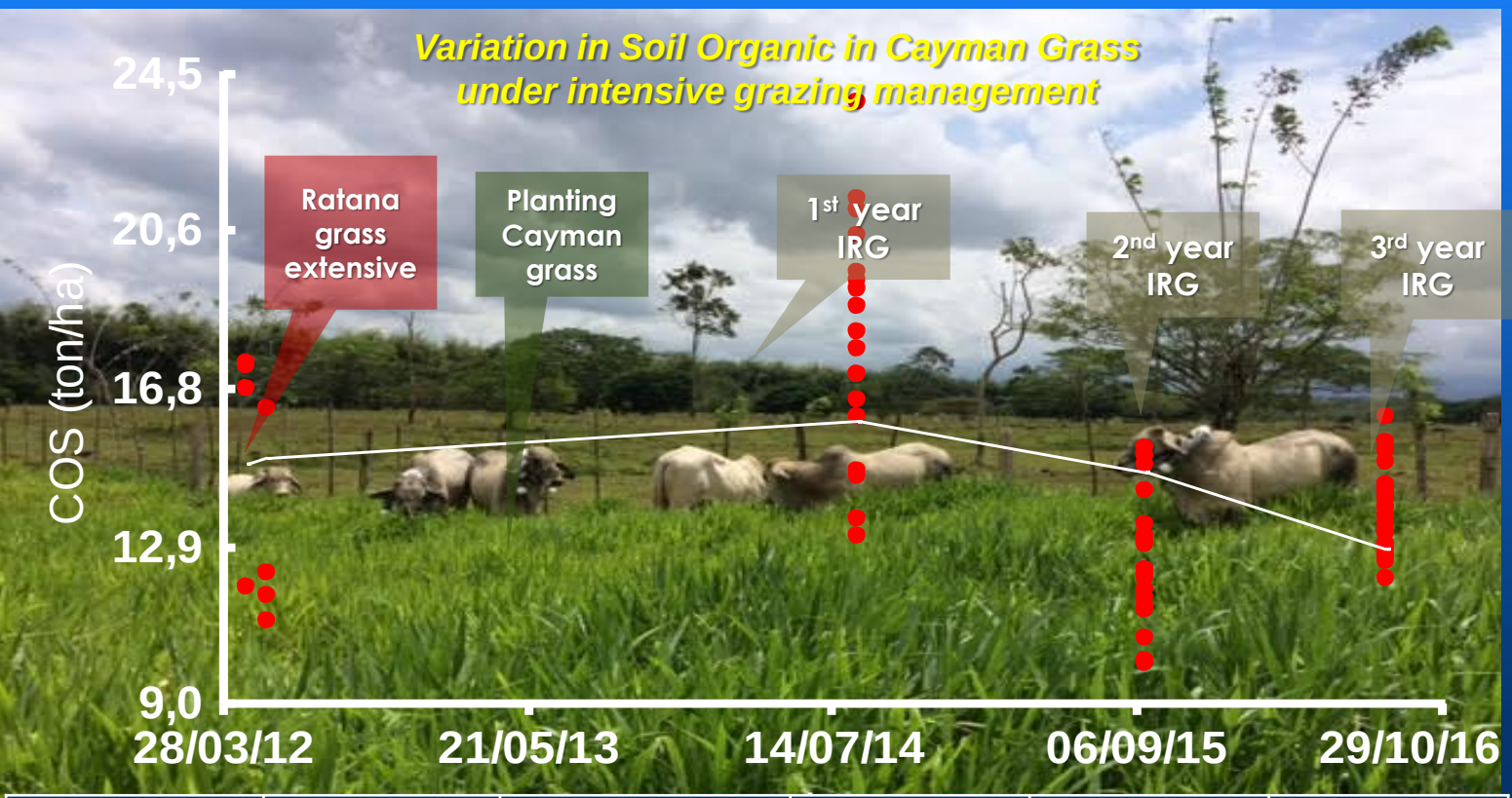
- Better soil cover in sloping areas using trailing species rastreras and/or combination of erect and trailing species.
- Species adapted to partially flooded lands (i.e. tanner, aleman, pará, Caimán, *U. humidicola*).

Shorter rainy season:

- Species with shorter growing periods (i.e. sorghum replacing maize) or genotypes more tolerant to drought (i.e. Marandú & Caimán more tolerant to drought, as well as several forage legumes and woody perennials).

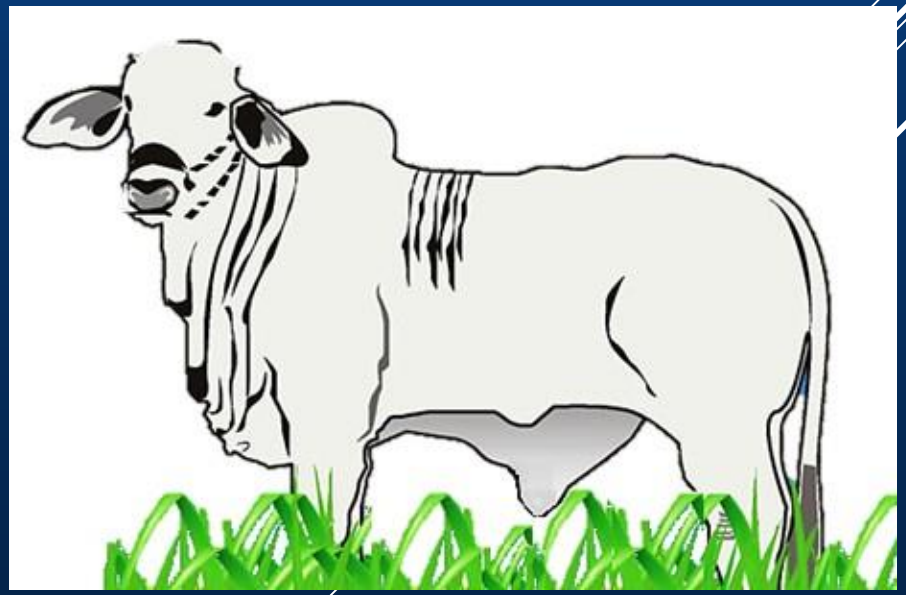
TROPICAL PASTURES & CC MITIGATION

- ***Increased C-sequestration***: The roots of well managed pastures are usually good C-sinks (only forests are better).
- ***Reduction in CH_4 emissions***:
  - Improved herbage quality results in decreasing GHG emissions by 15 – 30%.
  - Legumes with higher N content could help to improve the digestibility of poor quality forage diets.
  - Secondary metabolites (i.e. tannis, saponins) contained in some tropical legumes help to reduce CH_4 emissions.
- ***Reduction in NO_2 emissions*** : Many *Urochloa* species have mechanisms to reduce biological nitrification in the soil.



Parameter	Units	2012	2014	2015	2016
		Ratana grass[2] Extensive grazing	Cayman grass[3] – Intensive Rotational Grazing (IRG)		
OM[1]	%	2.0	2.57	3.46	3.80
AD	G cm^{-3}	1.10	1.09	0.78	0.79
SOC[1]	Mg ha^{-1}	13.0	16.4	15.8	17.5
SR	AU ha^{-1}	1.1 a	1.9	2.3	2.5

Excreta deposition (ha^{-1} $year^{-1}$)	
Average SR	2.3 AU
DM yield	3.77 ton
Carbon	1.511 ton
Nitrogen	60.4 kg



Source: Abarca *et al.* 2018

Intensive Rotational Grazing

Objectives:

- To promote animals eating high quality forages (Mitigation)
- To keep enough residues after grazing and/or having a long enough resting period to promote the recovery of organic reserves needed for the persistence of valuable species (Adaptation).
- To maintain adequate soil cover (Adaptación)

- Physiological criteria to decide when animals enter to paddocks for tropical pastures are needed

- RATIONALITY = FLEXIBILITY

Intensive Rotational Grazing Management

Rainy Season

Dry Season

Forage Yield and Animal Production

7-

EXCESS OF GRASSES

Dry Season supplements

Nutrient requierements for 4 kg of milk

DEFICIT

My Jn Jl Ag S O N D

Months

Smart Use of Agricultural Inputs (Mitigation)

- Fertilizers & herbicides: High needs of fossil energy and high GHG emissions in production and transport,
- Precision agriculture (¿?): Fertilizer dosage & frequency for optimizing efficiency of utilization → < N_2O emissions
- Use of slow-releasing fertilizers (¿?)
- Introduction of legumes into pasture systems :
  - N-fixation using photosynthetic energy
  - Many legumes release N at a rate that matches absorption by companion grasses (less N_2O losses)

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