Livestock research and Climate Change, EMBRAPA experience

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EMBRAPA AGRICULTURAL INFORMATICS

Embrapa
Informática Agropecuária

Ministério da Agricultura, Pecuária e Abastecimento

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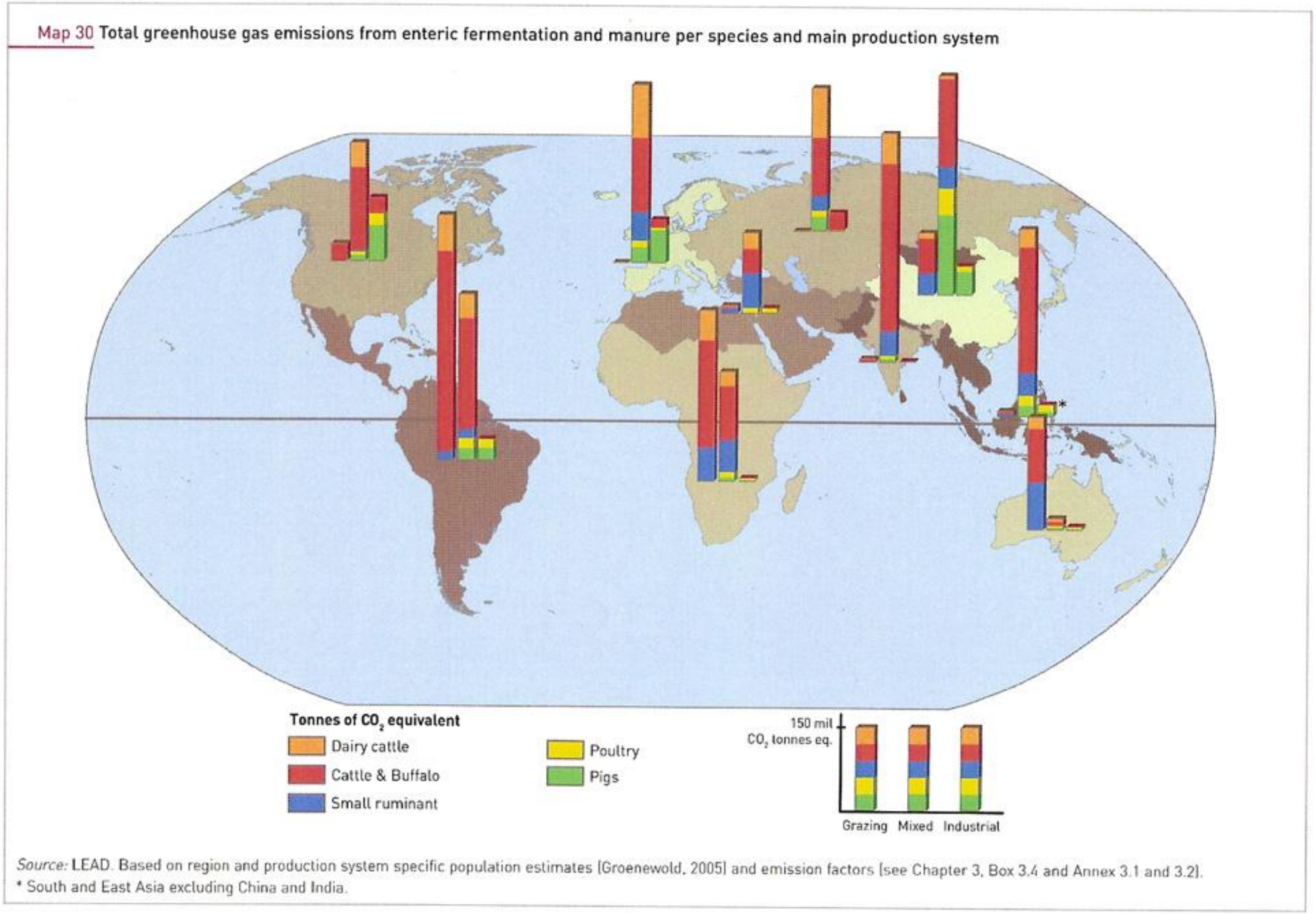
GHGs emissions from Brazilian Livestock

GHG emissions from enteric fermentation



Source: FAO, 2006

Greenhouse Gases Emissions and Brazilian Livestock

Table 3 Enteric emissions of CH_4 from cattle, main emitting countries (over 20 million head of cattle in 2004)

	Population (millions)		Percent	Percent of global	Annual CH_4 emissions (Tg)		
	1984	2004	change	population 2004	1984	2004	IPCC2004
Brazil	127.7	192	50.3	14	6.90	10.37	9.6
India	195.2	185.5	(5.0)	14	6.83	6.49	8.6
China	59.0	106.5	80.5	8	2.07	3.73	4.7
USA	113.4	94.9	(16.3)	7	6.58	5.50	5.1
Argentina	54.6	50.8	(7)	4	2.95	2.74	2.5
Sudan	21.0	38.3	82.4	3	0.74	1.34	1.2
Ethiopia	N/A	35.5	N/A	3	N/A	1.24	1.2
Mexico	30.5	30.8	1.0	2	1.07	1.08	1.6
Australia	22.1	26.4	19.5	2	1.19	1.43	1.4
Colombia	23.4	25.3	8.1	2	0.82	0.89	1.3
Russia	N/A	24.8	N/A	2	N/A	1.36	1.6
Bangladesh	21.9	24.5	11.9	2	0.77	0.86	1.1
Pakistan	16.4	23.8	45.1	2	0.57	0.83	1.1
Developing	827.7	1,018.4	23.0	76.3	32.43	39.82	43.76
Developed	426.1	316.1	(25.8)	23.7	23.77	17.67	17.55
Total	1,253.8	1,334.5	6.4		56.2	57.49	61.31

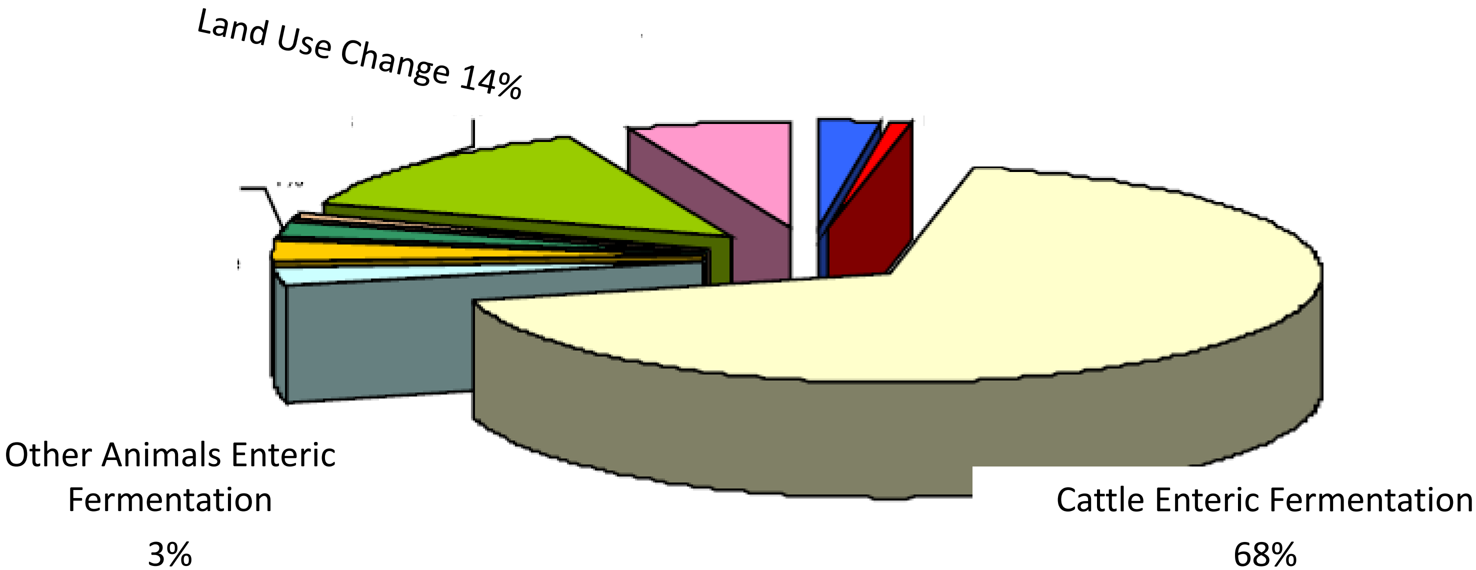
1984 and 2004 Annual CH_4 emissions are calculated using the EF originally applied by CAS in their 1986 paper. The IPCC2004 emissions are calculated using the regional IPCC Tier 1 Default values—and for this reason may differ slightly from the figures shown in national inventory tables. Source: FAOSTAT

Source: Thorpe, A. Climatic Change (2009) 93: 407-431

GHG Emissions from Livestock in Brazil

Figura 2.4 - Emissões de CH_4 por setor - 1994

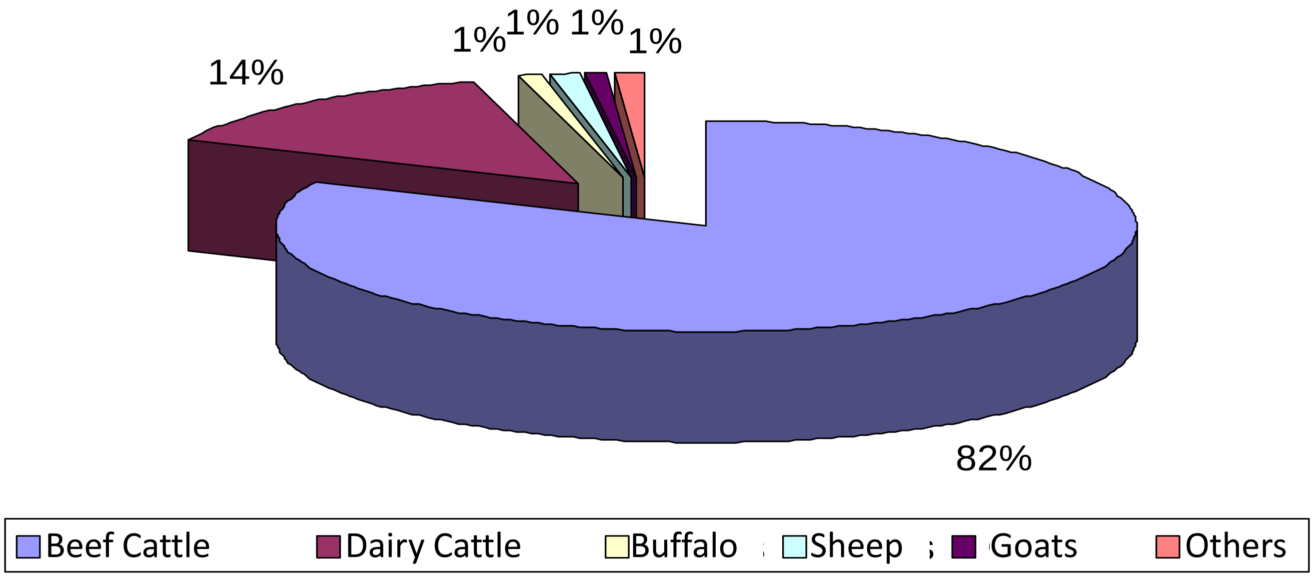
Cattle Enteric Fermentation 68% of CH4 emissions (1994)



Source: Brazilian Ministry of Science and Tecnology (2004)

GHG Emissions from Livestock in Brazil

Beef Cattle 82% of enteric fermetation emissions in Brazil (1994)
Cattle about 18% of the country emissions (current estimates)



Source: Brazilian Ministry of Science and Tecnology (2004)

Brazilian Livestock Production Systems

"Brachiaria x Nelore" Low Input System

Brachiaria

Tolerant to low fertility soils

and also responsive to soil fertility

Easy to seed and persistent

Tolerant to bad pasture management

Highly productive

Low to average quality feed

Nellore (zebu)

Lower maintenance requirements

Higher intake of low quality feed

Higher tolerance to low protein diets

Higher tolerance to heat

Feed Supplementation and Feedlots

Feed supplementation on pasture and feedlots are carried out in the dry season

Feedlots are not covered and only for finishing for 70-120 days (usually only males)

Large use of agricultural byproducts (cottonseed, citrus pulp, maize and soybean residues, sugacane yeast, etc.)

Sugarcane and maize silage used as fiber source

Crop-livestock Systems

Pasture after rice in the low fertility lands

Pasture after soybeans or intercroped with maize in more fertile land and large scale farms

Need large investments

High management demand

Silvopasture Systems

Decrease heat stress

Improved carbon balance

Allow use of high declivity areas

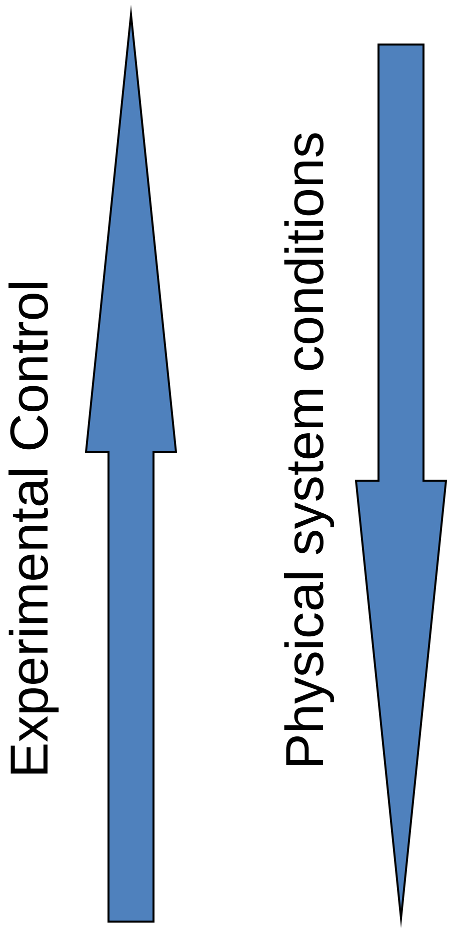
Usually Eucaliptus or pinus but oil producing palms (Dendê and Macaúba), Mohogany and other high value woods are being studied

High wood and coal demand with increasing control of deforestation

High management demand in the first years

Enteric Methane Emissions

Enteric Methane Production Techniques



In vitro methods

Respirometry Chambers

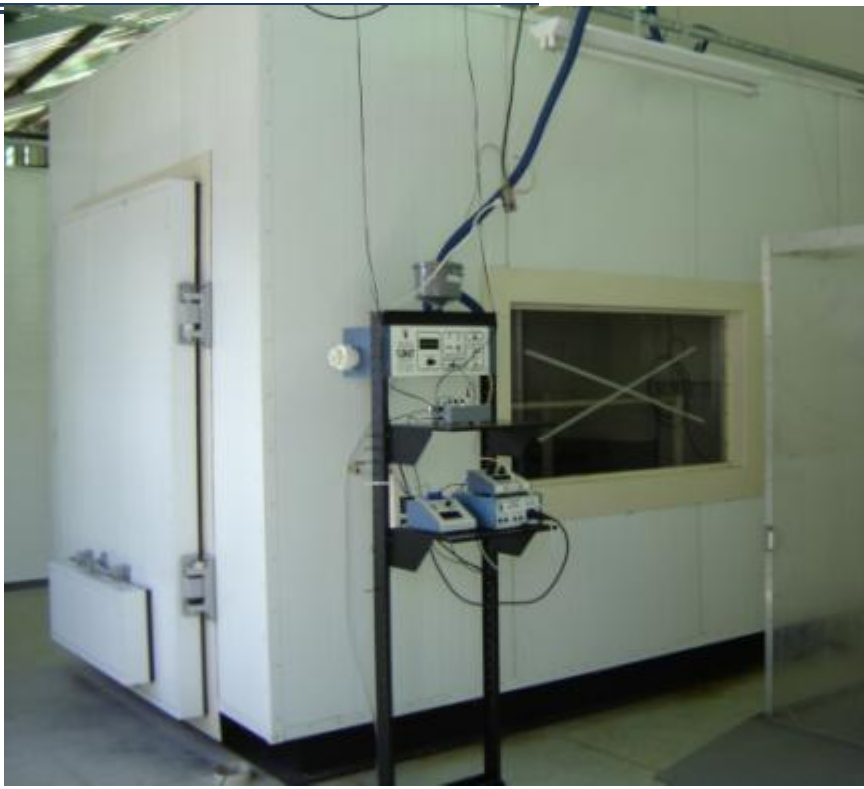
Tunnel Systems

“Feeding hood system”

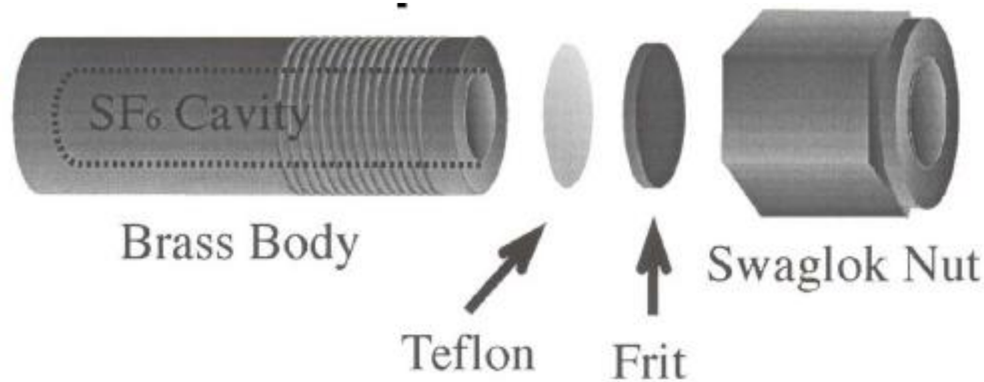
SF6 tracer gas

Micro meteorological methods

Respirometry Chambers

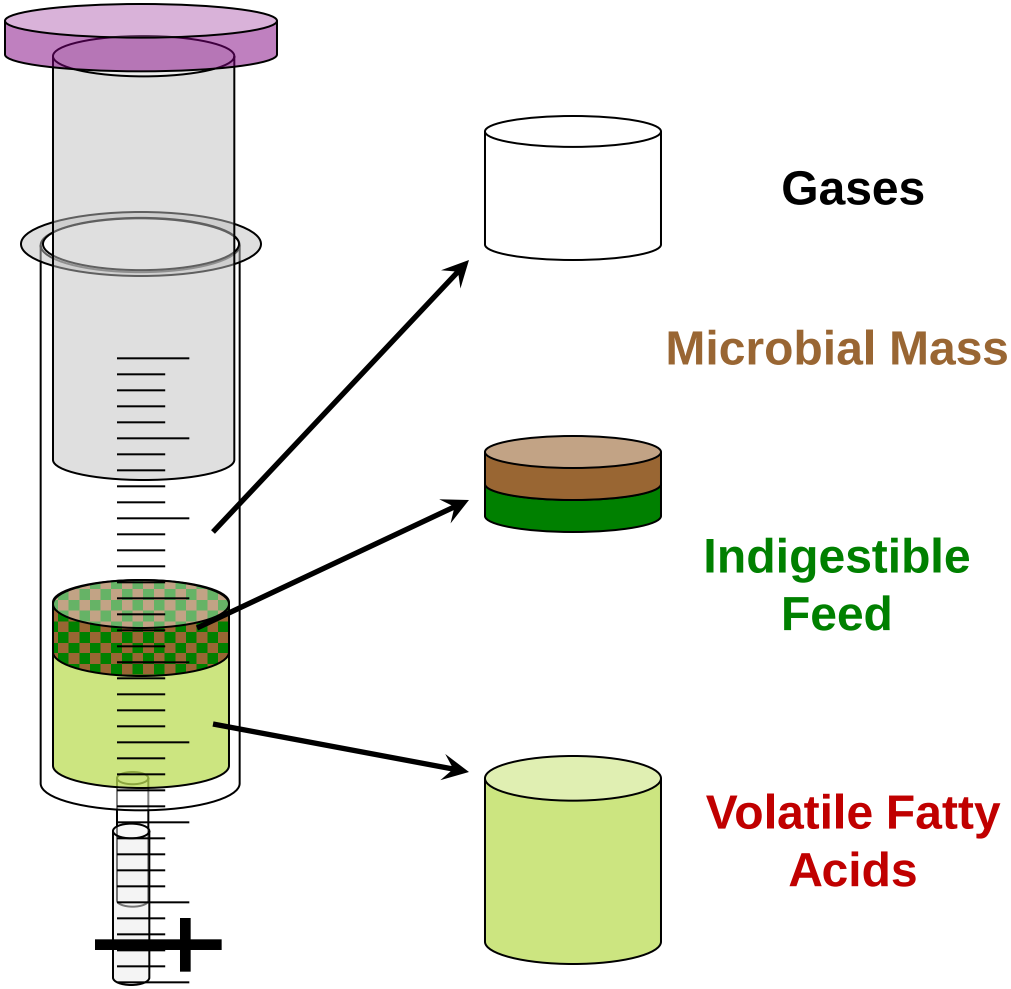


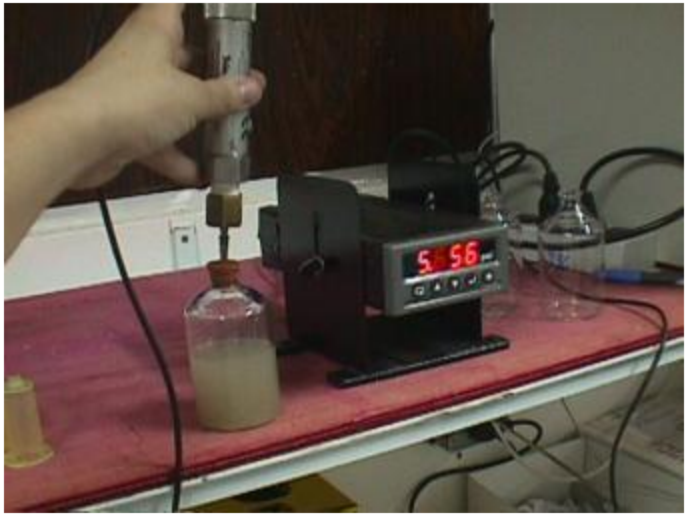
SF6 Technique



SF6 Technique

“In Vitro” Method





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Main Reseach Streams

- Respirometry Chambers
  - Evaluation of methane production of reference feeds
  - Reference calibration of SF6 and “In Vitro” methods
- In Vitro
  - Evaluation methane production by new forage species and cultivars (pre-release)
  - Screening of new materials for genetic improvement
- SF6
  - Methane emissions of grazing animals
  - Evaluation of methane emission of diets (particularly grass + supplements)

Reseach Priorities

- Define emission factors for tropical grasses and supplemented diets
- Identify low CH4 production tropical genotypes
- Parameterize rumen models with tropical forages

GHG Emissions from Cattle Waste

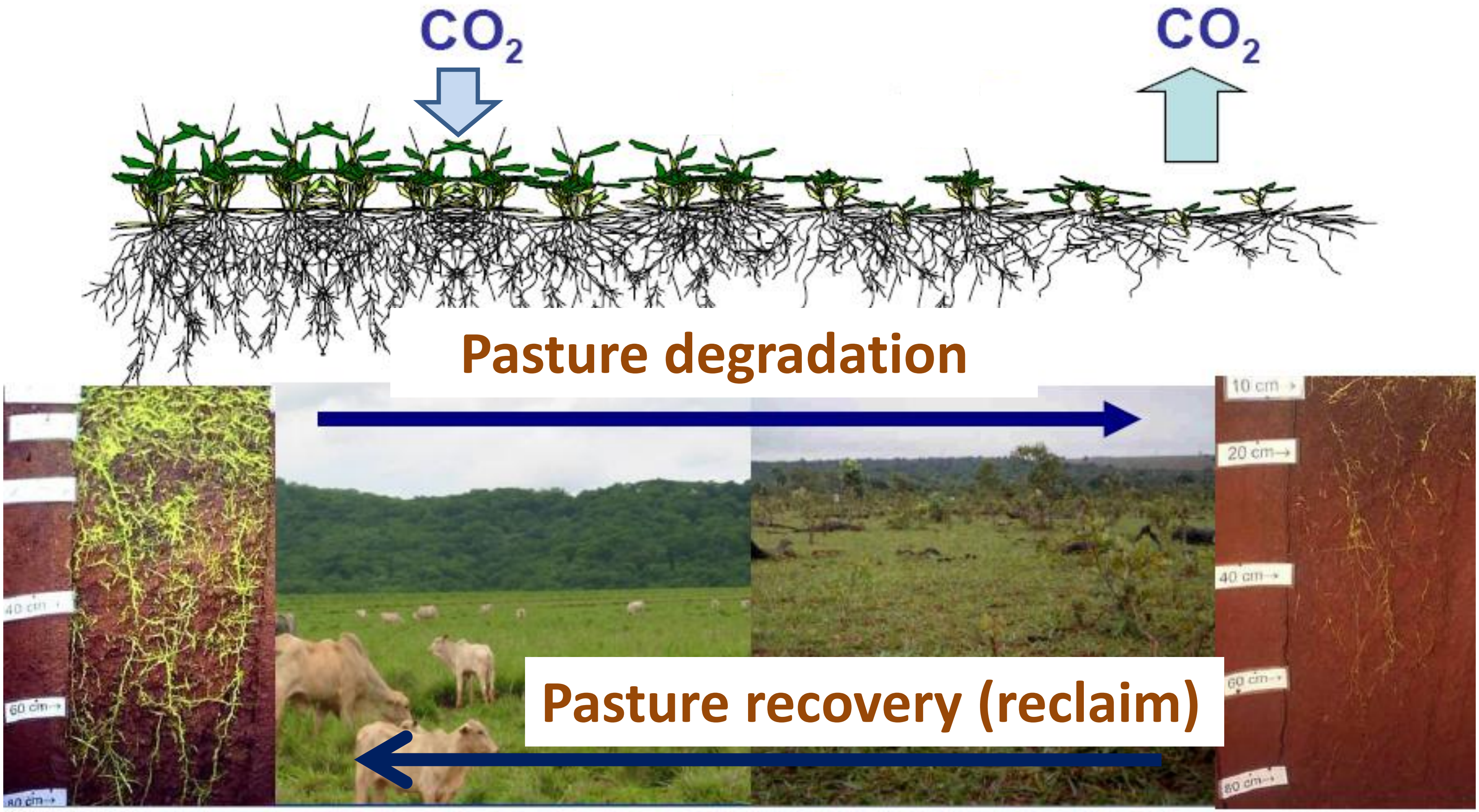
Emissions from Cattle Waste

Reseach Priorities

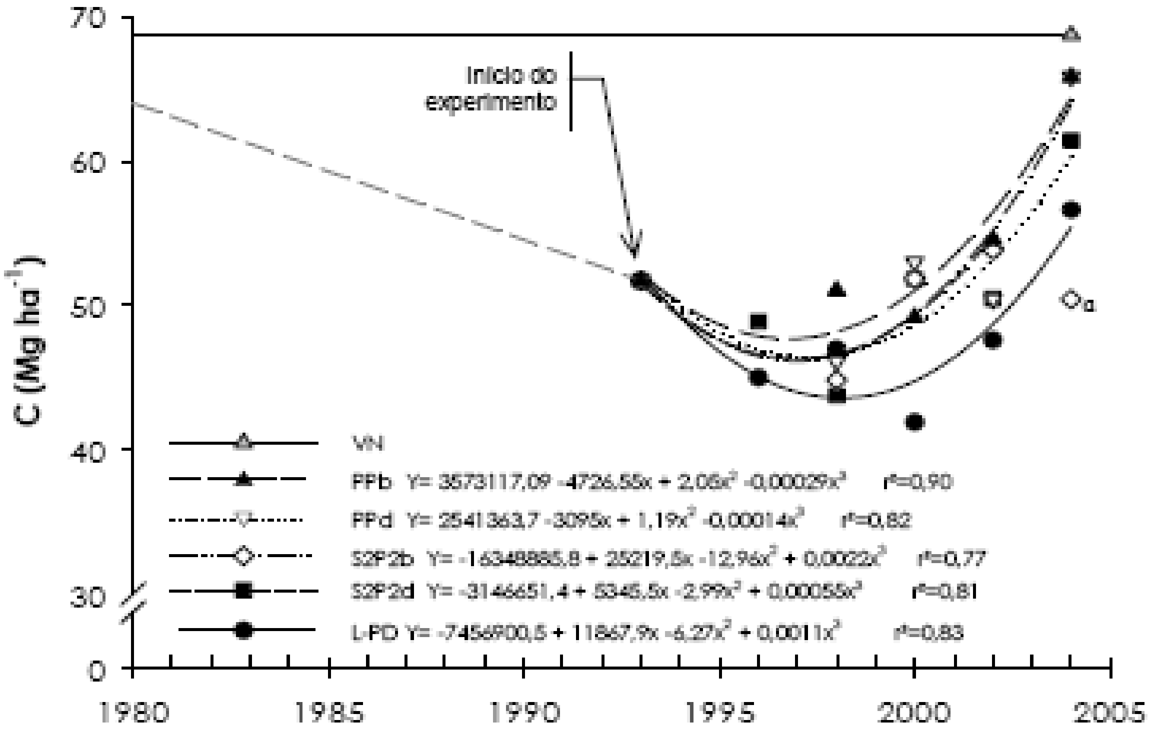
- Improve emission factors and model parameters for tropical pastures

Soil Carbon Dynamics

Pasture and Soil Carbon Dynamics



Pasture reclaiming with a Crop – Livestock System (Maracaju, MS)



Salton, 2005

Modelling Soil Carbon Dynamics

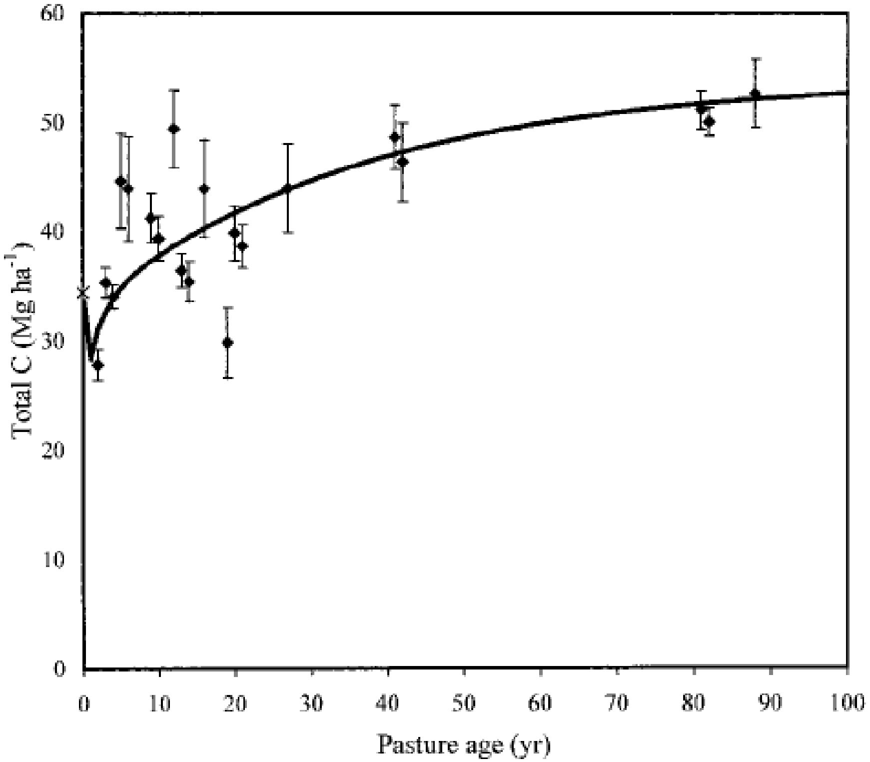


Fig. 1. Predicted (solid line) and measured (symbols) total soil C in the 0- to 30-cm layer from the Nova Vida Ranch chronosequence, Brazil. Clay content assumed to be 286 g kg^{-1} and C input assumed to be 8.28 Mg ha^{-1} yr^{-1}; pasture age (◆) and forest (∗). Bars indicate standard errors.

Source: Cerri et al. (2003)

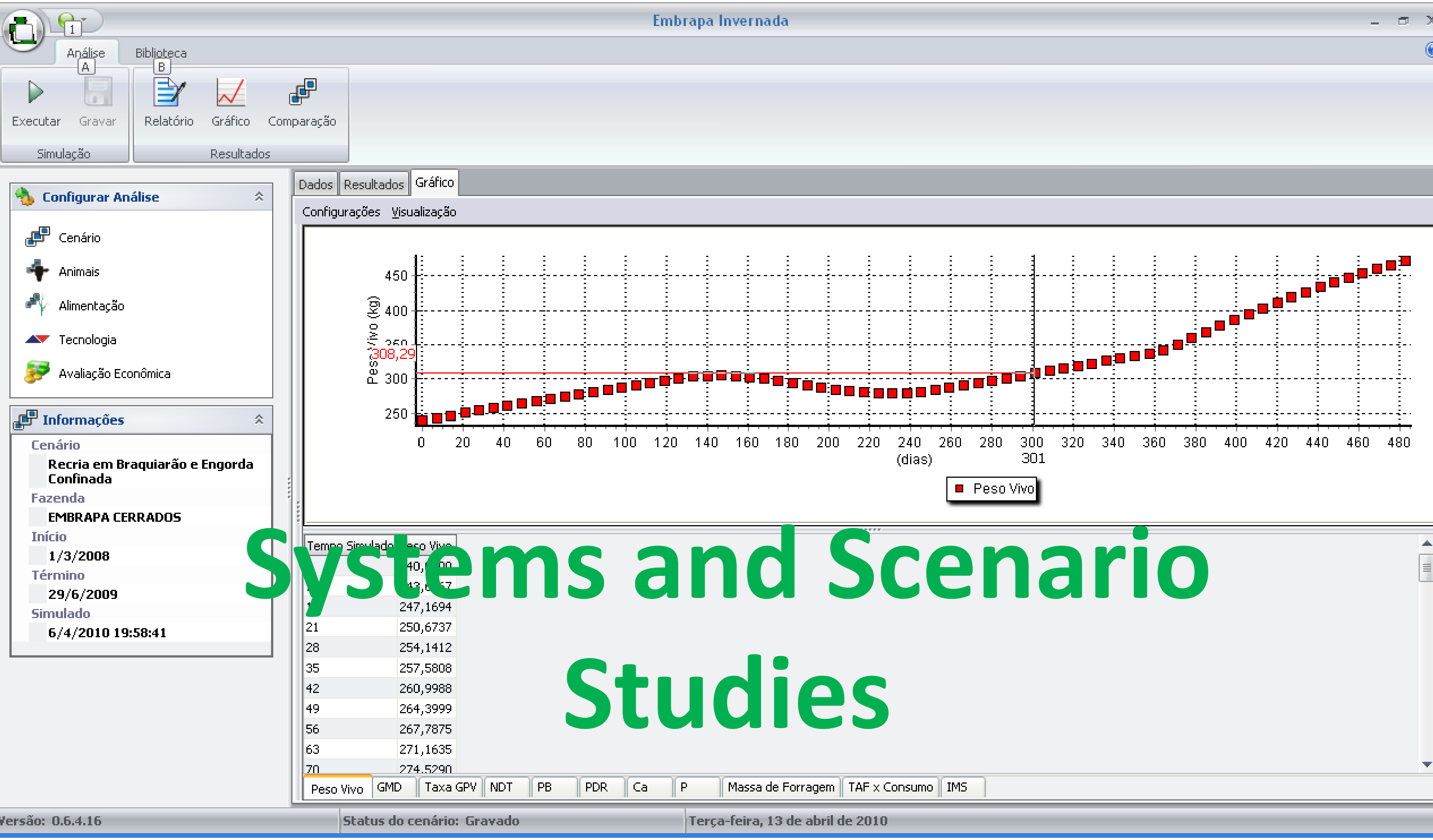
Main Reseach Streams

- Total C dynamics
  - Chronosequence studies (Native vegetation -> aging pastures)
  - Long-term experiments
  - Micrometeorological methods (Fluxes)
- SOM fractioning and humic substances
  - Laser method
- Modelling SOM dynamics
  - Maily using Century
    - Do not allow feedback in simulating pasture degradation

Reseach Priorities

- Increase the number of studies on Soil Organic Matter dynamics, particularly on pasture reclaiming and crop-livestock systems in different conditions.
- Methods for monitoring C quantity and quality in the soil in short time period (verification of change in carbon stocks)
- Modifying current soil organic matter dynamics models in order to simulate CO_2 flows in pasture degradation and reclaiming processes using measurable state variables (maybe re-parameterization of the current SOM dynamics models)

Systems and Scenario Studies

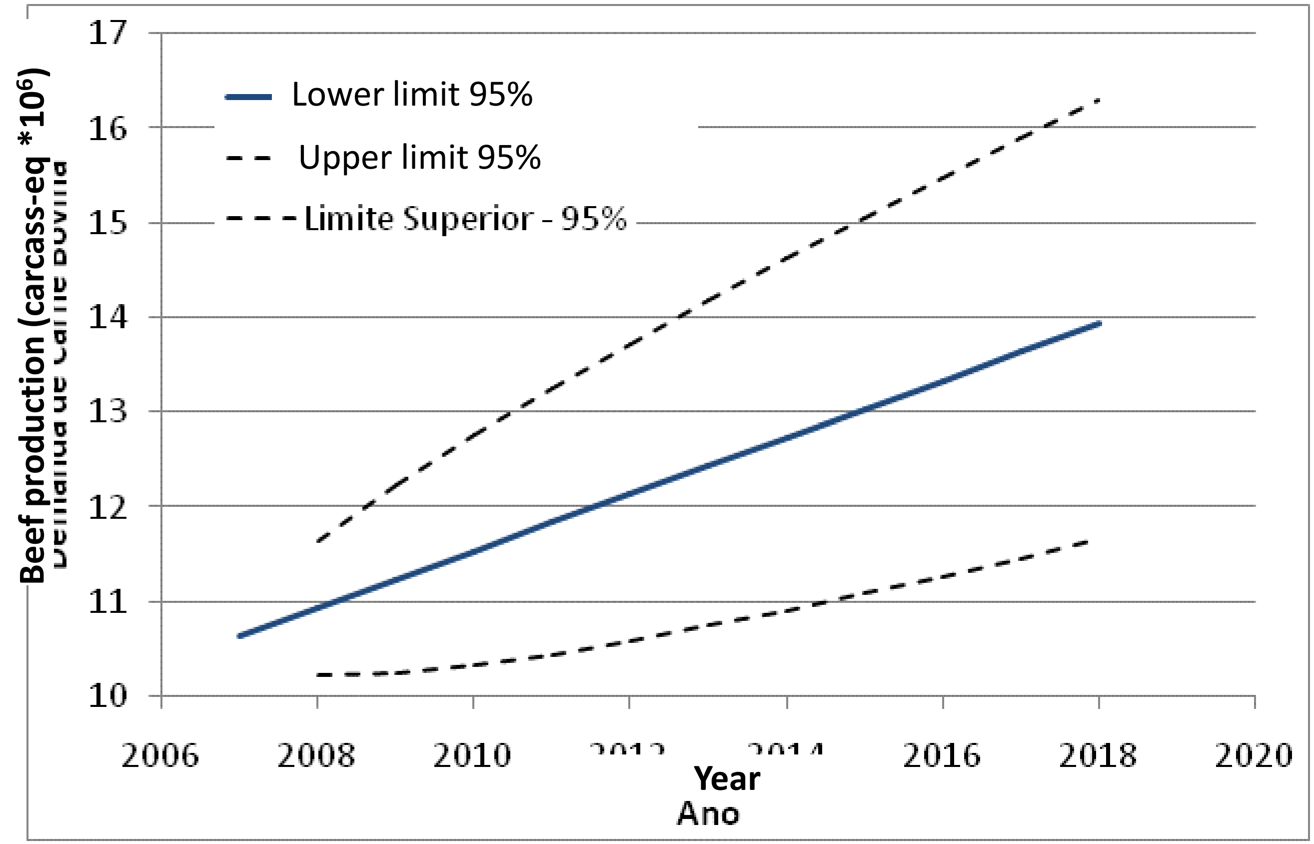


Projected Expansion of Agricultural Production

Year	Soy	Rice	Corn	Sugar	Ethanol
2006/07	57.55	11.27	48.32	30.71	17.60
2007/08	59.17	11.98	49.90	32.63	18.90
2008/09	60.79	12.10	51.48	33.23	20.90
2009/10	62.40	12.33	53.06	34.17	23.00
2010/11	64.02	12.44	54.64	36.57	25.40
2011/12	65.64	12.56	56.22	37.76	27.40
2012/13	67.26	12.67	57.80	38.33	29.60
2013/14	68.88	12.79	59.38	39.39	31.80
2014/15	70.49	12.90	60.96	40.83	34.20
2015/16	72.11	13.02	62.54	41.66	36.80
2016/17	73.73	13.13	64.12	42.29	37.70
Crescimento Relativo	28%	17%	33%	38%	114%

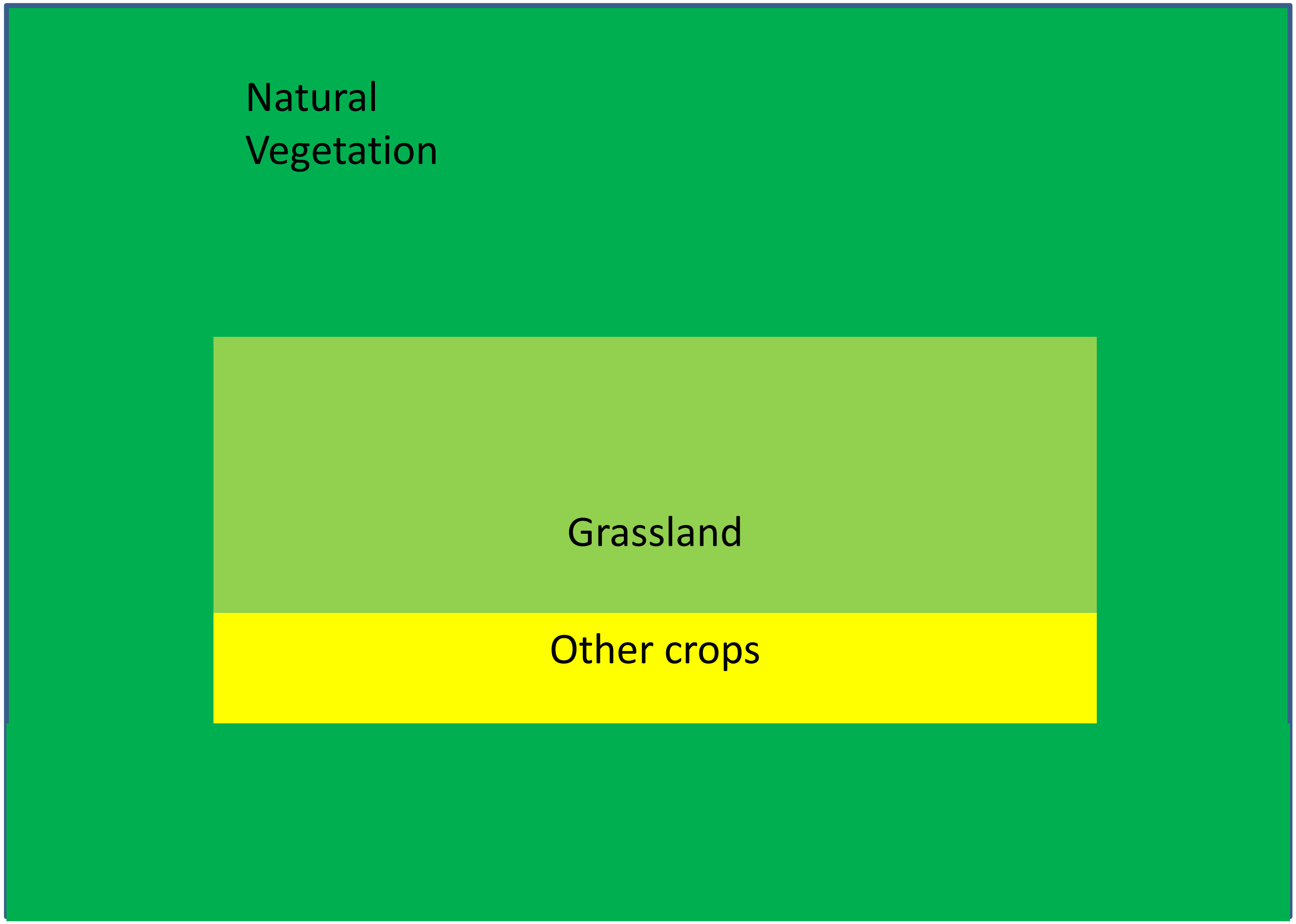
Ministry of Agriculture, Brazil (Jan 2008)

Projected Brazilian Beef Production

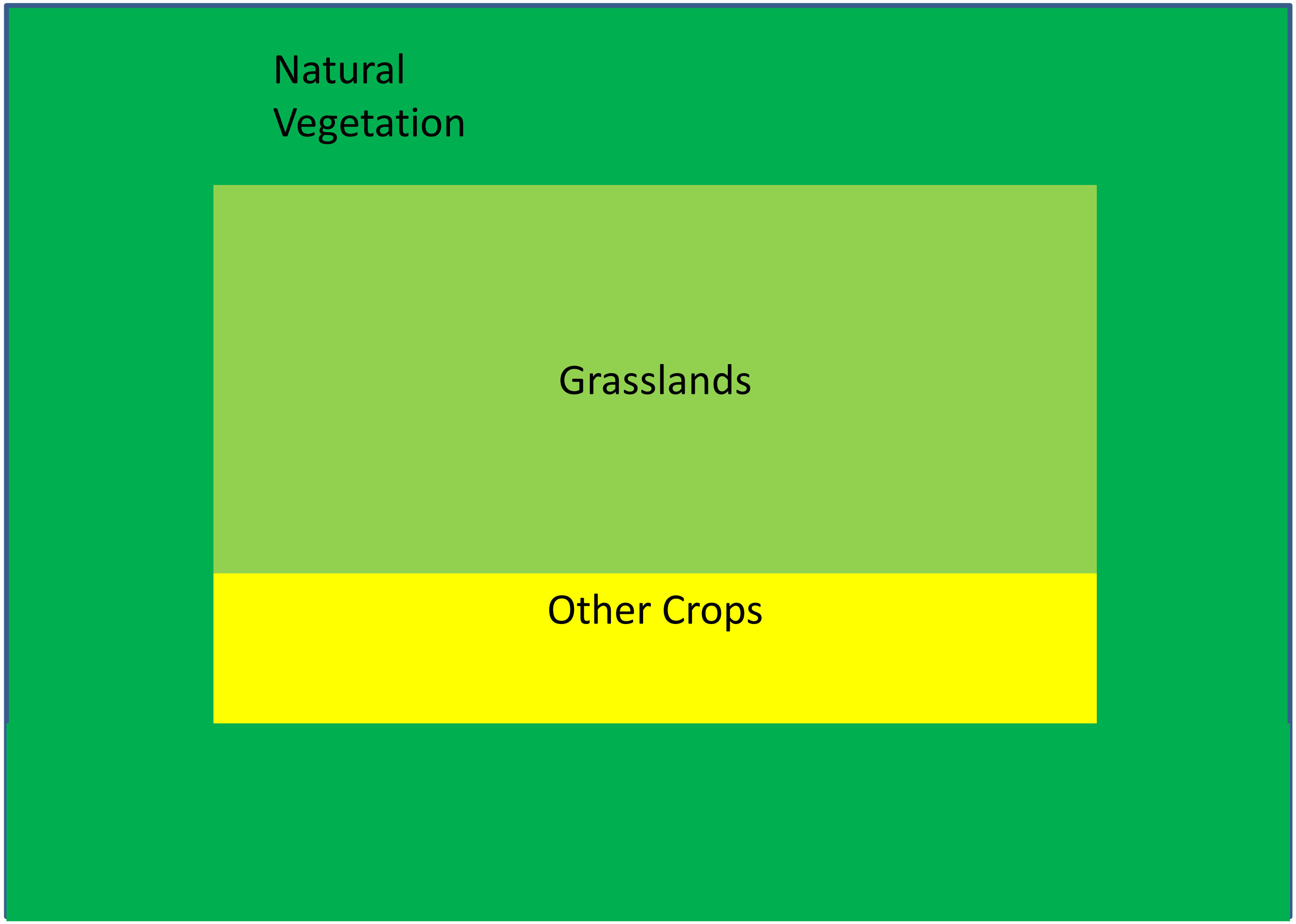


MAPA (Jan 2008)

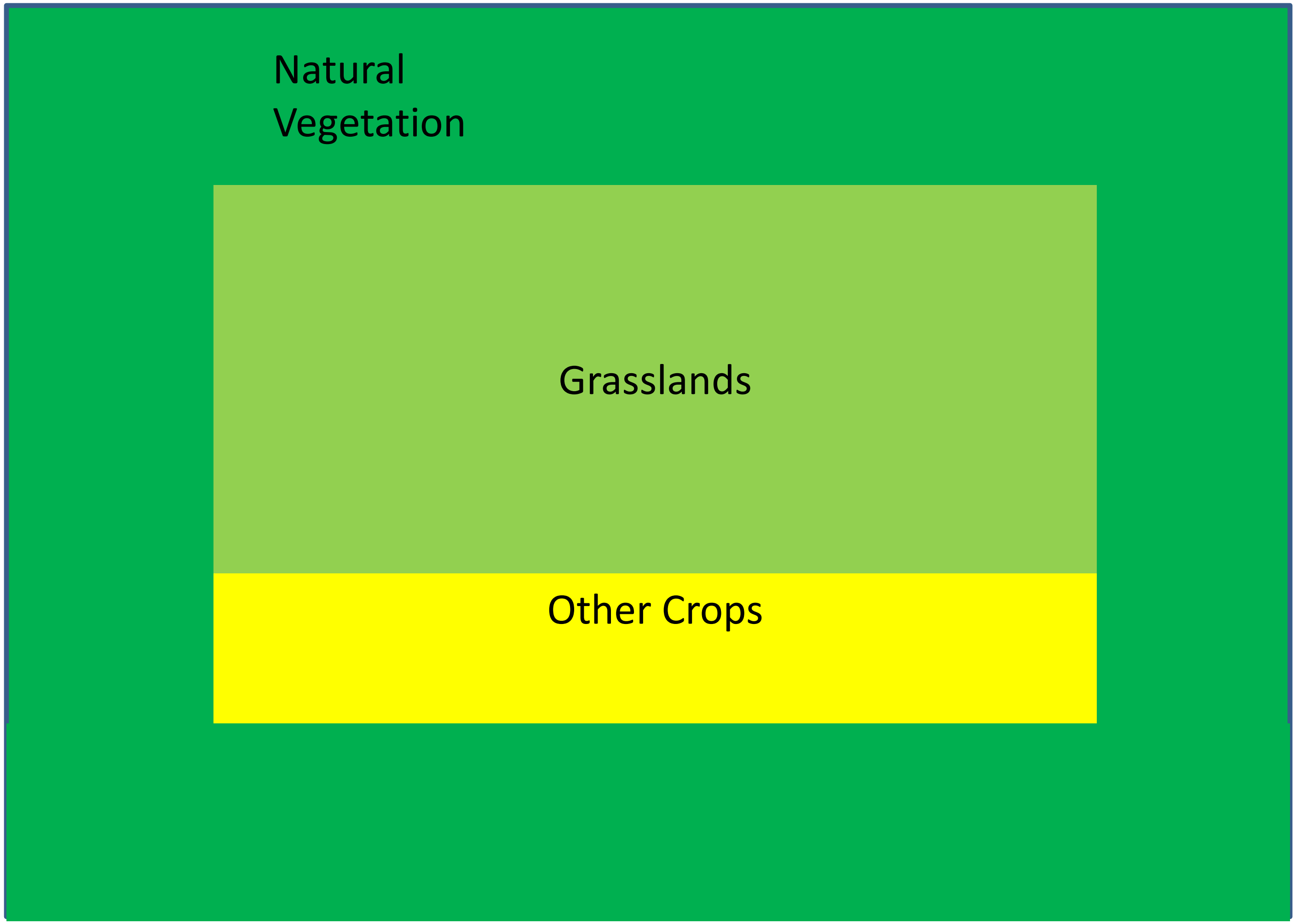
LAND USE CHANGE (past)



LAND USE CHANGE (present)

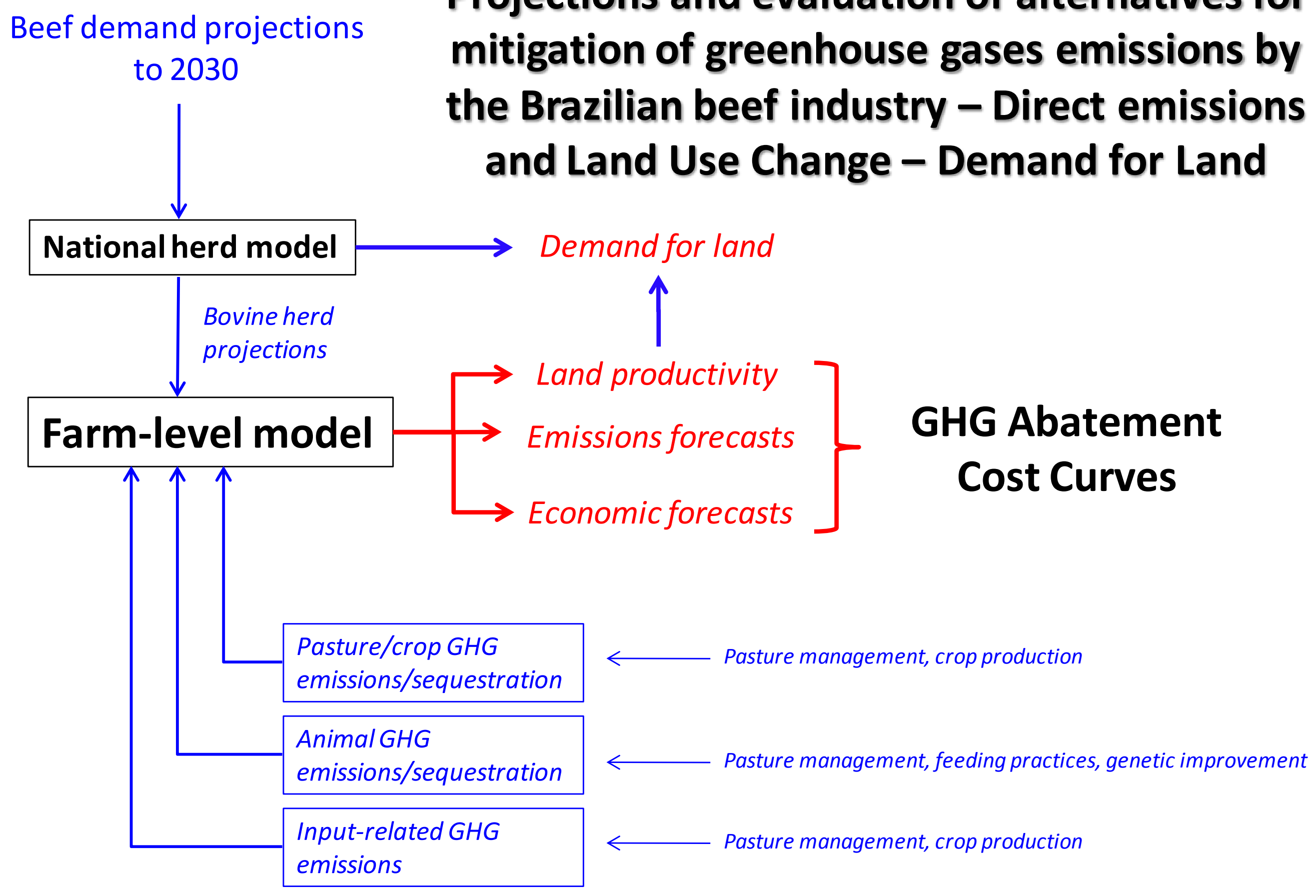


LAND USE CHANGE (future)

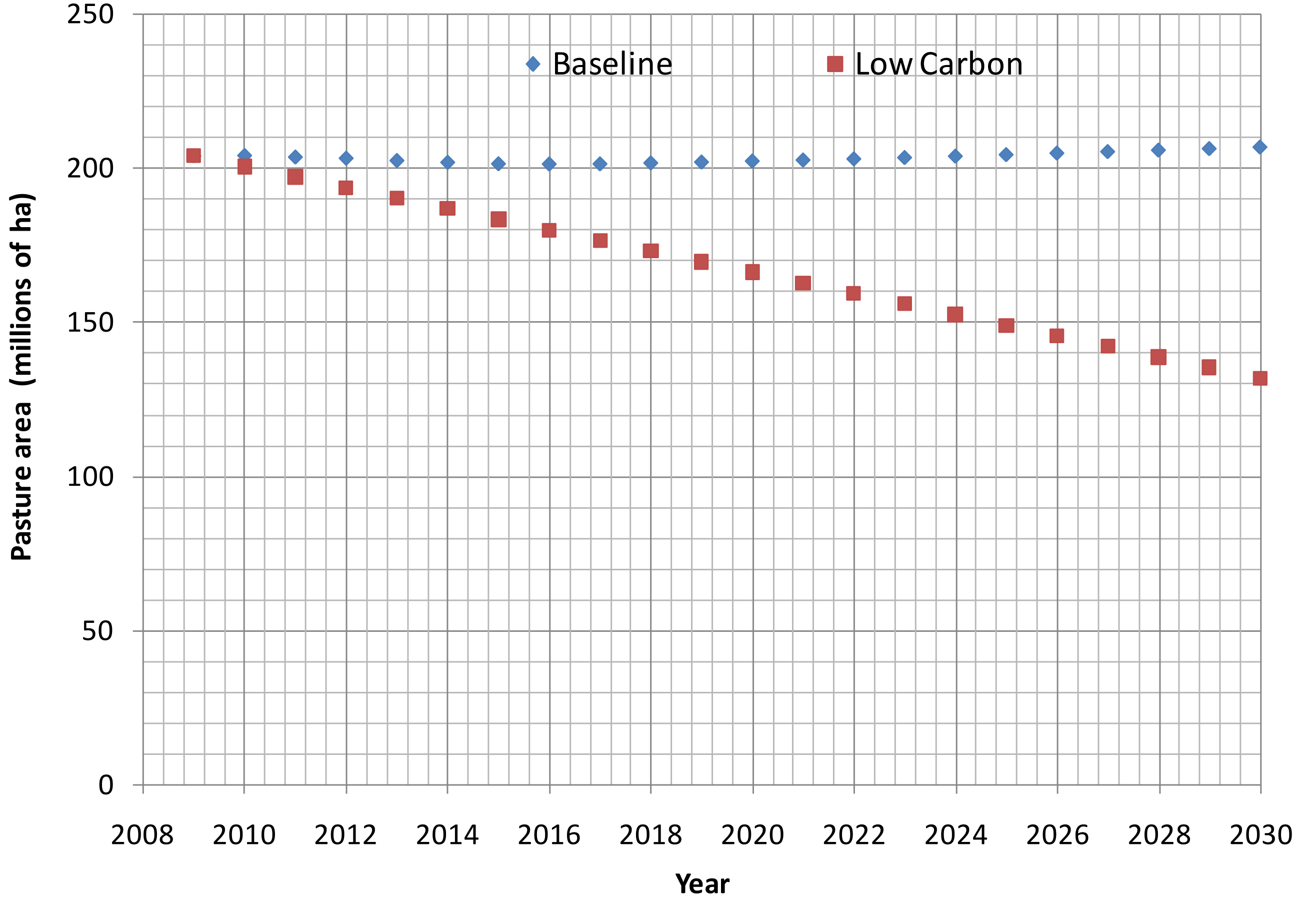


Projections

Projections and evaluation of alternatives for mitigation of greenhouse gases emissions by the Brazilian beef industry – Direct emissions and Land Use Change – Demand for Land

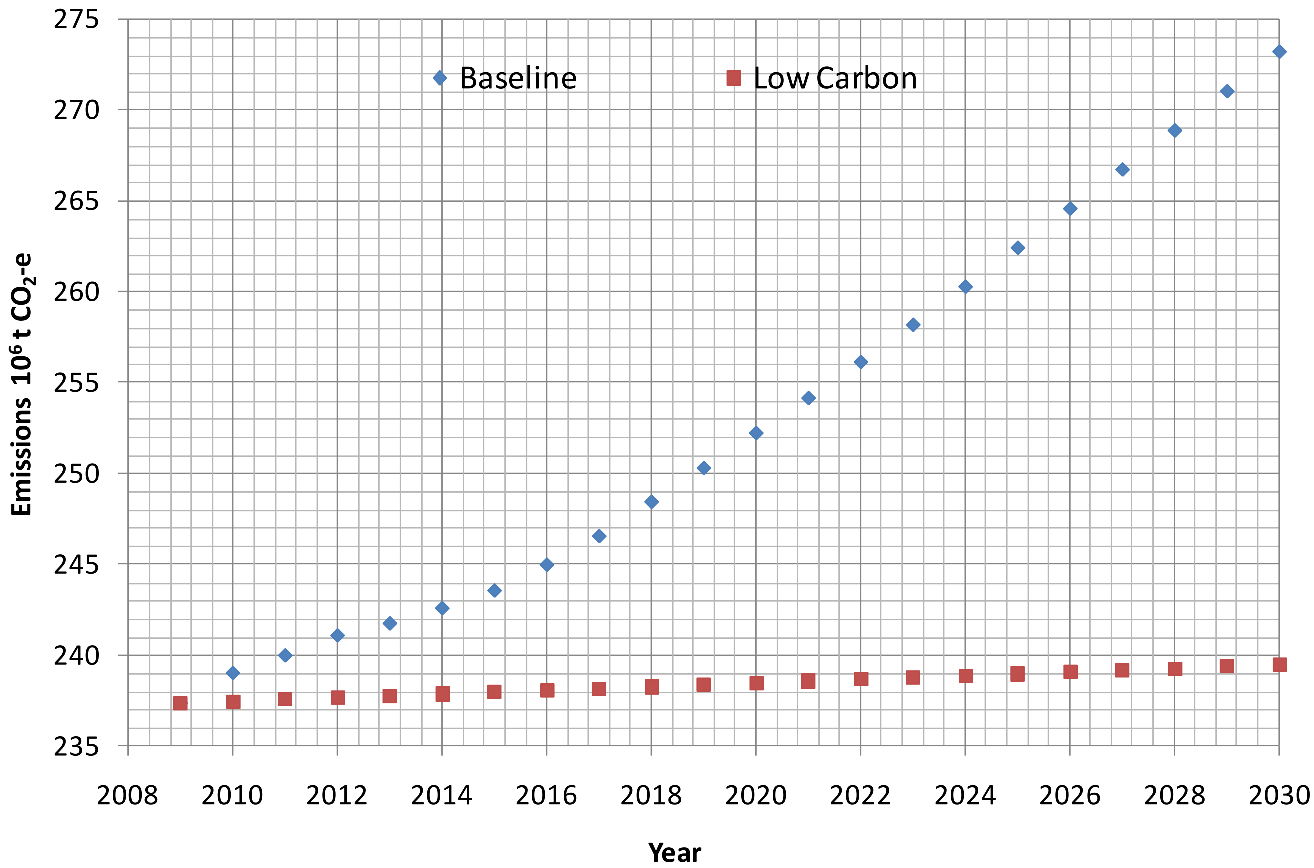


Projections
low carbon scenario

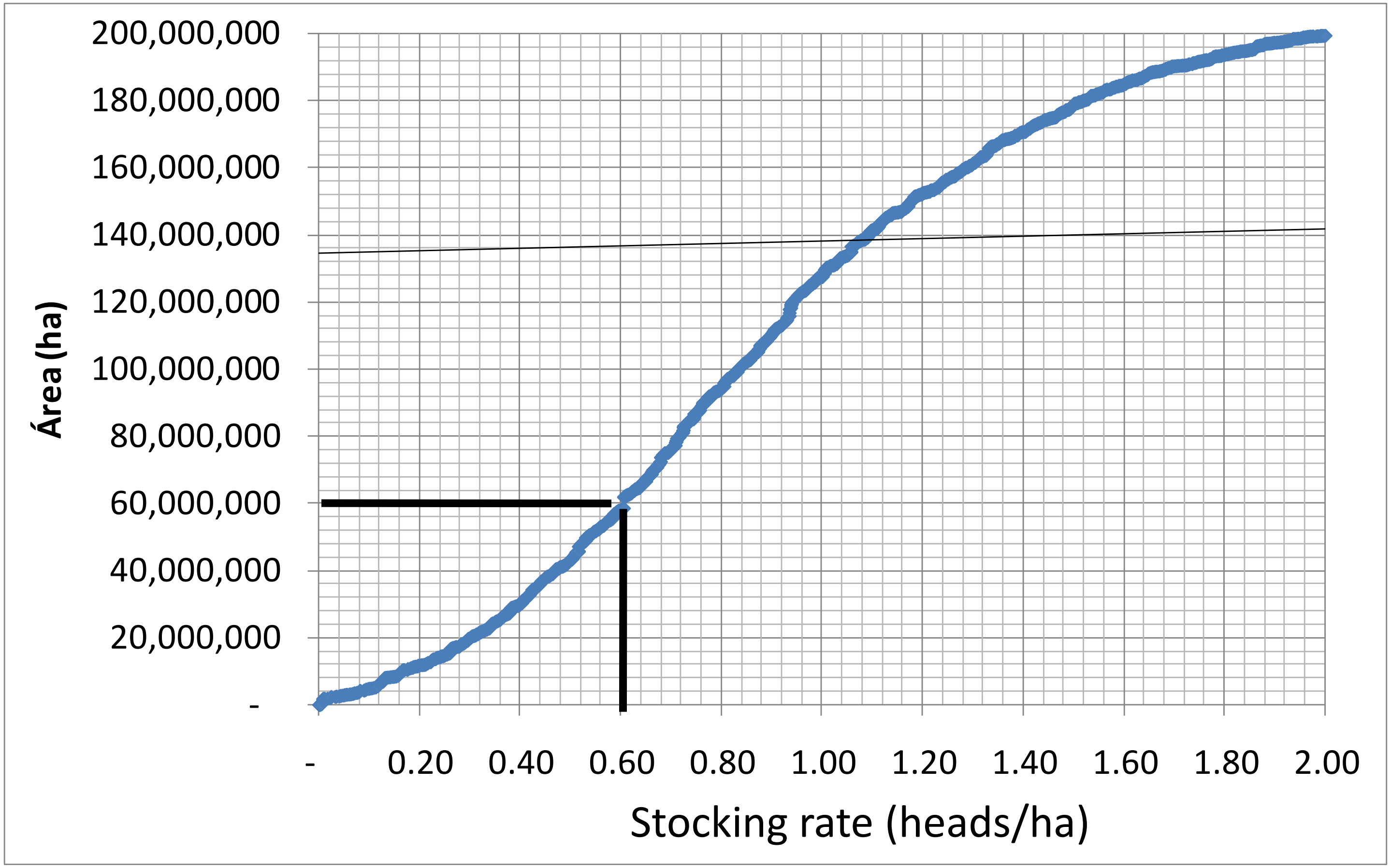


World Bank Low Carbon Brazil Case Study (unpublished)

Projections
low carbon scenario



Pasture Degradation
Stocking rates



Unpublished data

NAMAs propostos pelo Brasil na COP15

- Reclaiming 15 million ha of grasslands
- Implementation of aditional 4 million ha of crop-livestock systems
- 80% reduction in the Amazon deforestation
- 40% reduction in the Cerrado deforestation

Brazilian NAMA (Cattle)

Year	Area Converted (million ha)	Emissions (kg CO_{2}.e/ano * 10^{6}) baseline	intervention	reduction	Land Use Effect: Area saved (million ha)	Additional Animals (million hd)	Cost (US$, million/yr): Investimento	Custeio	Total
2011	1,9	104.479,10	91.598,24	12.880,86	3,80	1,52	1243	334	1577
2012	3,8	104.479,10	78.717,38	25.761,72	7,60	3,04	1243	668	1911
2013	5,7	104.479,10	65.836,52	38.642,58	11,40	4,56	1243	1003	2245
2014	7,6	104.479,10	52.955,66	51.523,44	15,20	6,08	1243	1337	2580
2015	9,5	104.479,10	40.074,80	64.404,30	19,00	7,60	1243	1671	2914
2016	11,4	104.479,10	27.193,94	77.285,16	22,80	9,12	1243	2005	3248
2017	13,3	104.479,10	14.313,08	90.166,02	26,60	10,64	1243	2339	3582
2018	15,2	104.479,10	1.432,22	103.046,88	30,40	12,16	1243	2673	3916
2019	17,1	104.479,10	(11.448,64)	115.927,74	34,20	13,68	1243	3008	4250
2020	19	104.479,10	(24.329,50)	128.808,60	38,00	15,20	1243	3342	4585
Total							**12.428,57**	**18.379,43**	**30.808,00**

Source: Environmental Modelling Laboratory (Embrapa)

Research Priorities

- Social and Economic Barriers and Extenalities in Smallholders Livestock System Intensification
- Lifecycle analysis of beef production in diferent systems
- Systems models for evaluating simultaneously GHG balances and economics
- Modelling Land Use and Technological Dynamics and relating it to interventions at a regional basis

Brazilian Main Research Projects and Networks

- Agrogases
  - Network on greenhouse gases in the Brazilian Agriculture

  (http://www.cnpma.embrapa.br/clima/rede_agrogases)
- AVISAR
  - Measuring the environmental, social and economic impacts of beef cattle production in the Amazon, Cerrado and Pantanal Biomes of Brazil: trends, driving forces and policy options

  (http://www.avisar2.cnptia.embrapa.br)
- New networks
  - Rumen Gases (Embrapa Gado de Leite)
  - Livestock GEEs (Embrapa Pecuária Sudeste)
  - Animal Change (Embrapa and URFGS in a EU project)