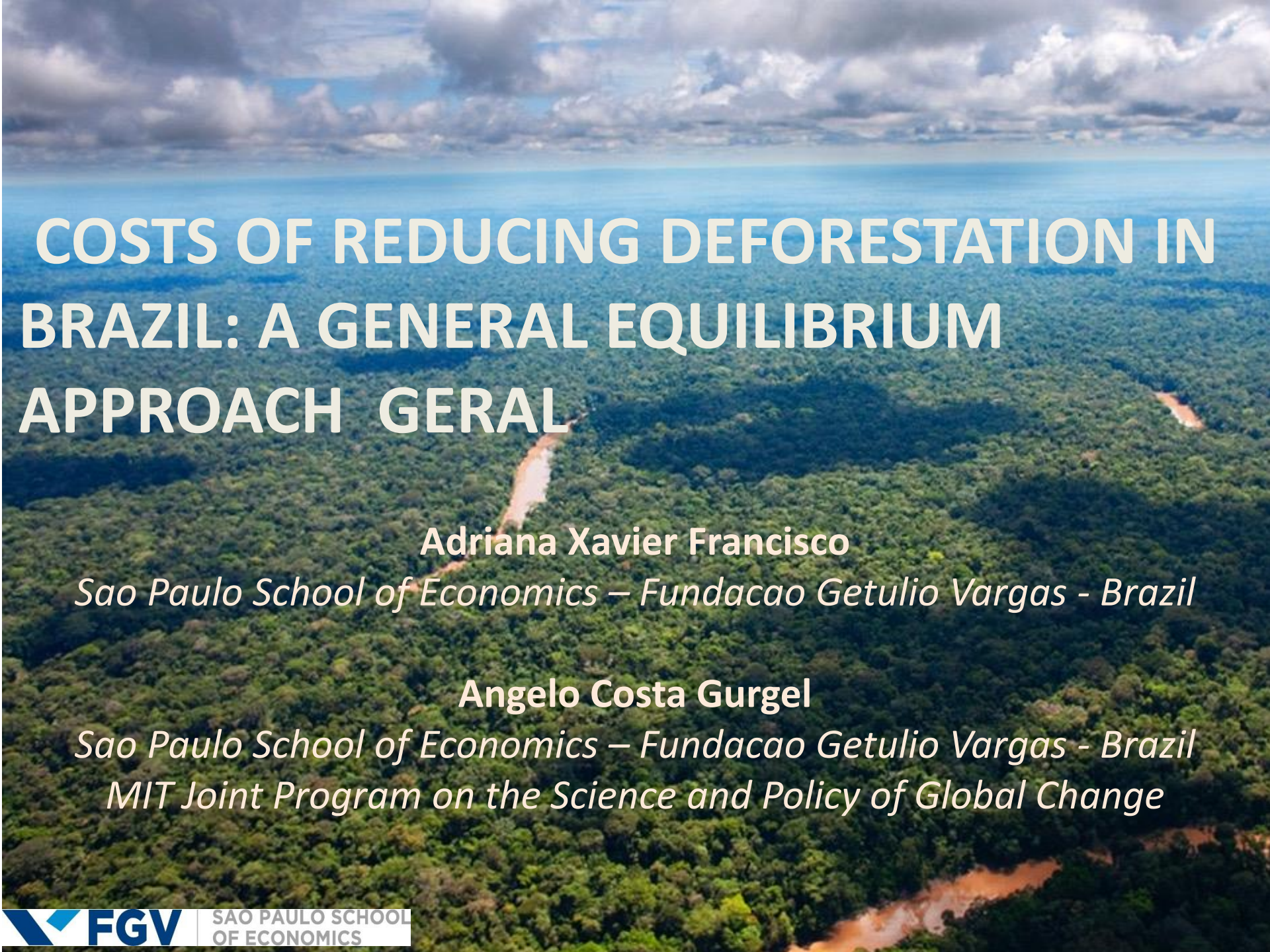




COSTS OF REDUCING DEFORESTATION IN BRAZIL: A GENERAL EQUILIBRIUM APPROACH GERAL

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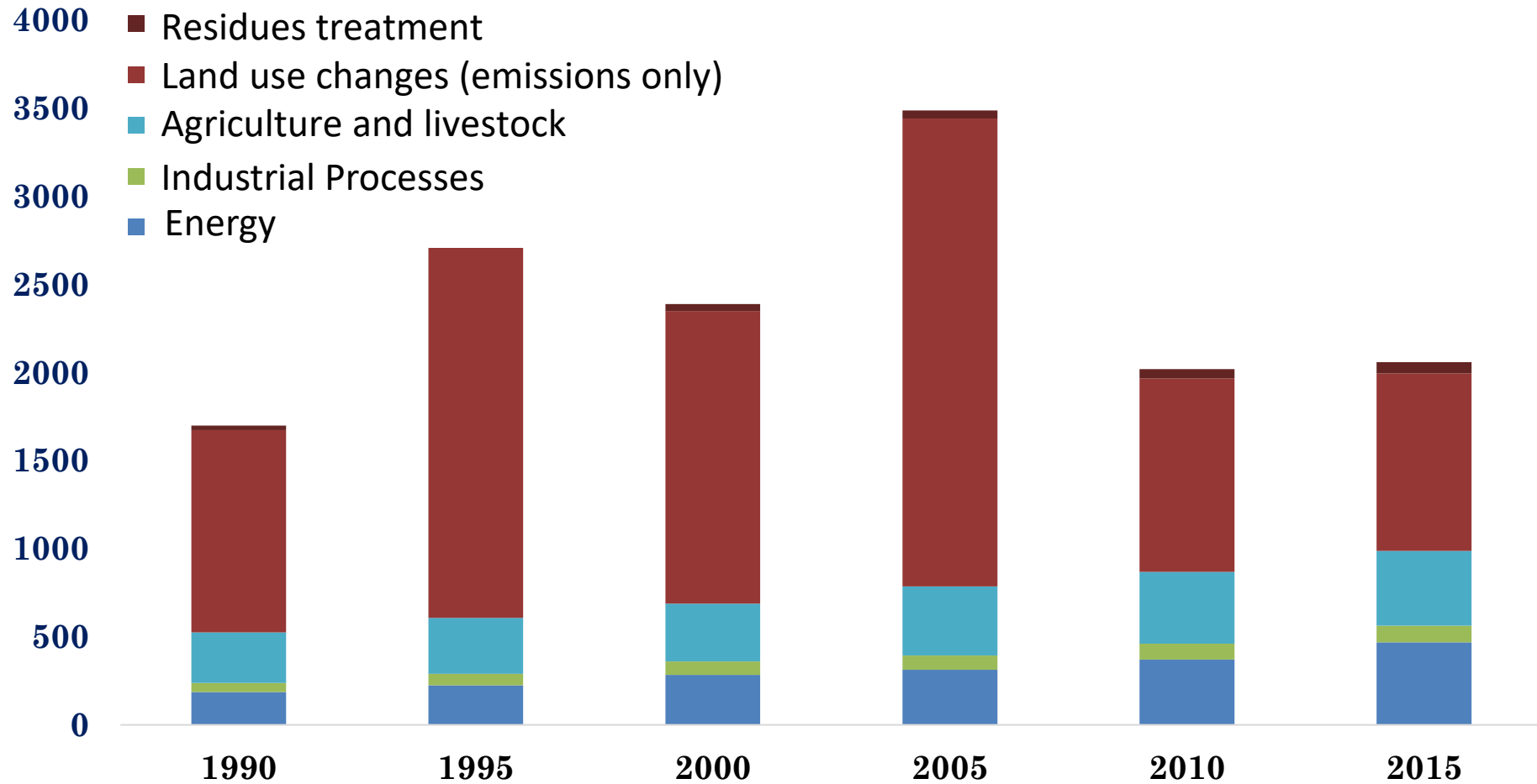
Sao Paulo School of Economics – Fundacao Getulio Vargas - Brazil

MIT Joint Program on the Science and Policy of Global Change

Outline

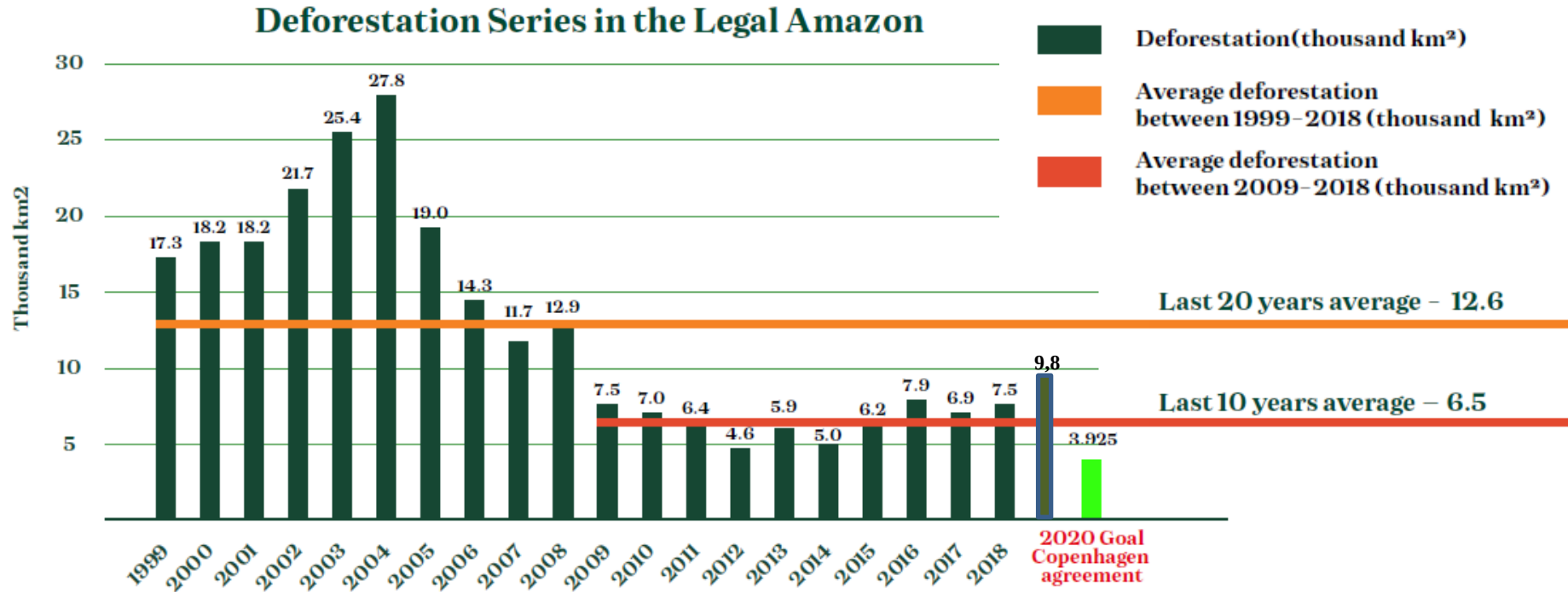
- Context
- Research problem
- Method
- Scenarios
- Results
- Conclusions

GHG Emissions - Brazil



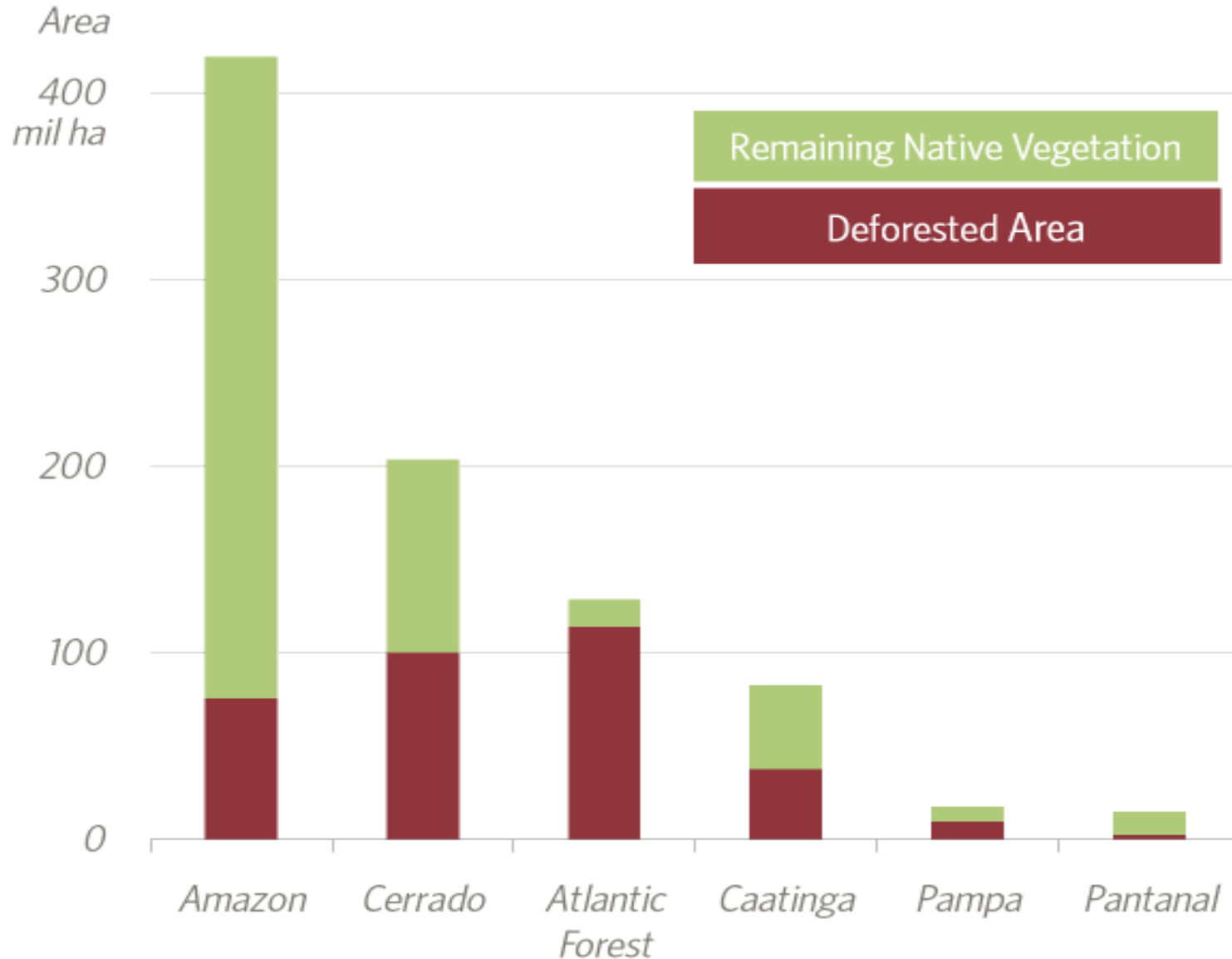
Source: Brazilian Ministry of Science, Technology and Innovation

Amazon Deforestation



Source: IBGE-Geoscience (Map of biomes and vegetation) and INPE, extracted on 28/08/19. Last available data.

TOTAL DEFORESTED AREAS AND REMAINING NATURAL VEGETATION IN BRAZILIAN BIOMES



Brazil Nationally Determined Contributions (NDC) in the Paris Agreement

Cut 37% of GHG emissions by 2025 and 43% by 2030, relative to 2005 emissions

Possible actions:

- End illegal deforestation;
- Recover 12 million ha of forests and degraded areas;
- Increase energy efficiency by 10%;
- Increase renewables in the energy mix;
- Increase the “low carbon emissions plan in agriculture” (recover degraded pastures and increase the adoption of integrated crop-livestock-forest systems);
- ...

BRAZILIAN AGRIBUSINESS

21%

(BRL 1,43 tri)

Agribusiness GDP

(2018)

Inputs

5%

Agric.&Livestock

24%

Agri-Industry

30%

Distribution

41%

20%

Employments
(2018)

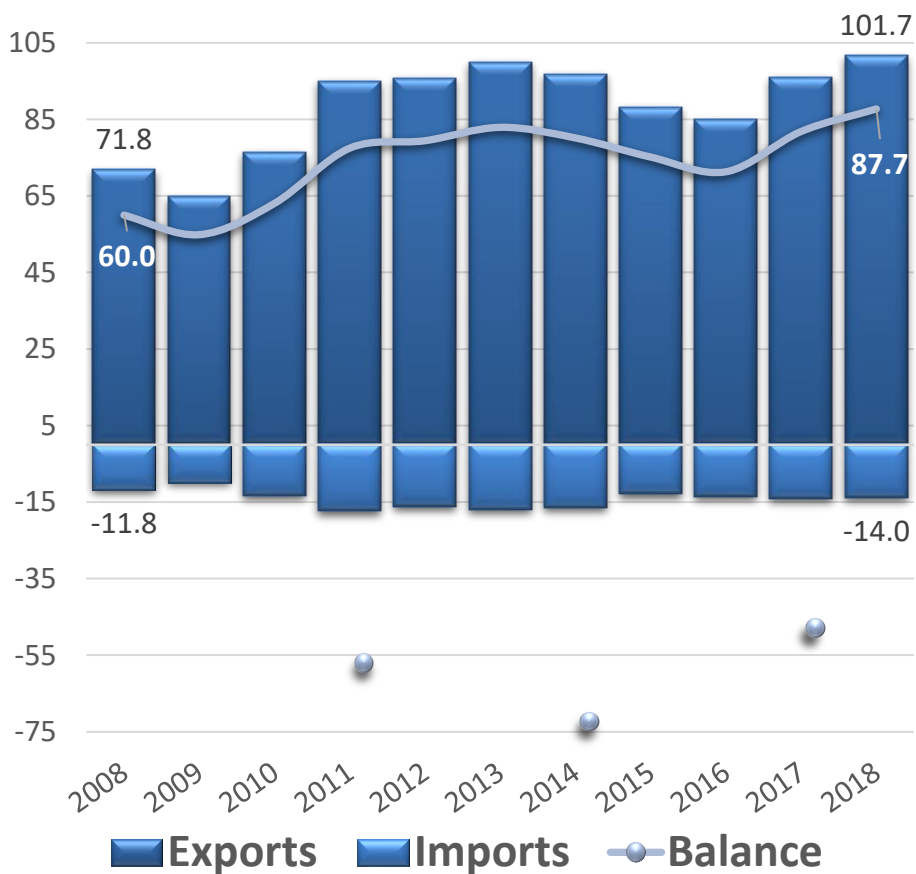
42%

Exports
(2019)

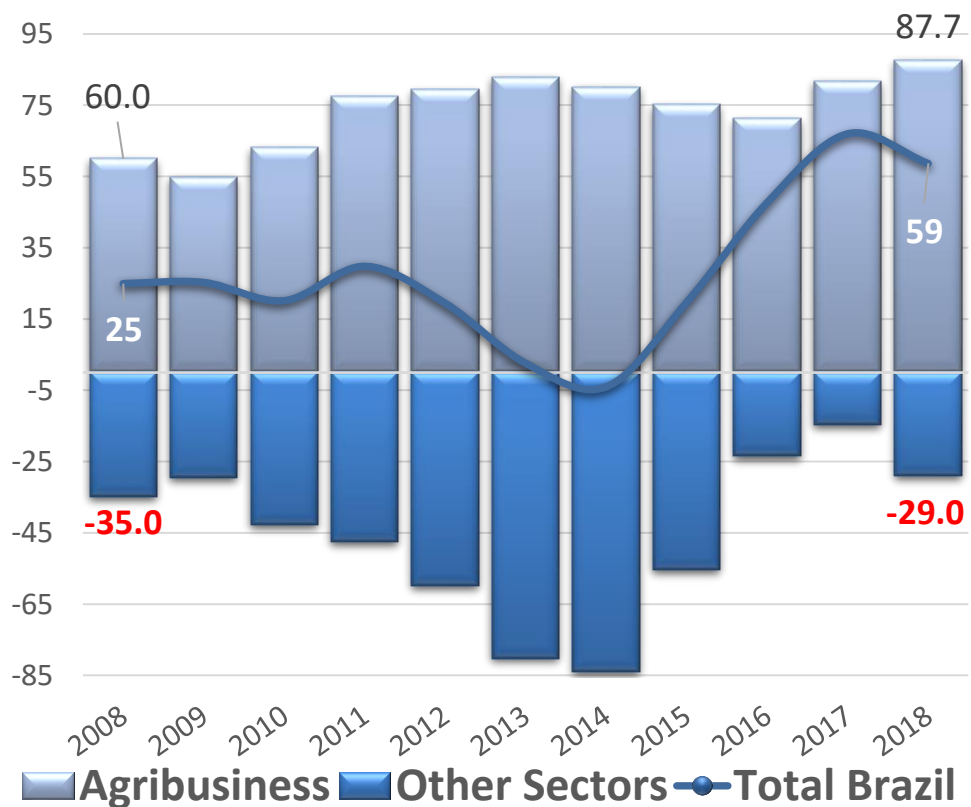
Sources: CEPEA/USP, CNA, IPEA, MAPA e MDIC. Elaboração: GV Agro

BRAZILIAN AGRIBUSINESS

AGRIBUSINESS TRADE BALANCE



BRAZILIAN TRADE BALANCE



RESEARCH PROBLEM

Challenges:

- Climate change impacts;
- Commitments at the Paris Agreement;
- Current levels of deforestation;
- Importance of the agricultural sector for the Brazilian Economy and as a world food supplier;

What are the possible impacts from ending deforestation in Brazil by 2030 on the Brazilian and world economy?

LITERATURE REVIEW

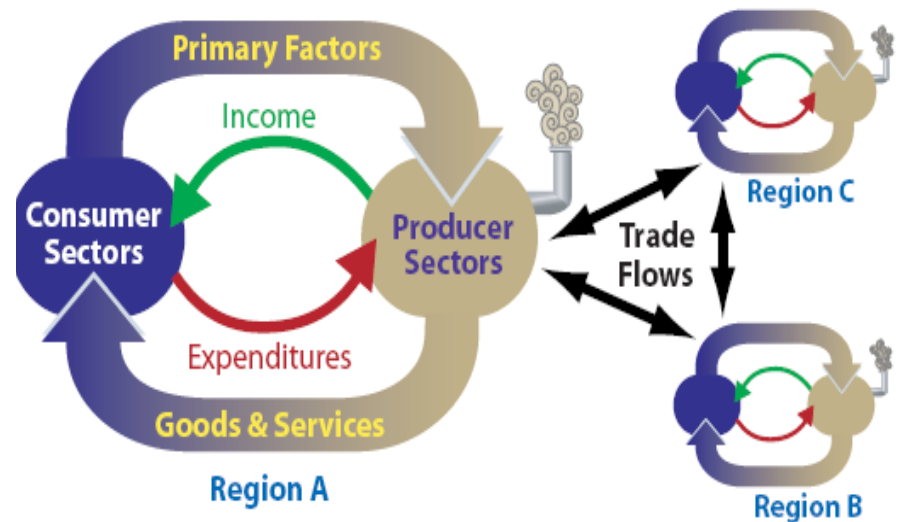
- Ferreira Filho & Horridge (2012)
- Diniz (2012)
- Cabral (2013)
- Carvalho & Domingues (2014)
- Carvalho, Magalhães & Domingues (2016)
- Ferreira Filho, Ribera & Horridge (2016)
- Santos et al. (2017)
- Instituto Escolhas (2017)
- Silva et al. (2017)
- Ferreira Filho & Horridge (2017)
- ...

Method

Economic Projection and Policy Analysis model – EPPA6

- Computable General Equilibrium Model of the world economy;
- Multiregional and multisetorial;
- Recursive dynamic;
- Full representation of demand and supply/endowments in all markets;
- Endogenous investment and capital evolution, with vintaging;
- Represent several natural resources and GHG emissions sources and sinks;
- Climate policies and other impacting natural resources

MIT Emissions Prediction and Policy Analysis (EPPA) Model



Model Features

- All greenhouse-relevant gases
- Flexible regions
- Flexible producer sectors
- Energy sector detail
- Welfare costs of policies

Mitigation Policies

- Emissions limits
- Carbon taxes
- Energy taxes
- Tradeable permits
- Technology regulation

Method

Setors		Primary Fators
Economic Sectors		Non Renewable Natural Capital
Agriculture- Crops	CROP	Oil
Livestock	LIVE	Shale oil
Forestry	FORS	Natural Gas
Food	FOOD	Coal
Coal	COAL	Renewable Natural Capital
Crude oil	OIL	Solar and wind
Refined oil	ROIL	Hydro
Natural gas	GAS	Nuclear
Eletricity	ELEC	Natural forests
Energy intensive	EINT	Natural grass
Other industries	OTHR	“Produced” Capital
Services	SERV	Capital
Transportation	TRAN	Cropland
Household “Sectors”		Pastures
Own transportation	HHTRAN	Managed and harvested forests
Dwellings	DWE	Trabalho
Other services	HHOTHR	

Method

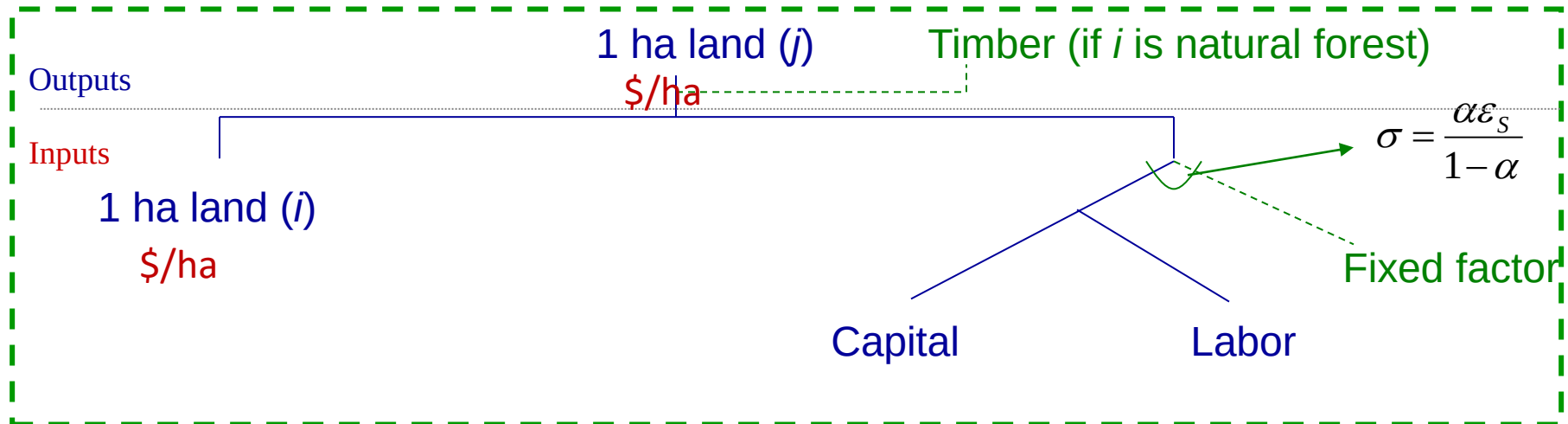
Regional representation in EPPA6



Method

Land Use “Transformation” Functions

i and j : land use types



Observed Land Supply Response model (OLSR)

value of land (i) + value of other inputs = value of land (j)
\$/ha *\$/ha*

Allows to calibrate land use change trajectories close to observed past data, where ε_s represents the price-elasticity of agricultural land supply

Method

Land Use Changes

Endowments (income):

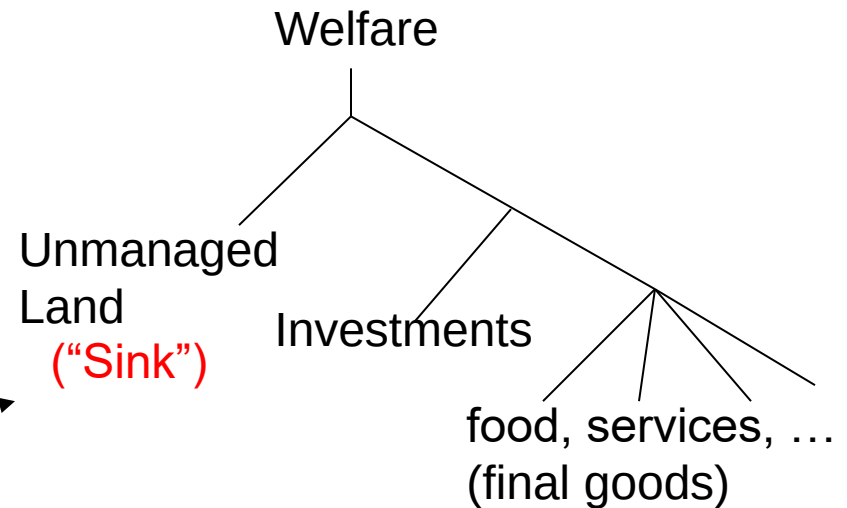
Labor

Capital

Natural Resources:

- fossil fuels
- managed land
- unmanaged land

Welfare Function:



(“Source”)

Unmanaged land value:

$$NPV_{\text{of Virgin Forest}} = X_0 + \sum_{t=1}^{\infty} \frac{X_t}{(1+r)^t}$$

Timber value at time 0

NPV value of future harvests

(\$/ha of natural forest relative to managed forest)

Method

Scenarios

- **BAU**: Reference scenario, historical deforestation trend observed in the last 15 years;
- Policy scenarios: we implement an economic penalty to deforestation activities until reach some maximum deforestation target:
 - **Stop_illegal**: Stop illegal deforestation by 2030 with some remaining legal deforestation after 2030;
 - **Stop_2030**: Stop all deforestation by 2030;
 - **Stop_now**: Stop all deforestation by 2020;

Method

Scenarios

EPPA6 projections of deforested areas in the BAU scenario and Cumulative areas allowed to be deforested in each scenario (in Mha)

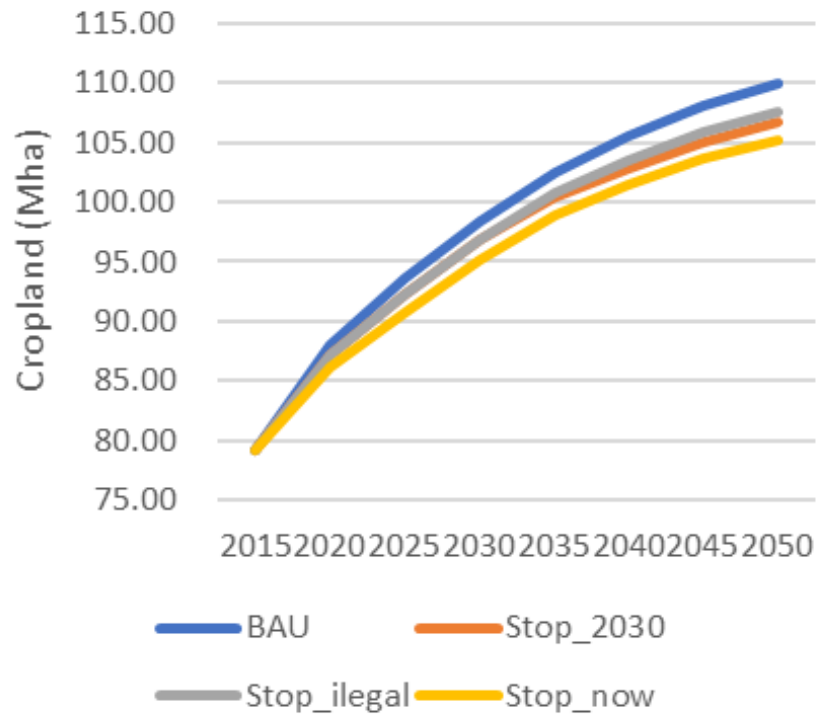
	Forest (Amazon and Atlantic Forest)	Natural Grass (Cerrado and Pampa)	Total
	2016-2050	2016-2050	2016-2050
BAU	6.87	20.34	27.21
Stop_Illegal	3.53	8.16	11.69
Stop_2030	3.12	5.89	9.01
Stop Now	0	0	0

Areas allowed to be deforested by the current Land Use Law (“Forest Code”) with medium to high suitability to agriculture (based on Sparovek et al., 2018)

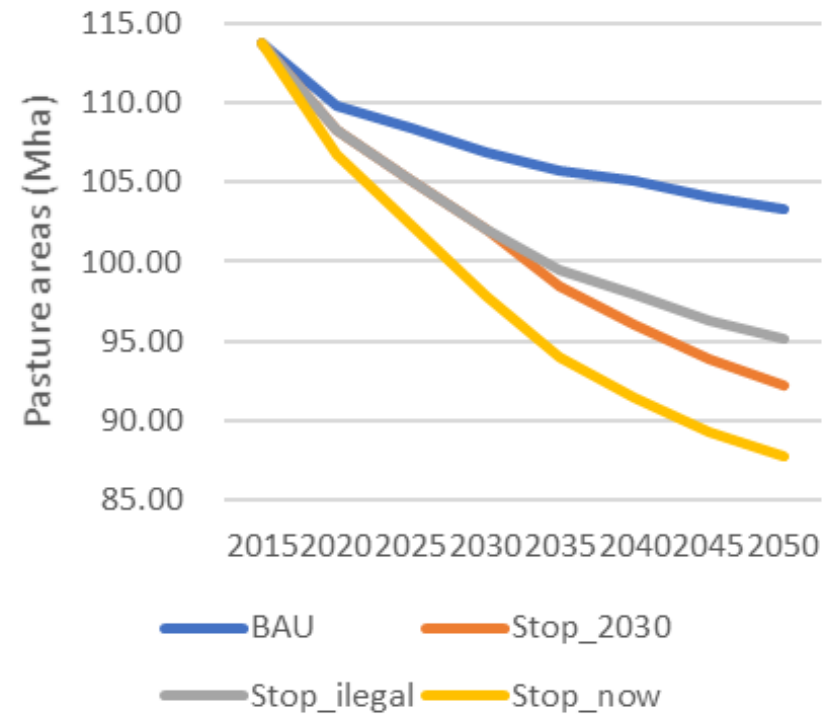
Results

Land use trajectories

Cropland



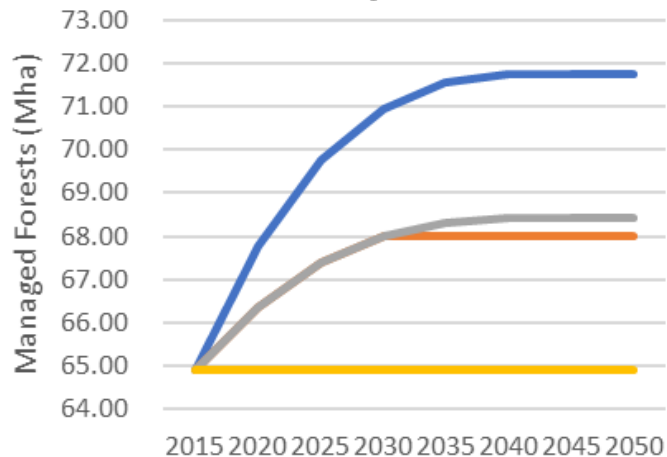
Pasture



Results

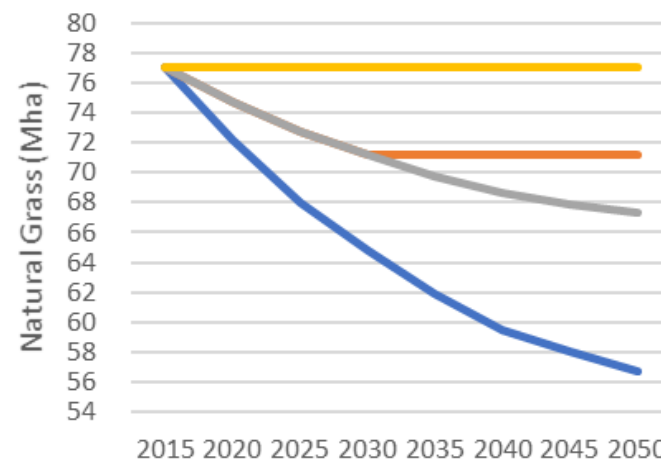
Land use trajectories

Managed Forest



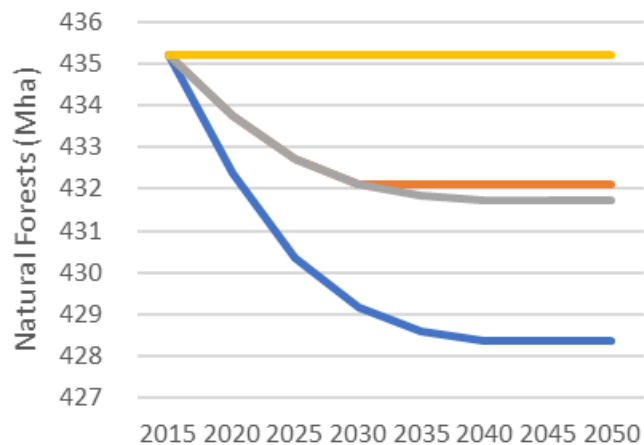
BAU Stop_2030
Stop_illegal Stop_now

Natural Grass



BAU Stop_2030
Stop_illegal Stop_now

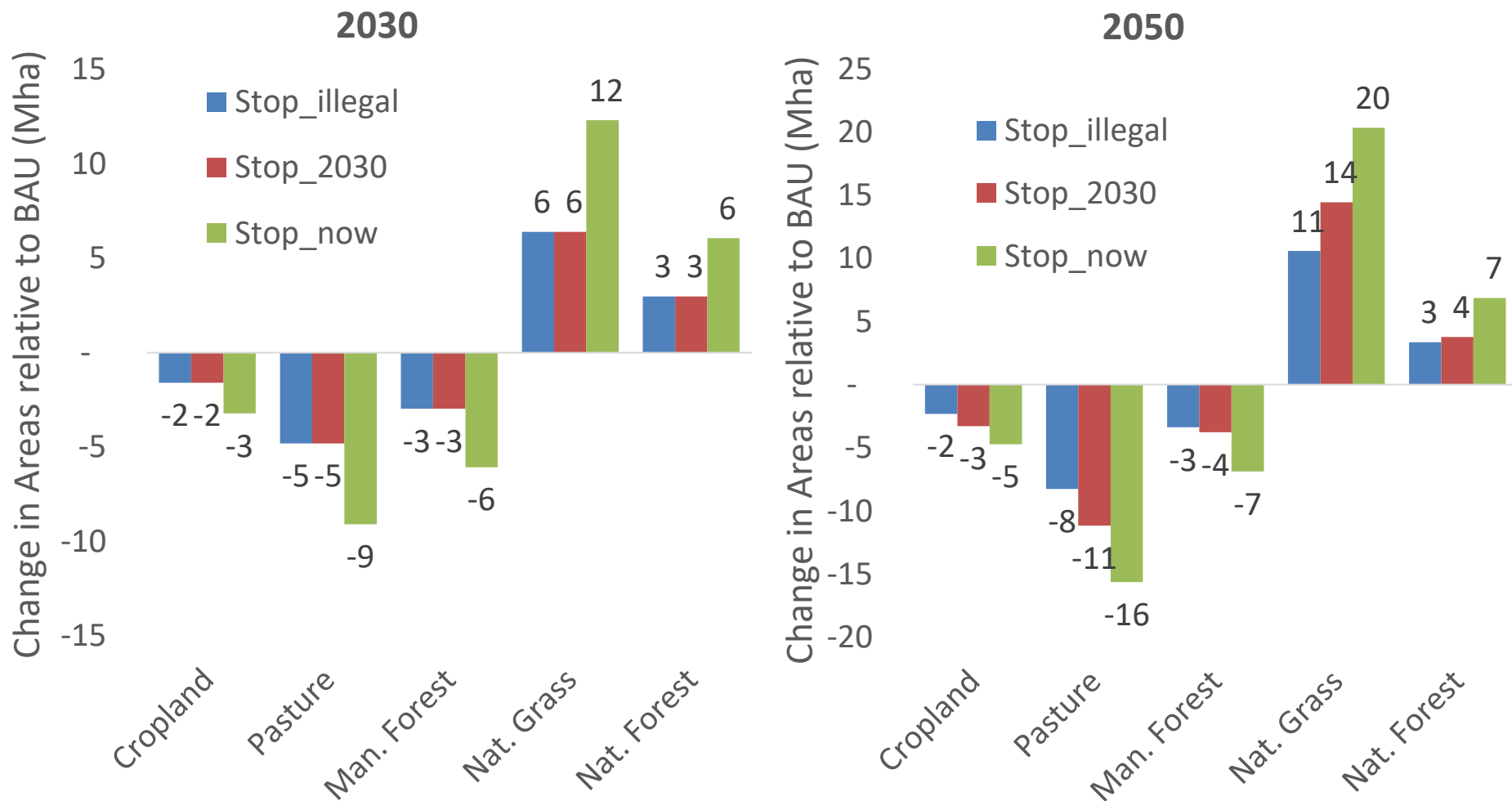
Natural Forest



BAU Stop_2030
Stop_illegal Stop_now

Results

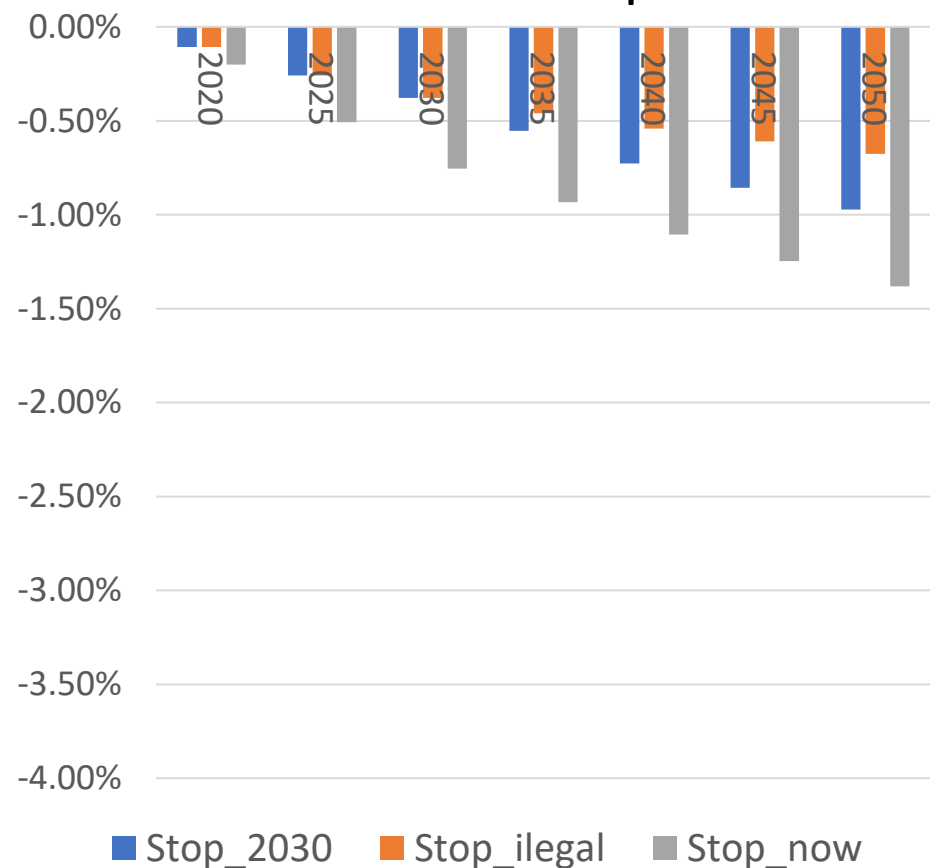
Changes in Land use relative to BAU (in Mha)



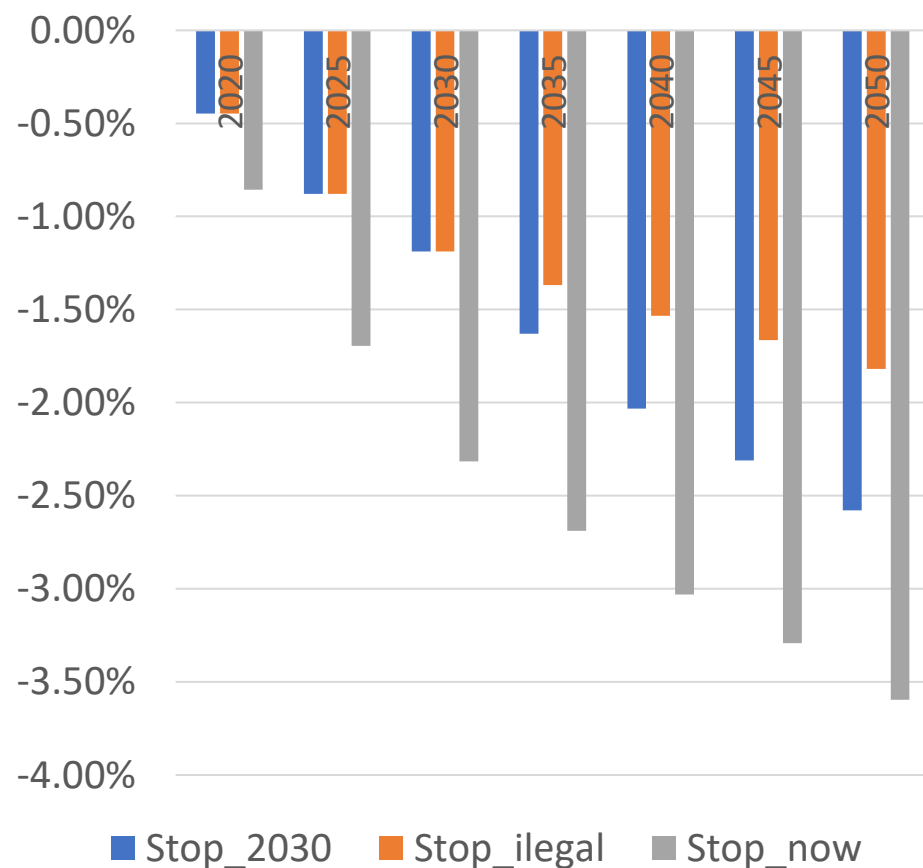
Results

Changes in Output (%) relative to BAU

Crop



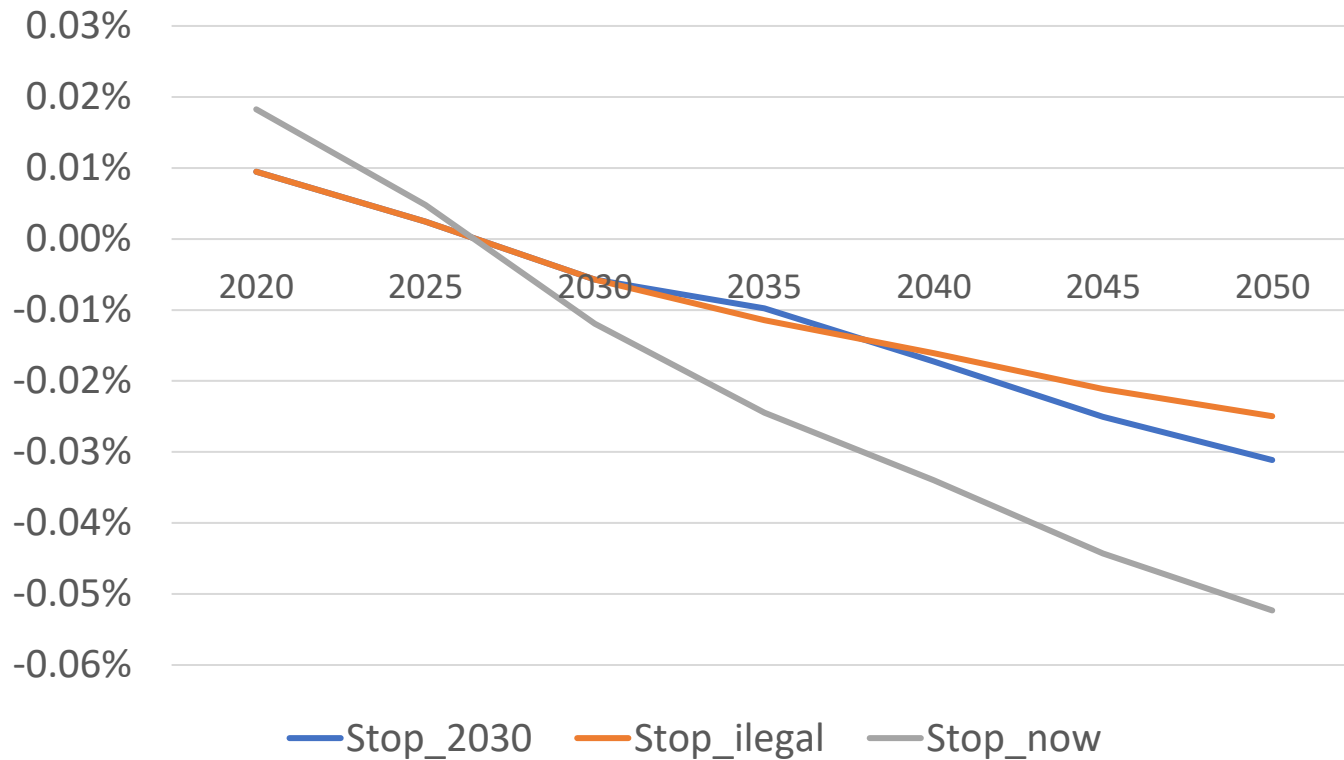
Livestock



Results

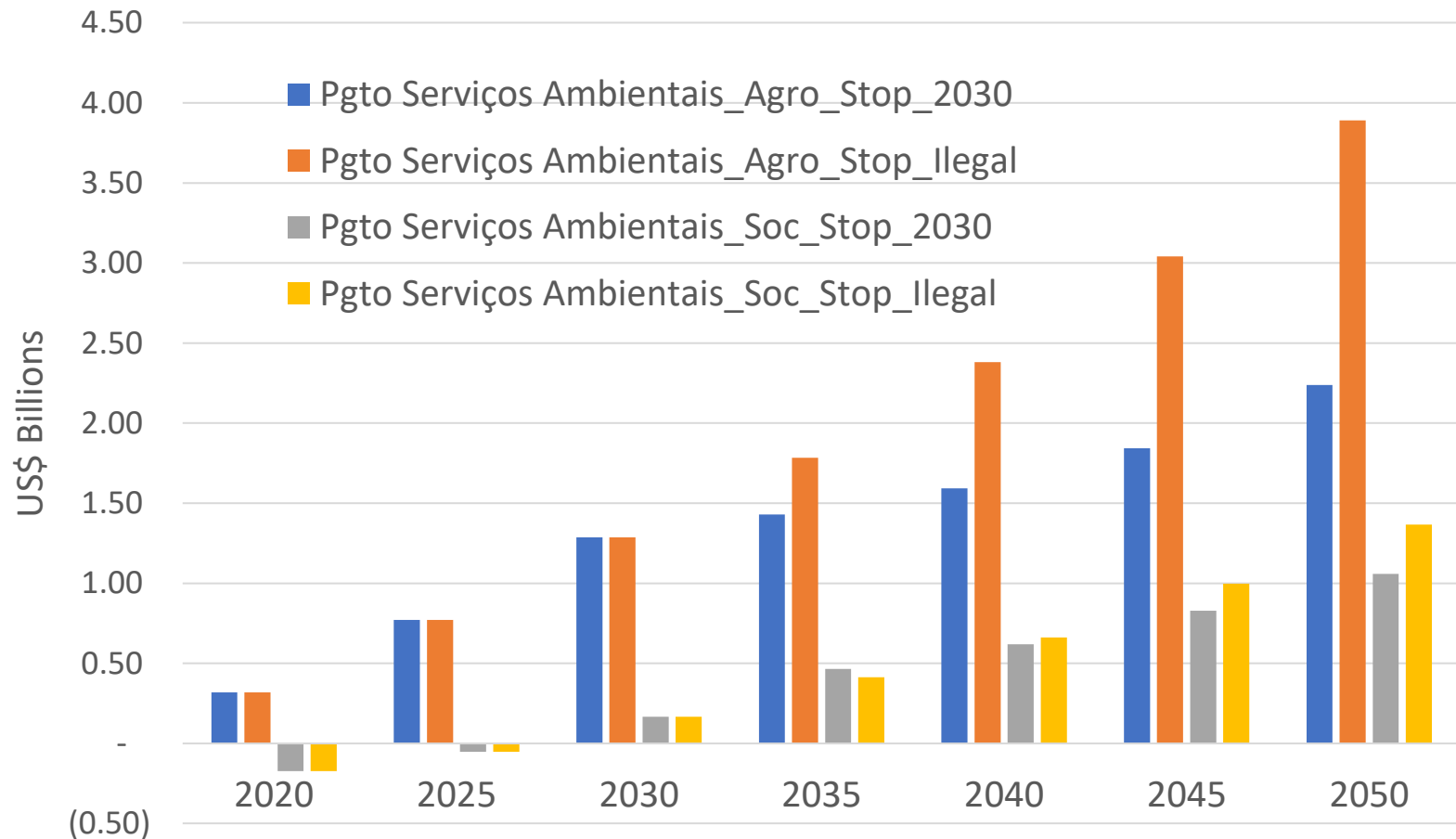
Changes in Output (%) relative to BAU

Changes in GDP (%) relative to BAU



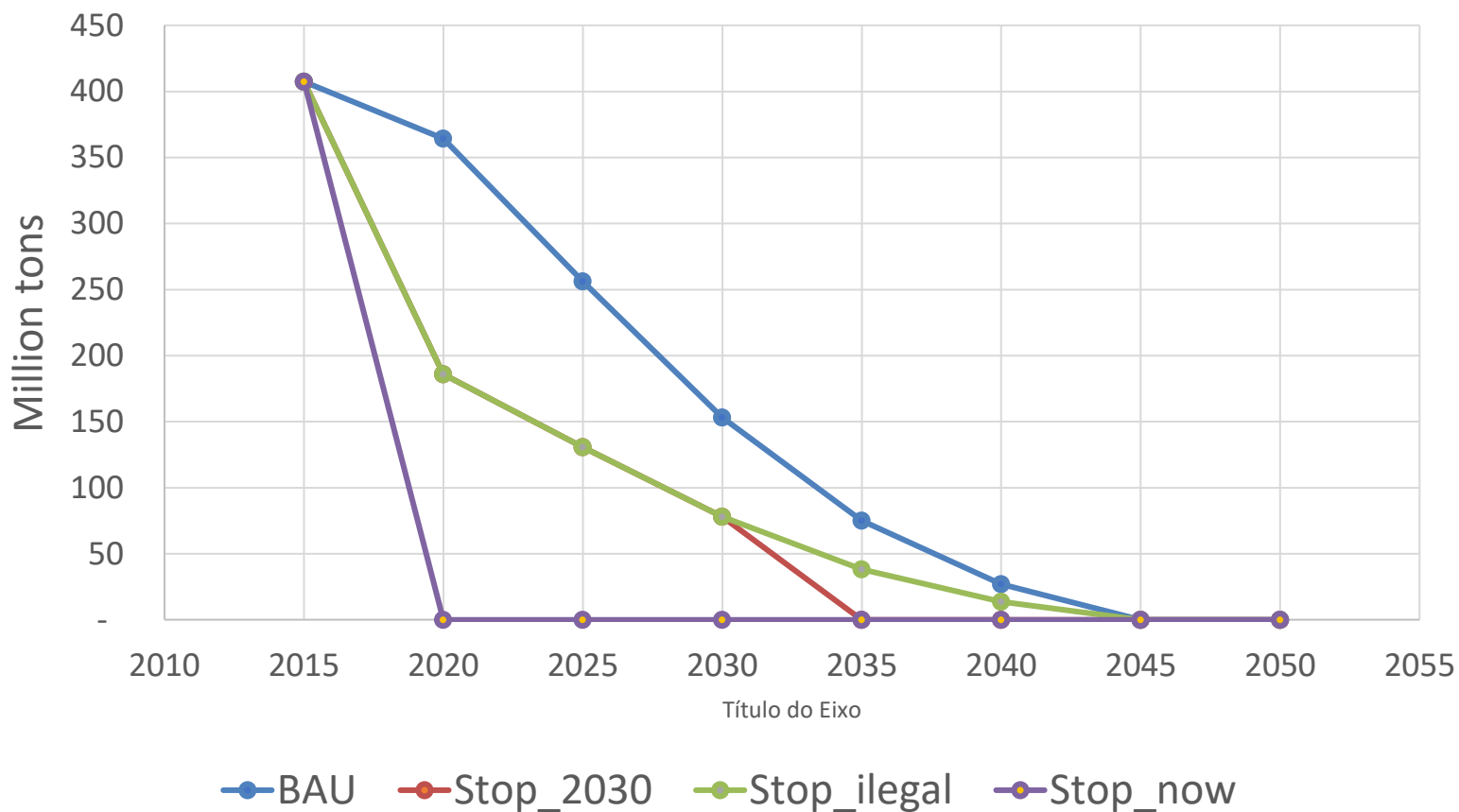
Results

How much farmers would require as “payments for environmental services” to avoid deforestation?
(billion of USD)



Results

CO2 from land use changes



Results

Deforestation in the rest of the world

2030	Natural Grass (Mha)		Natural Forest (Mha)	
	Avoided Deforestation in Brasil	Deforestation in the rest of the world	Avoided Deforestation in Brasil	Deforestation in the rest of the world
Stop_2030	6,40	-0,01	2,97	-0,01
Stop_ilegal	6,40	-0,01	2,97	-0,01
Stop_now	12,31	-0,02	6,07	-0,01
2050	Natural Grass (Mha)		Natural Forest (Mha)	
	Avoided Deforestation in Brasil	Deforestation in the rest of the world	Avoided Deforestation in Brasil	Deforestation in the rest of the world
Stop_2030	14,43	-0,02	3,77	-0,00
Stop_ilegal	10,58	-0,01	3,36	-0,00
Stop_now	20,34	-0,03	6,87	-0,01

Conclusions

- Stricter deforestation policies induce higher pasture intensification and conversion to cropland, as also as less increase in managed forest areas (which includes secondary forests and abandoned areas)
- Economic impacts from ending deforestation seem modest: crop production falls by only 1% by 2030 and 1,5% by 2050; livestock production falls by 3,58%; GDP decreases by only 0,06.
- Among US\$ 1,3 billion in 2030 and US\$ 3,9 billion in 2050 would be the “equivalente payment” for environmental services to convince farmers to keep natural forest and grasslands areas.

Conclusions

- Ending deforestation in Brazil has a negligible impact on the rest of the world (no negative spillovers or leakage) due to the relative low cost of improving yields and optimizing the use of existing pasture and agriculture areas;
- Strong anti-deforestation policies are desirable as an instrument to improve the environmental footprint of the Brazilian agribusiness and prevent indirect land use changes.

Thank you for your attention

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