Brazil Regional Model

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CARD/FAPRI Modeling Efforts

- Supported by 23 years of continuous earmarks to Iowa State and Univ. of Missouri
- Baseline projections and policy analysis for House and Senate Ag committees of Congress
- Why did EPA come to us?

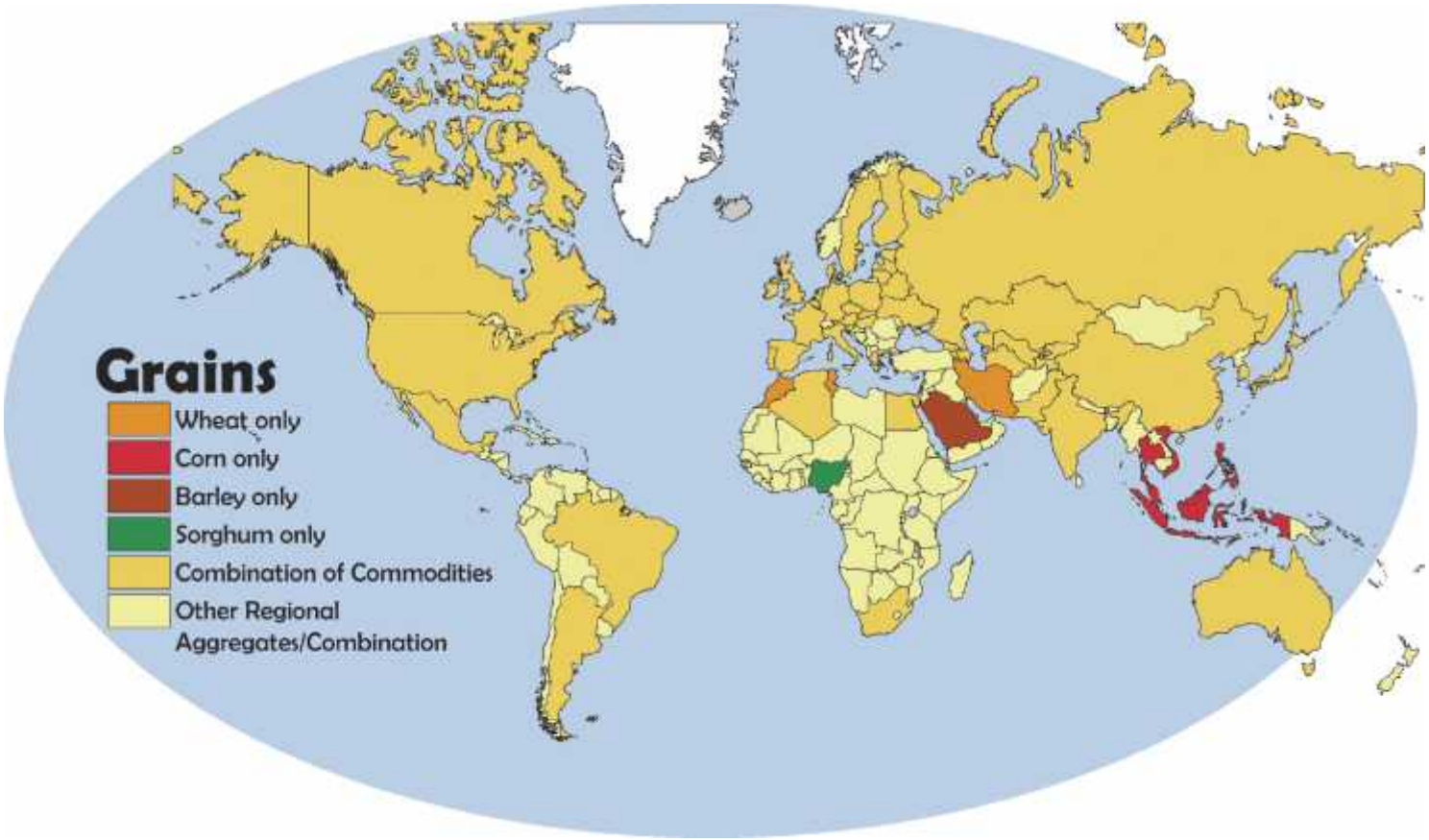
U.S. and International Models Commodity Coverage

Grains	Oilseeds	Cash Crops	Livestock	Dairy	Biofuels
Wheat	Soybeans	Sugar	Beef	Milk	Ethanol
Rice	Rapeseed		Pork	Butter	Biodiesel
Corn	Sunflower Seed		Mutton	Cheese	
Barley	Ground Nuts		Poultry	Non-fat Dry Milk	
Sorghum	Palm		Eggs	Whole-fat Dry Milk	

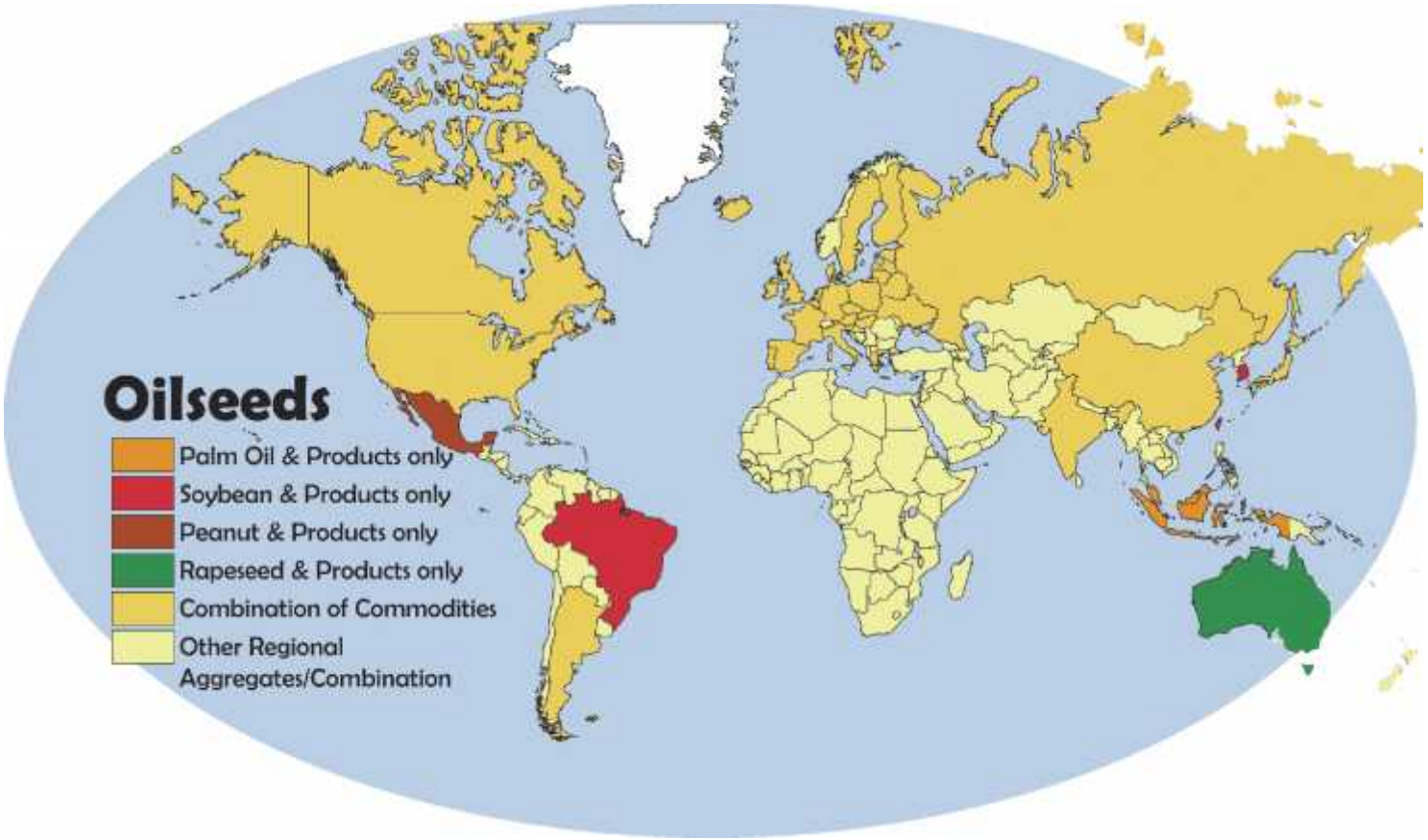
Crops of Brazil

Grains	Oilseeds	Cash Crops	Livestock	Dairy	Biofuels
Wheat	Soybeans	Sugar	Beef	Milk	Ethanol
Rice	Rapeseed	Cotton	Pork	Butter	Biodiesel
Corn	Sunflower Seed		Mutton	Cheese	
Barley	Ground Nuts		Poultry	Non-fat Dry Milk	
Sorghum	Palm		Eggs	Whole-fat Dry Milk	

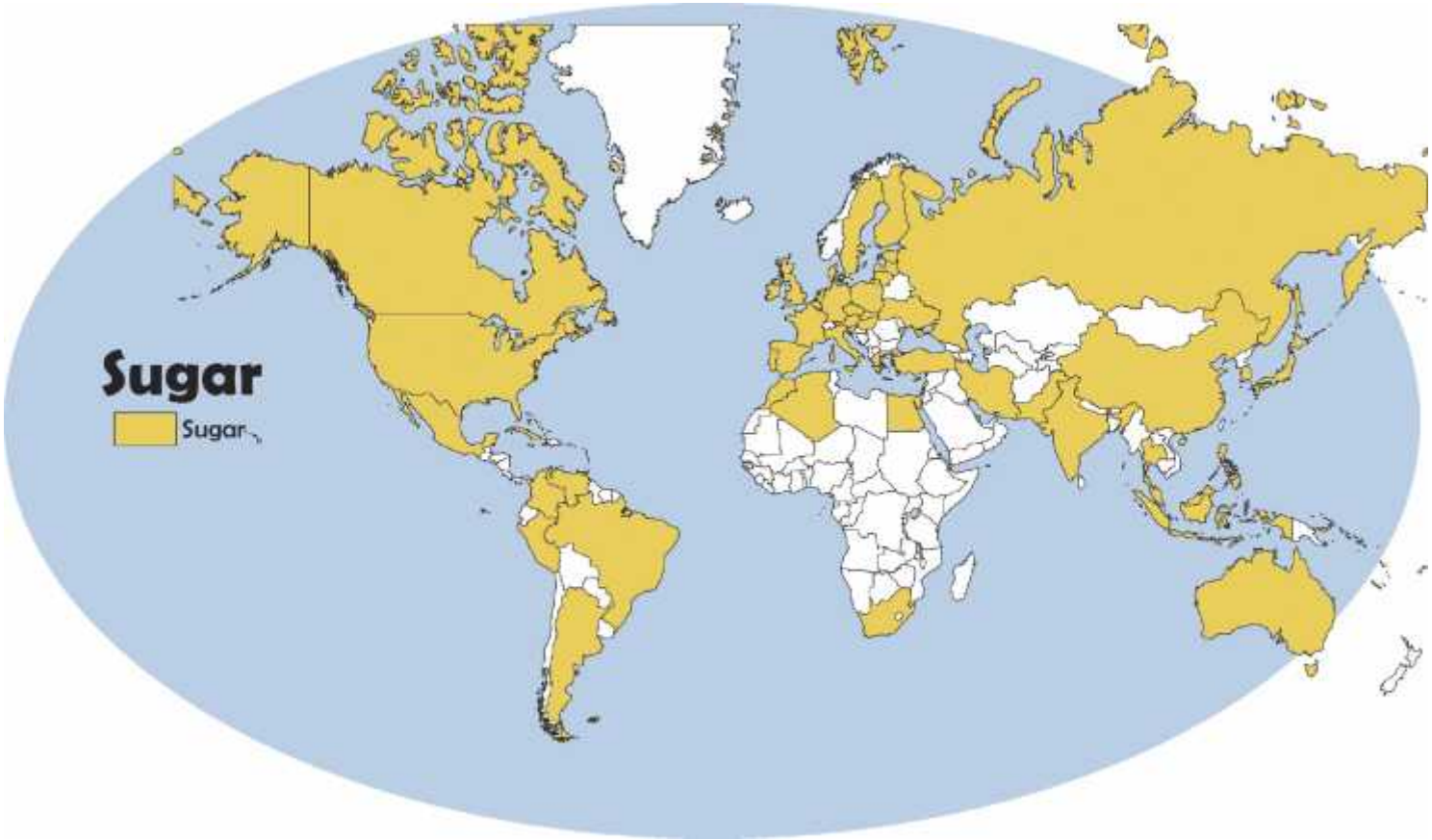
Country Coverage by Commodity



Country Coverage by Commodity



Country Coverage by Commodity



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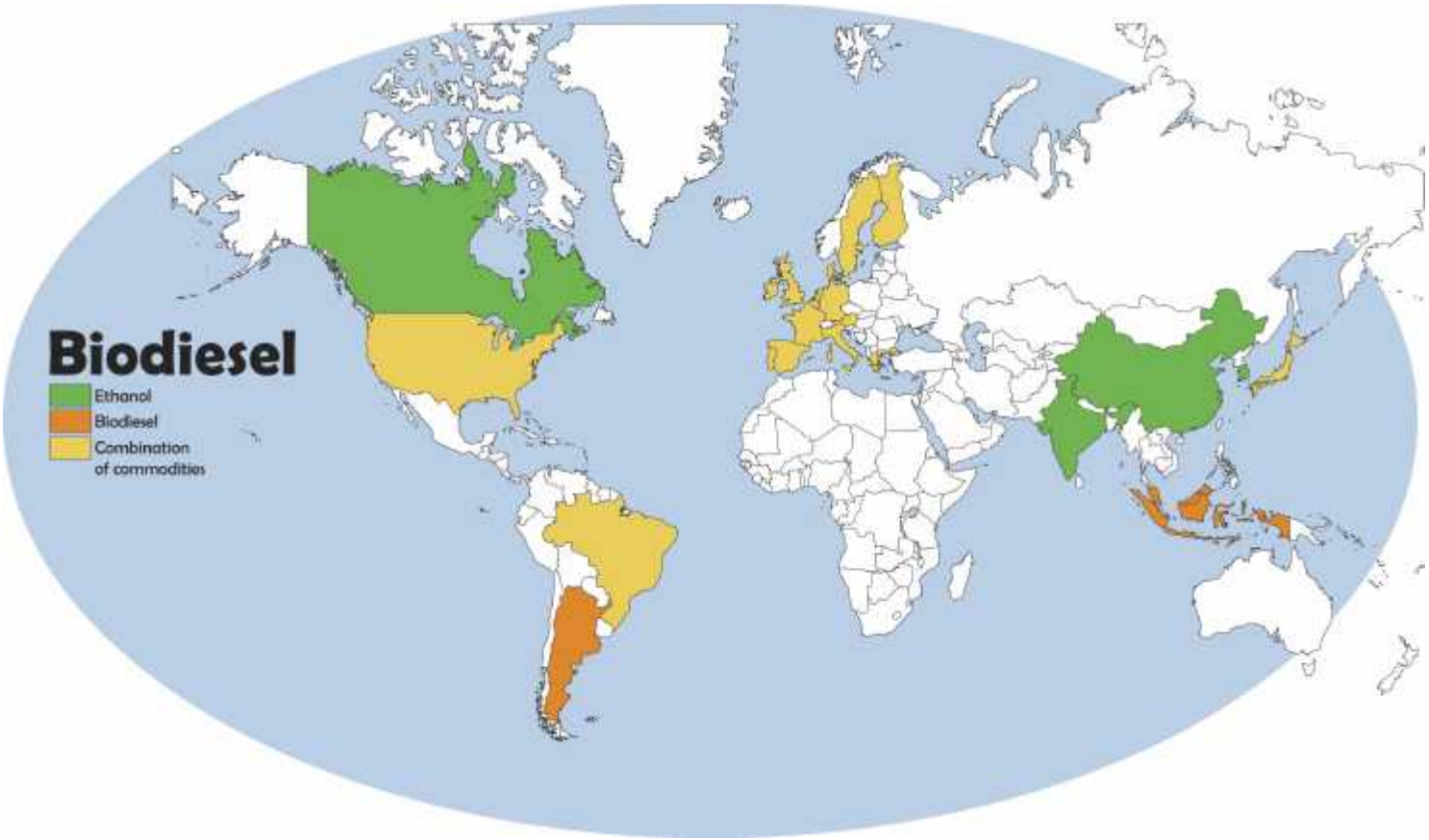
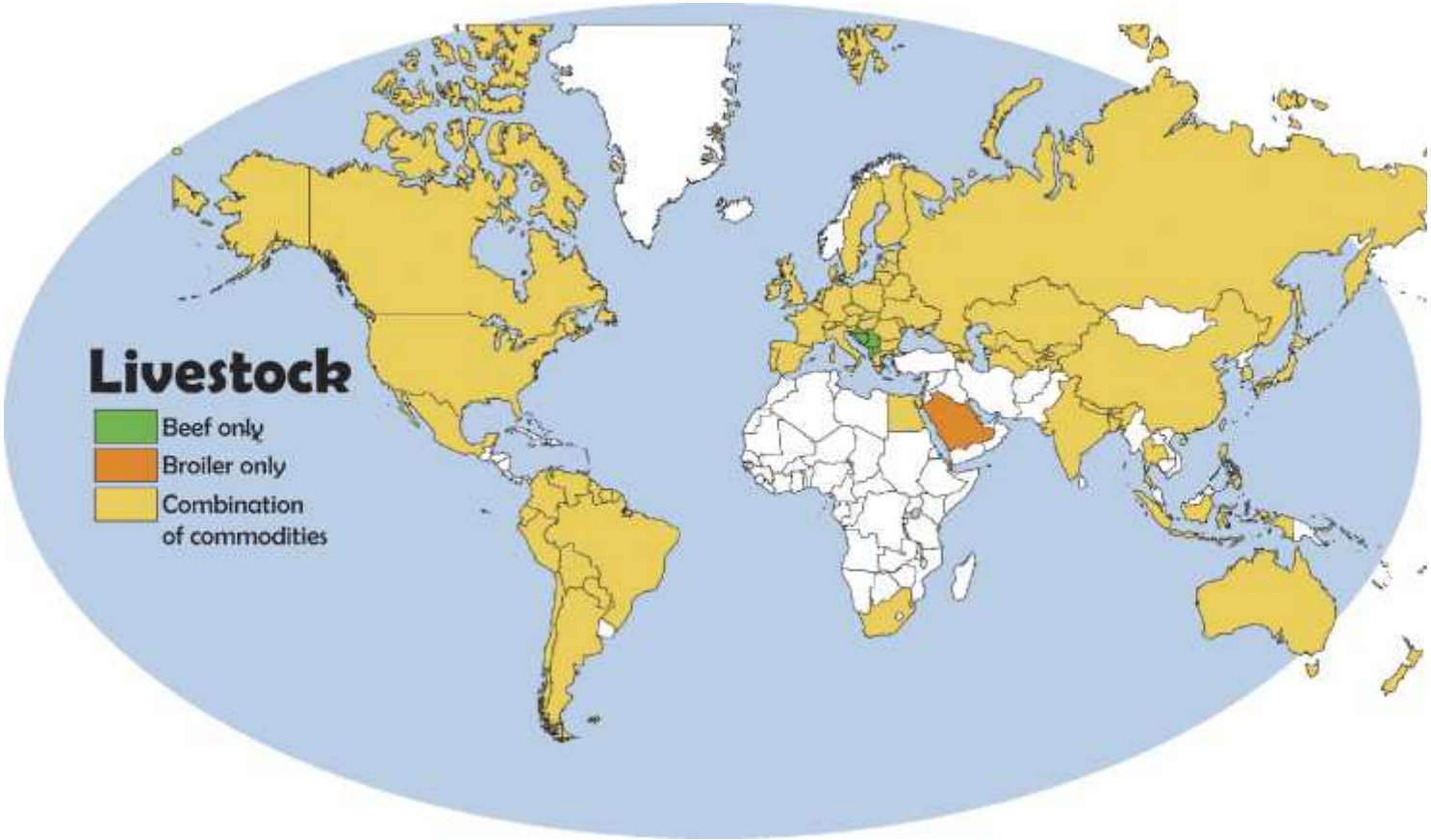
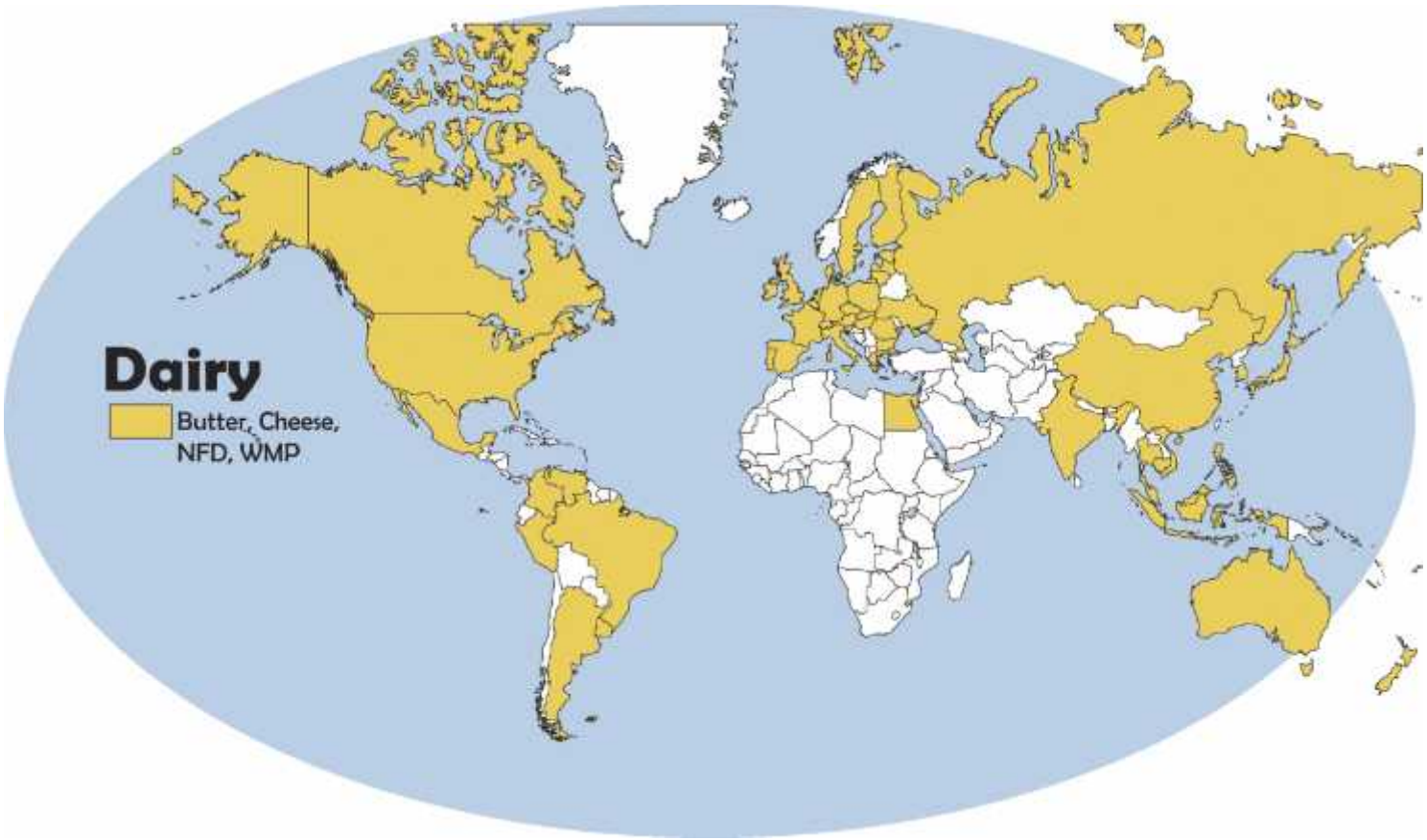


Country Coverage by Commodity



Country Coverage by Commodity



Current Land Projections

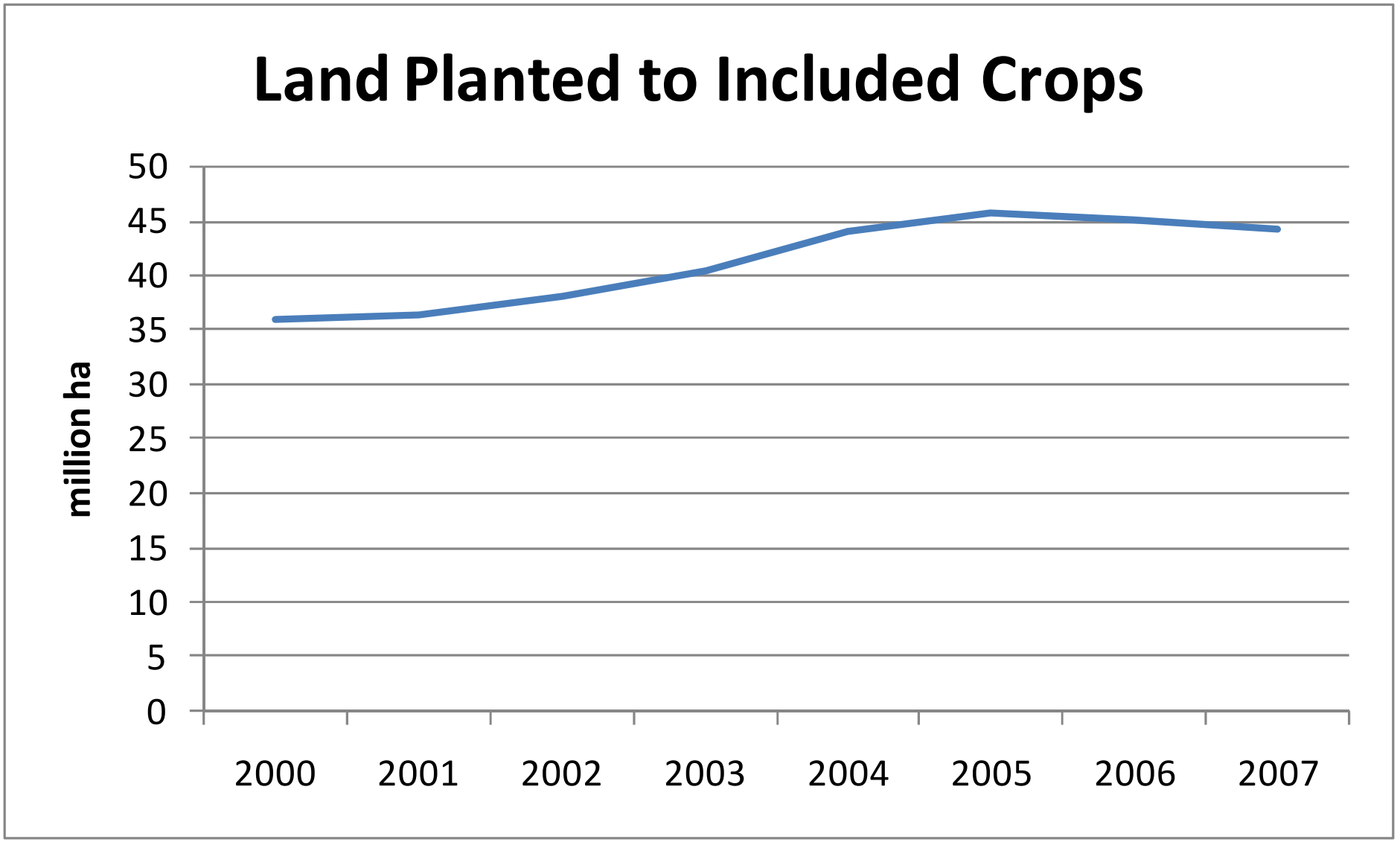
- CARD's international models are national aggregates
  - No accounting for where supply expansion may take place
  - No accounting for varying land availability
  - No accounting for variations in crop yields
- Sufficient for world supply and demand estimation
- Not sufficient for
  - Brazil domestic agricultural policy evaluation
  - Estimation of greenhouse gas implications of land conversion

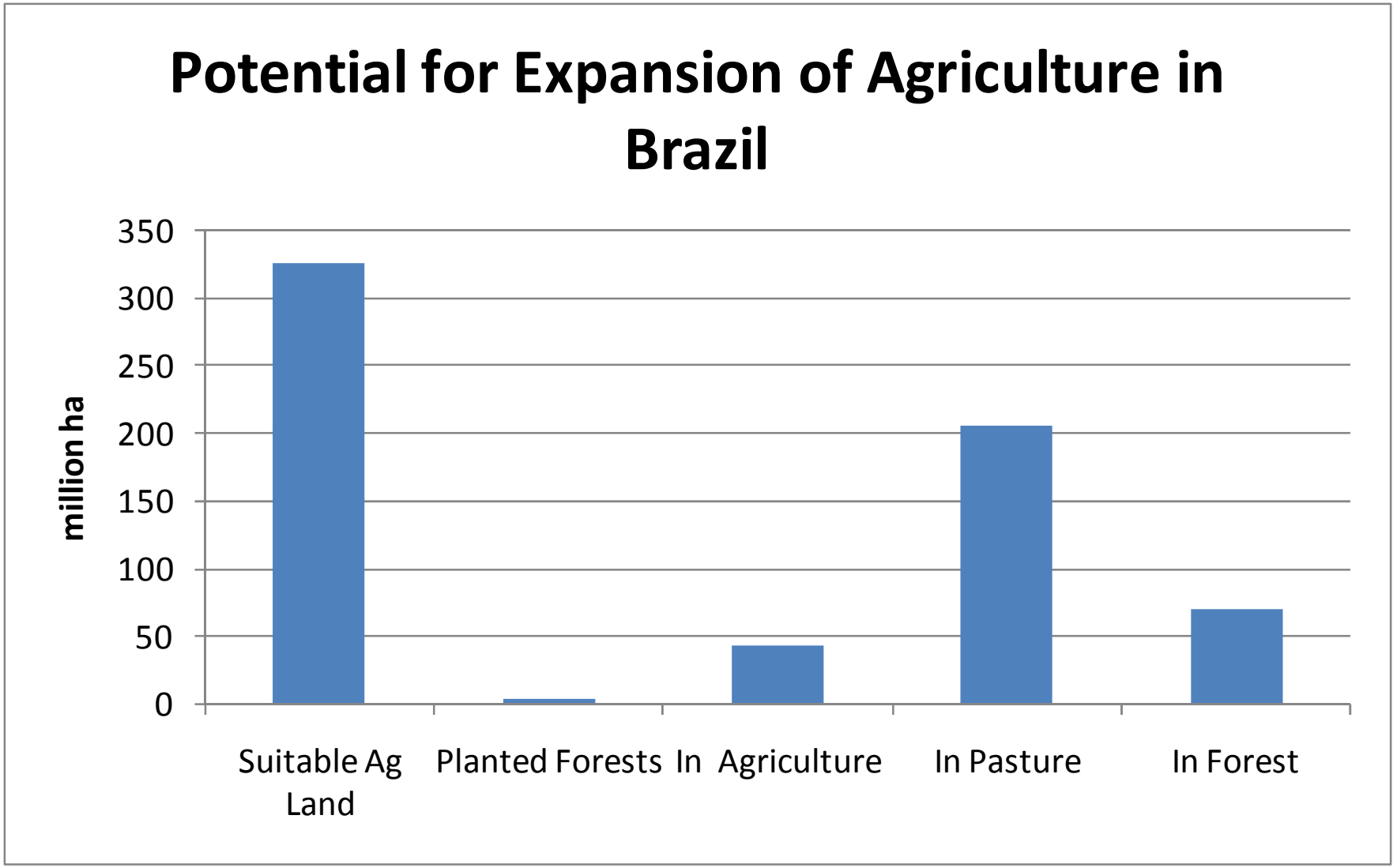
New Brazil Regional Model

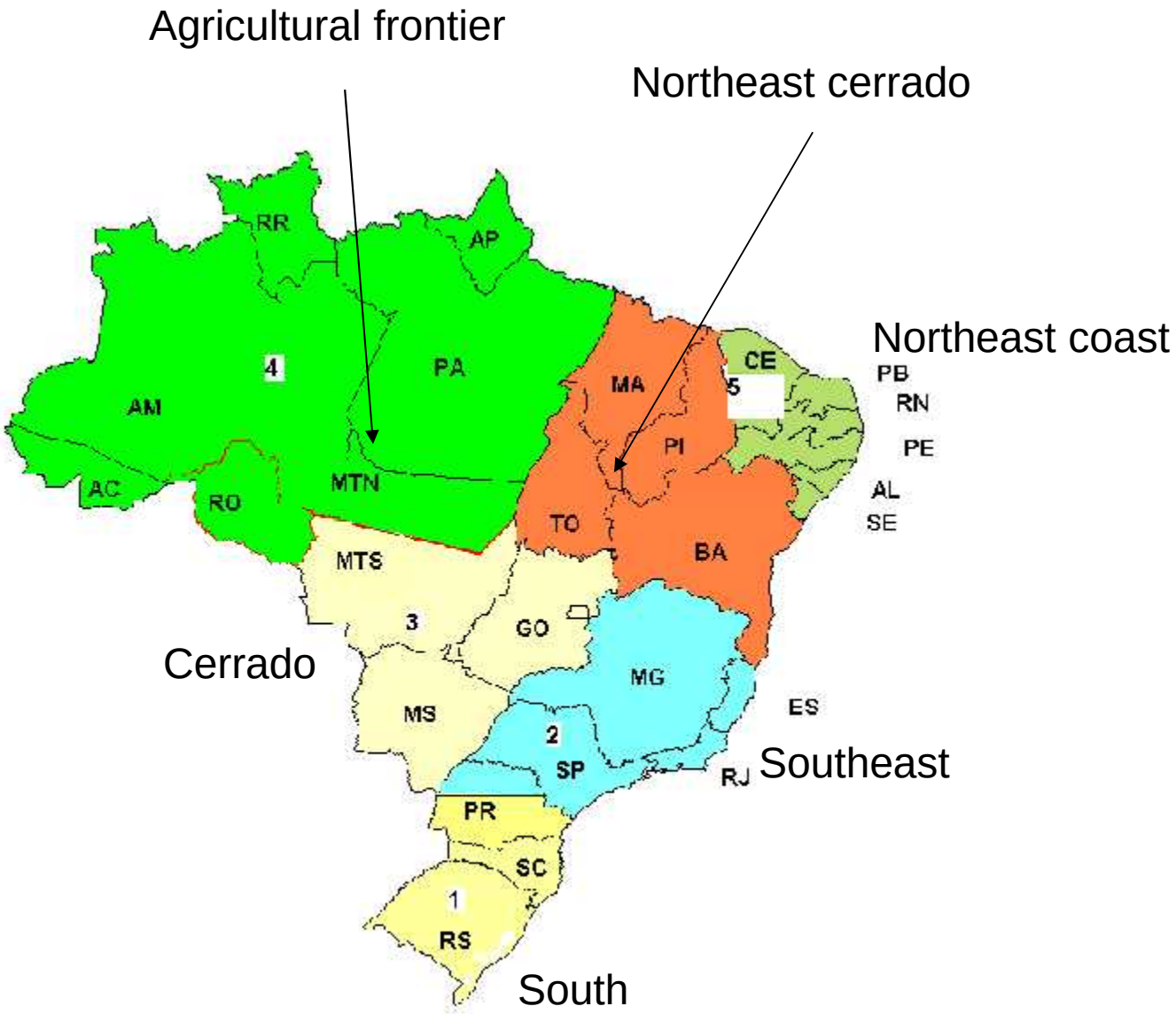
- Jointly developed by CARD and ICONE (Institute for International Trade Negotiations) Andre Nassar, Director
- Will be integral part of the FAPRI modeling system and FAPRI baseline projections
- All current Brazil supply and demand equations replaced by Brazil integrated model

Brazilian Commodities Covered

- Crops
  - Soybeans, corn, cotton, rice, sugar and dry beans
- Livestock
  - Calves, beef production, milk, pork, broilers, eggs, cattle herd, swine herd, pasture
- Biofuels
  - Ethanol, biodiesel

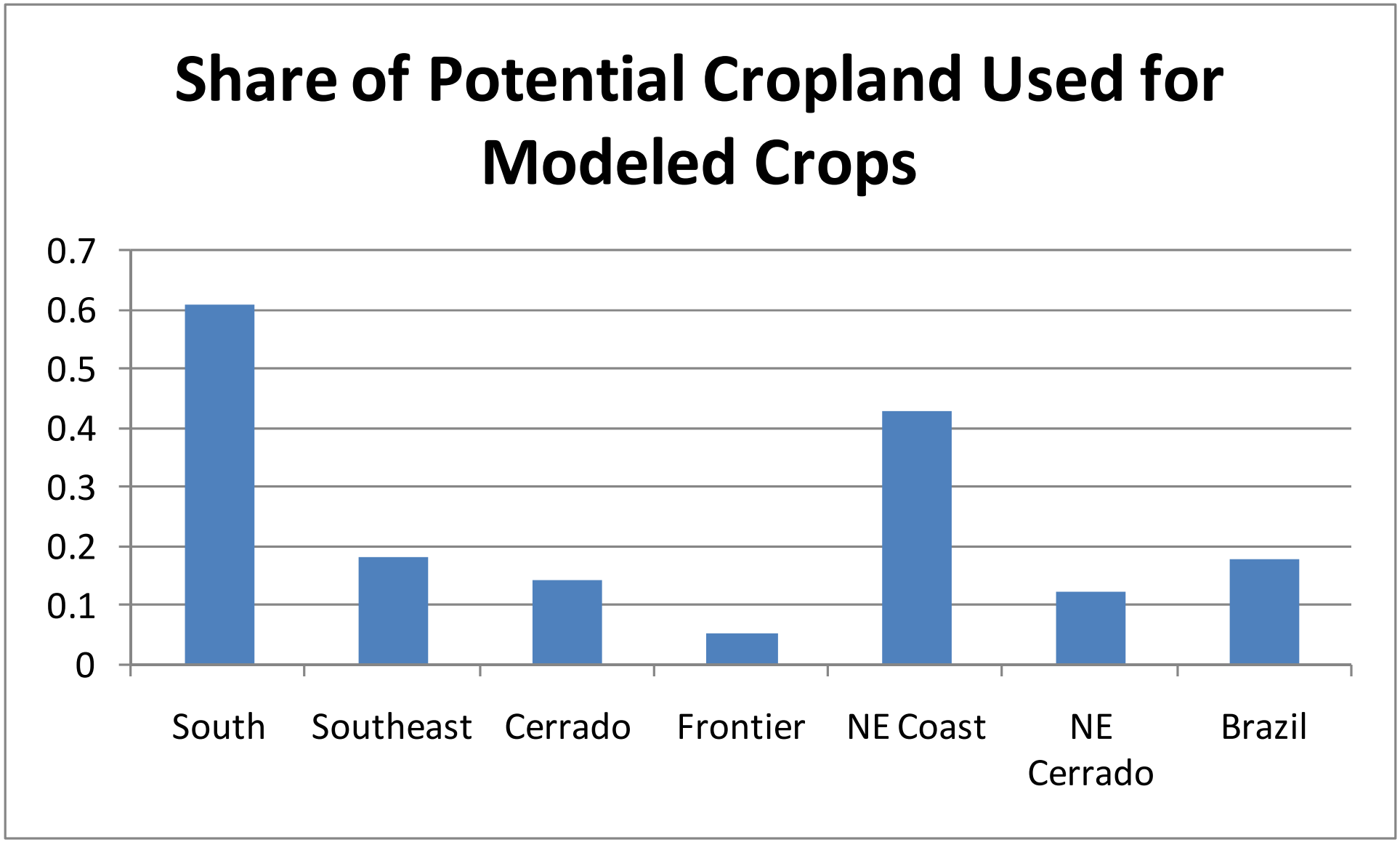

Land Planted to Included Crops
million ha
50
45
40
35
30
25
20
15
10
5
0
2000
2001
2002
2003
2004
2005
2006
2007


Potential for Expansion of Agriculture in Brazil
million ha
350
300
250
200
150
100
50
0
Suitable Ag Land
Planted Forests
In Agriculture
In Pasture
In Forest


Agricultural frontier
Northeast cerrado
Northeast coast
Cerrado
Southeast
South
RR
AP
4
PA
AM
MA
CE
5
PB
RN
PE
AL
SE
PI
AC
RO
MTN
TO
BA
MTS
3
GO
MG
ES
MS
2
SP
RJ
PR
SC
1
RS

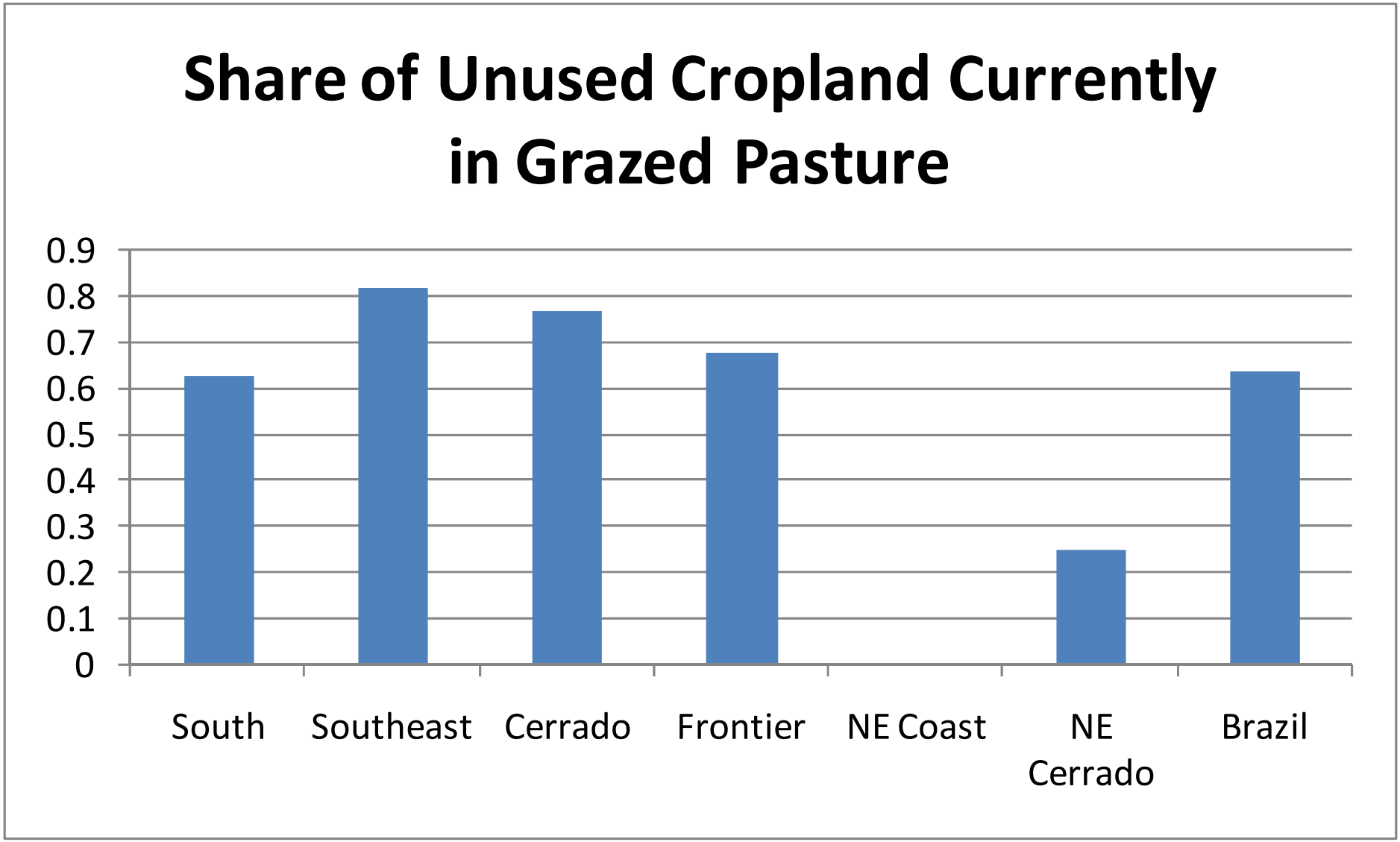
Regional Differences

- Brazil has 327 million ha of land available for agricultural use
  - current grazed pasture (206 million ha)
  - planted forest (5.5 million ha)
  - current cropland in modeled crops (44.1 million ha)
  - forest and non-grazed grassland that is suitable (and legal) for cropland conversion (71 million ha)
- 126 million ha of pasture could be converted to crops making 241 million ha of potential cropland
- About 20% of potential cropland being utilized


Share of Potential Cropland Used for Modeled Crops
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
South
Southeast
Cerrado
Frontier
NE Coast
NE Cerrado
Brazil

Implications for Supply Response

- Less available cropland in the South than other regions
- Lots of potential cropland available in the cerrado, southeast, and frontier
- Supply response modeled first as the supply of land brought into cropland and pasture, then as competition for land between different crops


Share of Unused Cropland Currently in Grazed Pasture
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
South
Southeast
Cerrado
Frontier
NE Coast
NE Cerrado
Brazil

Implications for Land Use

- Regional breakdown allows for differential estimates of types of land begin converted from expansion of cropland by region
- Most land converted to crops in the Southeast will be currently grazed pasture
- Most land converted in the NE Coast will be ungrazed grassland or forest.

Land Allocation model

- Holt (1999): Acreage Allocation Model
- Farmers maximize profit by choosing land acreages allocated to each crop.
- Land share for each crop is a linear function of expected returns of **all** crops.
- Estimate a system with symmetry, adding-up, and homogeneity constraints on parameters.

Empirical estimation

- Regional-level annual data from 1996 to 2006
- Corn, soybean, rice, cotton, sugarcane and dry beans (the residual crop)
- Jointly estimate a system of all crops expect the residual crop

$$\text{Land share}_i = b_i + \sum_j {}_{ij}\text{Return}_j + £_i$$

Constraints implied by the model

Adding-up condition: $\sum_i b_i = 1 \quad \sum_i \quad _{ij} = 0$

Homogeneity condition: $\sum_j \quad _{ij} = 0$

Symmetry condition: $_{ij} = \quad _{ji}$

Point Estimates

- Point estimates (*10000) **unconstrained** case:

	Rcr	Rsb	Rct	Rrc	Rsc	Rdb
vcr	**0.94**	**-0.71**	0.05	**-0.36**	**0.18**	0.09
vsb	-0.90	**1.50**	0.09	-0.27	**-0.59**	0.03
vct	0.07	-0.03	**0.10**	-0.13	-0.06	-0.06
vrc	0.04	-0.48	-0.11	**0.61**	**0.29**	0.00
vsc	-0.28	0.02	**-0.09**	0.05	**0.10**	-0.06

- Vi = land shares; Ri = expected returns
- Bold font denote significant at 5% level

Point Estimates

- Point estimates (*10000) **constrained** case:

	Rcr	Rsb	Rct	Rrc	Rsc	Rdb
vcr	**0.75**	**-0.73**	**0.08**	**-0.35**	0.10	**0.14**
vsb	**-0.73**	**1.52**	0.00	-0.29	**-0.26**	**-0.25**
vct	**0.08**	0.00	**0.09**	**-0.10**	**-0.05**	-0.03
vrc	**-0.35**	-0.29	**-0.10**	**0.58**	0.09	0.07
vsc	0.10	-0.26	-0.05	0.09	0.09	0.03

- Vi = land shares; Ri = expected returns
- Bold font denote significant at 5% level

Elasticity

- Percentage change in land acreage allocated to crop i in response to percentage change in expected price of crop j:

$$£_{ij} = \frac{ji}{\text{land share}_i} * \text{expected return}_j$$

- Elasticity of the residual crop (dry bean) is calculated from the adding-up constraint.

Elasticity - unconstrained case

	Pcr	Psb	Pct	Prc	Psc	Pdb
corn	**0.22**	**-0.25**	0.03	**-0.14**	**0.22**	0.03
soybean	-0.11	**0.27**	0.03	-0.05	**-0.36**	0.00
cotton	0.14	-0.10	**0.60**	-0.42	-0.64	-0.18
rice	0.02	-0.31	-0.14	**0.43**	**0.65**	0.00
sugarcane	-0.12	0.02	**-0.12**	0.03	**0.24**	-0.03
dry bean	0.12	-0.44	-0.10	0.16	0.36	0.01

Elasticity - constrained case

	Pcr	Psb	Pct	Prc	Psc	Pdb
corn	**0.17**	**-0.25**	**0.06**	**-0.13**	0.12	**0.04**
soybean	**-0.09**	**0.27**	0.00	-0.06	**-0.16**	**-0.04**
cotton	**0.17**	0.01	**0.56**	**-0.32**	**-0.56**	-0.09
Rice	**-0.15**	-0.19	**-0.12**	**0.41**	0.21	0.04
sugarcane	0.04	-0.17	-0.07	0.07	0.20	0.02
dry bean	0.14	-0.37	-0.10	0.11	0.16	0.05

Alternative approach

- Use own-elasticity estimates from literature
- Generate cross product elasticities that satisfy the regularity conditions
- The generating process also takes into account the ranking among cross product elasticities

Generated elasticity matrix

	Corn	Soybeans	Rice	Cotton	Sugar	Dry beans	Livestock
Corn	0.20	-0.09	-0.02	-0.01	-0.04	-0.01	-0.05
Soybeans	-0.03	0.45	-0.01	-0.01	-0.02	0.00	-0.12
Rice	-0.04	-0.03	0.15	-0.01	-0.02	-0.01	0.00
Cotton	-0.02	-0.04	-0.02	0.25	-0.01	-0.01	0.00
Sugar	-0.01	-0.02	0.00	0.00	0.40	0.00	-0.02
Dry beans	-0.02	-0.06	-0.01	-0.01	-0.02	0.10	-0.02
Livestock	-0.01	-0.05	0.00	0.00	-0.01	0.00	0.02

Demand Side

- Have both domestic demand and export demand
- Export demand is excess demand for the world minus U.S. exports

- World demand equals world supply each year for 15 years