

# Land Use Change and GHG Emissions:

## Panel Discussion on Major Models

### FAPRI-CARD Model

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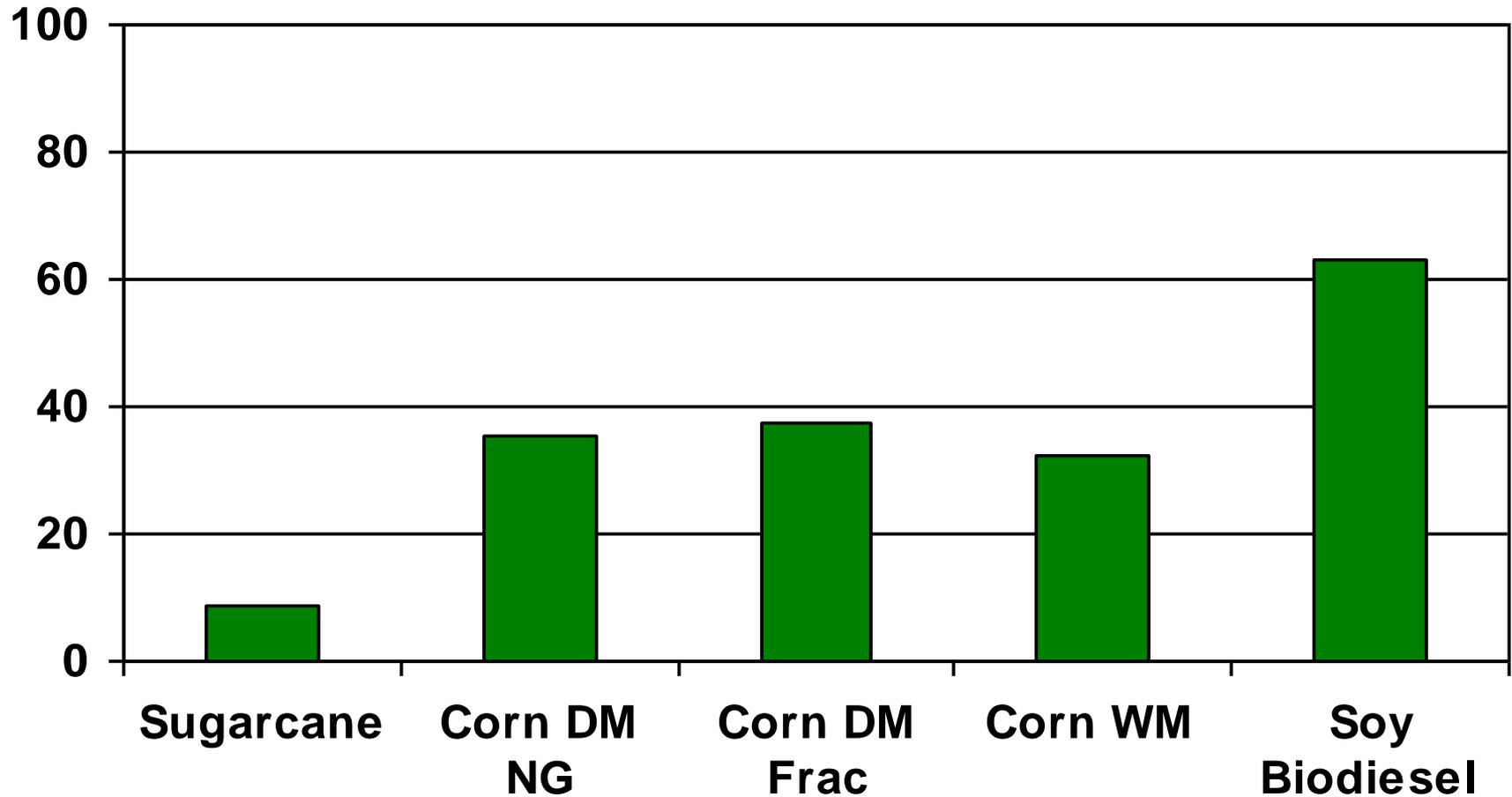
**FAPRI**

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Food and Agricultural  
Policy Research Institute

# Share of LUC in Increase in Emissions

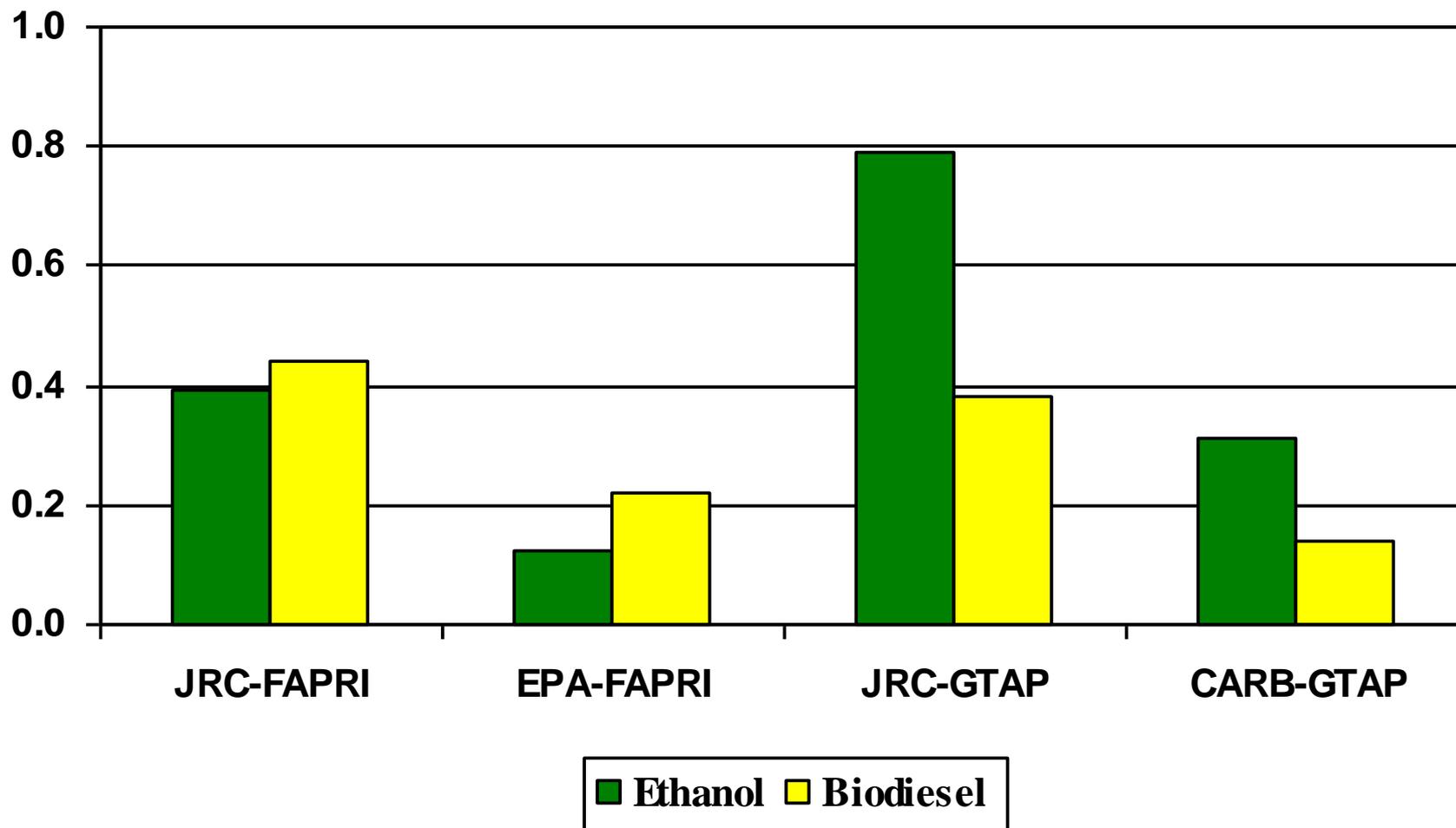
Percent



# LUC for Biofuel

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Ha/toe



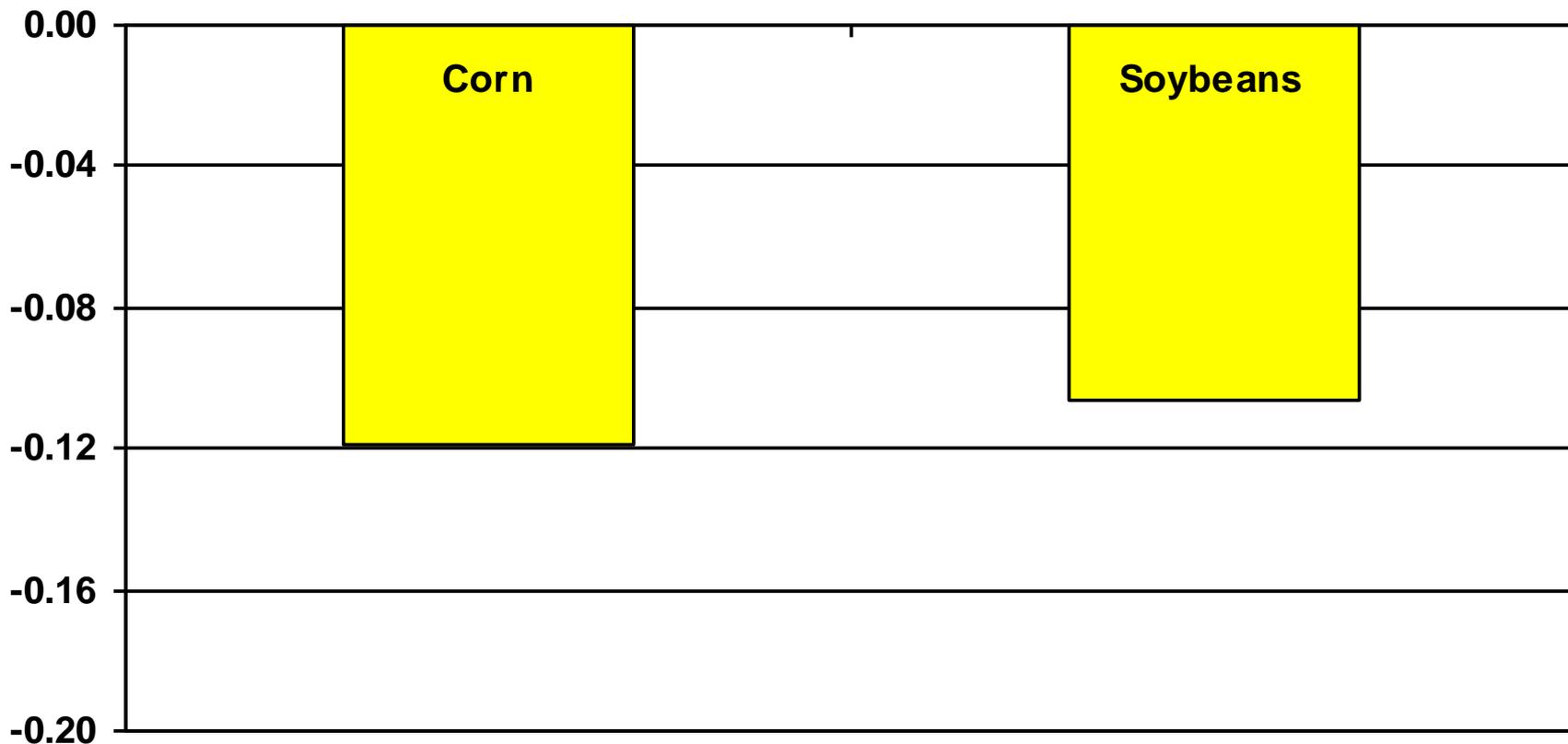
# Issues in LUC Modeling Developments

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- Trend yield estimates
  
- Intensification
  - Second crop
  - Livestock stocking rate
  
- Co-products
  - Feed efficiency gains
  - Fractionation
  - Displacements

# Sensitivity of LUC to Trend Yield

Percent



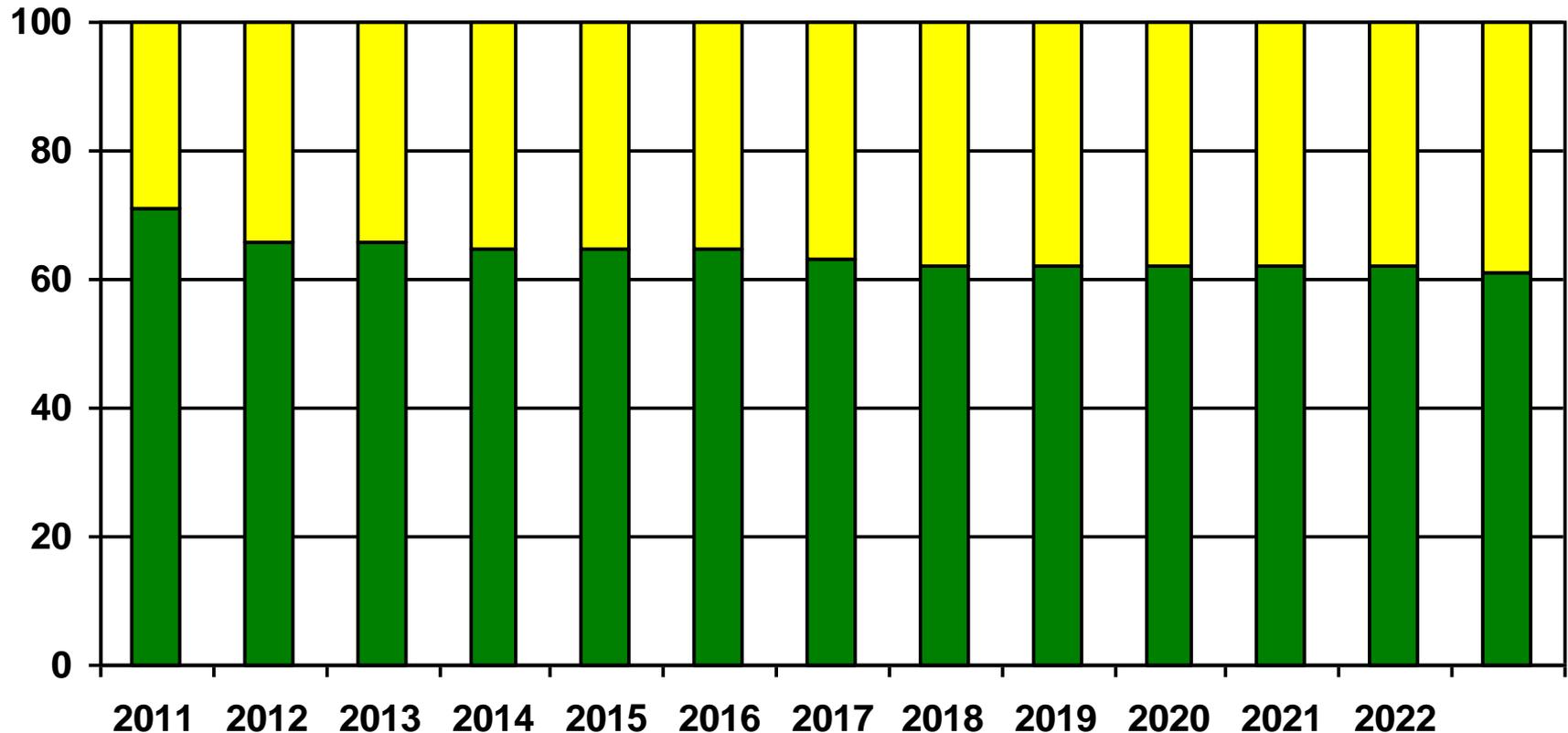
# Trend Yield and LUC

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Country	1960-1975	1976-1991	1992-2008
	metric ton per year		
Argentina	0.052	0.035	0.194
Brazil	0.017	0.035	0.090
China	0.081	0.130	0.039
India	0.007	0.030	0.036
Mexico	0.013	0.057	0.060
United States	0.125	0.084	0.144

# Second Crop and LUC – Brazil Corn

Percent

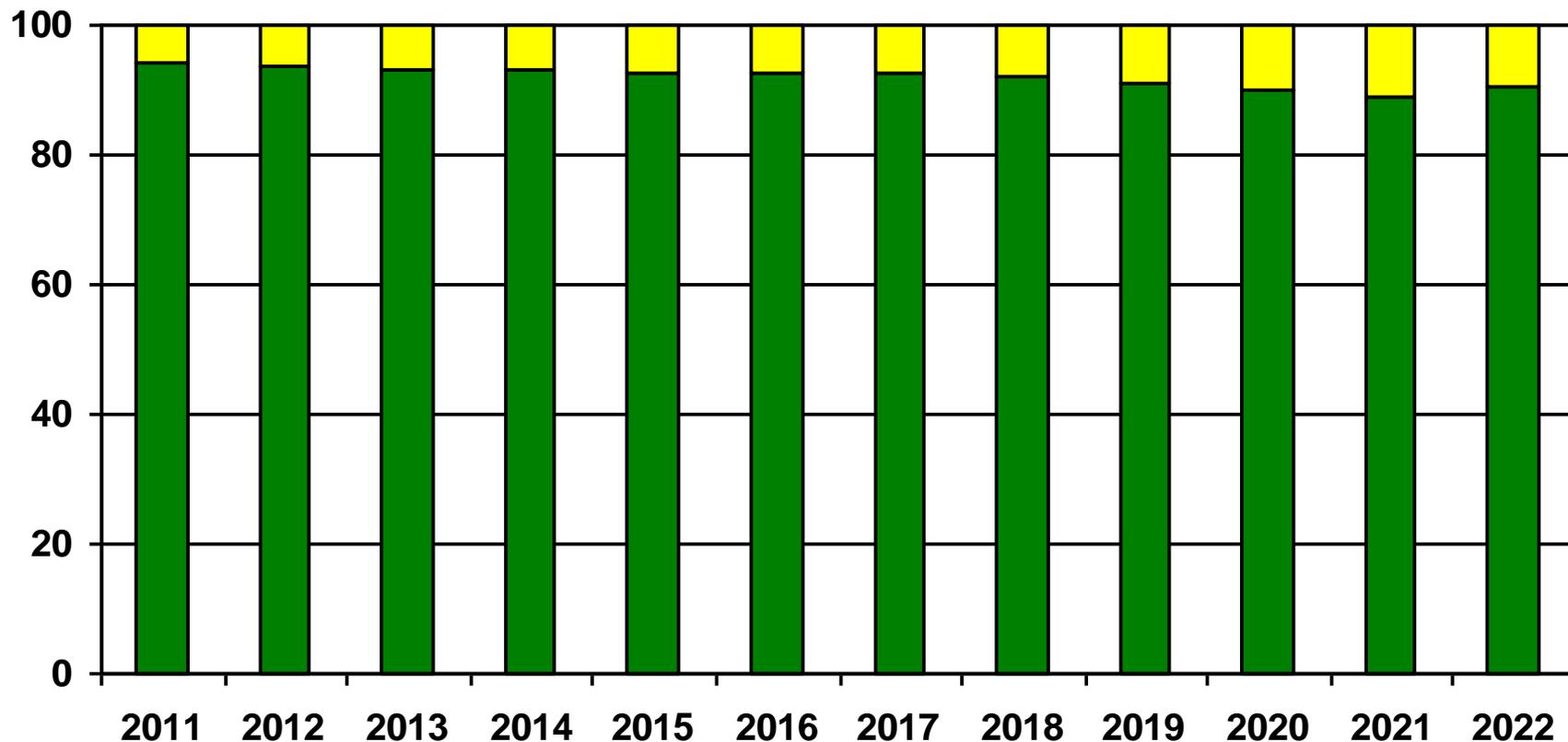


■ First Crop

■ Second Crop

# Second Crop and LUC – U.S. Wheat

Percent



■ First Crop

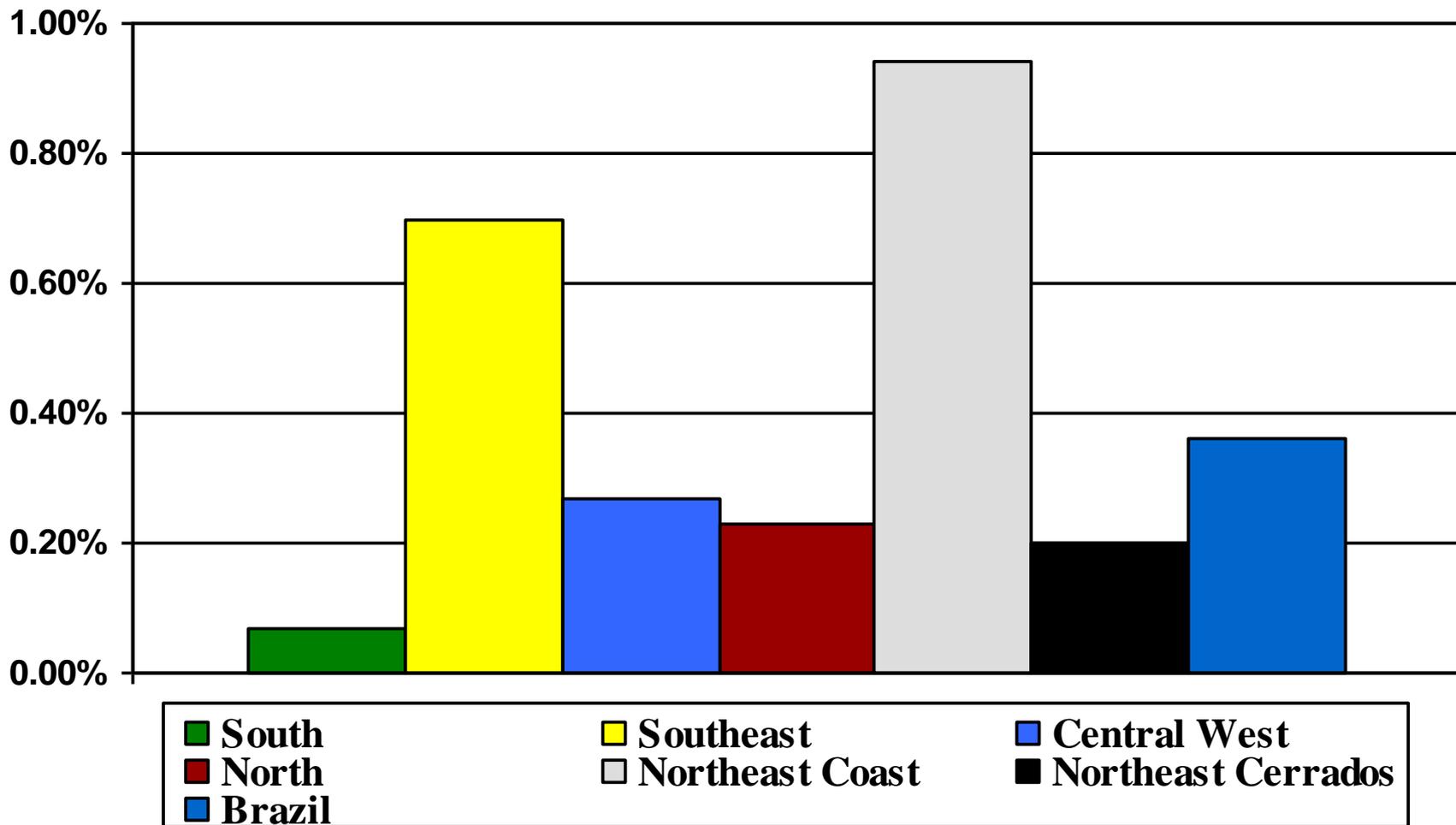
■ Second Crop

# Intensification and LUC – 25% Brazil

Region	Sugar cane	Other 1 <sup>st</sup> Crops	2 <sup>nd</sup> Crops	Area Planted	Pasture	Area Used
South	75	-16	107	165	6	64
Southeast	991	-237	14	768	-377	378
Central West	116	105	103	323	-95	126
North	10	58	3	71	67	135
Northeast Coast	143	37	0	180	-127	53
Northeast Cerrados	17	53	13	83	-24	47
Brazil	1,352	0	239	1,591	-551	802

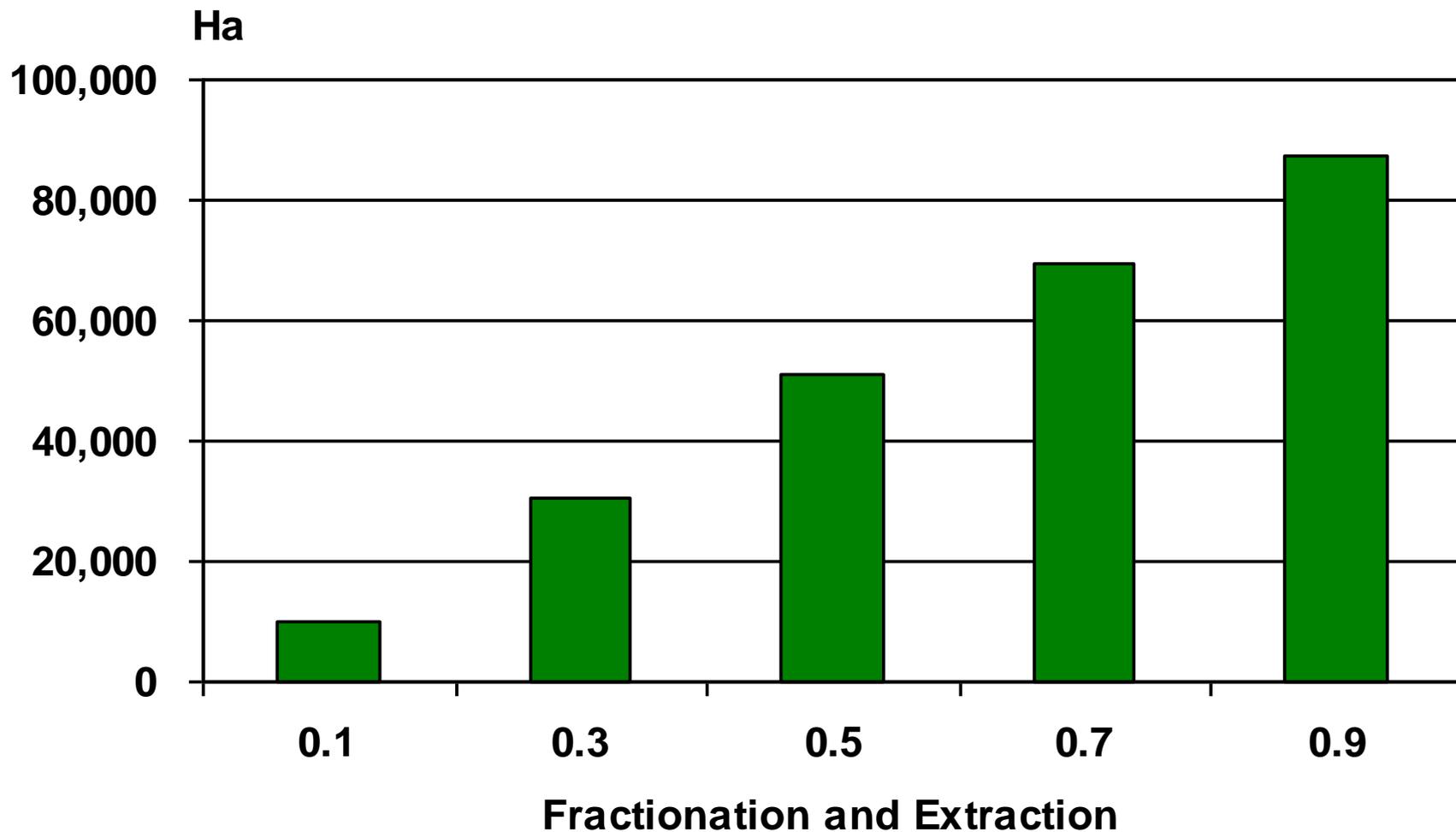
# Livestock Intensification and LUC

Percent



# Fractionation and LUC

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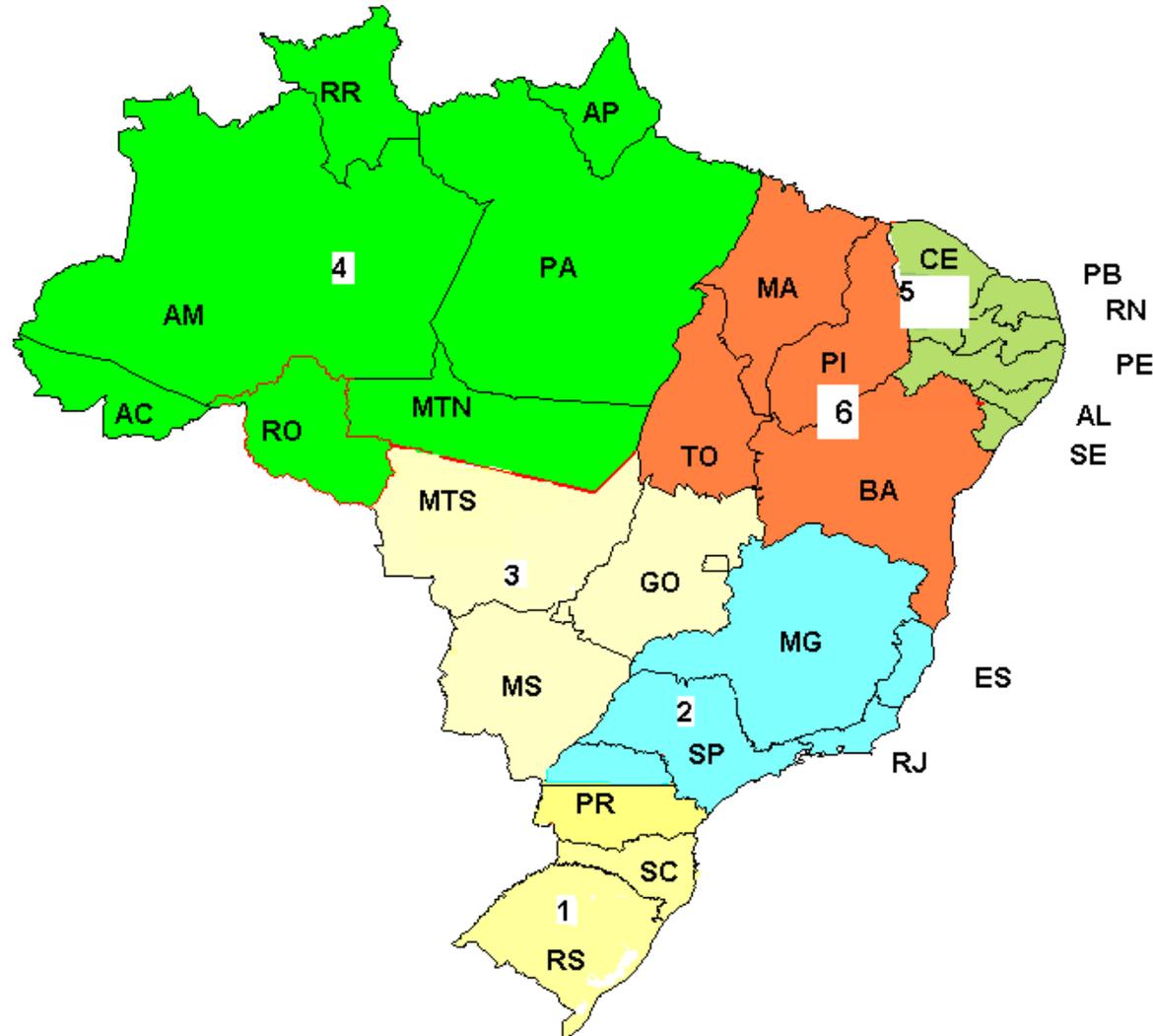


# Biofuel co-product displacement

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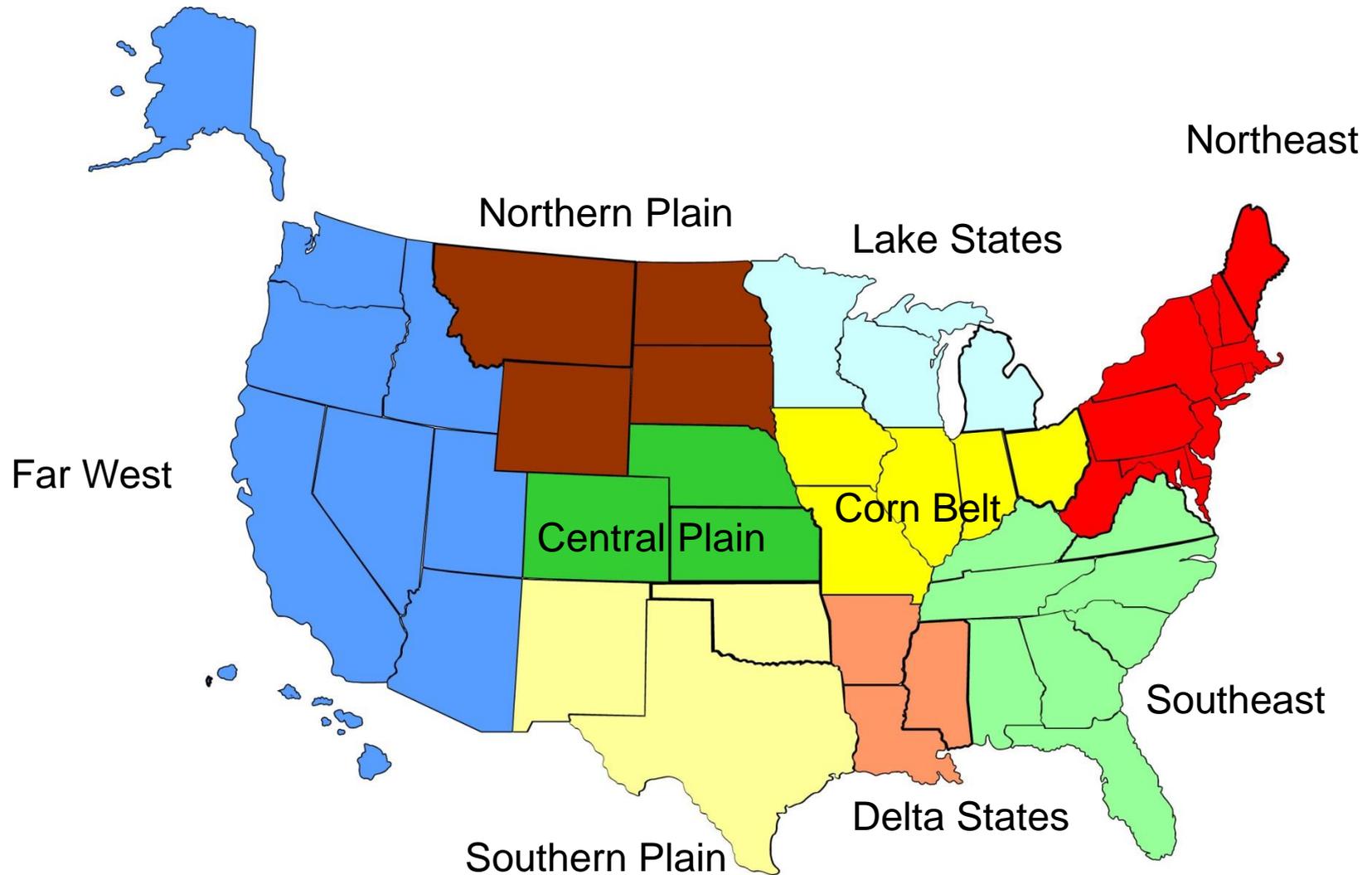
Feed Ingredient	US	EU
Energy Source (Barley, Wheat, Corn)	0.84	0.20
Protein Source (Soymeal, Rape meal, Sunflower meal)	0.14	0.81

# Regional Disaggregation of Brazil



# Regional Disaggregation of the U.S.

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# Major Developments in LUC Modeling: FAPRI-CARD Models

## ■ Area Allocation Specification

- Impose land supply limits with land policy compliance assumption and land suitability consideration
- Theoretical restrictions on elasticity-parameter space
  - Adding-up
  - Homogeneity
  - Symmetry
  - Etc.

# Major Developments in LUC Modeling: FAPRI-CARD Models continued ... 1

- Fertilizer Use Model (intensification)
  - By nutrient N-P-K
  - By commodity and By country
  
- Longrun Equilibrium
  - Supply side - normal profit condition imposed
  - Demand side – ethanol energy-equivalence pricing
  
- Feedback impact of ethanol on gasoline sector

# Convergence or Divergence of LUC Findings

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- Divergence factors outside the model
  - Definition and implementation of biofuel scenario
    - Searchinger, et al. - Change in exogenous variable and entire model solved for new equilibrium
    - JRC - Expand biofuel consumption, fixed trade, and model solves for new equilibrium
    - EPA - Exogenize biofuel sector

# Convergence or Divergence of LUC Findings

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- Divergence factors outside the model
  - Size of shock and non-linearity in the models
    - Elasticity differences in the additive, E-10, and E-85 ethanol markets.

# Convergence or Divergence of LUC Findings

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- Divergence factors in the model coverage
  - Intensification
  - Extensification
  - Co-products
  - Forestland, pastureland, etc

# Convergence or Divergence of LUC Findings

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- Divergence factors in the model structure
  - General Equilibrium versus Partial Equilibrium
  - FAPRI's Homogenous Product Single-equilibrium World and GTAP's Armington World

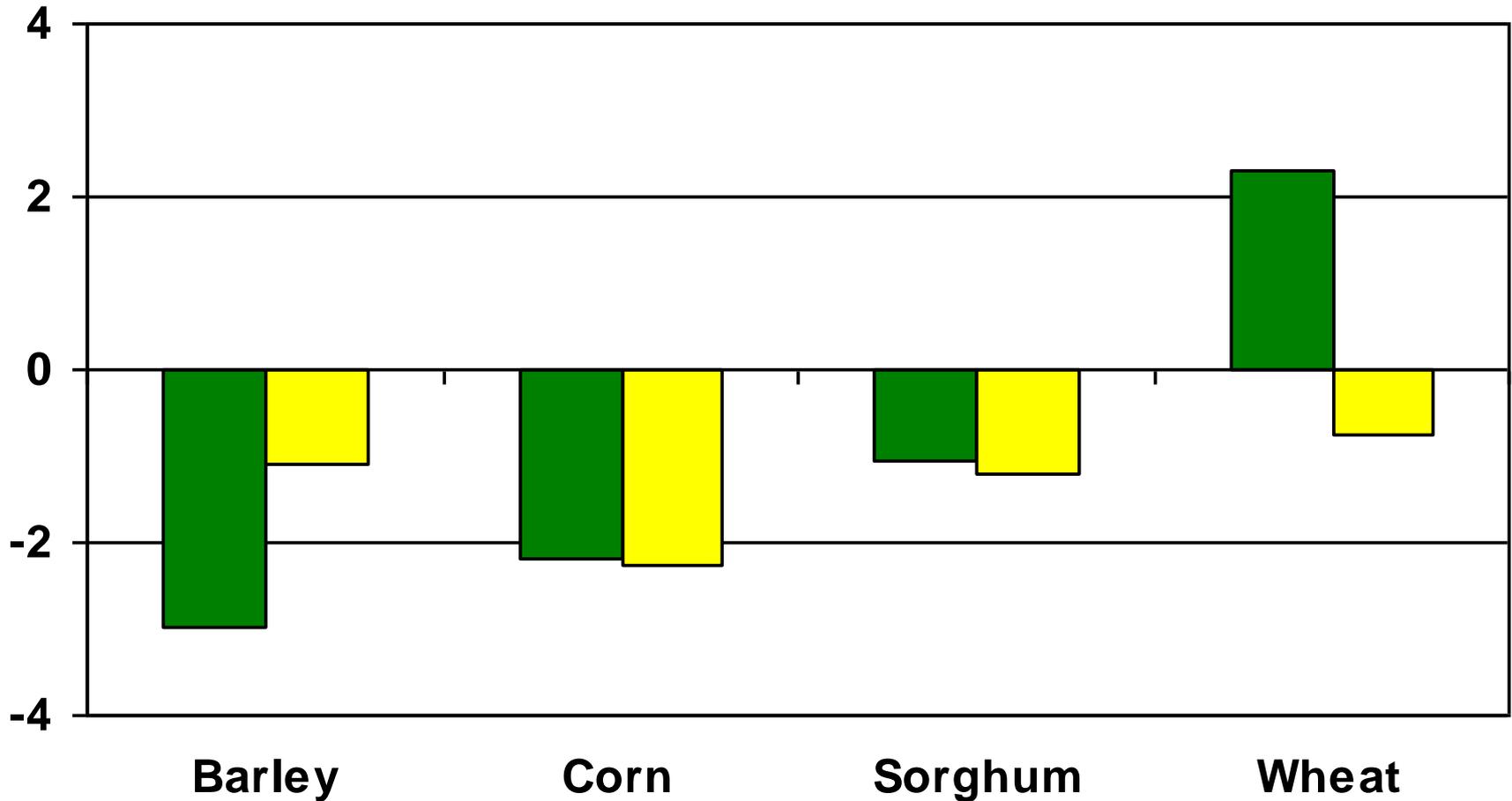
# Convergence or Divergence of LUC Findings

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- Divergence factors in the model specification
  - Functional form
  - Parameters-elasticities
  - Cross-price elasticities matter

# Price Changes in Corn Only Case

Percent



# Data and Analysis Needs to Improve Models

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- Livestock and dairy intensification – pastureland data
- Extensification and yield
- Quantification of inputs in yield intensification and associated GHG emissions
- Land availability and suitability

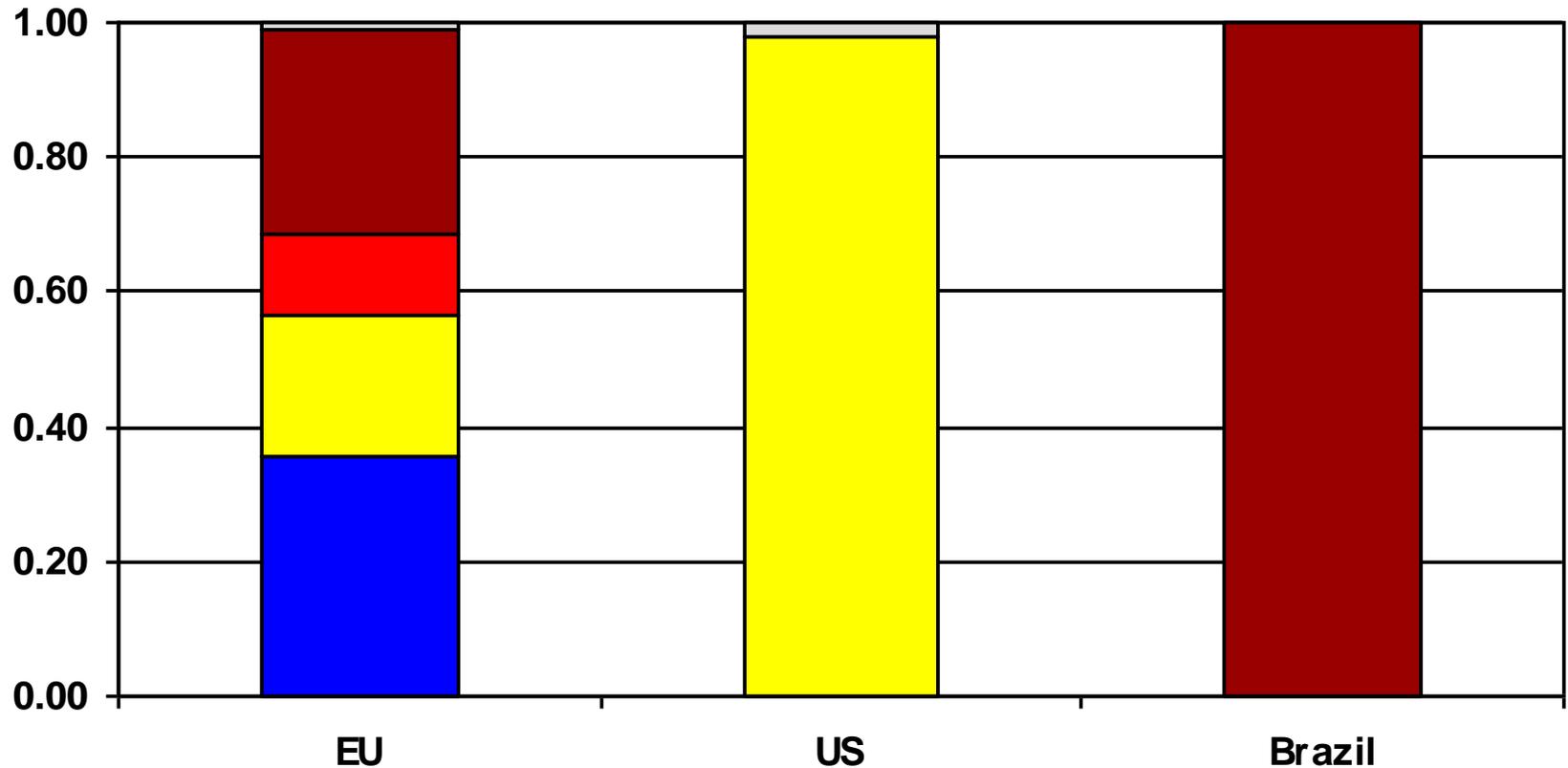
# Data and Analysis Needs to Improve Models

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- Proper modeling of biofuel feedstocks
- Proper modeling of competing uses of feedstock – especially as feeds for the animal sector
- Proper modeling of cross-price elasticities

# Bioethanol Feedstock

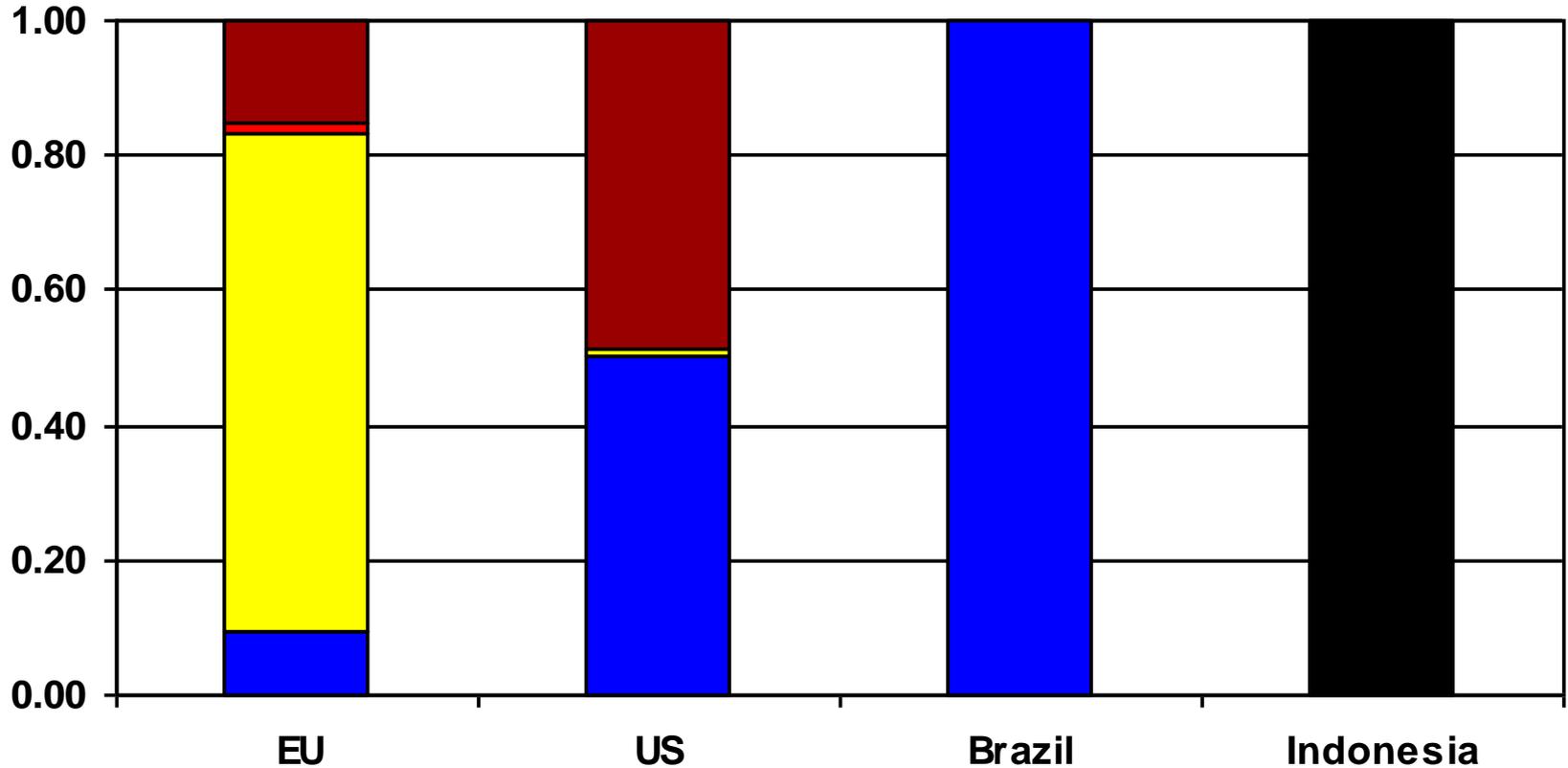
Percent



■ Wheat ■ Corn ■ Barley ■ Sugarcane or beet □ Others

# Biodiesel Feedstock

Percent



■ Soybean Oil

■ Rapeseed Oil

■ Sunflower Oil

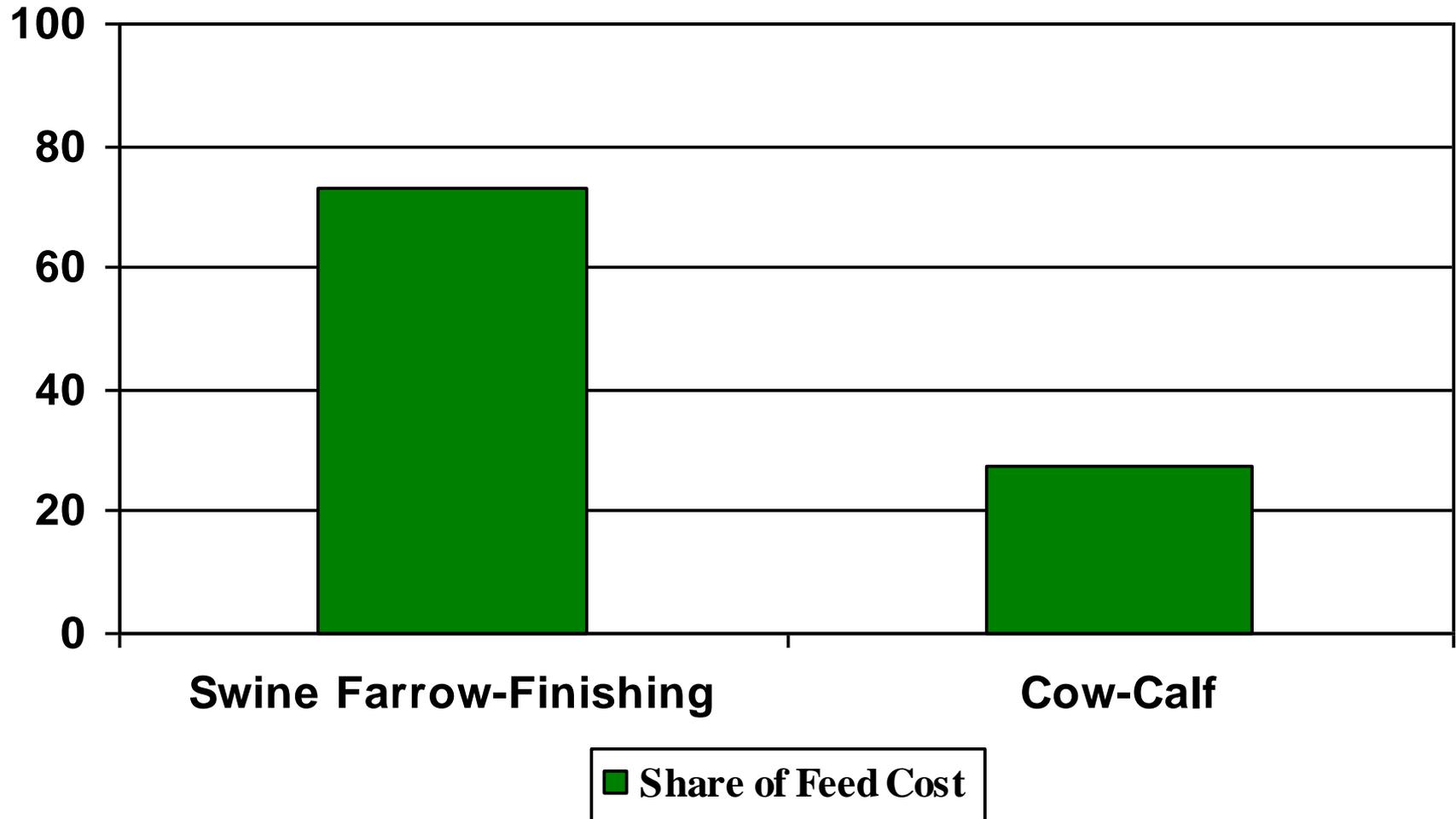
■ Palm Oil

■ Others

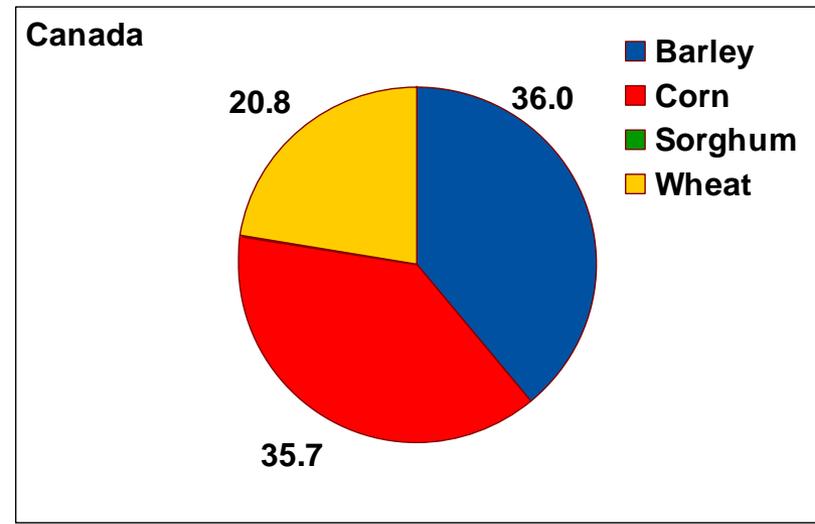
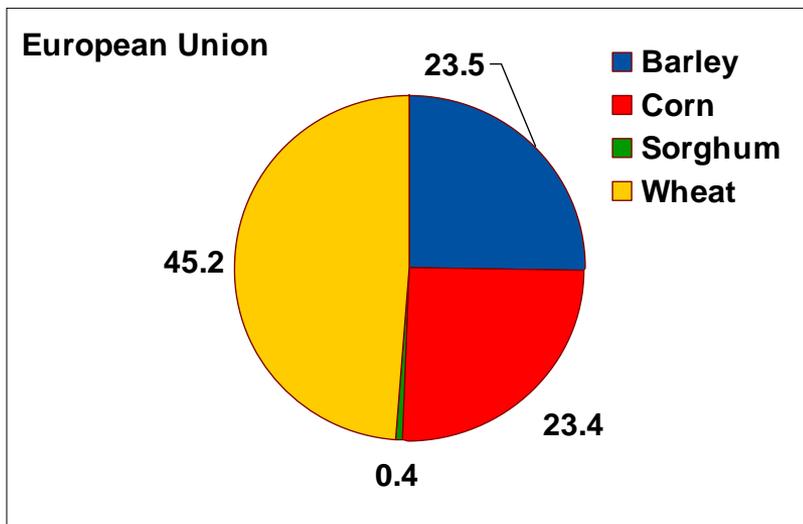
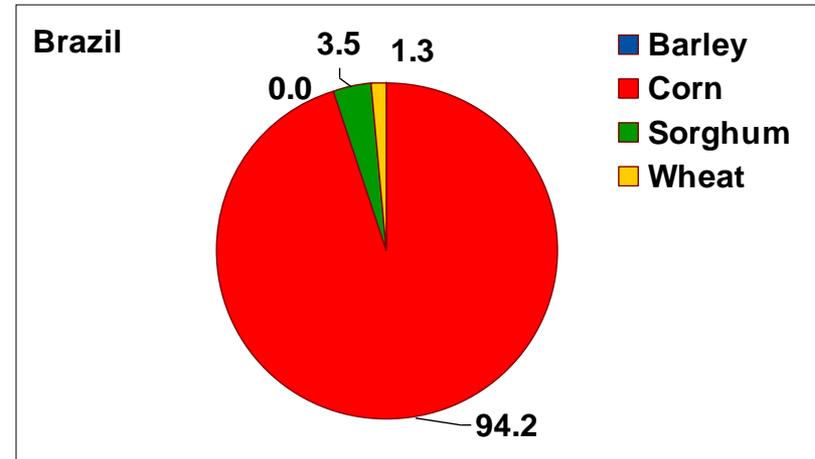
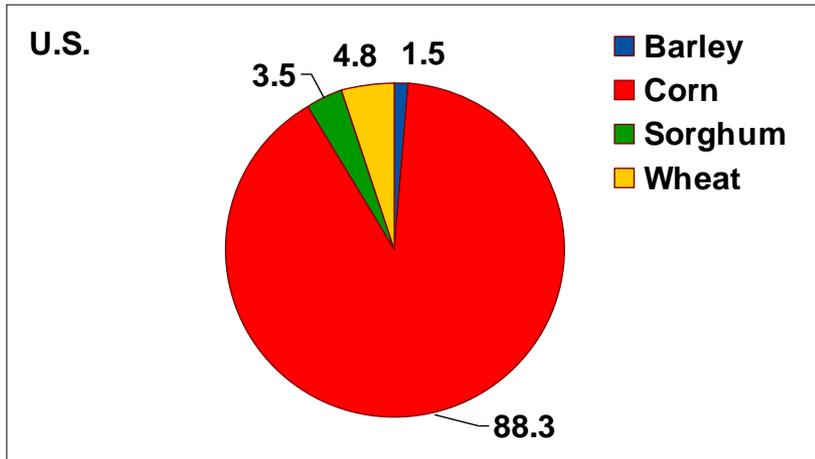
# Production Cost Structure

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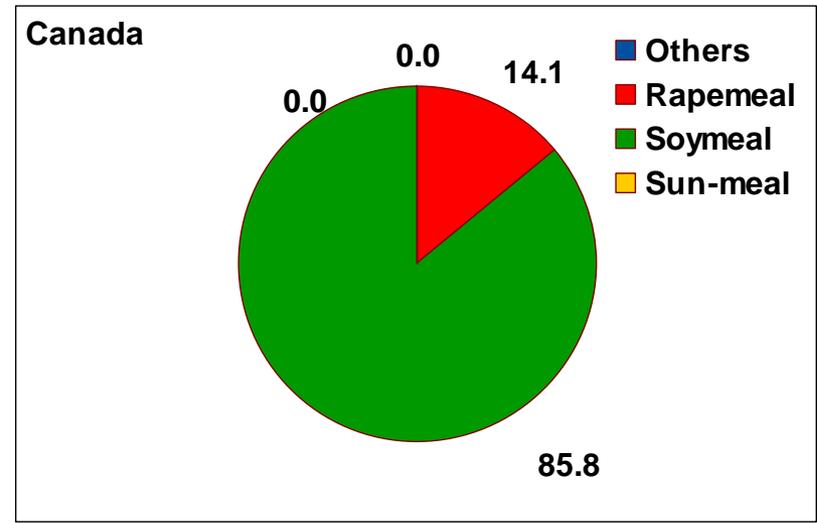
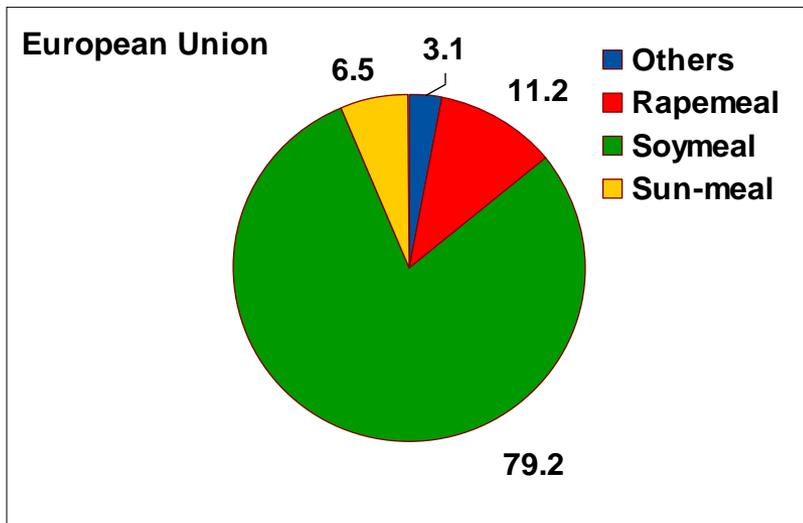
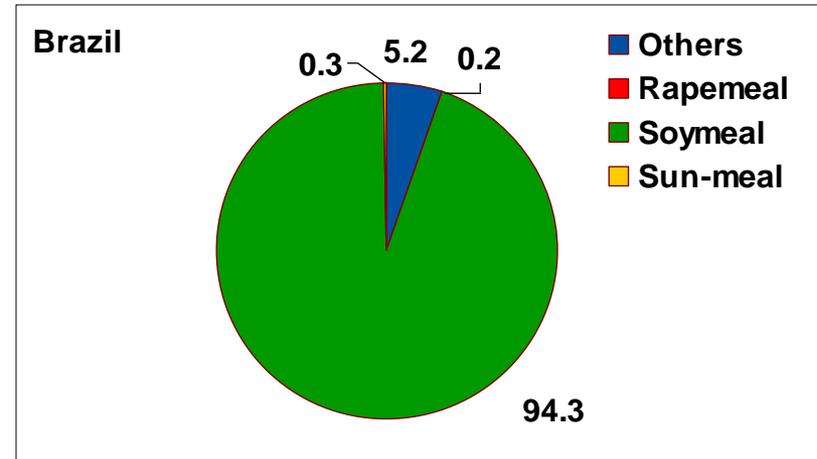
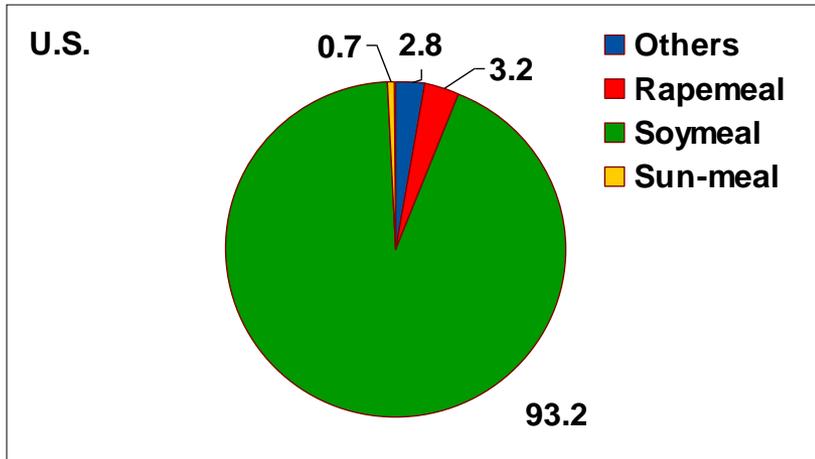
Percent



# Feed Ration Energy Sources



# Feed Ration Protein Sources



# Thanks!

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