

**LCA, Renewable Fuels and modeling:  
Some thoughts related to FASOM**

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## Plan of presentation

Will cover a few LCA aspects of FASOM

1. Major developments that affect LCA results.
2. Nature of greenhouse gas accounting in FASOM and way it differs from traditional LCA.
3. Data sources and reliance on other models
4. The divergence of LCA results in international land use accounting
5. Challenges to land use modeling and biofuels
6. Plans for model improvement

# Recent FASOM Modeling Developments

- Land-use class disaggregation
  - Cropland (from to forest, cropland pasture)
  - CropLand\_Pasture (from to forest, cropland)
  - Rangeland
  - Pasture (from to forest)
  - CRP (to cropland)
  - Forest\_Pasture
- Crop expansion
  - (Winter, spring barley, double crop soybeans, canola, miscanthus, energy sorghum)
- N<sub>2</sub>O updates
  - Unifications with DAYCENT
- Expanded fertilization possibilities
  - 115%, N inhibitor

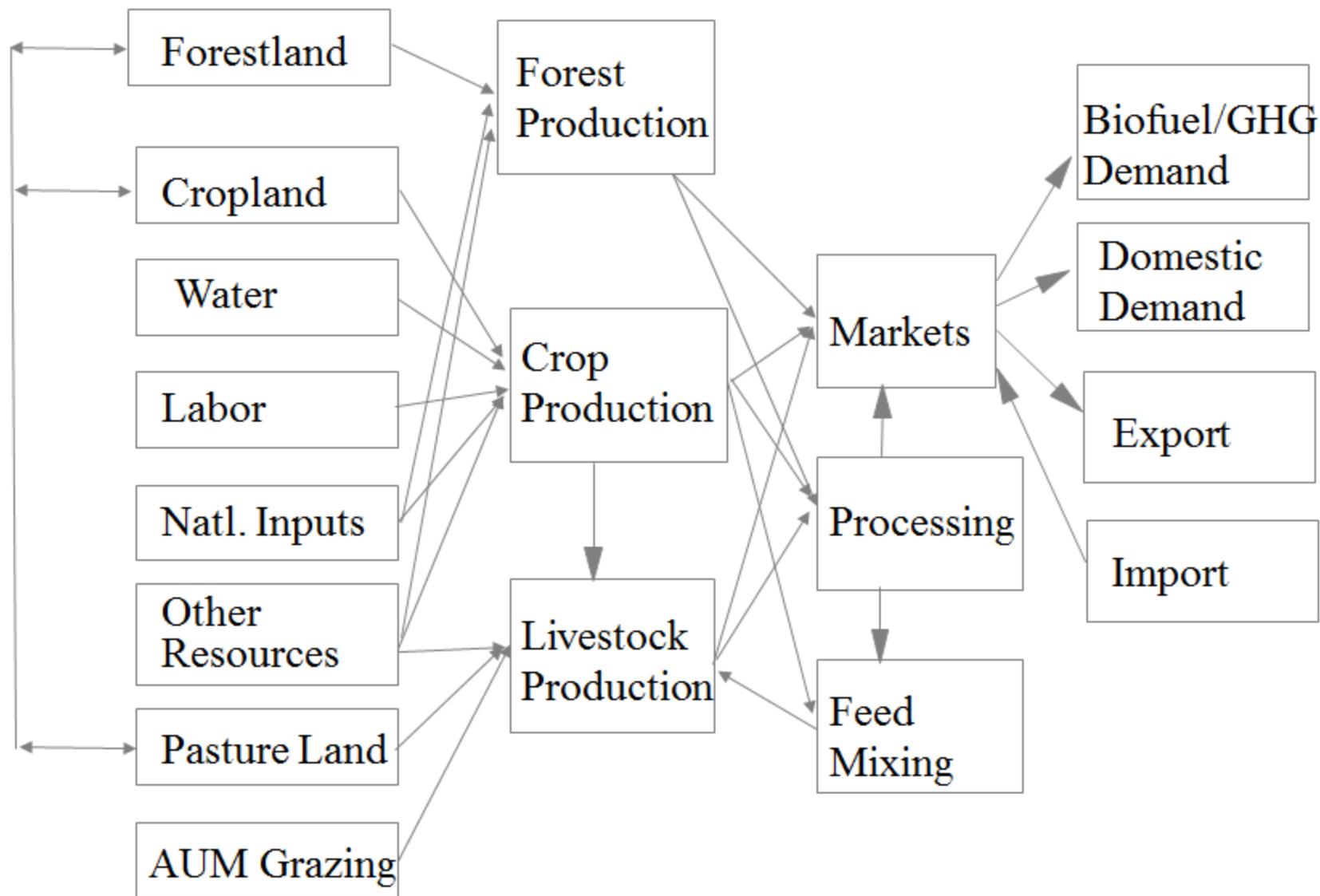
## Recent FASOM Modeling Developments

- Transactions costs, storage
  - Months of storage, fixed and variable cost
    - Longer for residues (10 months)
    - Shorter for energy crops (6-8)
    - Low for forest wood
  - Two stage transport for cofiring
  - Costs of assembly, uncertainty, other transactions
- Unification with global GLOBBIOM.

## FASOM GHG Accounting and differences from LCA

- FASOM is not a LCA model
- In one small part FASOM contains LCA type of information
- But it is not a total accounting in any one place
  - Input GHG content under purchased inputs
  - Farm production by 63 regions (input use)
  - Hauling in processing variables
  - Also processing GHG emissions
  - Many categories (next page)
- When solved all is added together

# Basic Modeling -- FASOMGHG



# FASOM GHG Accounting and differences from LCA

## In forest

Forest\_SoilSequest\_FI

Forest\_SoilSequest\_OP

Forest\_AfforestSoil\_OP

Forest\_LitterUnder\_FI

Forest\_LitterUnder\_OP

Forest\_AfforLitter\_OP

Forest\_ContinueTree\_FI

Forest\_ContinueTree\_OP

Forest\_AfforestTree\_OP

## Forest products

Forest\_USpvtProduct

Forest\_USExport

Forest\_USFuelResidue

Carbon\_For\_Fuel

Forest\_USpubProduct

Forest\_USImport

Forest\_USresidProduct

Forest\_CANProduct

Forest\_USFuelWood

Forest\_CANresidProduct

## Dev land

Dev\_Land\_from\_Ag

Dev\_Land\_from\_Forest

## Ag soil

AgSoil\_CropSequest\_Initial

AgSoil\_PastureSequest

AgSoil\_CropSequest\_Till

AgSoil\_CropChange

## Ag production

Carbon\_AgFuel

Carbon\_Pest

Carbon\_Dryg

Carbon\_Irrg

Carbon\_Fert

# FASOM GHG Accounting and differences from LCA

## Bioenergy

Carb_Ethl_Offset	Carb_Ethl_Haul	Carb_Ethl_Process
Carb_CEth_Offset	Carb_CEth_Haul	Carb_CEth_Process
Carb_CEth_Residue_Offset	Carb_CEth_Res_Haul	Carb_CEth_Residue_Process
Carb_BioElec_Offset	Carb_BioElec_Haul	Carb_BioElec_Process
Carb_BioElec_Residue_Offset	Carb_BioElec_Res_Haul	Carb_BioEl_Res_Proc
Carb_Biodiesel_Offset	Carb_Biodiesel_Haul	Carb_Biodiesel_Process

## Animals

Methane_Liquidmangement	Methane_EnterickFerm	Methane_Manure
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## Crops

Methane_RiceCult	Methane_AgResid_Burn
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## Processing

Methane_BioElec	Methane_Biodiesel	Methane_Ethl
Methane_CEth		

# FASOM GHG Accounting and differences from LCA

## Animals

NitrousOxide\_Manure

## Bioenergy processing

NitrousOxide\_BioElec

NitrousOxide\_Biodiesel

NitrousOxide\_Ethl

NitrousOxide\_CEth

## Feritlization, legumes, crop residues, jistosoil

NitrOx\_Cropland\_Direct

NitrOxide\_Cropland\_Volat

NitrOxide\_Crop\_Leach

NitrOx\_Cropland\_Sludge

NitrousOxide\_Nfixing

NitrousOxide\_CropResid

NitrOx\_Crop\_Histosoil

NitrOx\_Crop\_Resid\_Burn

## Pasture

NitrOx\_Pasture\_Direct

NitrOx\_Pasture\_Volat

NitrOxide\_Past\_Leach

## Data Sources including Models

- State crop budgets
- GREET
- EPA
- USDA Agricultural Statistics
- EPIC
- DAYCENT
- EPA GHG Inventory
- ARMS survey
- USDA Livestock budgets

## Divergence

Results critically depend on assumptions

To model Brazil well need

- Southern land (corn and soy and pasture)
- More northern land (soy and pasture)
- Rainforest land (pasture and rainforest)
- Transport costs

## Challenges

What to do about new stuff

Butanol and plug in fuels

Cellulosic ethanol

Pyrolysis

Energy crops

- miscanthus, energy sorghum.  
jatropha

## Challenges

Technological change

Storage

Transactions costs

Energy price as quantity is large

Land classes

Marginal lands and feedstocks

# Plans for improvement

More feedstocks

Marginal lands

Better storage and transactions costs

International expansion and dynamics

Two stage processing and retrofits

Climate change and crop mix