Modeling framework for biofuels policy in India

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Outline

- Recap of policy issues
- Modeling structure
  - Discussion of multi-market partial equilibrium model
  - Data sources/requirements
- Extensions and next steps

Key issues

- Increased demand for energy in India, much of which is coming from imported sources.

- Potential for biofuels as a means to leverage indigenous sources of inputs, potentially increasing income and opportunities in rural areas …

- … with the tradeoff of potentially increasing prices for staple food products for poor consumers, increasing food insecurity
  - Direct effects for biofuel source products (e.g., sugar)
  - Indirect effects in competing land sources & livestock

Key issues

- How to assess tradeoffs in biofuels from a policy standpoint? Need for empirical support to inform decision making.

- Approach taken: use of a dynamic partial-equilibrium multimarket model (general template of Rich & Lundberg, 2002)

- Rationales
  - Detailed focus on interactions between agricultural crops and downstream industrial uses
  - Linkages to household distribution and poverty issues
  - Incorporation of important agricultural policy levers in India (MSP/PDS policy e.g.)
  - Examine evolution of biofuel sector and policy response

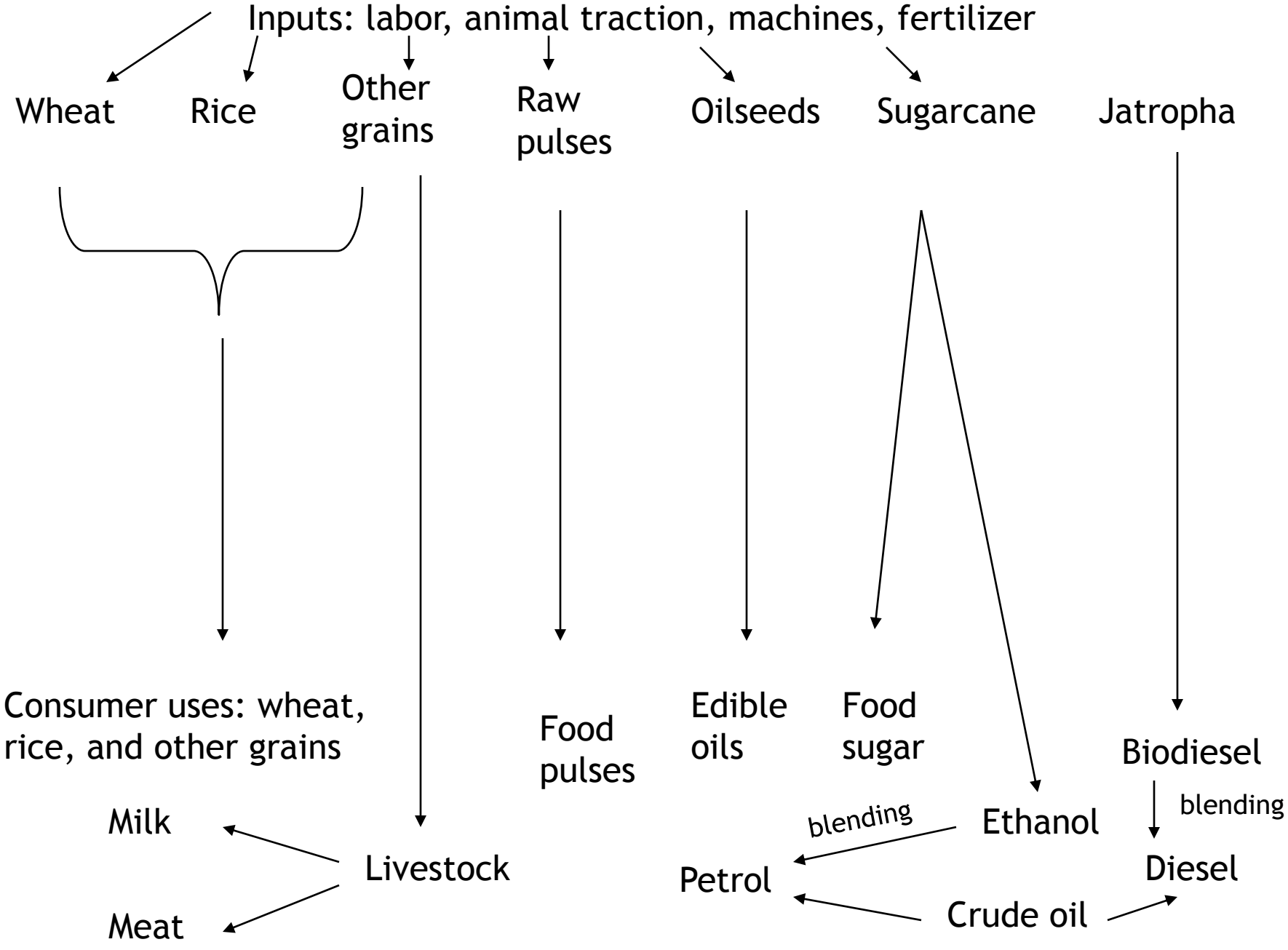
Key issues

- Advantages:
  - Ability to assess implications on biofuel promotion at a detailed sectoral level
  - (potentially) Greater transparency/ease in modeling results vis-à-vis general equilibrium approaches
  - Platform to scale up to address regional effects/spatial trade

- Disadvantages
  - Macro impacts not considered
  - Strong assumptions on tradability govern trade

Methodology

- Sectors included:
  - Primary crops: wheat, rice, other grains (e.g., corn, sorghum), oilseeds, sugarcane, raw pulses, jatropha
  - Processed food crops: edible oils (derived from oilseeds); sugar (derived from sugarcane); food pulses (derived from raw pulses)
  - Fuels derived from crops: ethanol (derived from sugarcane via molasses), biodiesel (derived from jatropha)
  - Fuel products: crude oil plus petrol and diesel derived from crude
  - Livestock: animal stocks, milk, and meat
  - Inputs: animal/labor/fertilizer/machine (capital)


Inputs: labor, animal traction, machines, fertilizer
Wheat
Rice
Other grains
Raw pulses
Oilseeds
Sugarcane
Jatropha
Consumer uses: wheat, rice, and other grains
Food pulses
Edible oils
Food sugar
Biodiesel
Milk
Livestock
Meat
blending
Ethanol
blending
Petrol
Diesel
Crude oil

Methodology

- **Primary crop relationships:**
  - Area and yield relationships of crops (other than jathropa) as function of producer prices of crops (own and cross-prices) and consumer prices of inputs

  A(i) = f(pp(i), pp(j), pc(inputs)), j=other crops
  Y(i) = f(pp(i), pp(j), pc(inputs)), j=other crops

  - Functions in multimarket model specified as double-log, constant elasticity forms

  - Elasticities econometrically estimated using cost function (cost of cultivation data, 1975-2005).

  - Land allocation fixed within crop sector.

Methodology

- **Jatropha:**
  - Area relationship defined as function of producer prices of jatropha and consumer prices of inputs: *A(i) = f(pp(i), pc(inputs))*
  - Cross price impacts not considered as jatropha area separate from crop area (this is an assumption to revisit as a simulation…)
  - Function specified as double-log, constant elasticity forms; elasticities based on expert opinion.
  - Yield relationships based on evolution of yields over time: model specifies dynamics of perennial production over five-year period (recursive solution)

Methodology

- Input relationships:
  - Input demand functions depend on producer prices of crops and consumer prices of inputs: ID(i) = f(pc(inputs), pp(crops))
  - Functions specified as double-log, constant elasticity forms
  - Elasticities econometrically estimated from cost function.
  - Animal and machine supply assumed perfectly inelastic (fixed stocks)
  - Labor and fertilizer supply assumed perfectly elastic.

Methodology

- Livestock markets:
  - Inventories of animals modeled as function of lagged prices and stock of calves (double-log)
  - Animal supply function of own producer price, feed price ("other grains"), lagged supply, and inventories (double-log)
  - Animal demand function of own consumer price, lagged demand, and producer prices of milk and meat
  - Meat and milk supply are fixed conversion rates of livestock demand

Methodology

- **Biofuel markets:**
  - For ethanol, supply is modeled as a conversion from sugarcane to ethanol based on:
    - Proportion of sugarcane diverted to food sugar production (55-60%)
    - Conversion of sugarcane to molasses (co-product of sugar production): 4%
    - Allocation of molasses to ethanol (80-85%)
    - Allocation of ethanol to fuel (36-42%): scope to endogenize this to look at response to price (+/- 5% range that could possibly adjust)
  - Demand is based on blending rates: currently mandated at 5% of petrol demand (scope to endogenize further?)

Methodology

- **Biofuel markets:**
  - For biodiesel, supply is modeled as a conversion from jatropha to biodiesel at a 30% conversion factor from jatropha to fuel.
  - Demand is based on blending rates: currently mandated at 5% of diesel demand (not being met at present in reality but expected by 2015)

Methodology

- **Final demand:**
  - Demand for food grains (wheat, rice, other grains), "processed" foods (food pulses, sugar, edible oils), meat, milk, and fuel (petrol/diesel) modeled as demand system in multimarket model.
  - Econometric estimates derived for food products as QAIDS and FCDS (NSS household data for 2004).
  - Fuel elasticities estimated separately (single-equation) (time series data from Ministry of Petroleum).
  - Demand and income elasticities separated by income quartile (rural/urban to be considered later in multimarket)

Methodology

- **Poverty measures:**
  - Measure income poverty (head count ratio %)
  - Undernurished population based on caloric intake
  - Linkages based on price movements from different scenarios (income and poverty rates)

Policy scenarios

- **Scenarios to examine:**
  - Changes in blending ratios (look at 10% blending mandates for 2016 and beyond)
  - Changes in general agricultural policy on biofuel incentives (e.g., MSP/PDS policy)
  - Public investment in technologies (consider also costs of investments and return)
  - Changes in tax and procurement policies for biofuels
  - Substitution of jatropha for crop land (“third rail” of biofuels policy)

Modeling challenges

- **Supply-demand balances, particularly on fuel products**
  - **Data imbalances on supply/demand side**
- **Measuring "potential demand" in terms of biofuels: reliance on fixed proportions from policy to govern behavior.**
- **Livestock behavior still to be more fully integrated with biofuels story.**

Timelines

- **Calibration ("finessing") of final model framework: in progress, to be completed within next week**
- **Simulation of initial policy runs: Nov-Dec 2009**
- **Write-ups/discussion on policy impacts: Dec 2009**
- **Model extensions: early 2010**

Extensions

- Potential extensions
  - Regionalization of model: incorporation of spatial impacts (MCP model of regional trade)
  - Greater disaggregation of livestock/feed sector vis-à-vis biofuel policy
  - Greater disaggregation of potential other biofuel crops (e.g., maize, sweet sorghum)
  - Greater disaggregation of household impacts on poverty and household food security
  - Others??