AIM/CGE
Land use, Agriculture and Bioenergy

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The 18th AIM international workshop

Outline

- Land use modeling in CGE model
  - Previous modeling issues
- The process of the model improvement
  - Framing the problem
  - Modeling
  - Data preparation
- What can be done by this improvement
  - Scenario example
  - The indicators which become available in this improvement.

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What we have done last year (1)

- A CGE model development
- 1 year step recursive
- Year coverage; 2005 to 2050 and 2100
- Regional coverage; global and national (flexible)
- Industrial sectors are 38; energy supply sectors are disaggregated

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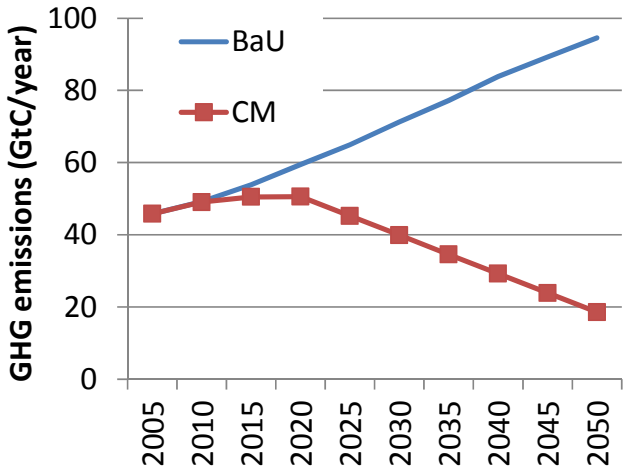
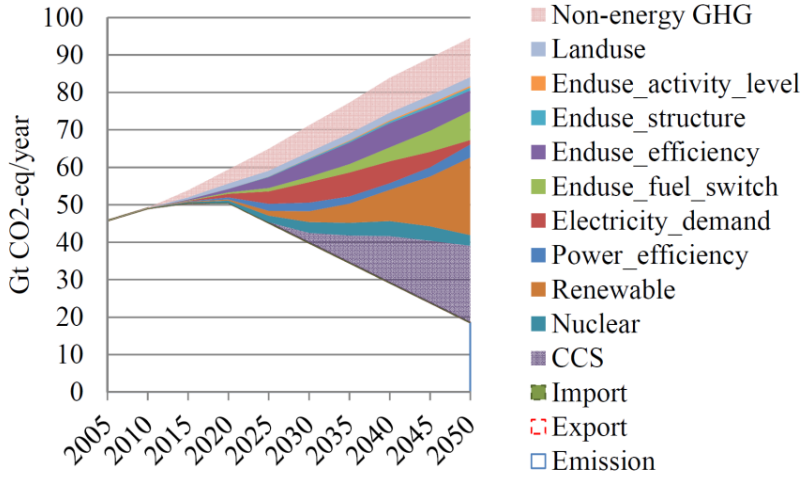
What we have done last year (2)

- Developing global and national climate mitigation scenarios by using CGE model
  - to halve emissions in 2050



Global emission trajectory



Global emission reduction

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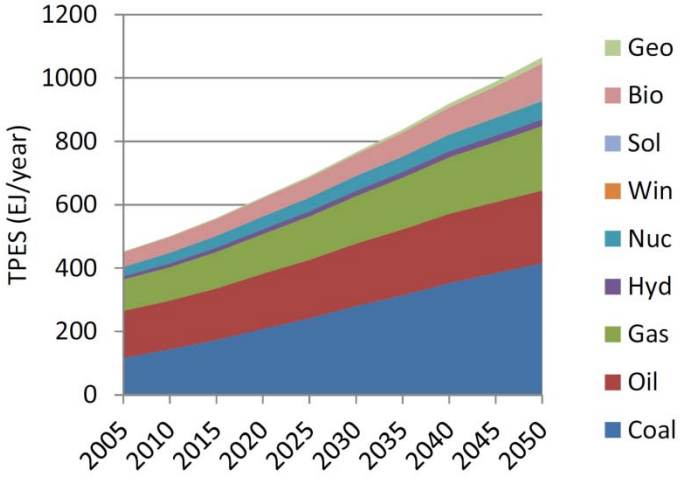
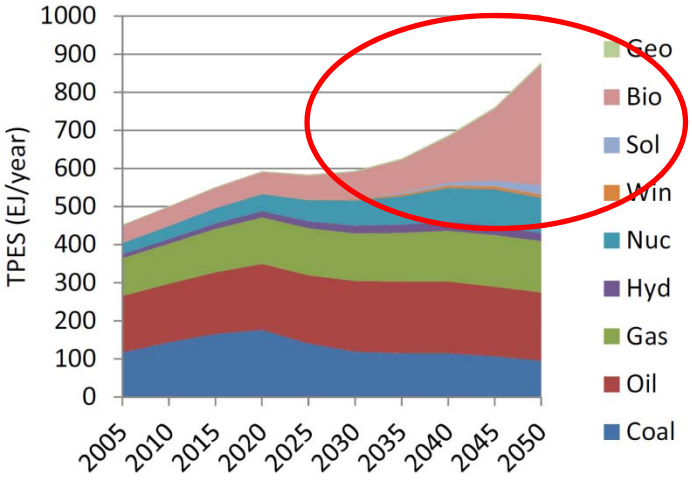
Previous modeling issues



BaU primary energy supply



CM primary energy supply

- Biomass energy is not so expensive mitigation option. BioCCS is much attractive with high carbon price.

- Agriculture sector is aggregated.
  - Not describing food demand appropriately.
- Physical land constraint was not considered.
  - How is the biomass energy source realized?

Framing the issues related to Land and Agriculture

1. Disaggregation of agricultural sectors and products

2. Model change
   - Crop production function (yield is a key)
   - Consumption function (Food demand and per capital calorie)
   - Land treatment (Harvested area, Physical cropping area, grazing and forestry land)

3. Bioenergy production sectors
   - Waste base and energy crops
   - Assume production function

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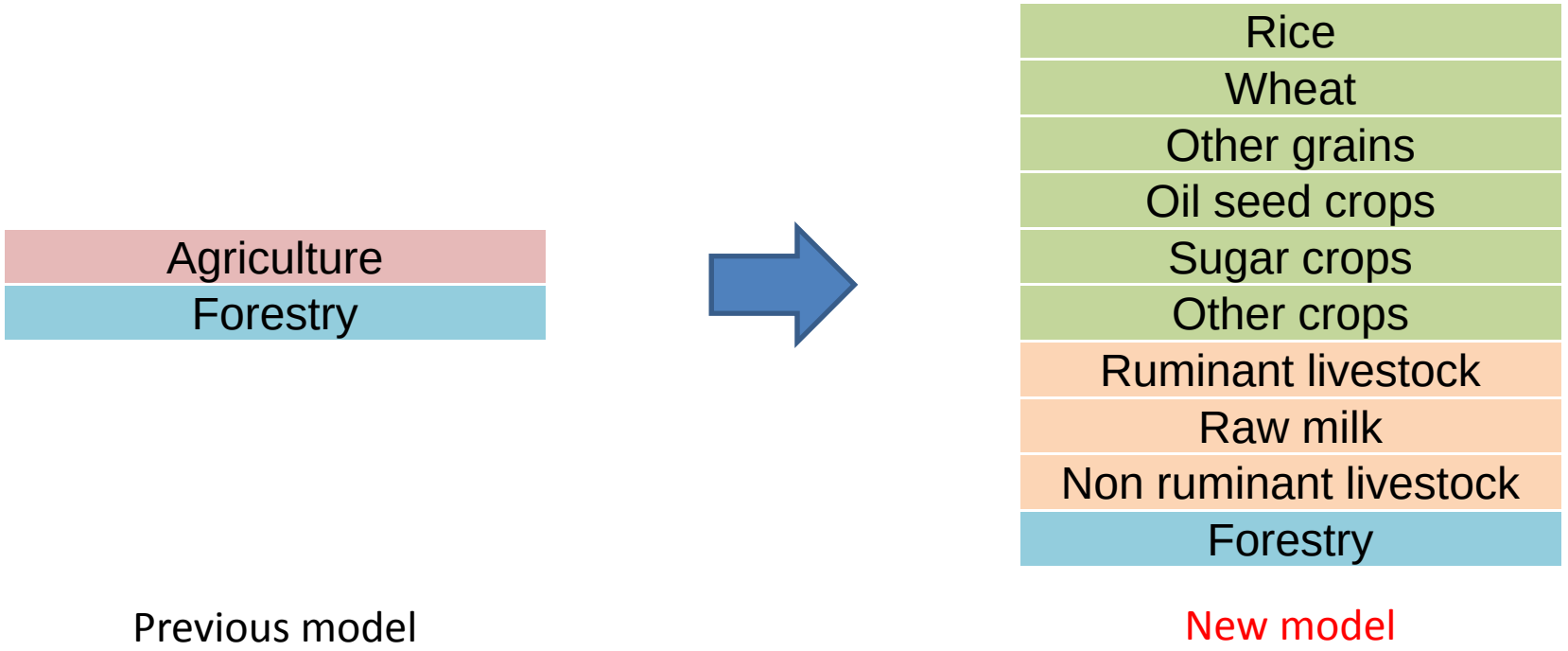
Disaggregation of agricultural sectors and products



- Just disaggregate!!

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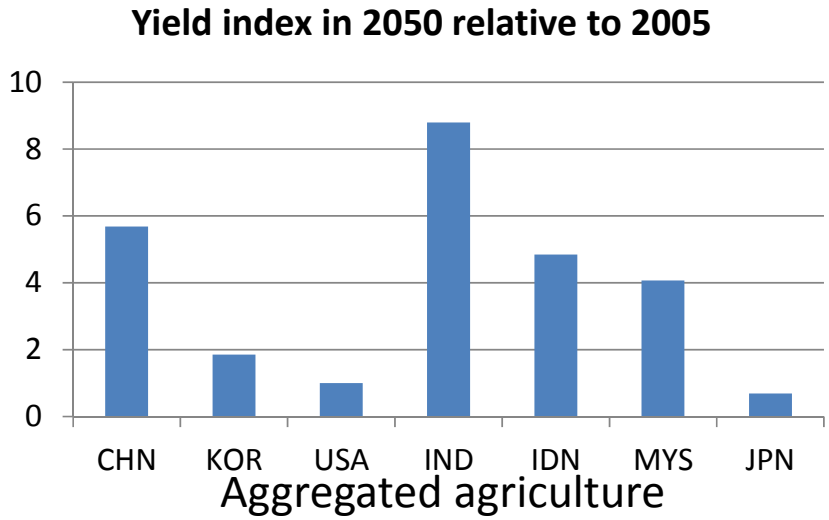
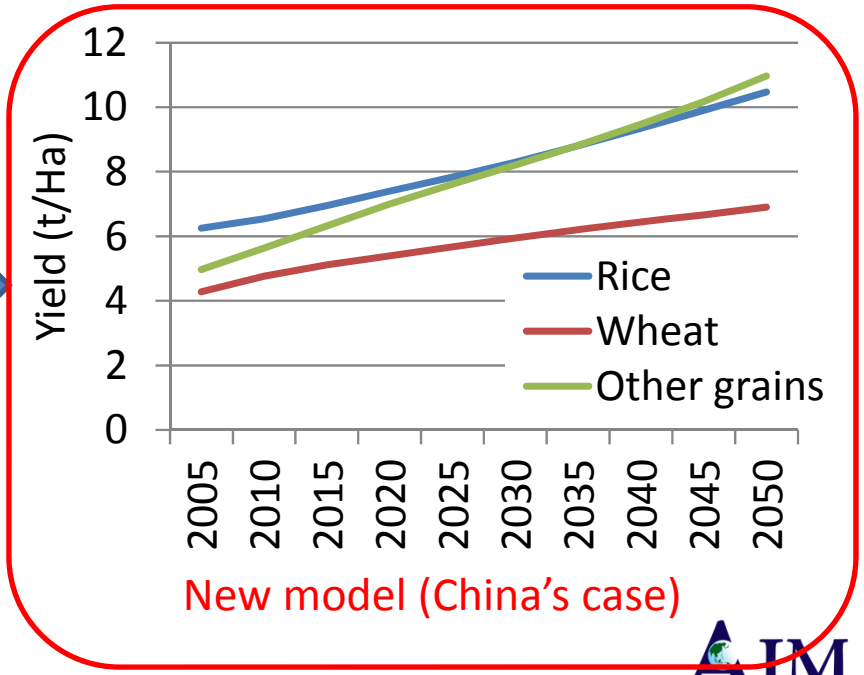
Crop production

- Production function is revised to consider yield in physical term.
  - CES nested → fixed coefficient
  - Unrealistic yield change is avoided.
- Exogenous yield change is explicitly assumed.



Previous model



New model (China's case)

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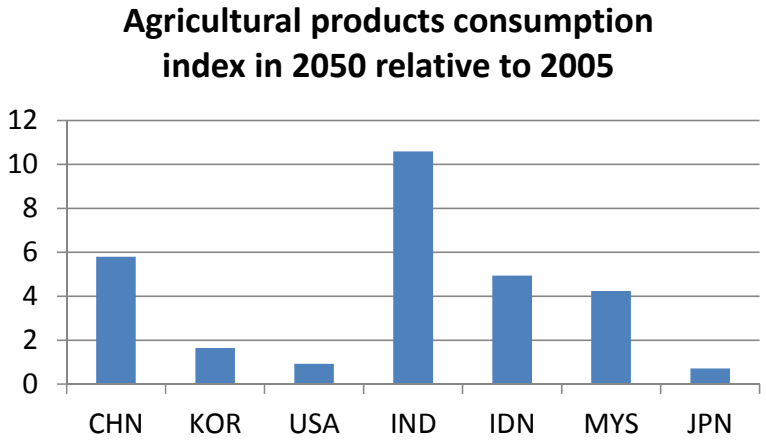
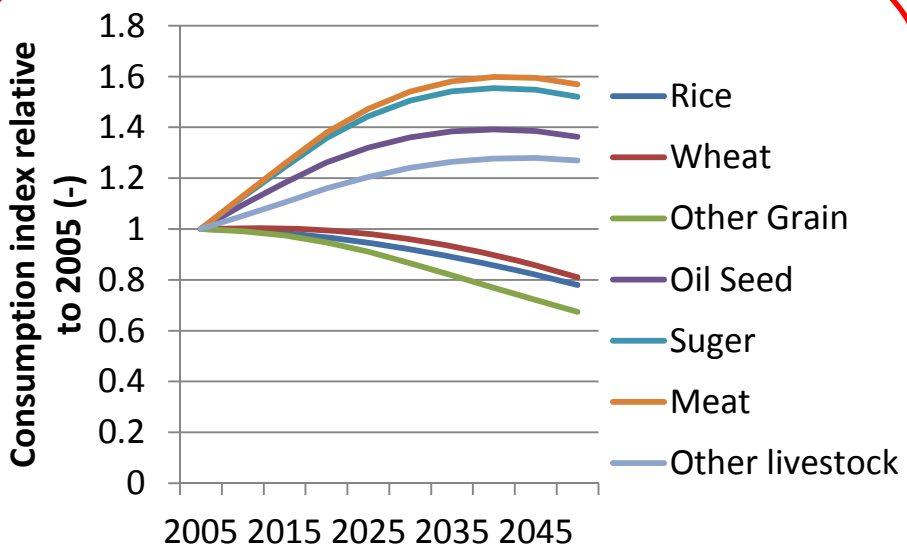
Food and feed demand

- Food demand is associated with household consumption.
  - Income elasticity
- Feed demand change is realized to assume the livestock industry's input coefficient change.



Previous model



New model (China's case)

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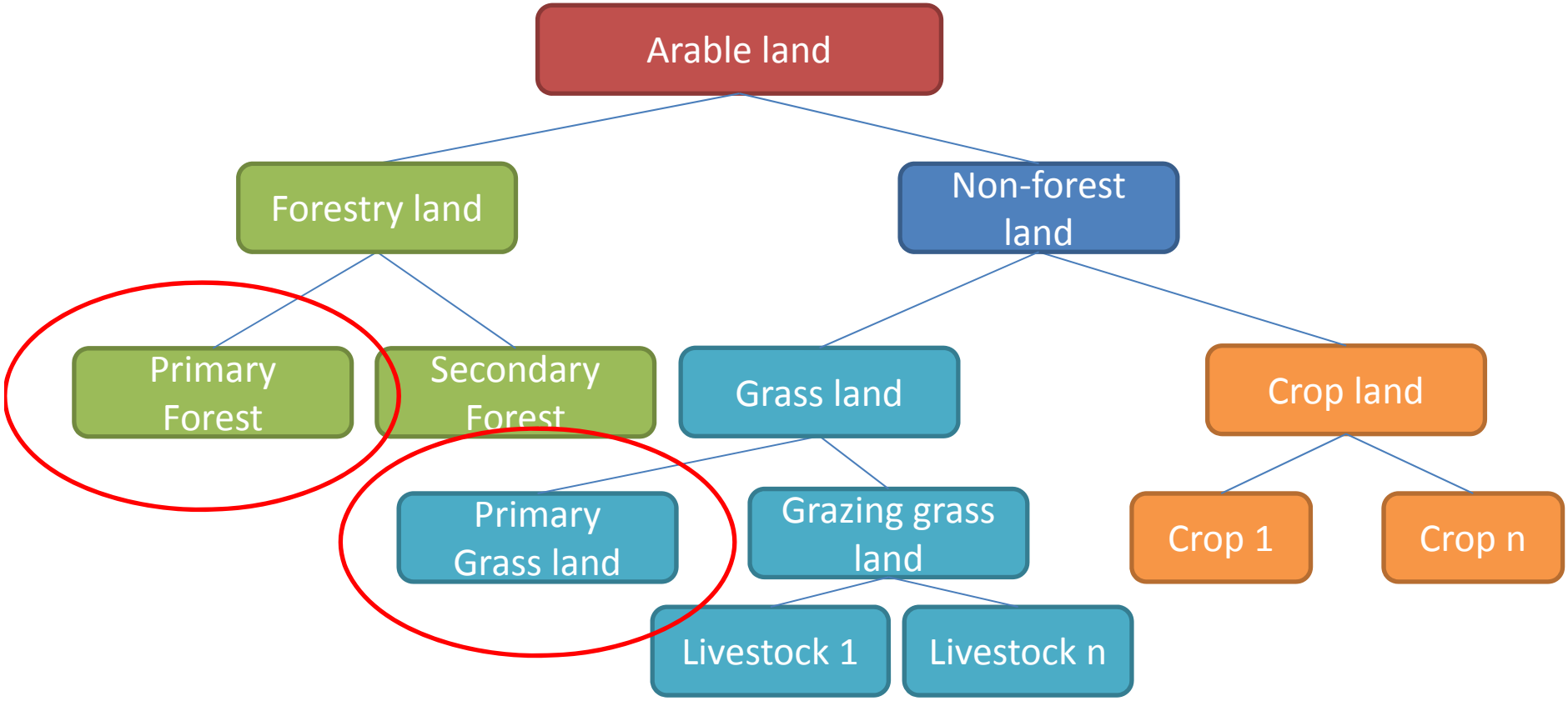
Land owner decision



- Non-used area becomes available
- The land use share is determined by the land rent

Bioenergy options

- Energy supply
  - 1st generation (made from food crops)
  - 2nd generation made from residues
  - 2nd generation made from energy crops
- Energy demand
  - Transport fuel
  - Power plant (with and without CCS)

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Data preparation

Base year data

- Crop and livestock commodity data
  - FAOSTAT reconciled with monetary data (SAM)
- Land use and Carbon stock data
  - RCP database connecting with FAO's production data
- Multi-cropping
  - IFPRI's crop map

Future assumption

- Food consumption perspective (FAO)
- Yield assumption (IFPRI)

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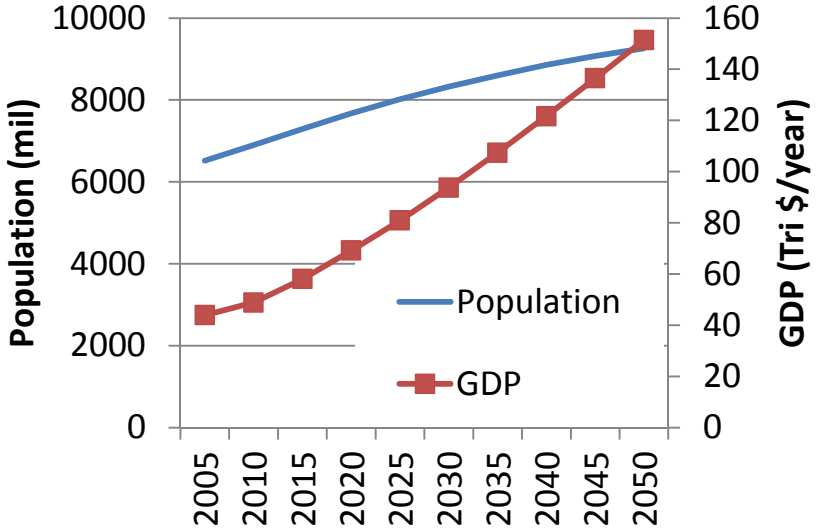
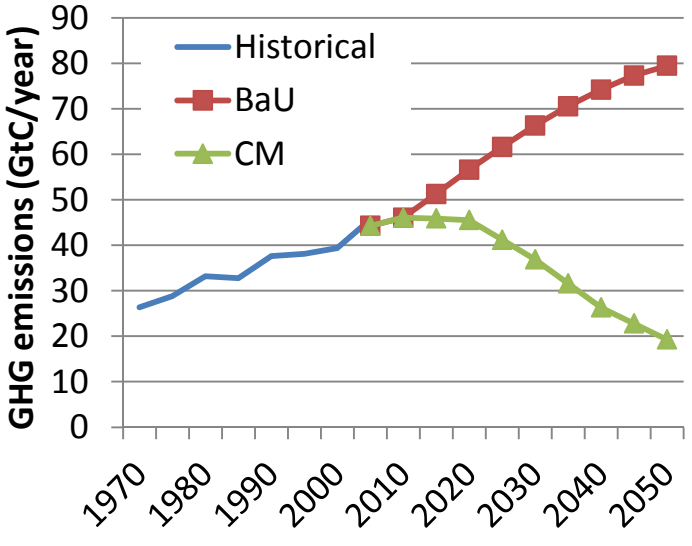
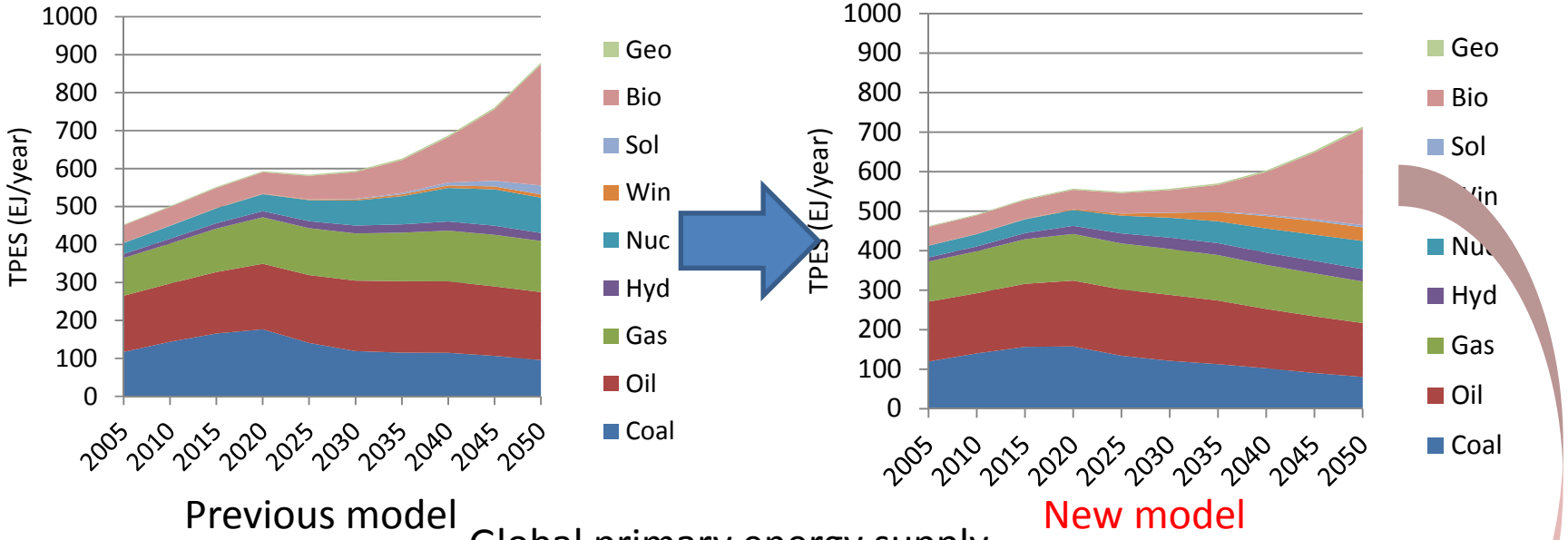
Scenario example

- Global; 17 regions
- Energy, agriculture and land are fully covered
- All GHG gases
- Time period ; 2005-2050
- Scenario assumptions
  - Socioeconomic assumptions; middle of the road
  - BaU and Climate mitigation scenarios (2 degree target)

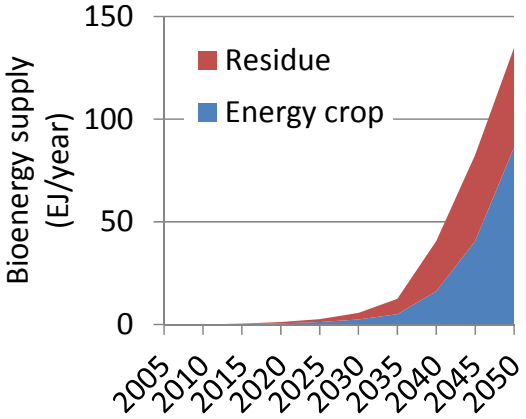




Key results – Primary energy



- Bioenergy availability decreases from previous model.
- Land and residue constraints work



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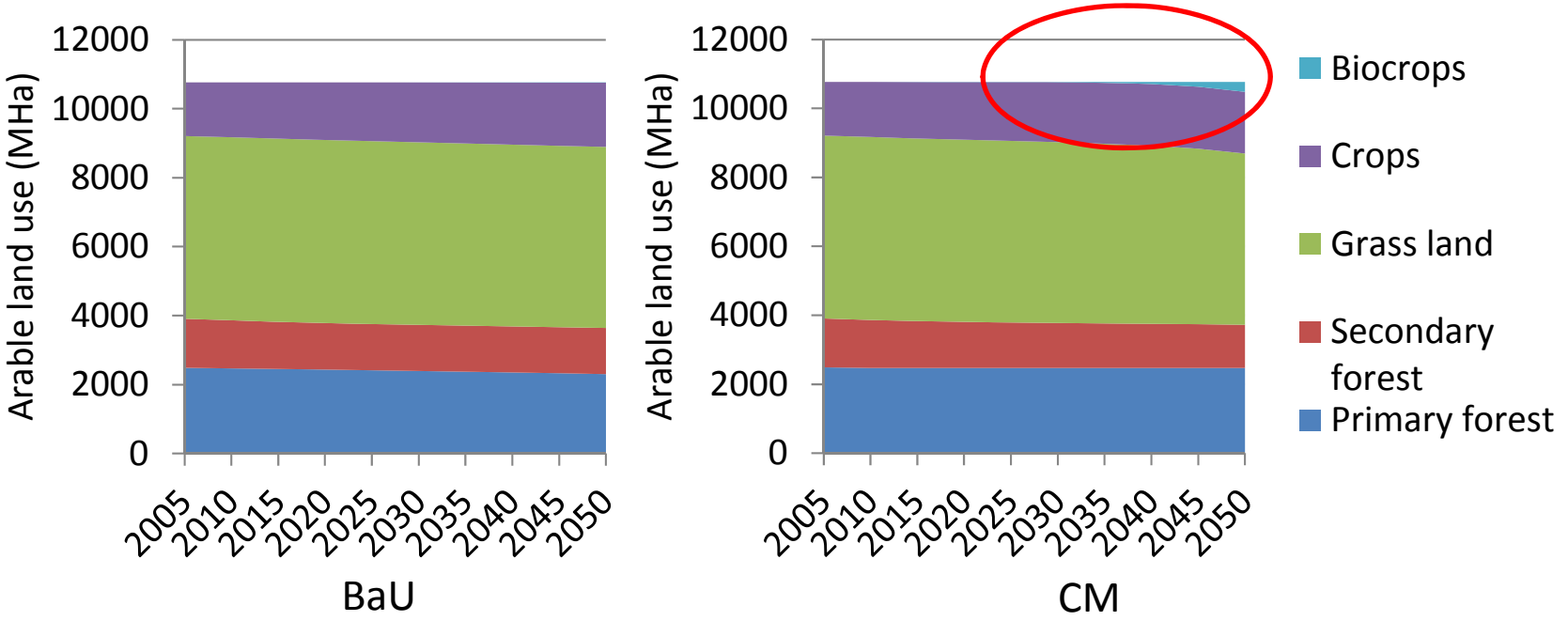
Key results – Land use



- Global view has not so drastic change
- Bioenergy crop is appeared in CM.

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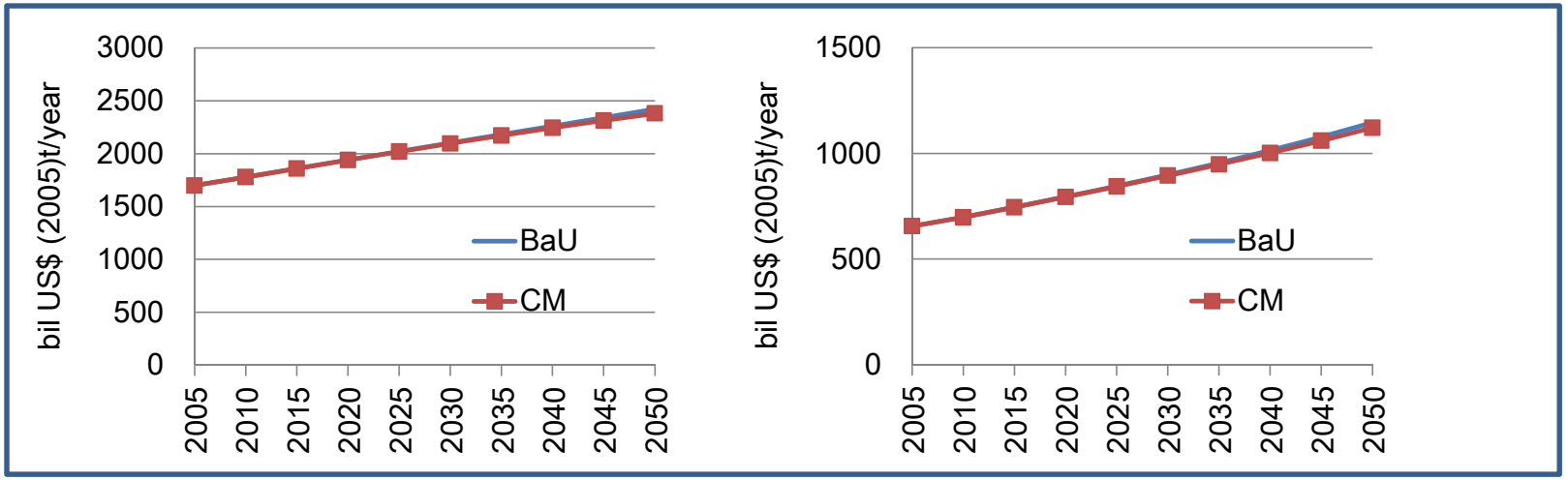
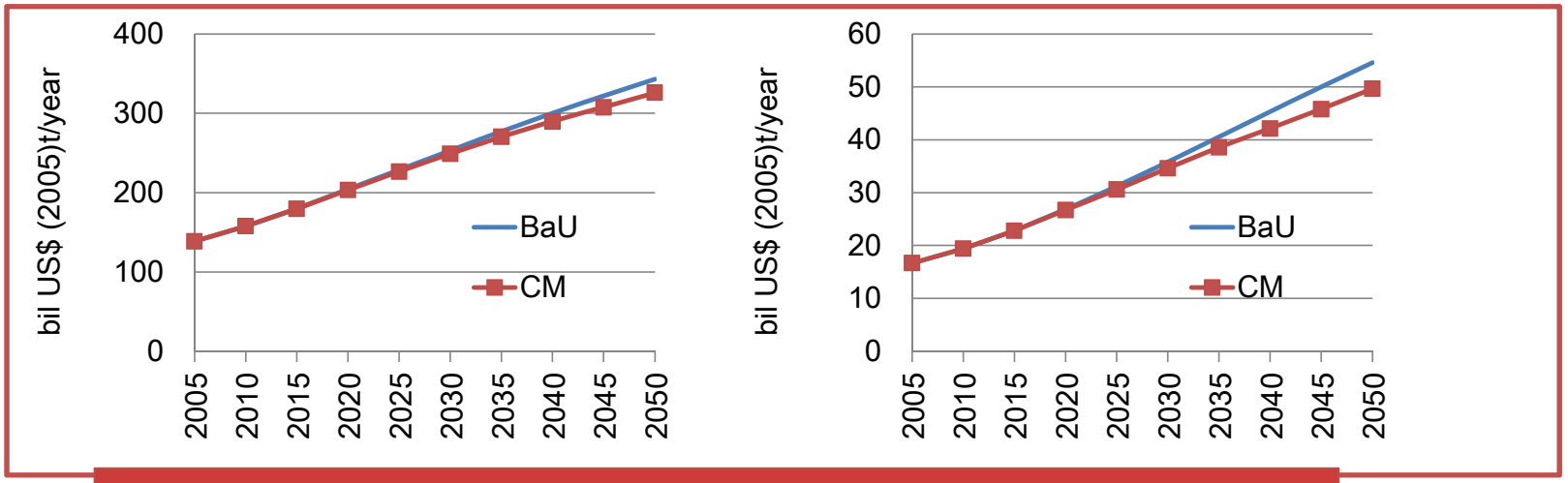
Key results – agricultural production

World total



Crop production | Livestock production

India



Regional responses are different!!

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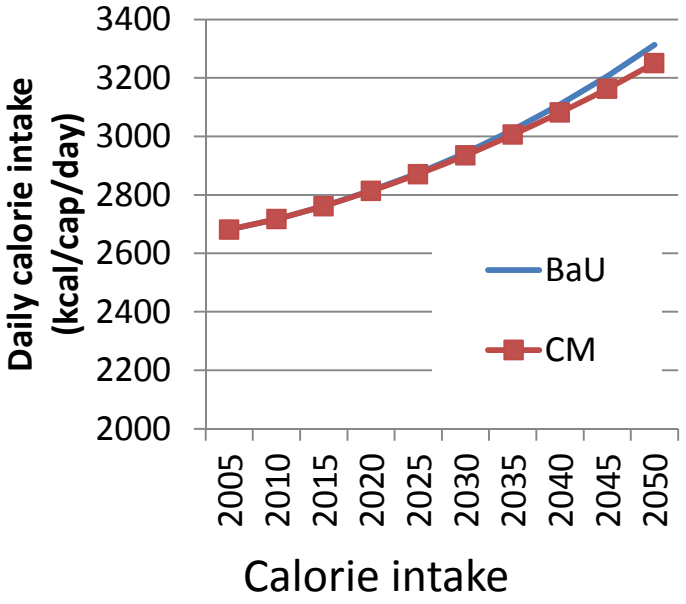
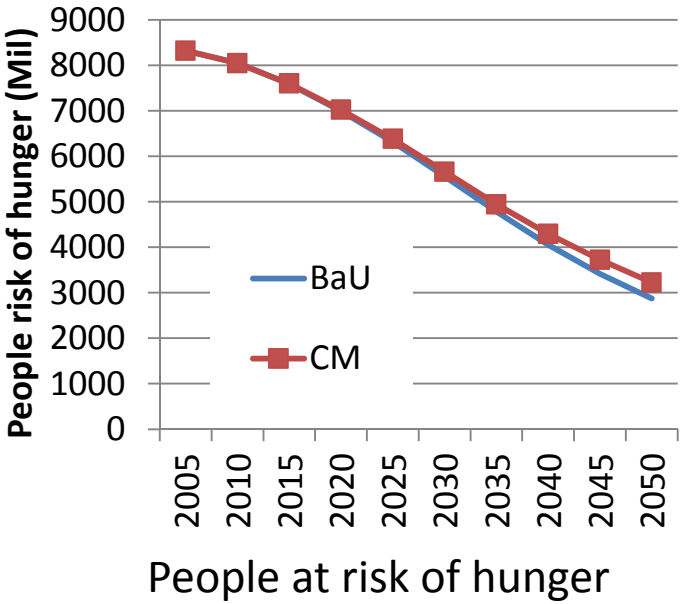
Key results – food demand



Calorie intake



People at risk of hunger

- Calorie intake has steady increase
- Mitigation scenario has negative impact
- Risk of hunger is same.

Land use competition

GDP loss associated with climate mitigation

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Summary

- Land use and agriculture modeling in CGE
  - Previous modeling issues are raised
- How to overcome
  - Agriculture disaggregation, Production and demand side change and Land use treatment
  - Data preparation
- Scenario analysis
  - Land and biomass is properly treated.
  - Some new things are coming up with this improvement.

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Future direction

- The global and national mitigation study application
  - SSPs quantification (New IPCC scenarios)
  - National study application (collaborating with KU)
- A key tool to integrate climate change mitigation, impact and adaptation analysis.
  - Preliminary trials will be shown in the Impact session.

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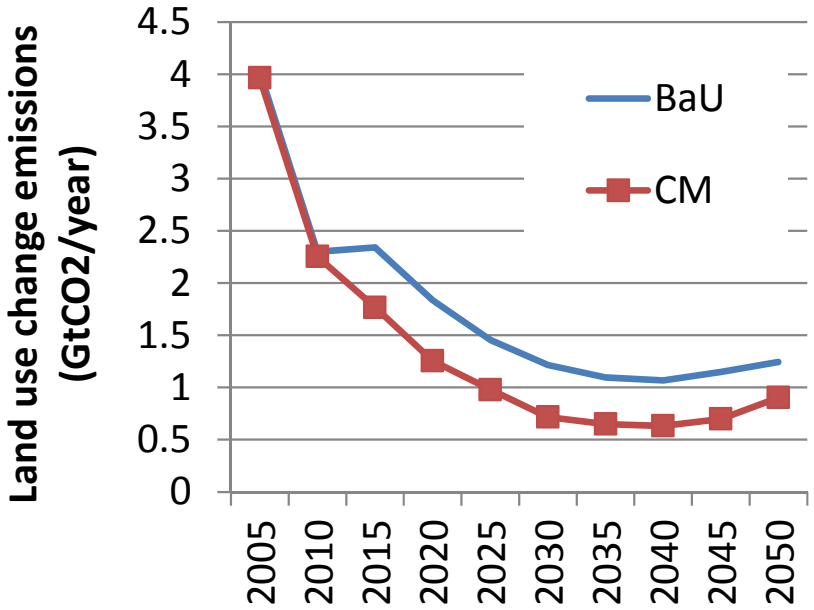
Key results – Land use change emissions



- Carbon tax in on the carbon stock.
- The carbon price prevents forestry even though bioenergy crop is required.

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