GHG Emissions and Mitigation Potentials in Agriculture

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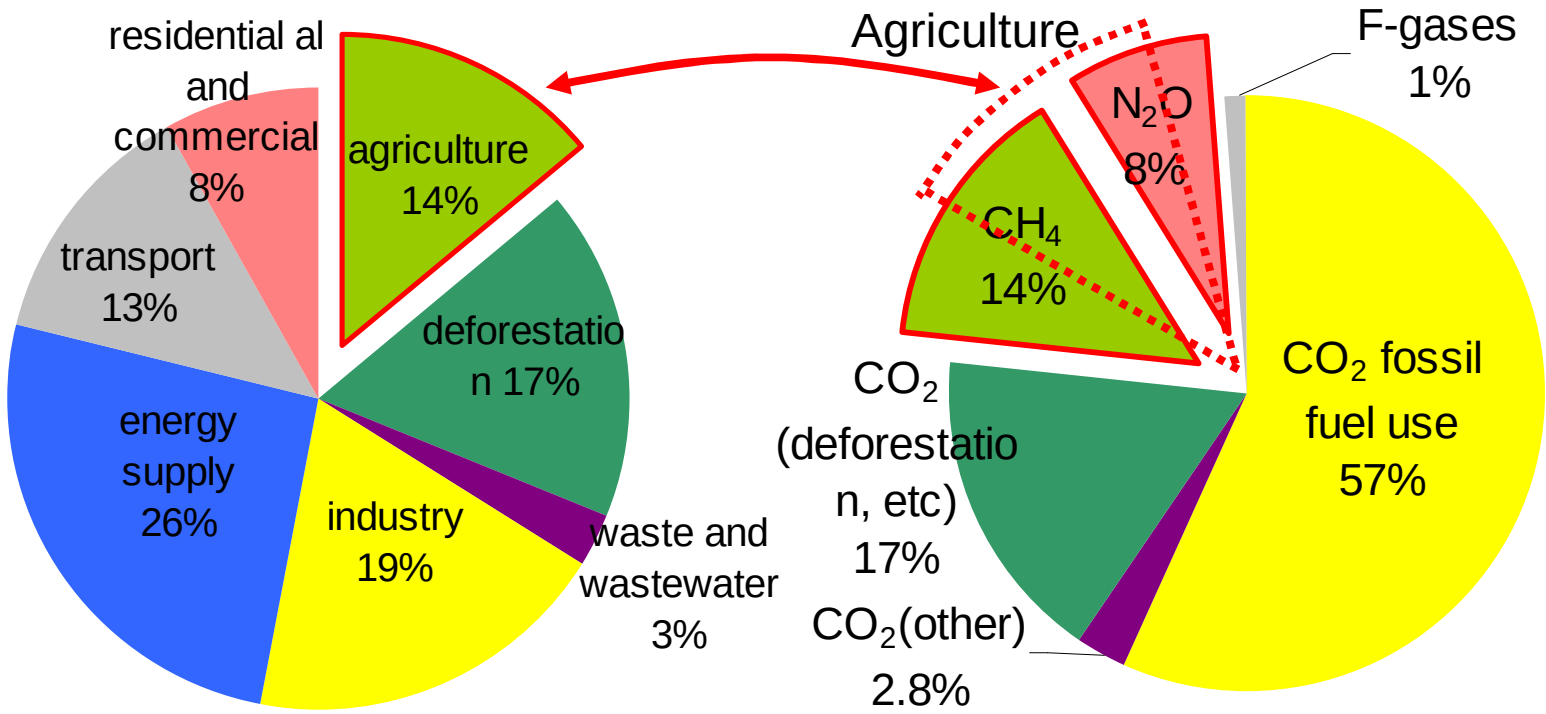
Contribution Ratio to Global Warming

- Agriculture accounts for ...
  - 14% of total GHG emission.
  - 50% of total CH_4 emission and 60% of N_2O emission in 2005 (IPCC, 2007).



contribution ratio by Sector

contribution ratio by Gas

h3

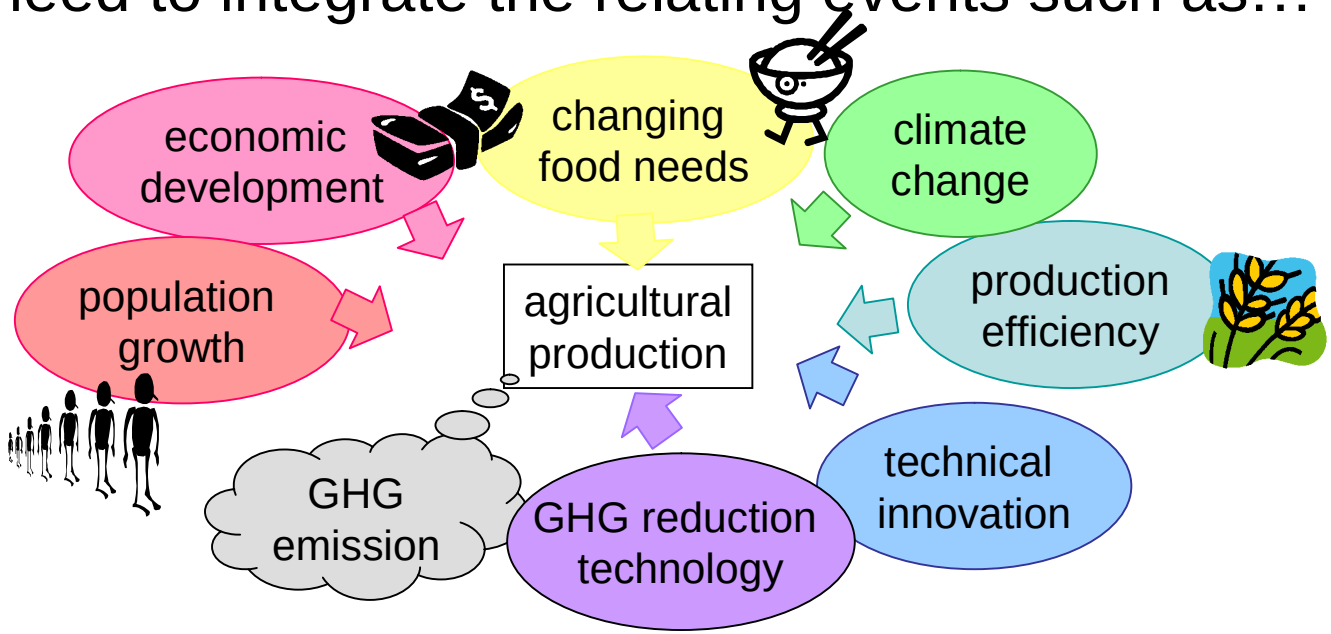
単位を，MtCO2eqに！

長谷川　知子, 2008/01/27

Objectives

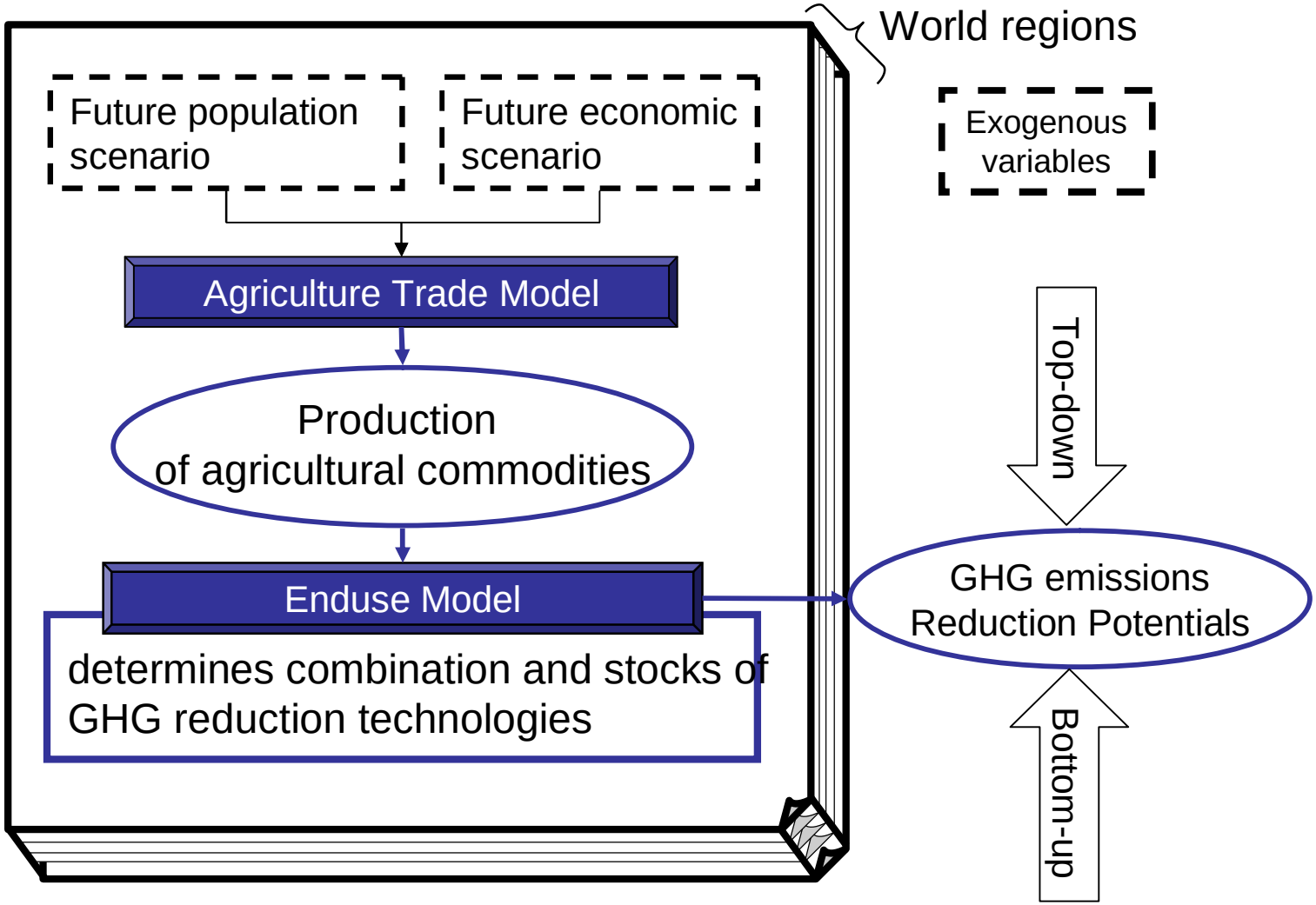
(1) To estimate and evaluate global GHG emissions and reduction potentials in Agriculture
(2) To specify effective technologies, regions and emission sources with high reduction potentials

To evaluate GHG emissions and reduction potentials, we need to integrate the relating events such as…



Methodology

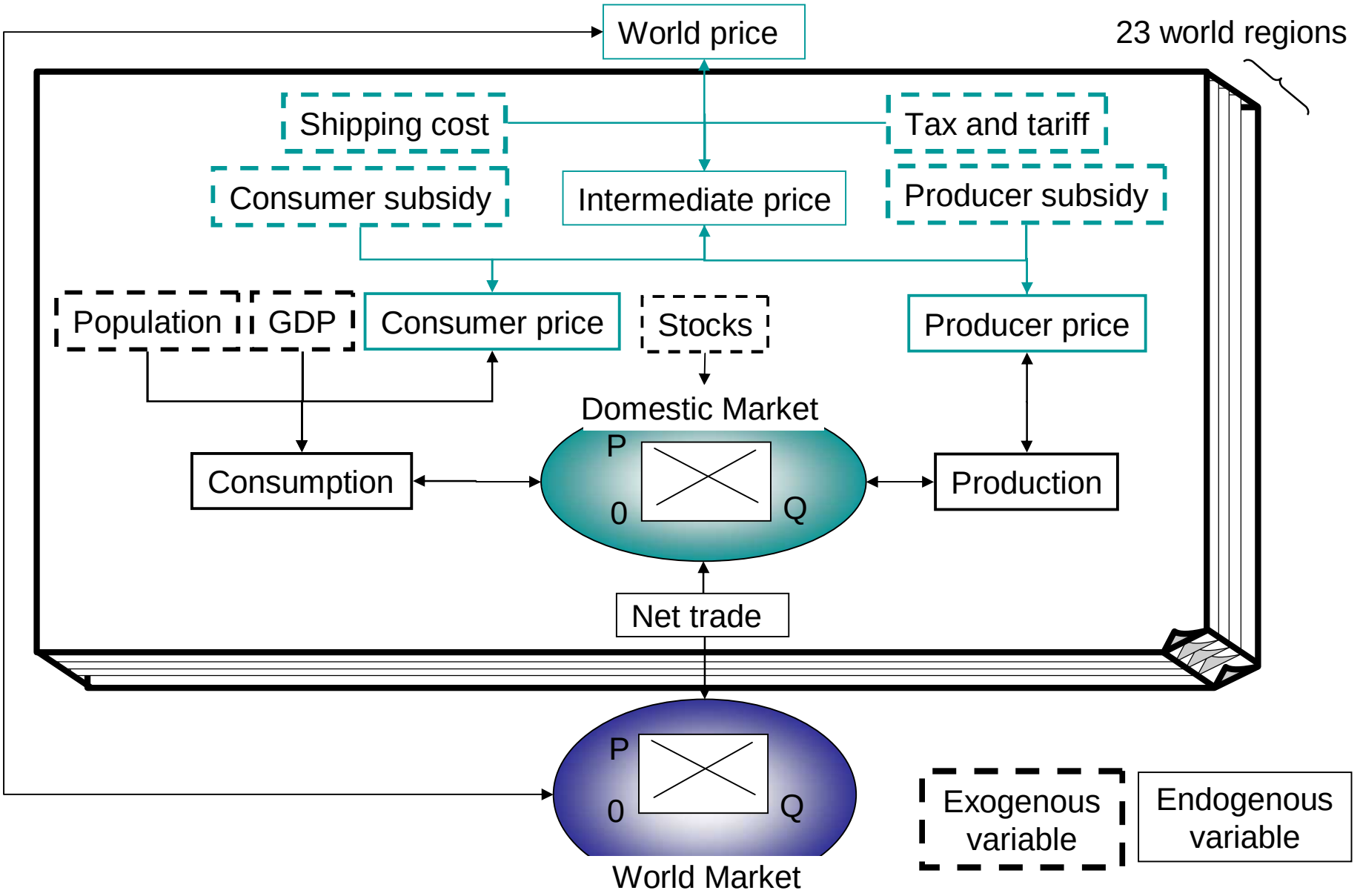
- Model is used for estimation.



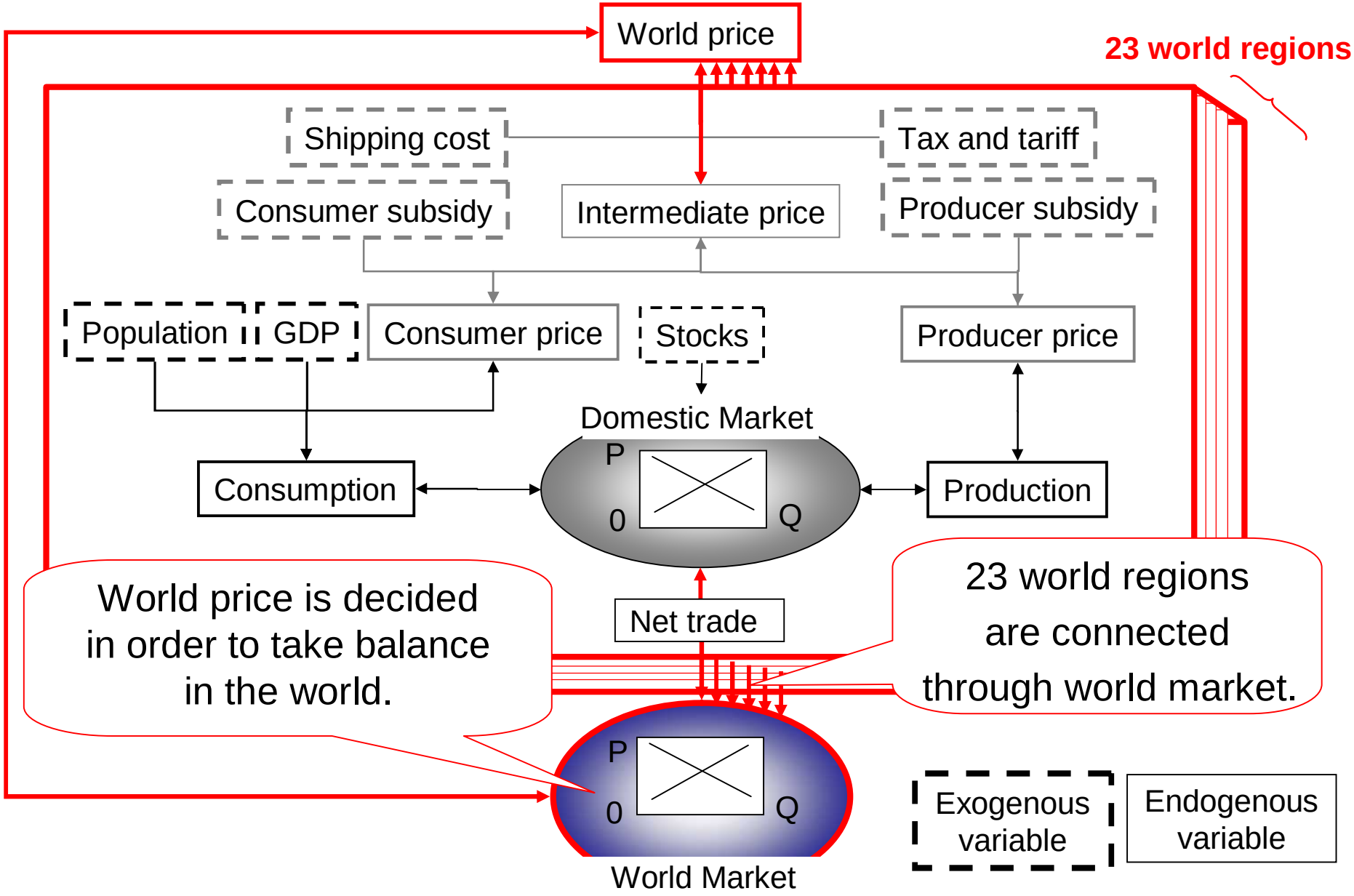
Agricultural Trade Model (ATM)

- Structure: Partial equilibrium model
  1200 functions and equations
- Input: Population and GDP
- Output: Production of agricultural commodities
- Calibration term: 1971 - 2003
- Estimation term: 2004 - 2030
- Region: 23 world regions

Structure


World price
23 world regions
Shipping cost
Tax and tariff
Consumer subsidy
Intermediate price
Producer subsidy
Population
GDP
Consumer price
Stocks
Producer price
Domestic Market
P
0
Q
Consumption
Production
Net trade
P
0
Q
World Market
Exogenous variable
Endogenous variable

Structure


World price
23 world regions
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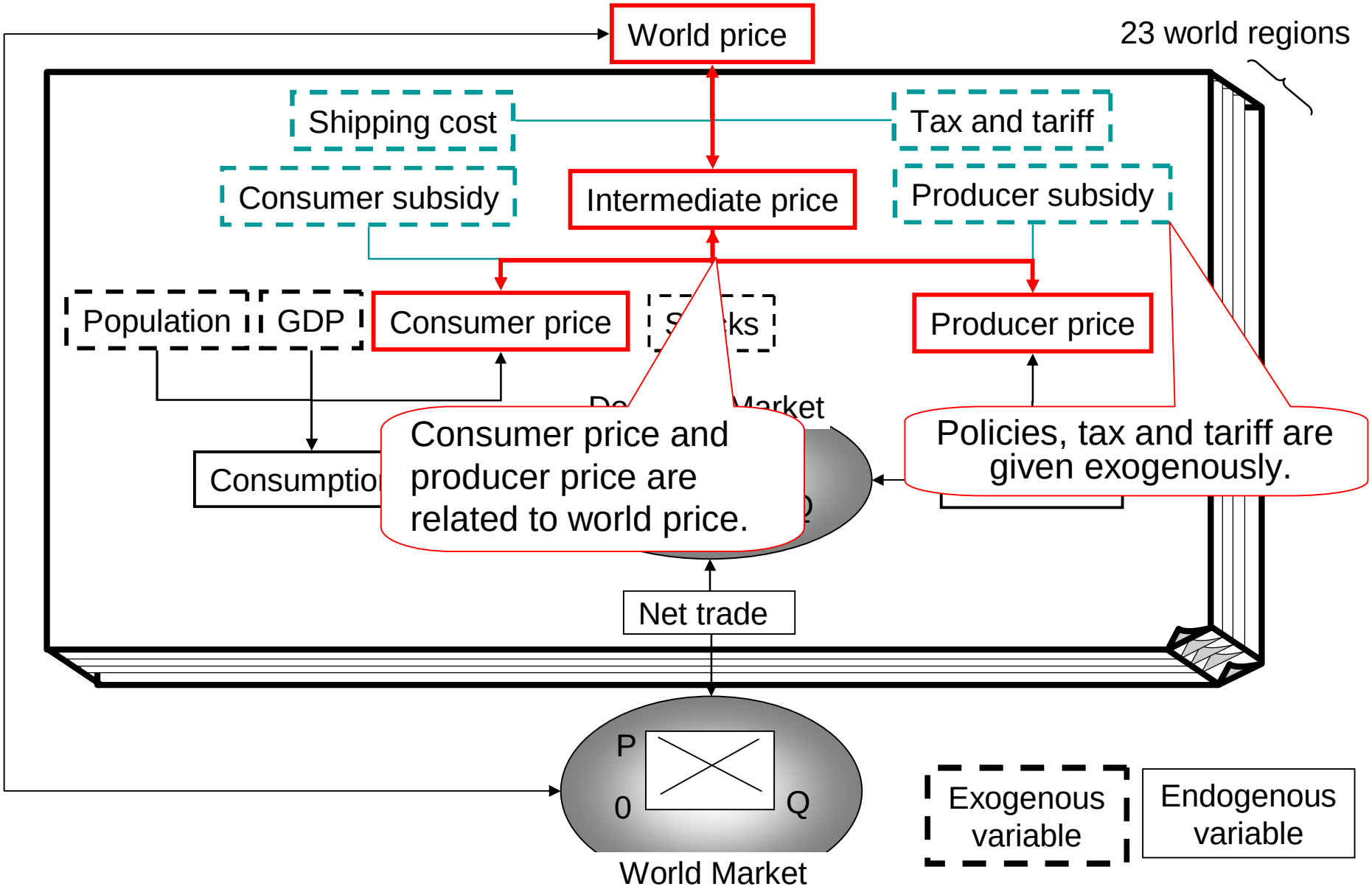
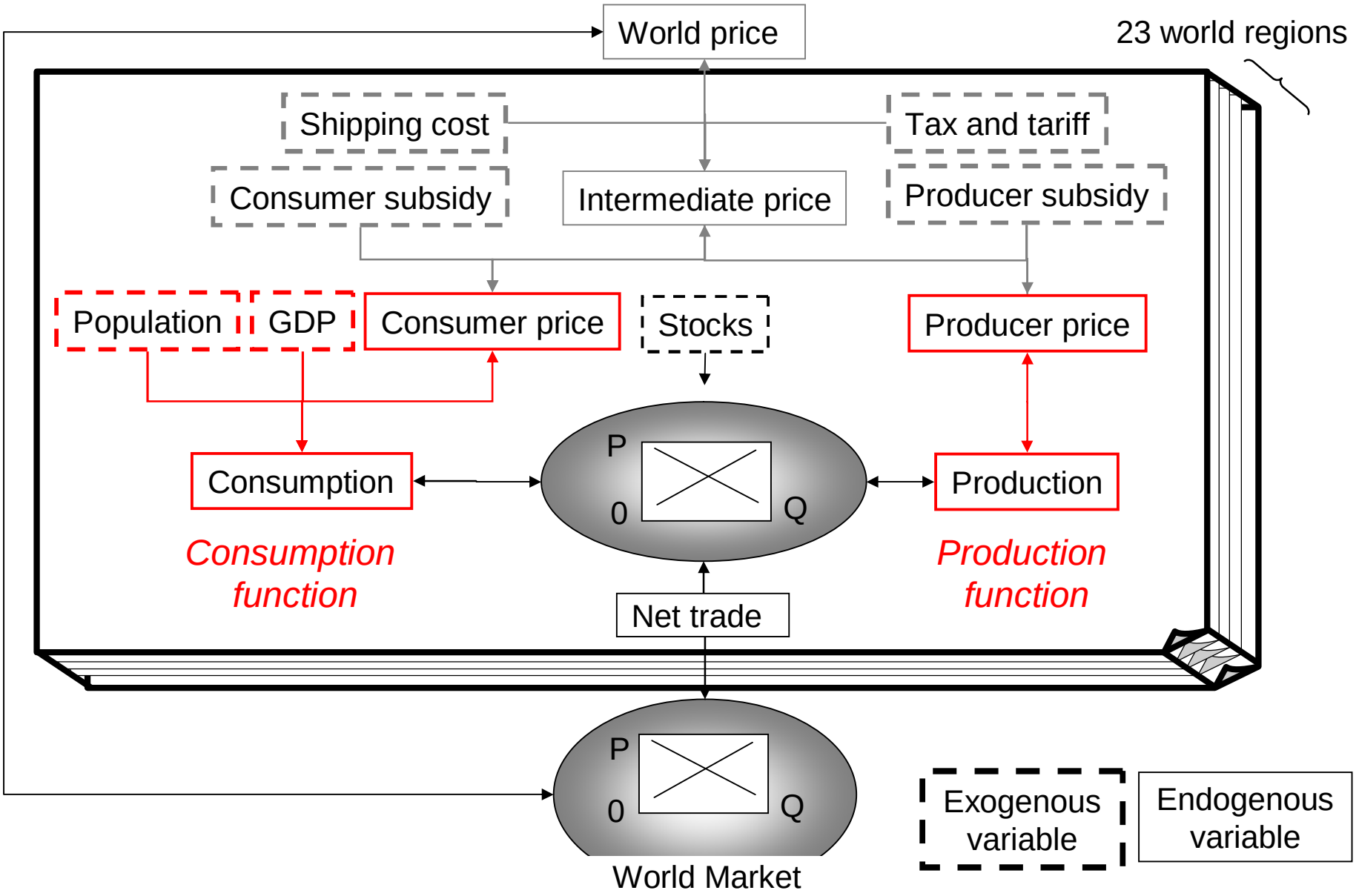
Consumer subsidy
Intermediate price
Producer subsidy
Population
GDP
Consumer price
Stocks
Producer price
Domestic Market
P
0
Q
Consumption
Production
Net trade
World price is decided in order to take balance in the world.
23 world regions are connected through world market.
P
0
Q
World Market
Exogenous variable
Endogenous variable

Structure


World price
23 world regions
Shipping cost
Tax and tariff
Consumer subsidy
Intermediate price
Producer subsidy
Population
GDP
Consumer price
Producer price
Consumptio
Consumer price and producer price are related to world price.
Policies, tax and tariff are given exogenously.
Net trade
P
0
Q
World Market
Exogenous variable
Endogenous variable

Structure


World price
23 world regions
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Tax and tariff
Consumer subsidy
Intermediate price
Producer subsidy
Population
GDP
Consumer price
Stocks
Producer price
P
0
Q
Consumption
Production
Consumption function
Production function
Net trade
P
0
Q
World Market
Exogenous variable
Endogenous variable

Functions: Production and Consumption

- Production function

$$Production_{i,r,t} = f(Production_{i,r,t-1}, Producer\ Price_{j,r,t})$$

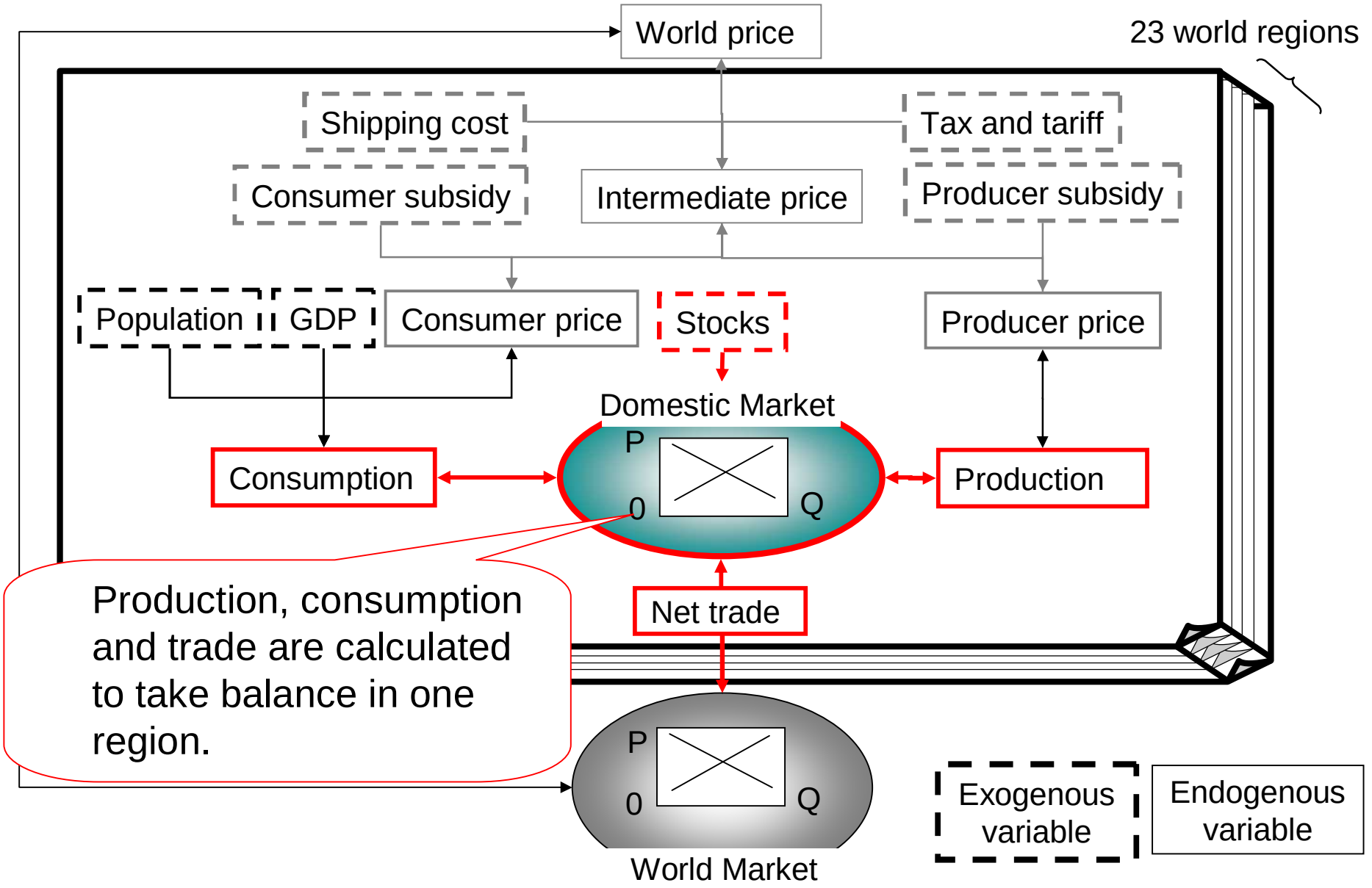
- Consumption (Con.) function

$$Food\ Con._{i,r,t} = f(Consumer\ price_{i,r,t}, \overline{GDPcap_{r,t}}, \overline{Population_{r,t}})$$

$$Feed\ Con._{i,r,t} = f(Consumer\ price_{i,r,t}, Livestock\ production_{i,r,t})$$

- Import and export are also decided by prices.

Structure


World price
23 world regions
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Tax and tariff
Consumer subsidy
Intermediate price
Producer subsidy
Population
GDP
Consumer price
Stocks
Producer price
Domestic Market
P
0
Q
Consumption
Production
Net trade
Production, consumption and trade are calculated to take balance in one region.
P
0
Q
World Market
Exogenous variable
Endogenous variable

Balance Equations

- Domestic balance equation

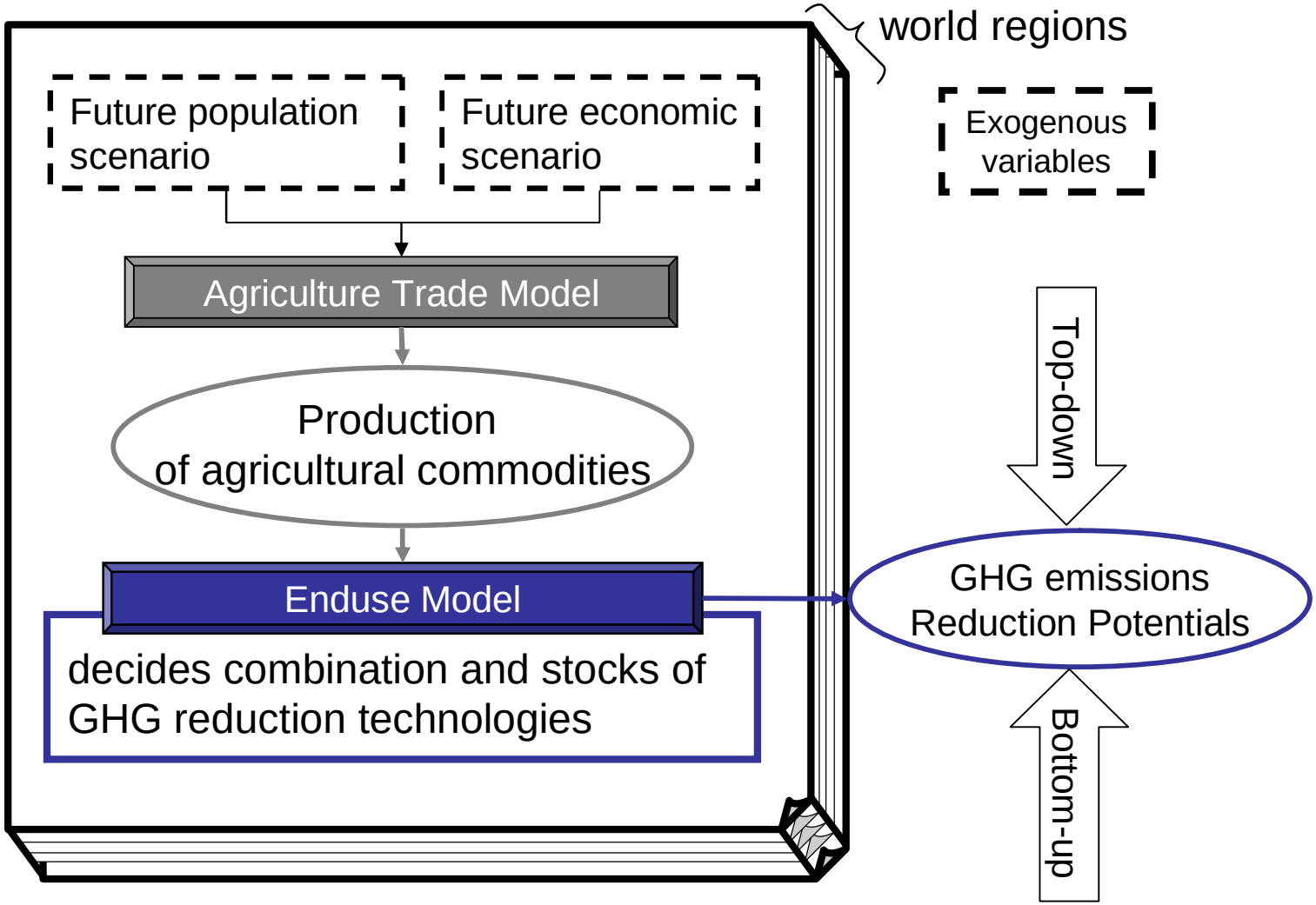
$$Production_{i,r,t} + Import_{i,r,t}$$
$$= Consumption_{i,r,t} + Export_{i,r,t} + Stock_{i,r,t}$$

- World balance equation

$$\sum_{r} Export_{i,r,t} = \sum_{r} Import_{i,r,t}$$

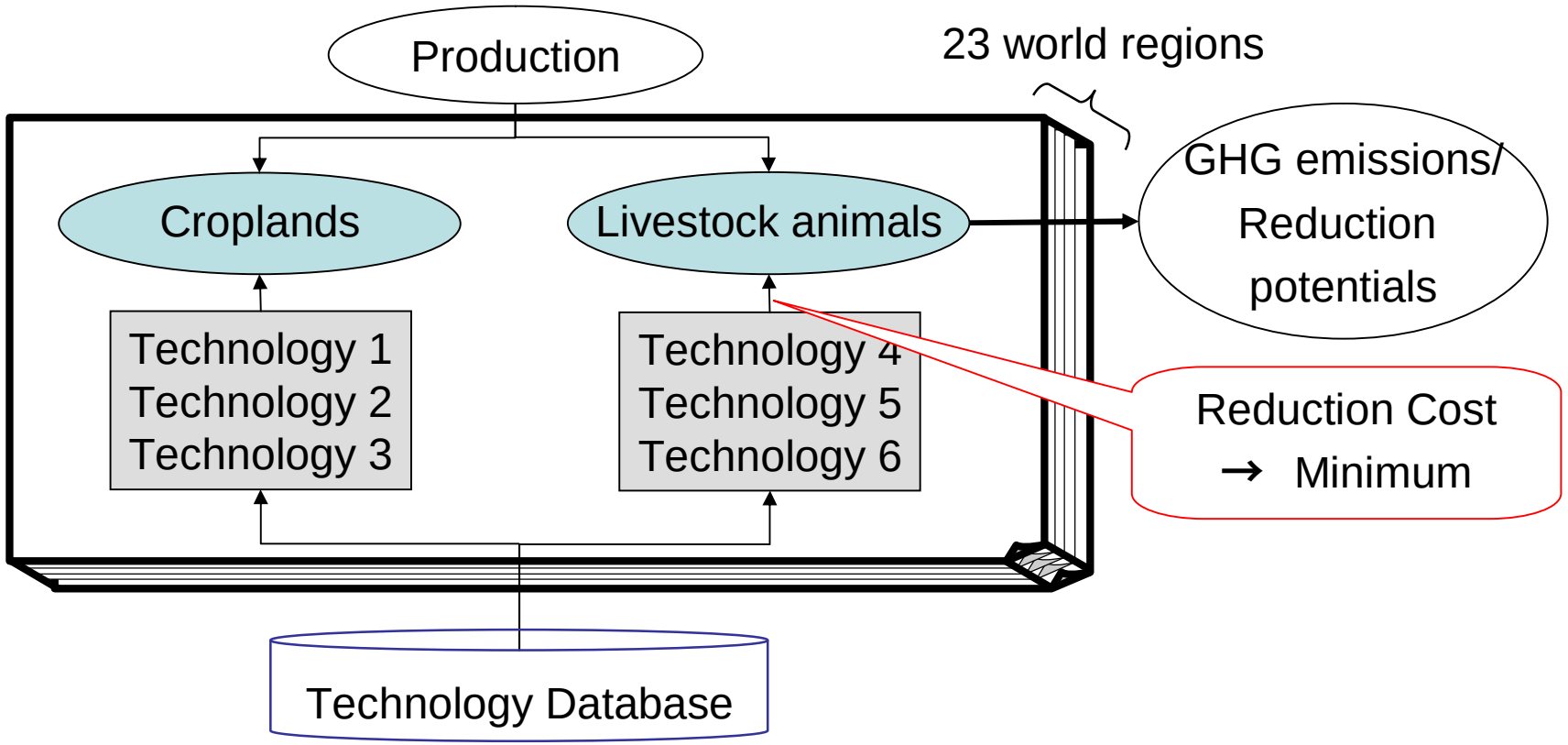
Methodology

- Model is used for estimation.



Enduse Model

- Structure: Dynamic model
- Input: Agricultural production
- Outputs: GHG emissions and Reduction potentials
- Calculates combination and stocks of GHG reduction technologies in order to minimize total reduction cost.

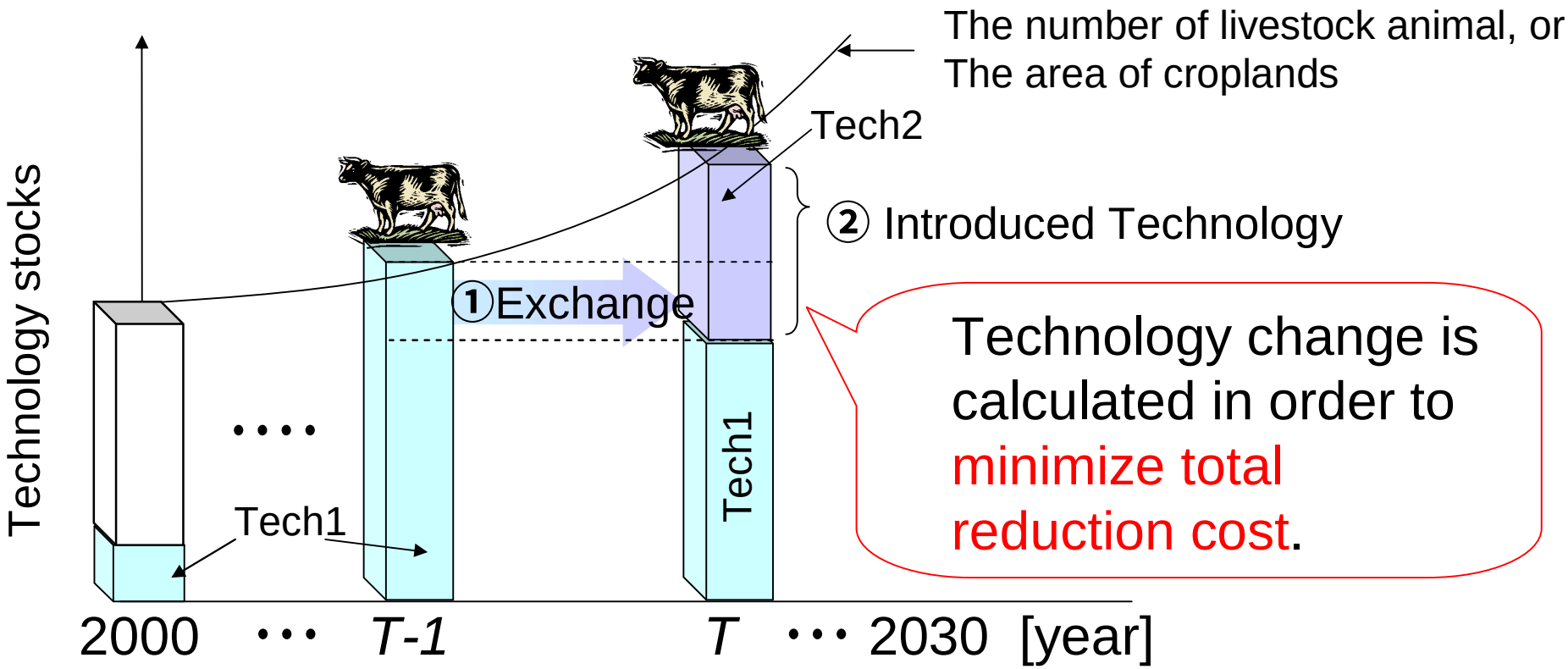


Technology Stock Change

A number of technology (tech.) is changed by 1) exchange and 2) introduction.

Stock (*T*)=

Stock(*T-1*) – ①exchanged tech.(*T*) + ②Introduced tech.(*T*)



Technology change is calculated in order to minimize total reduction cost.

Application

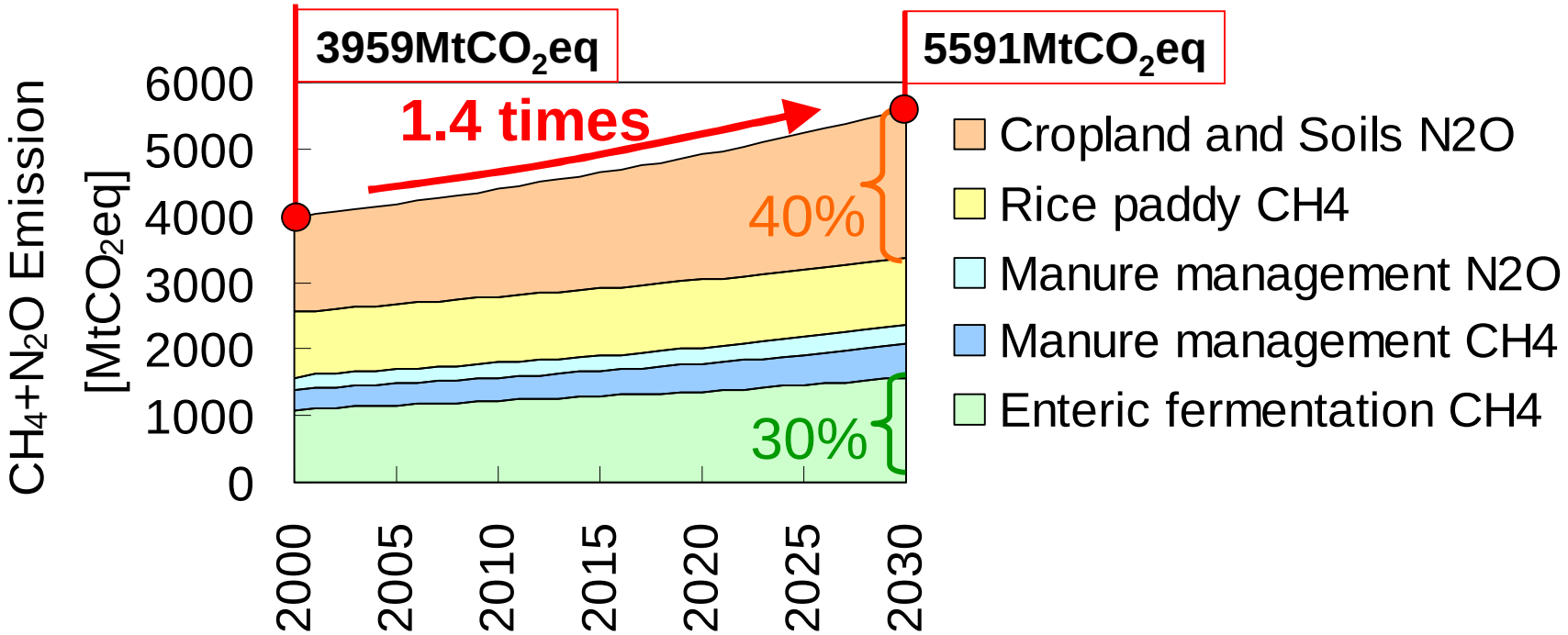
Objective

- 23 world regions
- 2000-2030
- Population: medium estimates of UN(2006)
- GDP: Akashi (2009)

Emission Sources	Gases
Enteric fermentation	CH_4
Manure management	CH_4, N_2O
Cropland and Soils	N_2O
Rice paddy	CH_4, N_2O

Baseline Emission in 2000-2030

- World GHG emission will increase by 1.4 times by 2030.
- In 2030,emissions from croplands and livestock enteric fermentation account for 40% and 30% of it respectively.
- Emission from livestocks will increase at high growth rate.h2
- Emission from rice paddy will decrease.



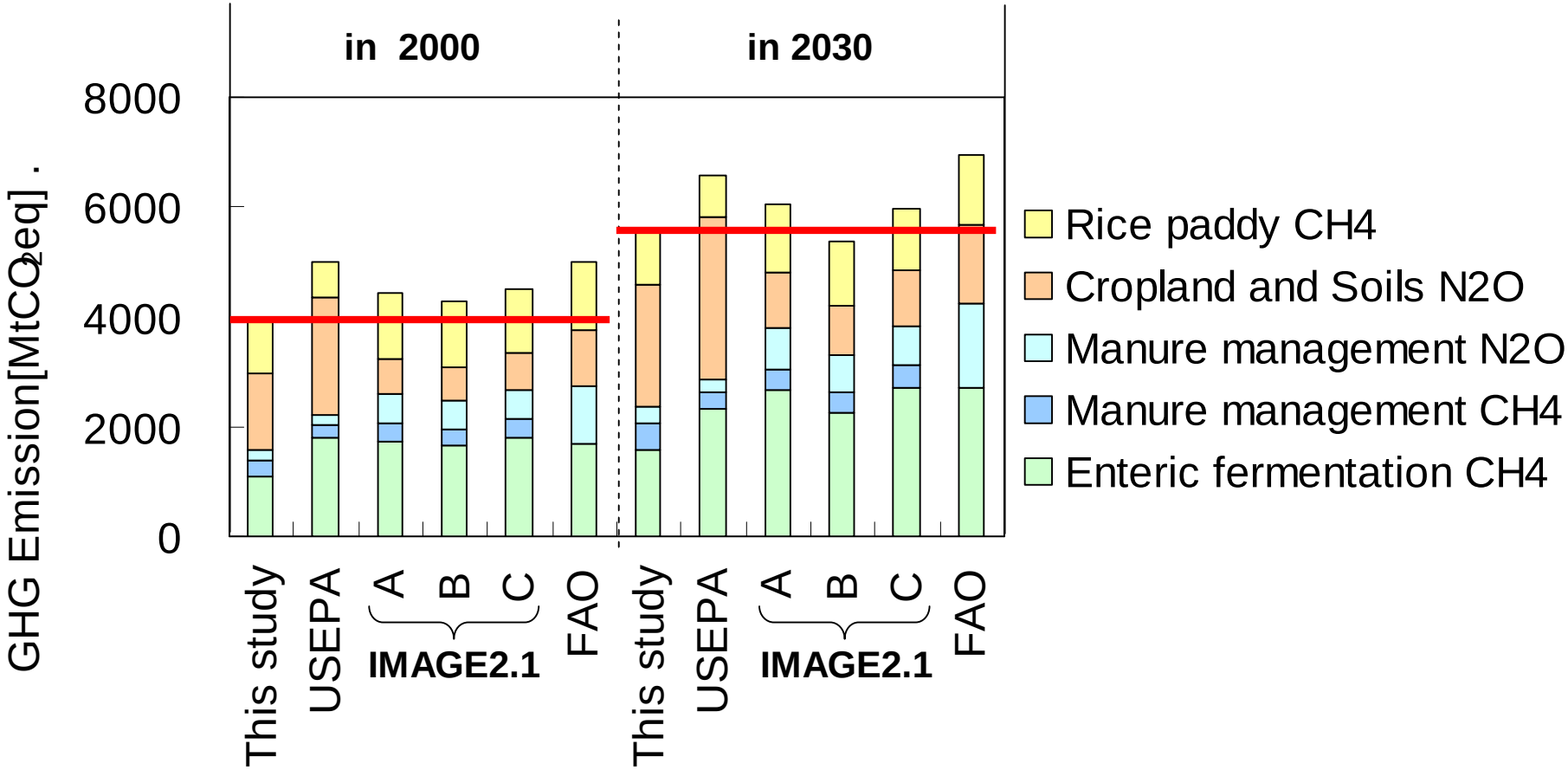
h2

C:\GAMS\Emission Model vol2\output\ReducionPotential

長谷川 知子, 2008/08/14

GHG Emission in 2000, 2030

- GHG Emission of this study is middle of other estimates.
- Cropland and Soils and Enteric Fermentations occupy high contribution ratio.



Which is Effective Source?

In 2030 Reduction Potential by Source

- In 2030, total max. reduction potential is 1403 Mt CO_2eq.
- Technologies for rice paddy is good.
- Technologies for enteric fermentation is not good.

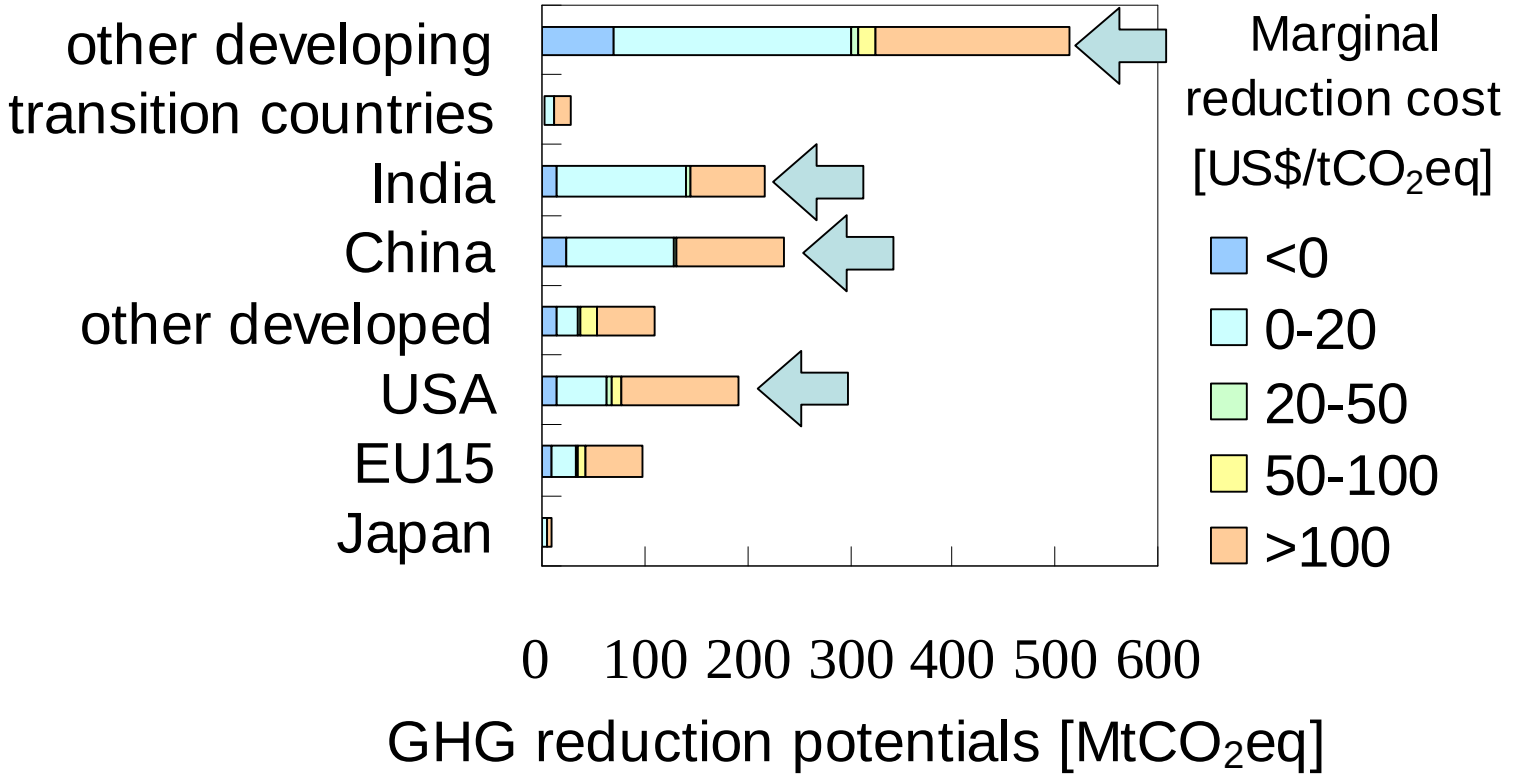
Reduction Potentials [MtCO_2eq]	Marginal Abatement Cost [US$/t$CO_2$eq]				
Emission sources	<0	<20	<50	<100	>100
Enteric fermentation CH_4	0	0	3	41	255
Manure management CH_4	0	95	98	110	345
Manure management N_2O	0	56	57	62	205
Rice paddy CH_4	0	367	381	381	381
Cropland and Soils N_2O	148	198	198	198	217
Total	148	716	737	793	1403

35% of total GHG emission from agriculture in 2000.

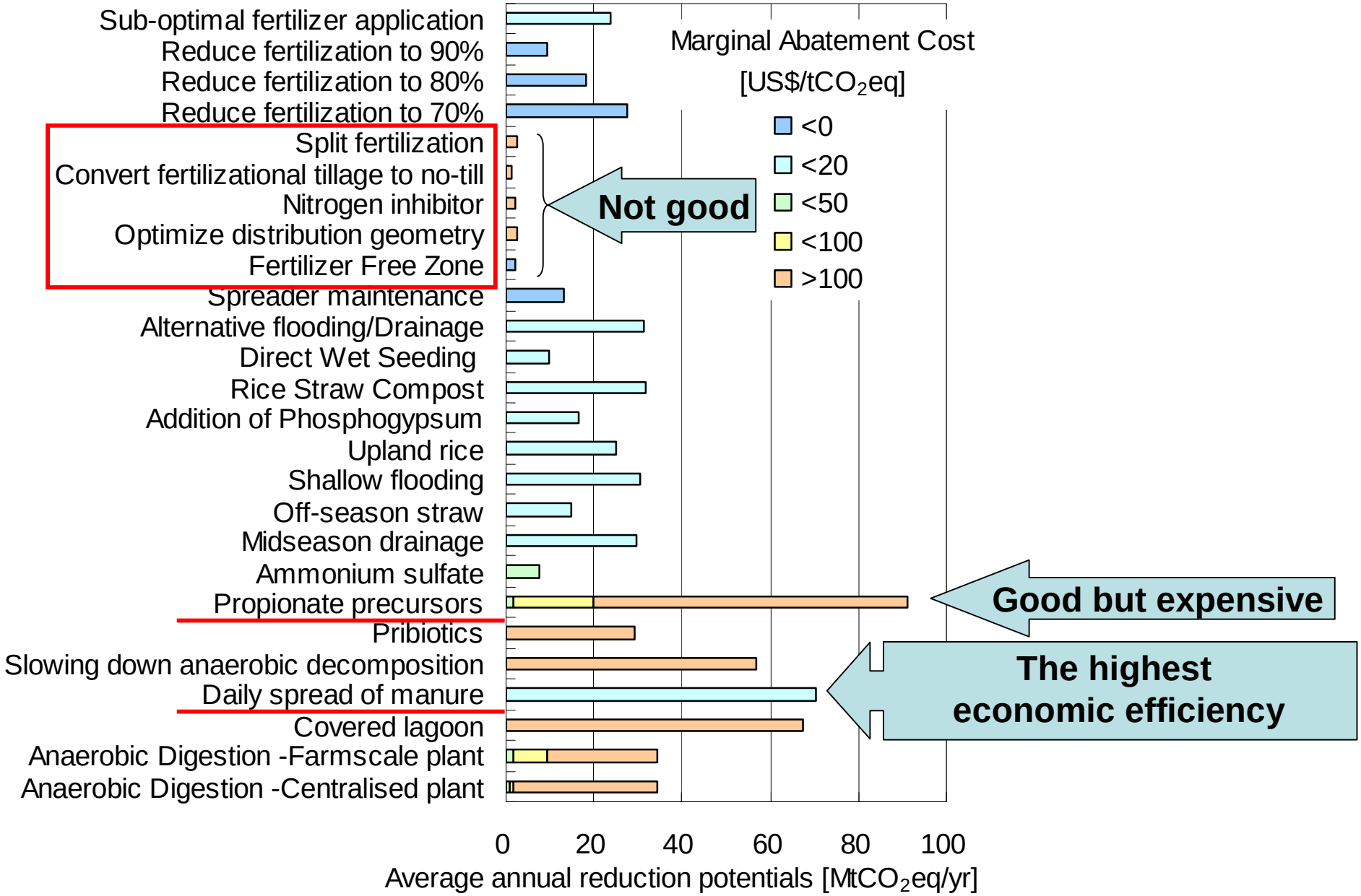
Where is Effective Region?

In 2030 Reduction Potential by region

- Reduction Potential in China, India and USA is large.
- Measurements in there regions take comparative low costs.



What is Effective Technology ?



Conclusion

We introduced a model to estimate GHG emissions and reduction potentials in agriculture. We showed you an application to estimate and specify effective technologies, high reduction potential regions and emission sources.

- Total non-CO_2 emission from agriculture is about 3959 $MtCO_2eq$ in 2000.
- Major emission source is Cropland and Soils.
- In 2030, the maximum global reduction potential is expected to be 1403 $MtCO_2eq$(35% of emission in 2000).
- China and India have major reduction potentials.
- The reduction technology with most economically efficient is expected to be "daily spread of manure ".

Thank you for your attention