

Analysis of Biofuel and its Impacts: GTAP-CHINAGRO and GTAP- CAPSiM

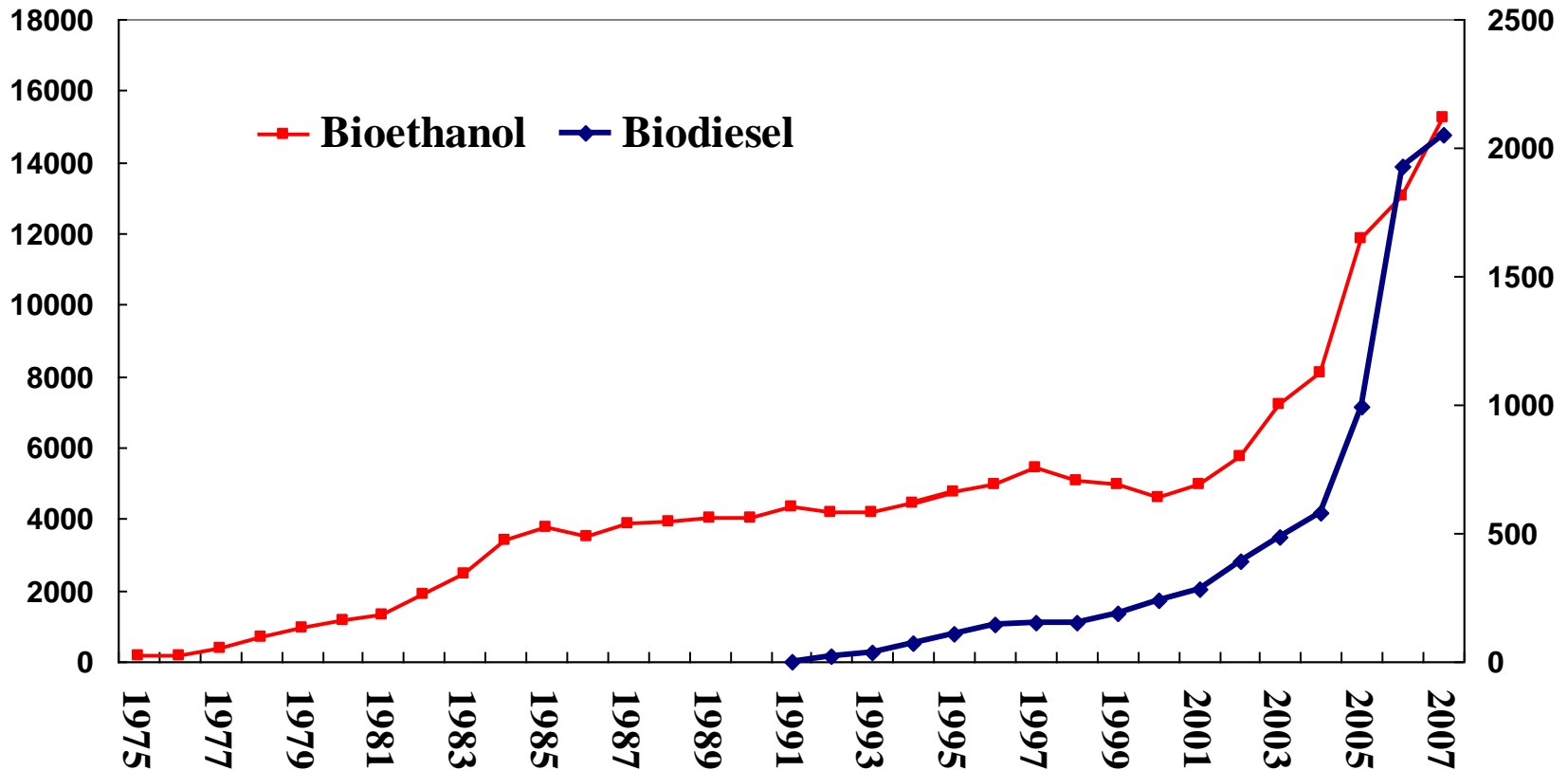
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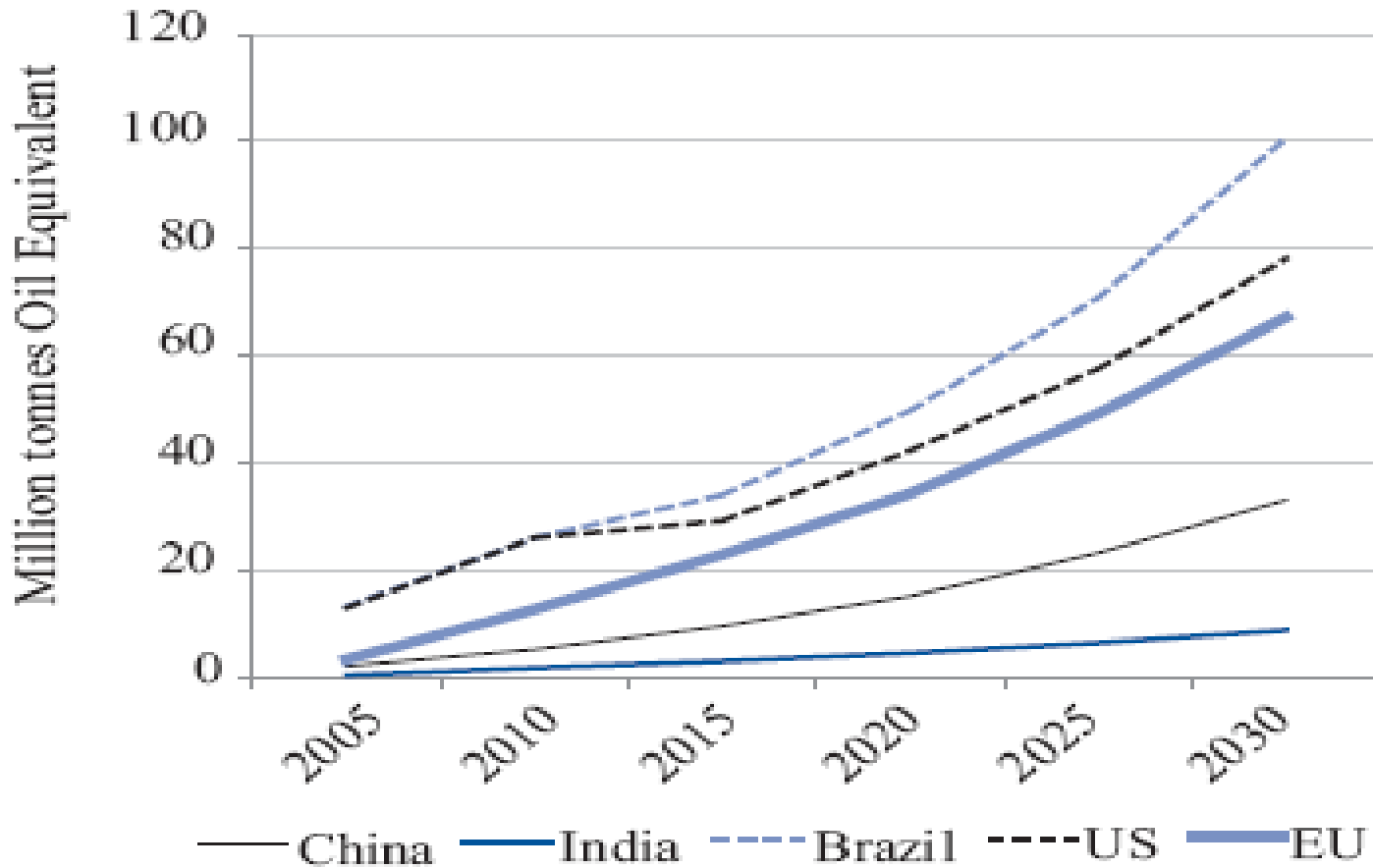
Stanford University

The development global biofuel production from 1975-2007 (million gallons)



Data source : F.O. Licht (2008)

And, future biofuel expansion is expected to grow even faster



Source: Msangi, et al., 2007

However, there are many concerns about the effects of Crop-Based Biofuels

- Food supply is being diverted to feed hungry cars...**
- The poor farmers could be hurt by high food prices..**
- Soaring food prices could lead to riots in scores of lower-income countries that rely on grain imports...**

The China government also very concerns about the impacts of biofuel development and its own biofuel development on its food prices and food security.

Due to those concerns, in 2007, Chinese government requires that its future biofuel development should be non-cereal based, and the feedstock should be produced on marginal lands

Purpose of this study

- **Understanding the pathway of biofuel impacts from international market → country level → regional → household level**
- **Using China as an example to show what will be the impacts of biofuel expansion on:**
 - **China's national and regional agriculture?**
 - **Farmers in different regions?**
 - **The poor in different regions?**
- **What are the policy implications?**

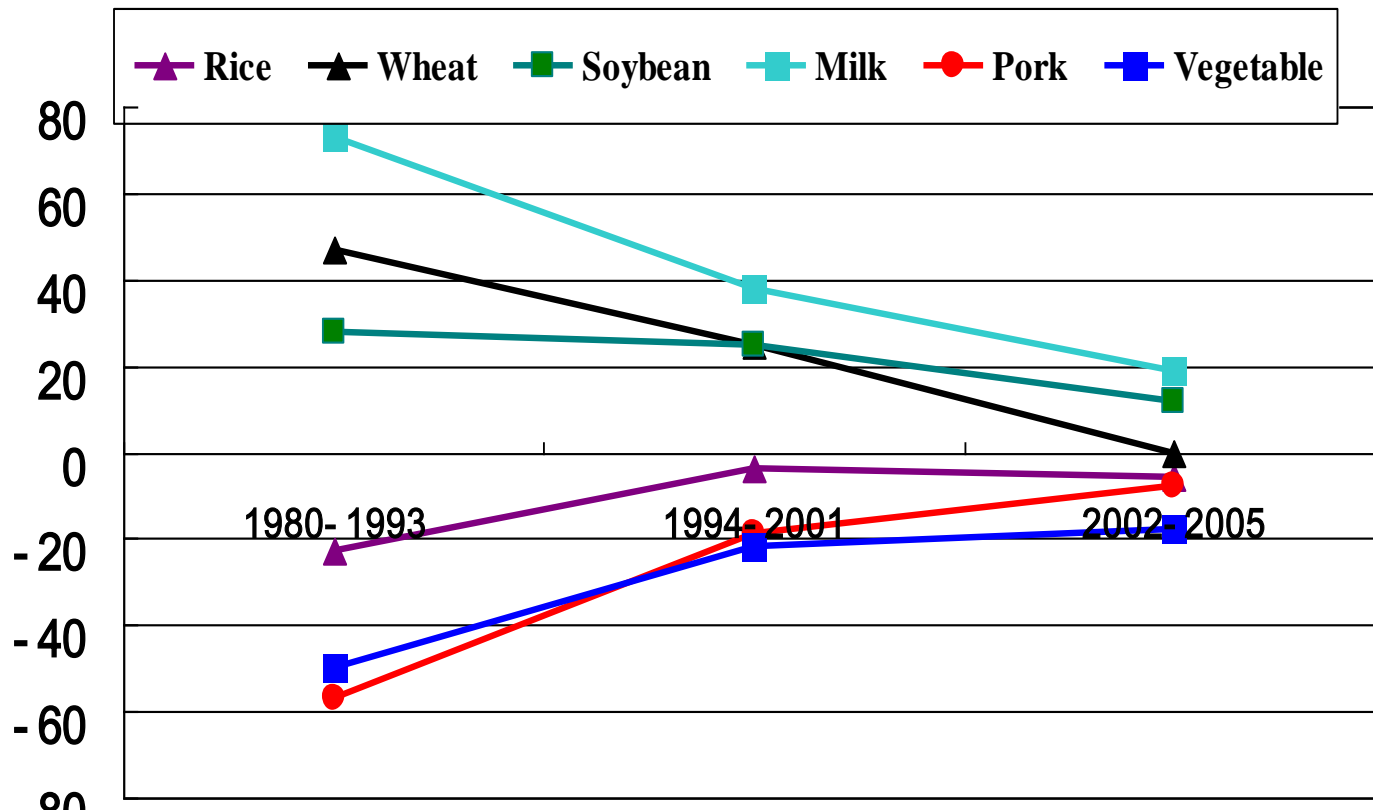
The rest of presentation

- **Background of China's agriculture**
- **Biofuel development in China**
- **Analytical framework and scenarios (baseline and biofuel scenarios)**
- **The likely impacts of biofuel development on China's agriculture, regional agricultural production and rural poverty**
- **Concluding remarks and discussions**

Background of China's agricultural Economy

1. China is one of the most open country in agricultural economy

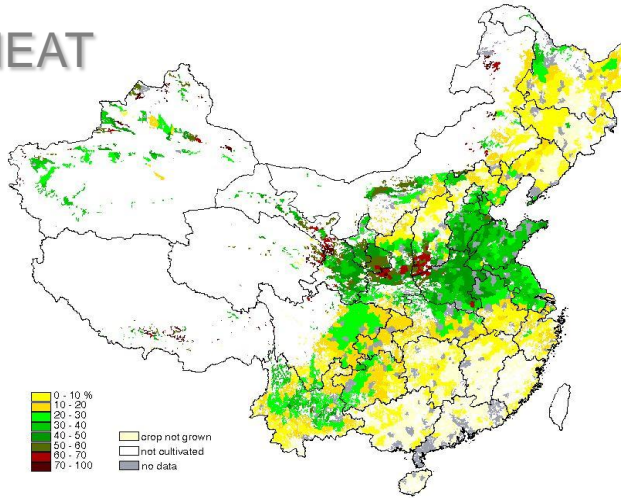
Nominal protection rates (%) in China, 1980-2005



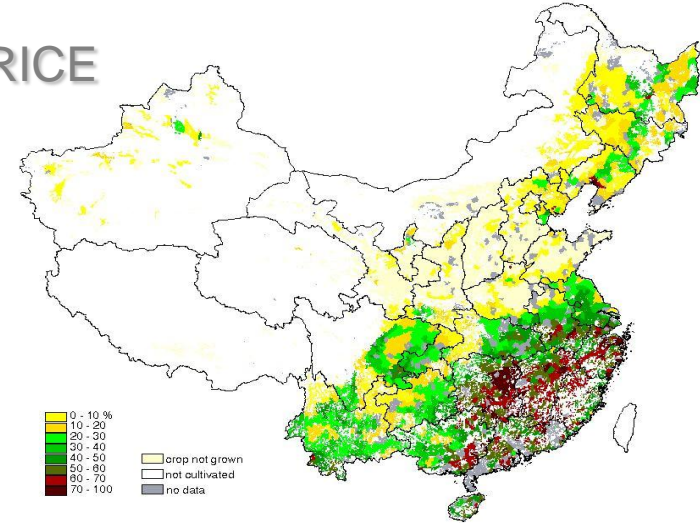
Source: Huang et. al., 2007

2. China's Regional Agricultural Production Patterns are very different

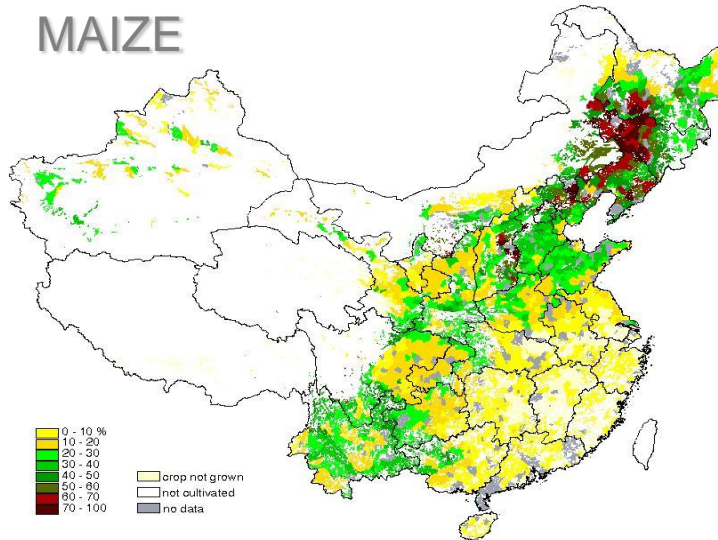
WHEAT



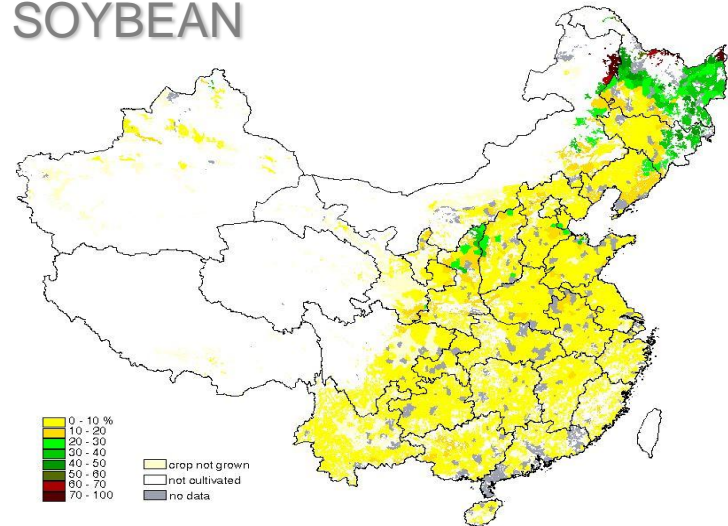
RICE



MAIZE

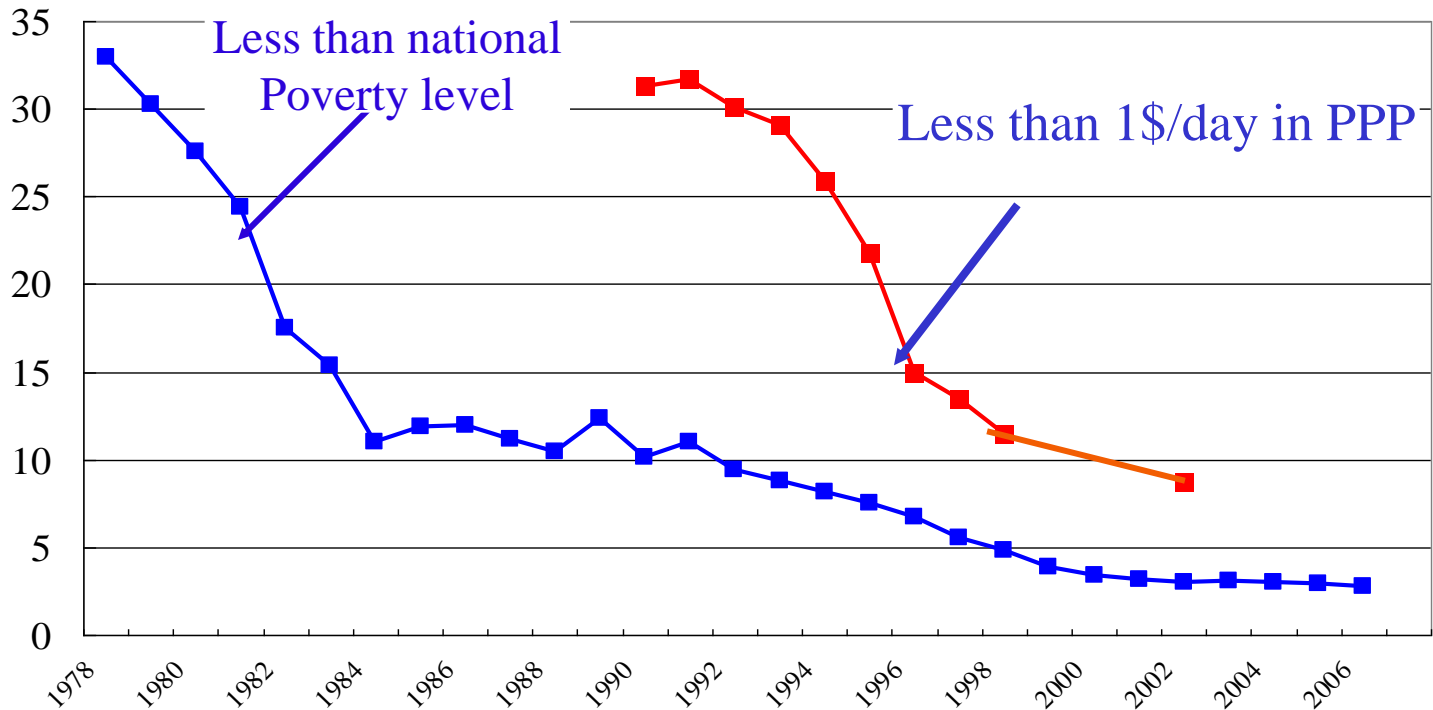


SOYBEAN



3. There are still a large number of poor people under poverty line, although it has been declining quickly

The poverty incidence (%) in China's rural area (1978-2006)

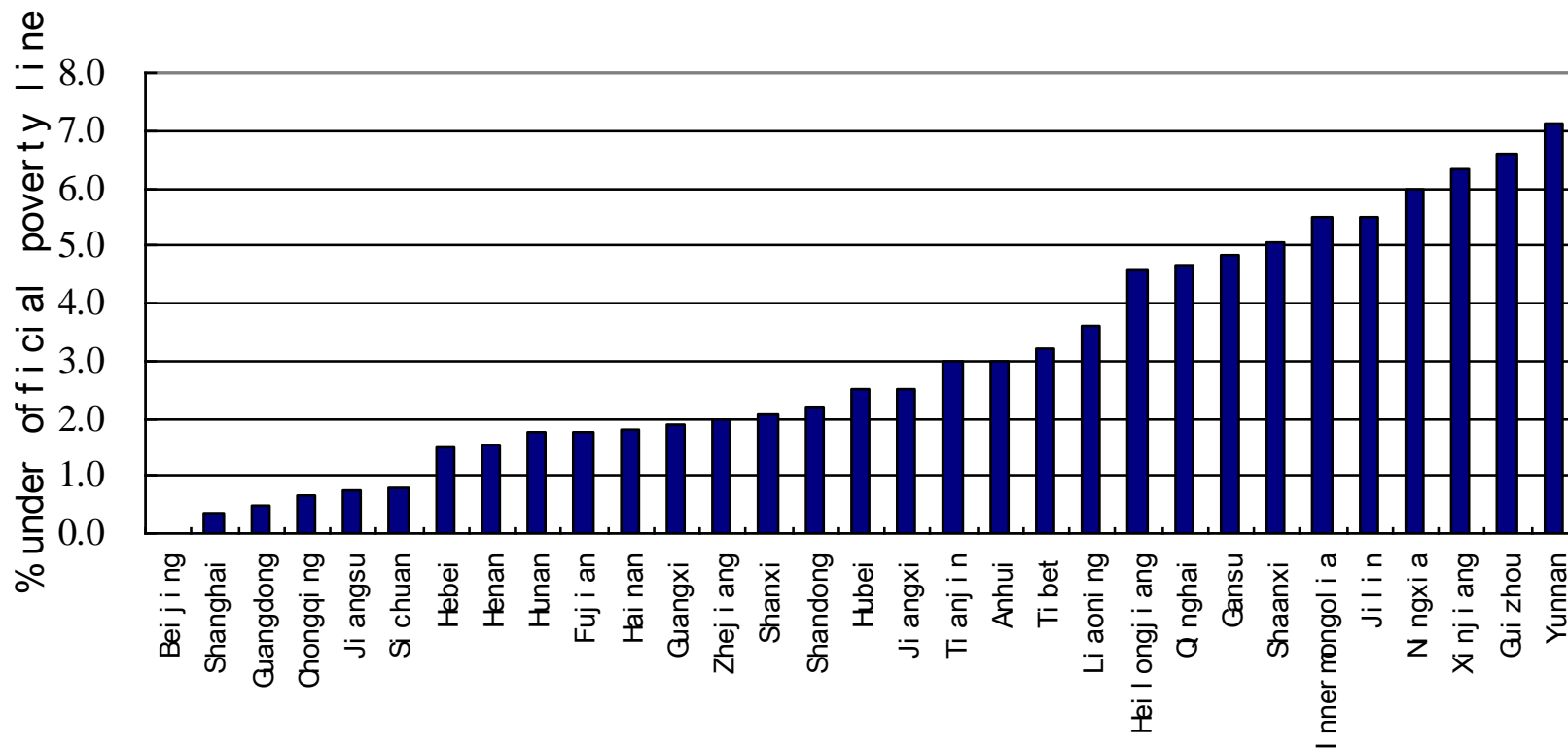


32% in 1978 (250 million) → 2.8% in 2006 (20 million)

Data source: China's poverty report 2007

And, the distribution of poor people in China are highly varied

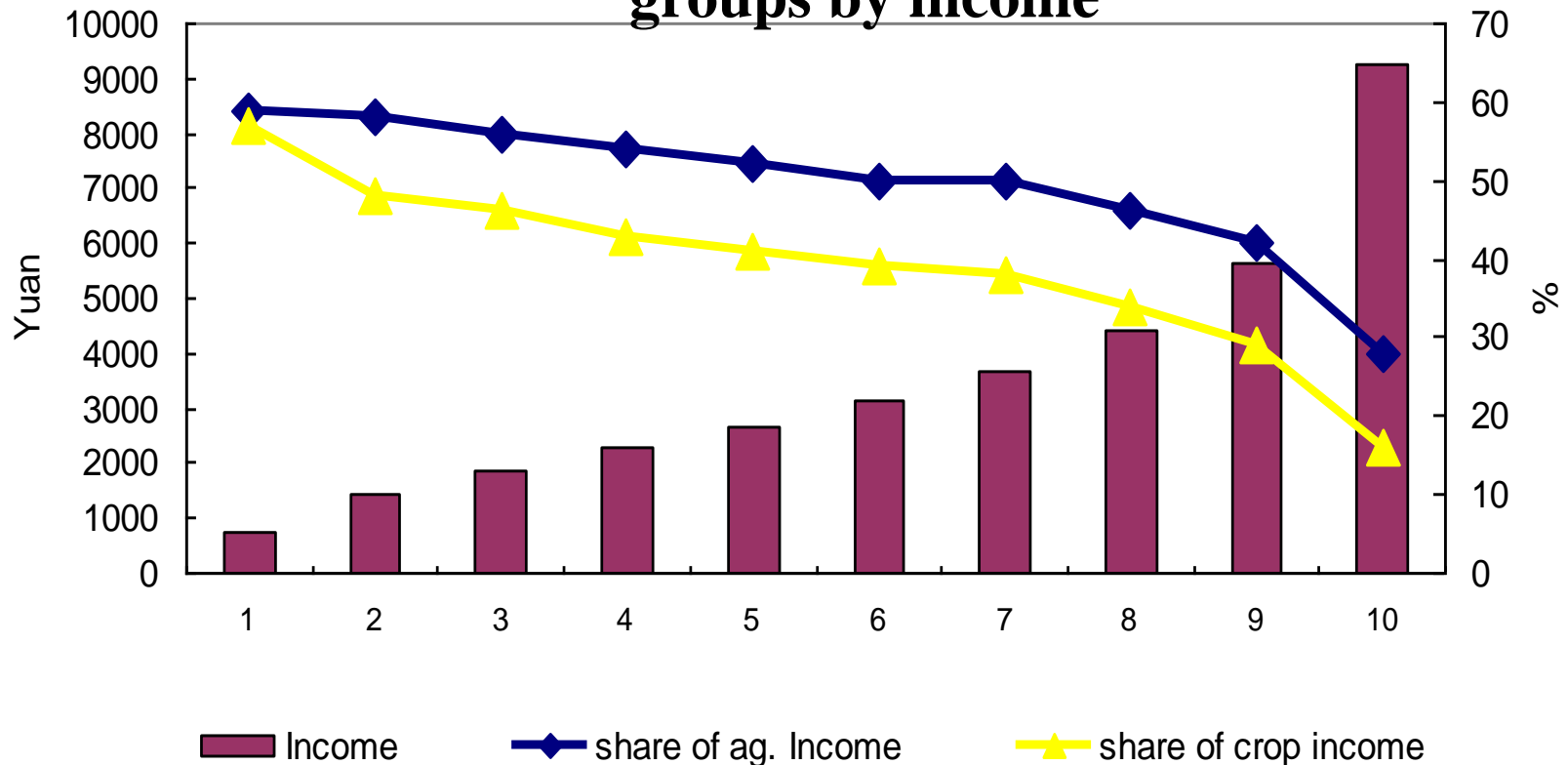
Share (%) of rural population living under official poverty line... varies substantially across provinces (2005)



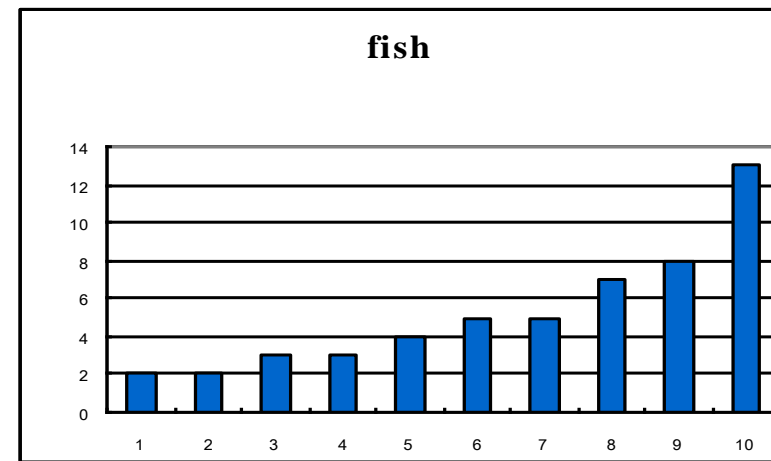
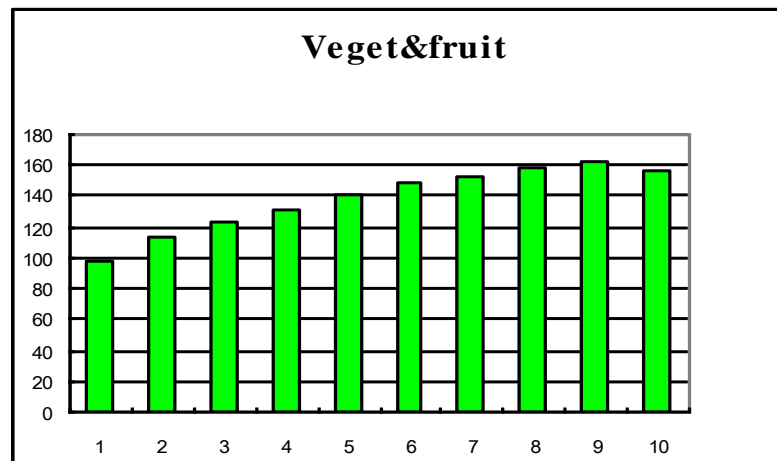
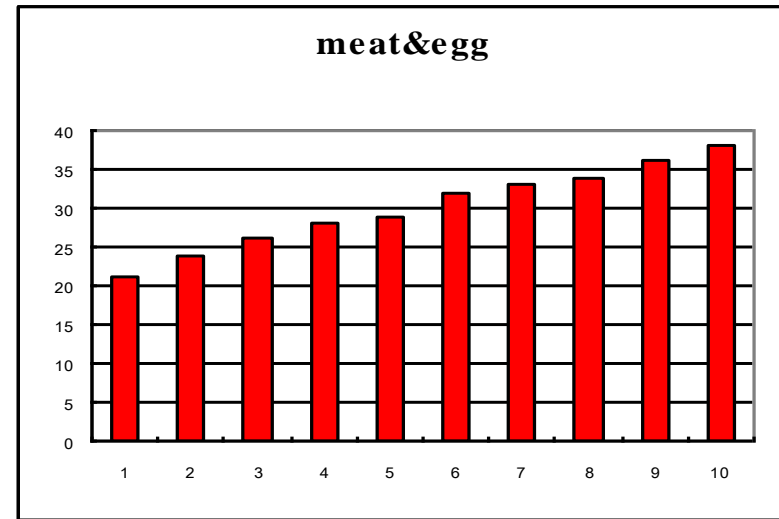
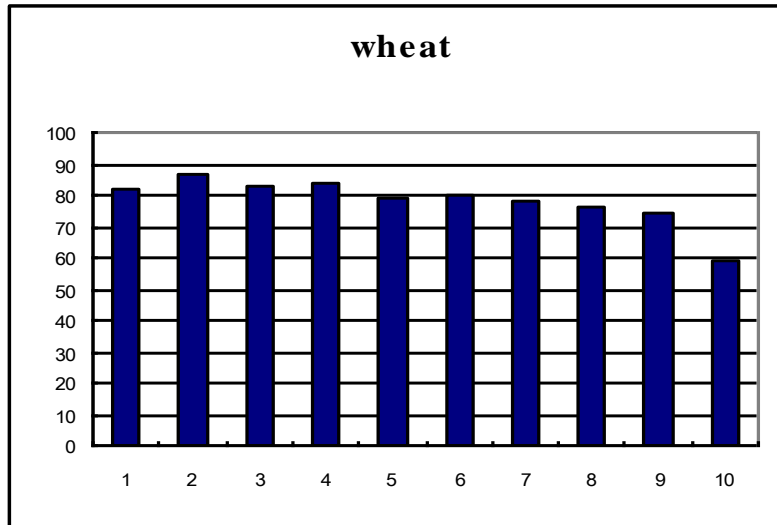
Source: Estimated based on rural income and expenditure survey conducted by National Bureau of Statistics of China in 2005

The income and expenditure structures among farmers are also very different

Share of agricultural income of different farmer groups by income



Food consumptions among different farmer groups by income (kg/capita)



Biofuel development and policies in China

- **Targets**

- **Bioethanol: 4 mmt** by 2010 (2.9 times of 2007 level), **10 mmt** in 2020 (7.1 times of 2007 level)
- **Biodiesel: 0.2 mmt** in 2010, **2 mmt** in 2020

- **Current incentive Policies**

- Waived **5%** consumption tax for biofuel
- Refunded VAT (**17%**) on biofuel production
- Direct subsidy to biofuel plants (about **2000 yuan** or about US\$ **300** per ton) to ensure biofuel companies can make appropriate profit
- Mandatory use of **E10** gasoline in 9 provinces.
- Subsidy to the biodiesel feedstock production base, **200 yuan/mu (US\$425 /ha)**

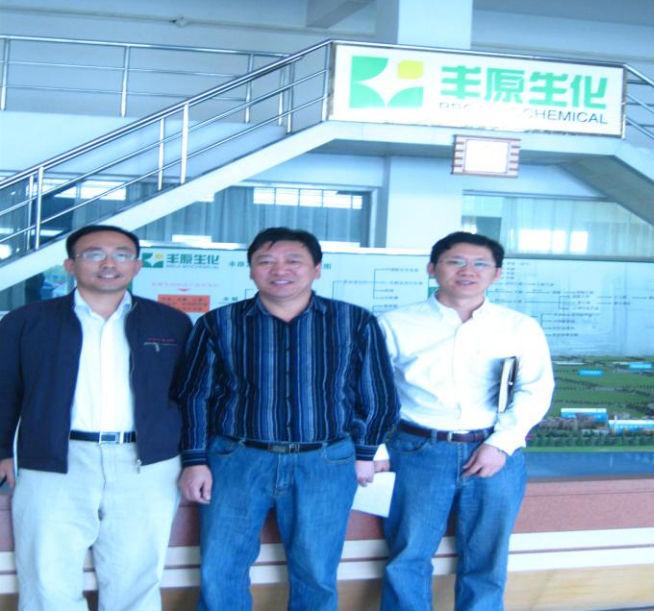
Visiting to the Bio-ethanol Plants

Saccharification

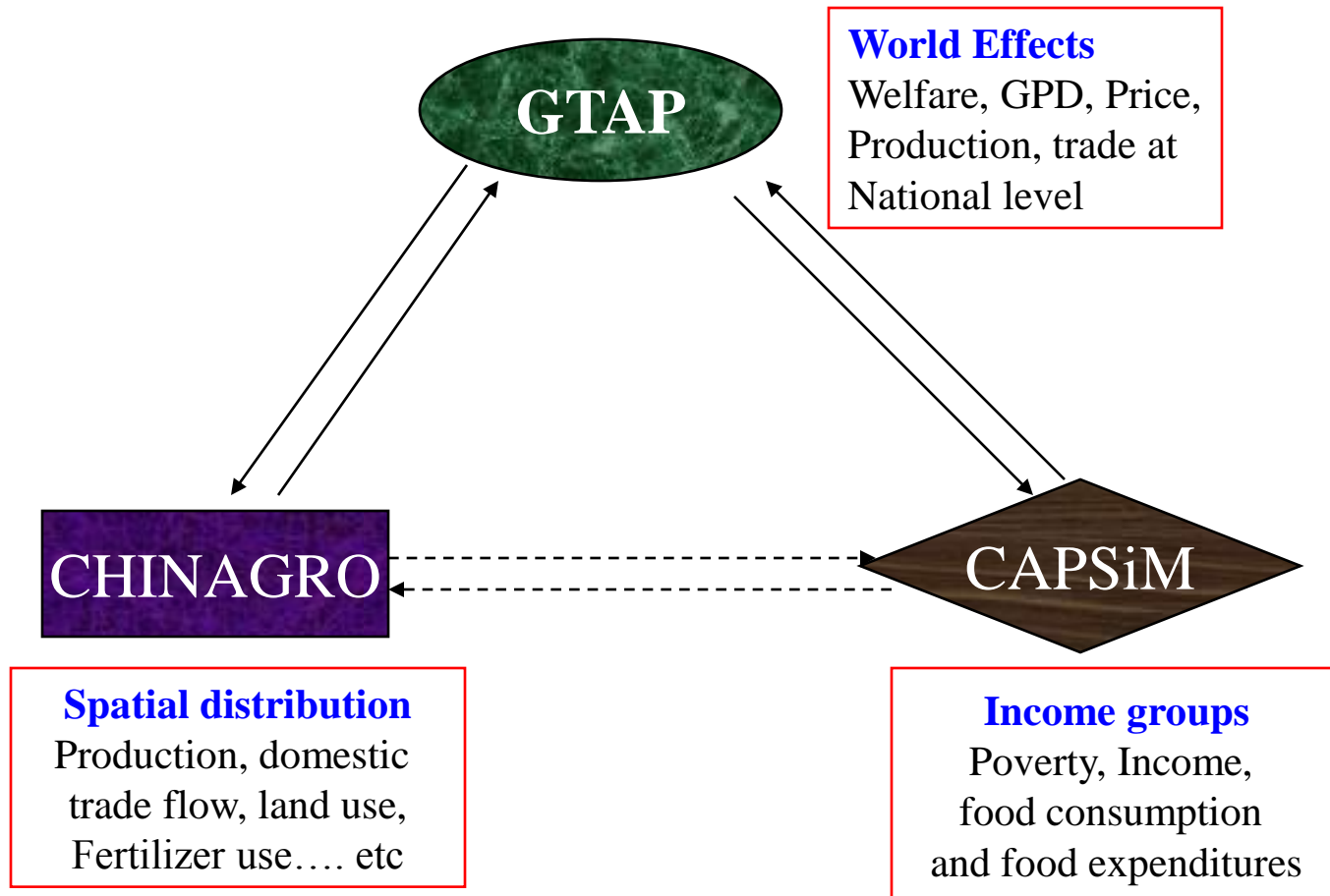
Fermentation

Distillation

Molecular sieve



Linking GTAP-Chinagro-CAPSiM



Multi-regional general equilibrium model-CHINAGRO

$$V^* = \max_{v_{rr'} \geq 0; e_c, m_r^-, m_r^+, q_c, x_c^v, x_r^u \geq 0; z_c^-, z_c^+ \geq 0, g_r} \sum_r \alpha_r^u u_r^u(x_r^u) + \sum_r \sum_{c \in C_r} \alpha_c^v u_c^v(x_c^v)$$

subject to

$$\begin{aligned} x_r^u + \sum_{r'} v_{rr'} + \sum_{c \in C_r} z_c^+ + g_r \delta^n + m_r^- \\ = \sum_{r'} \frac{1}{1 + \rho_{r'}} v_{r'r} + \sum_{c \in C_r} z_c^- + m_r^+ + \omega_r^u \end{aligned} \quad (p_r)$$

$$g_r = \sum_{r'} \theta_{rr'} v_{rr'} + \sum_{c \in C_r} (\tau_c^+ z_c^+ + \tau_c^- z_c^-) + \zeta_r^+ m_r^+ + \zeta_r^- m_r^-$$

$$\sum_r (\bar{p}_r^+ m_r^+ - \bar{p}_r^- m_r^-) \leq \bar{B}$$

$$x_c^v + e_c + z_c^- = q_c + \omega_c^v + z_c^+ \quad (p_c)$$

$$F_c(q_c, e_c) \leq 0, \quad c \in C_r.$$

China's Agricultural Policy Simulation and Projection Model (CAPSiM)

– Partial equilibrium model

– Commodities:

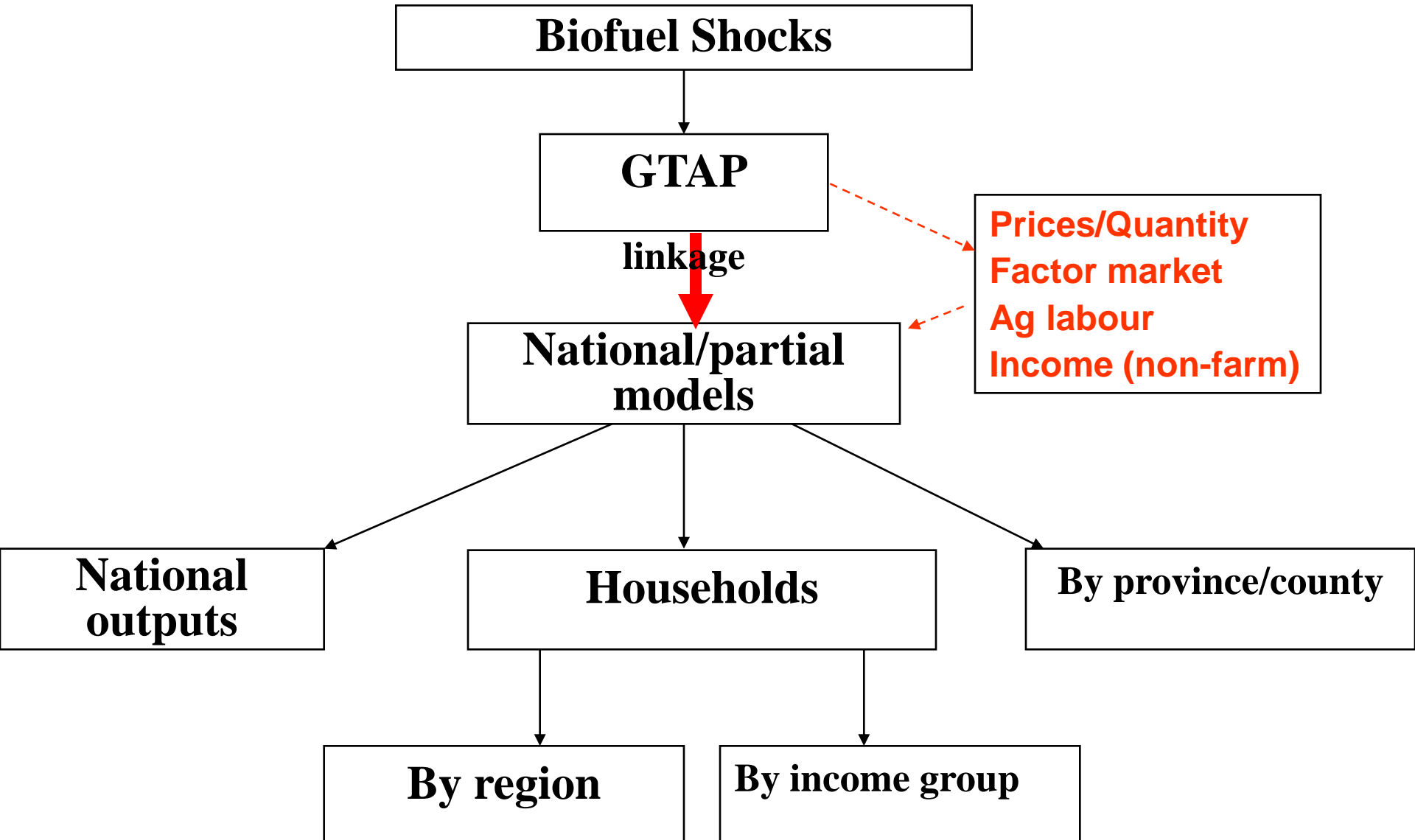
12 crops or crop groups

7 livestock and aquatic products

31 provinces

11 farmer groups per region (10 group+1 average)

Linkage Model



Scenarios

Reference scenario (RS)

- **Biofuels production in all countries in the world are kept at their 2006 levels** (in other words, we are simulating the effect of a world-wide ban of not allowing any expansion over what was already in place).

Biofuel scenario (S1): Biofuel development in USA, EU, Brazil will fulfill its targets in 2020 using the first generation technology (crop based biofuel)

- **Biofuel scenario (S2): USA, EU, Brazil and China will fulfill their targets in 2020.**

Targets of biofuel production of different countries/regions

	2006	2020
Ethanol Production		
USA (billion gallon)	4.86	32.9
EU27 (billion gallon)	0.79	6.42
Brazil (billion gallon)	4.50	13.20
China (billion gallon)	0.39	3.06
Diesel Production		
USA (billion gallon)	0.25	2.1
EU27 (billion gallon)	1.75	14.19

Assumptions for China's biofuel production in 2020

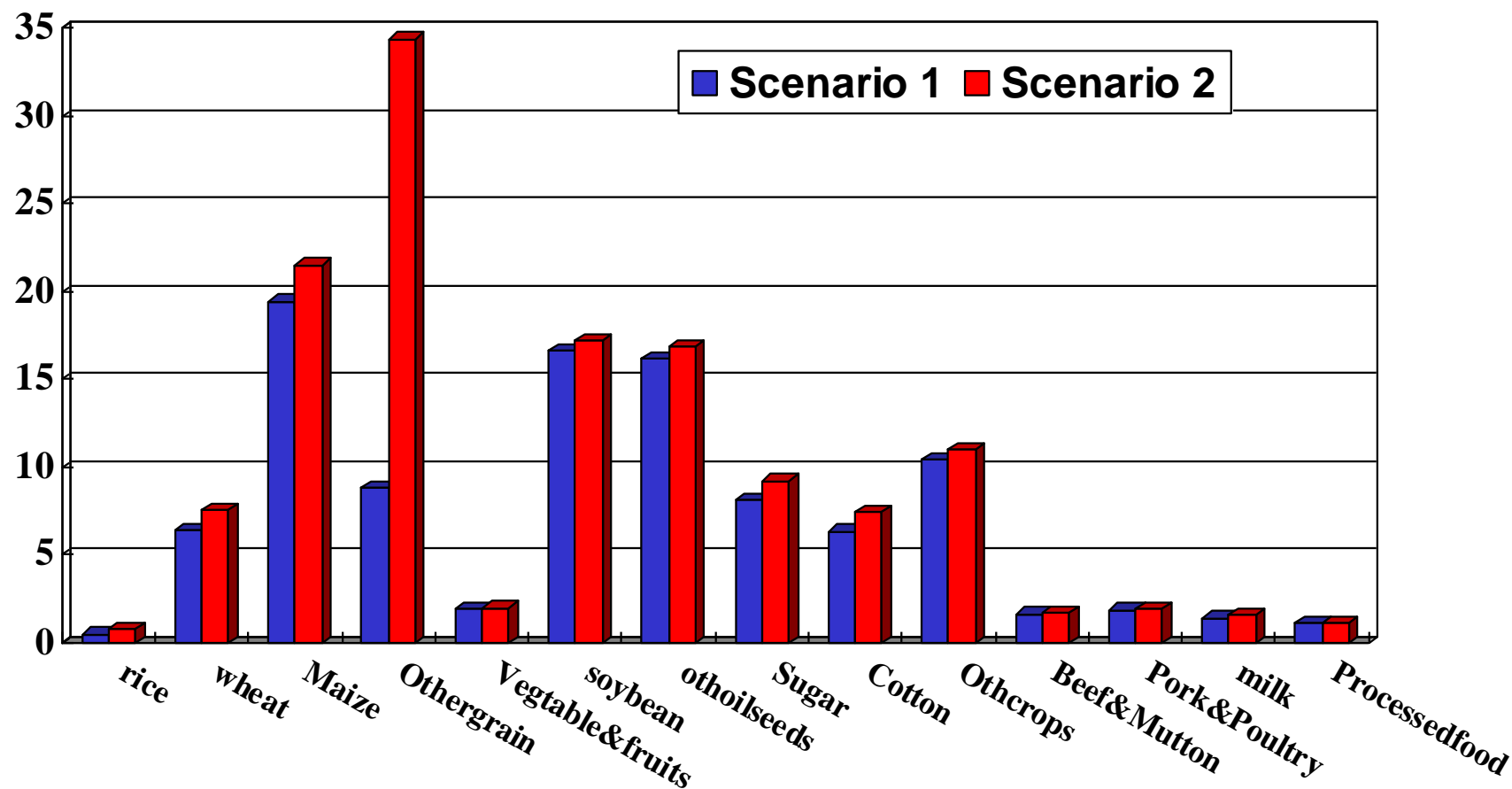
Production process:

- **10 million ton of bio-ethanol in 2020**
- **Maize use same as in reference (hence 15%)**
- **Other feedstocks: sorghum (50%), cassava (20%), sweet potato (7.5%) and sugarcane (7.5%)**
- **No use of marginal land**
- **Animal feed obtained as byproduct**

Results-National and Regional level
(GTAP+CHIANGRO)

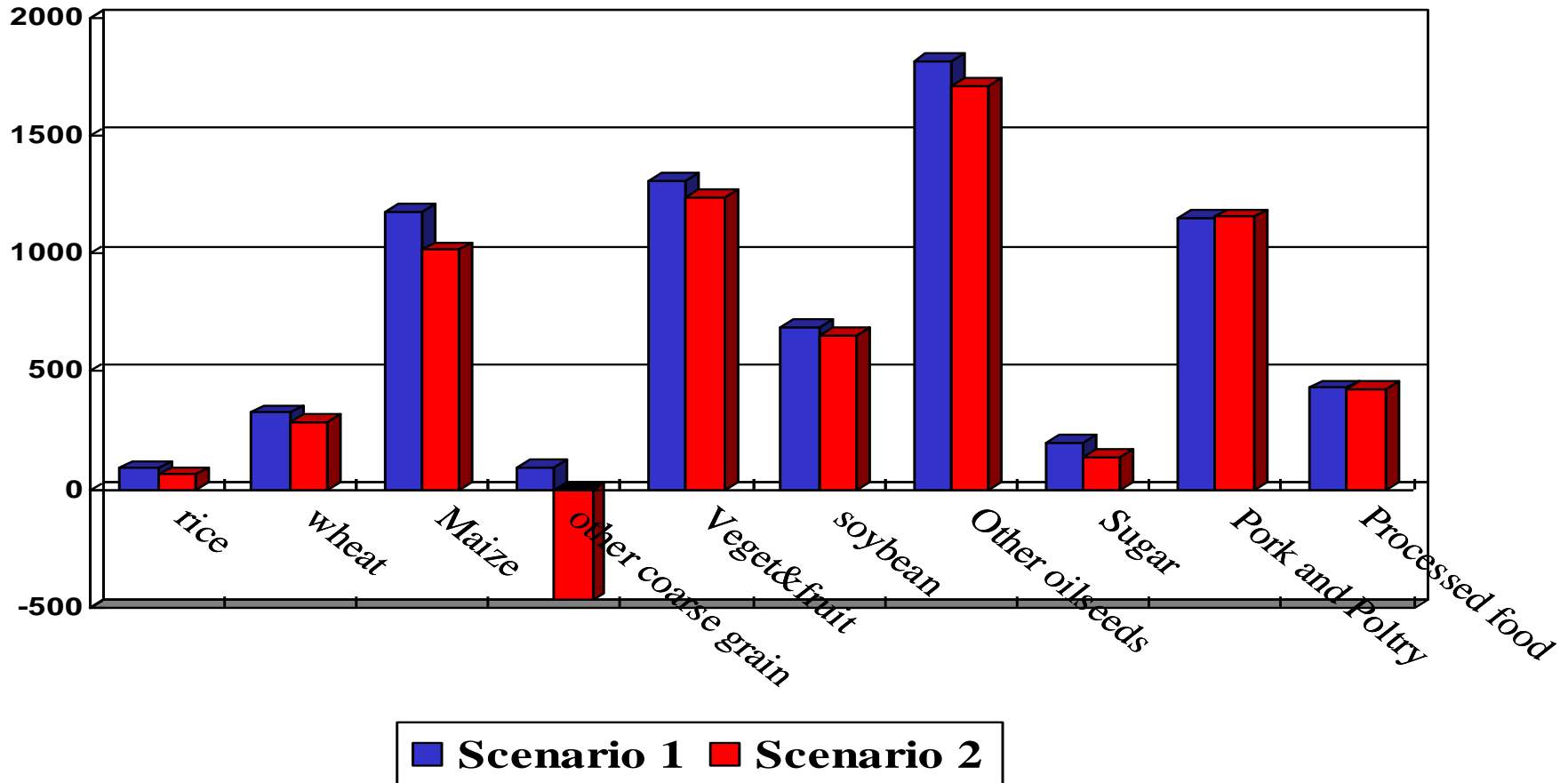
Impacts on price of agricultural commodities in China, comparing to the reference scenario

(%, 2020)



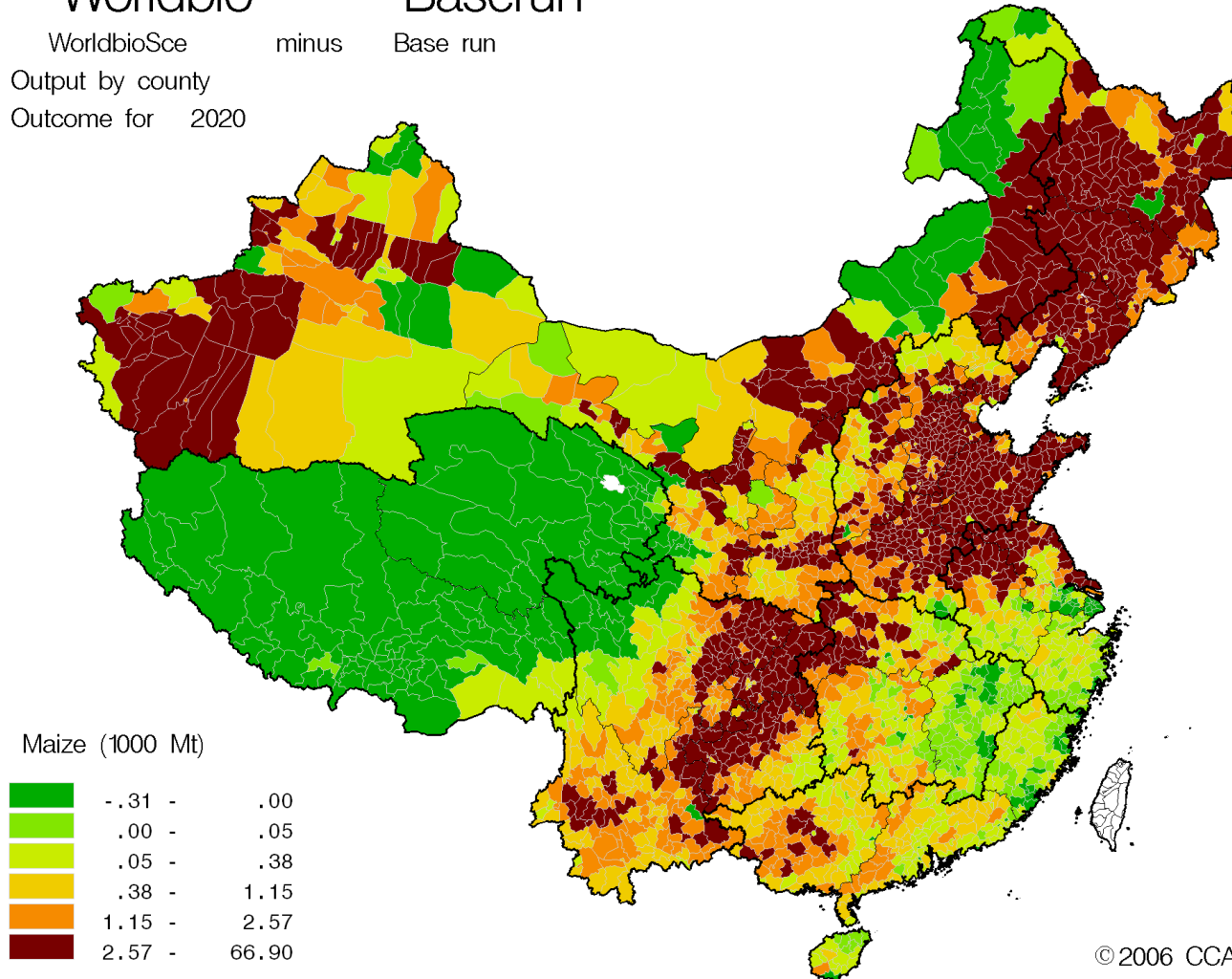
Impacts on China net agricultural export comparing to the RS

(million US\$; in 2020)



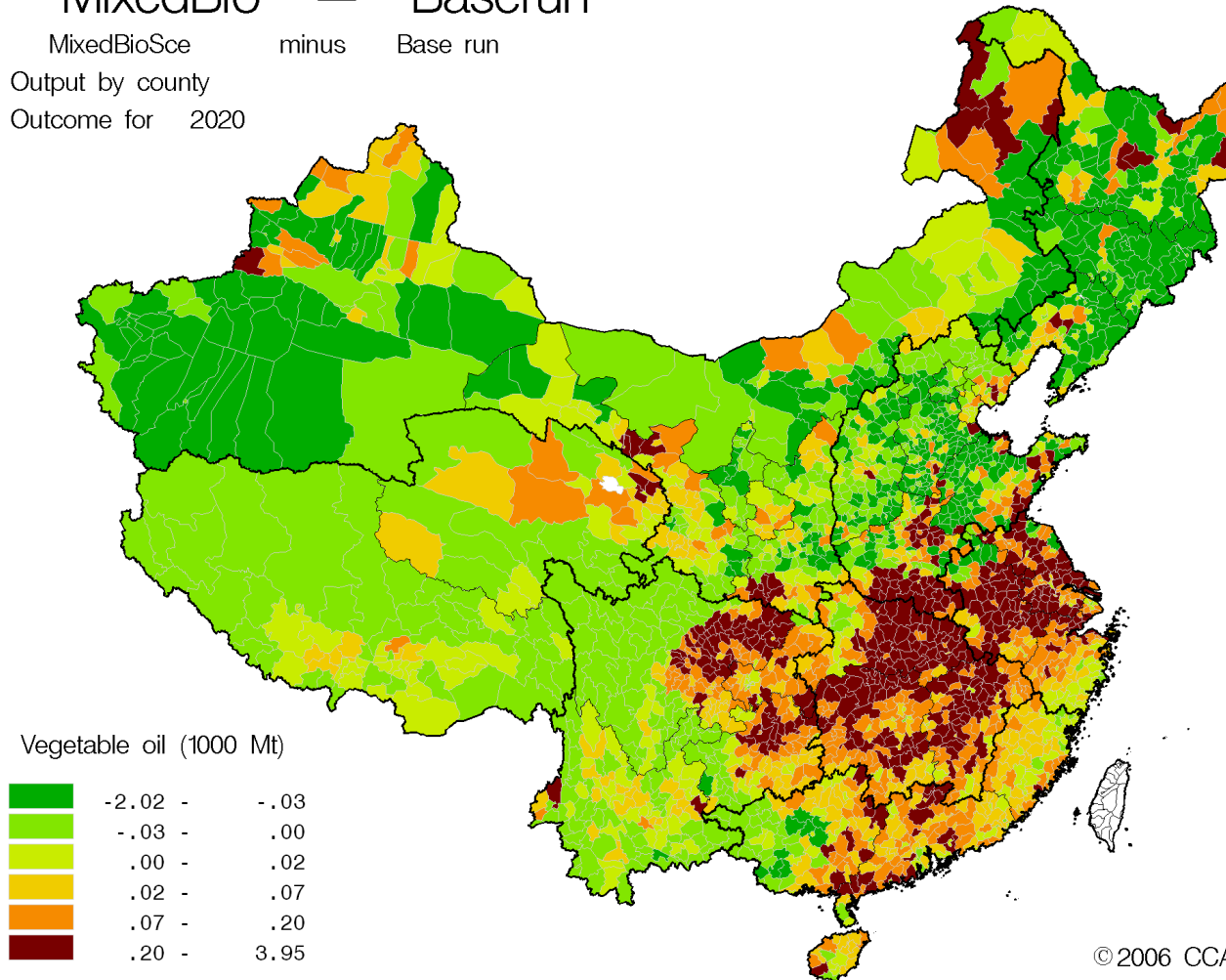
Impacts of biofuel development on China's regional maize production (S2 - RS)

Worldbio — Baserun
 WorldbioSce minus Base run
 Output by county
 Outcome for 2020



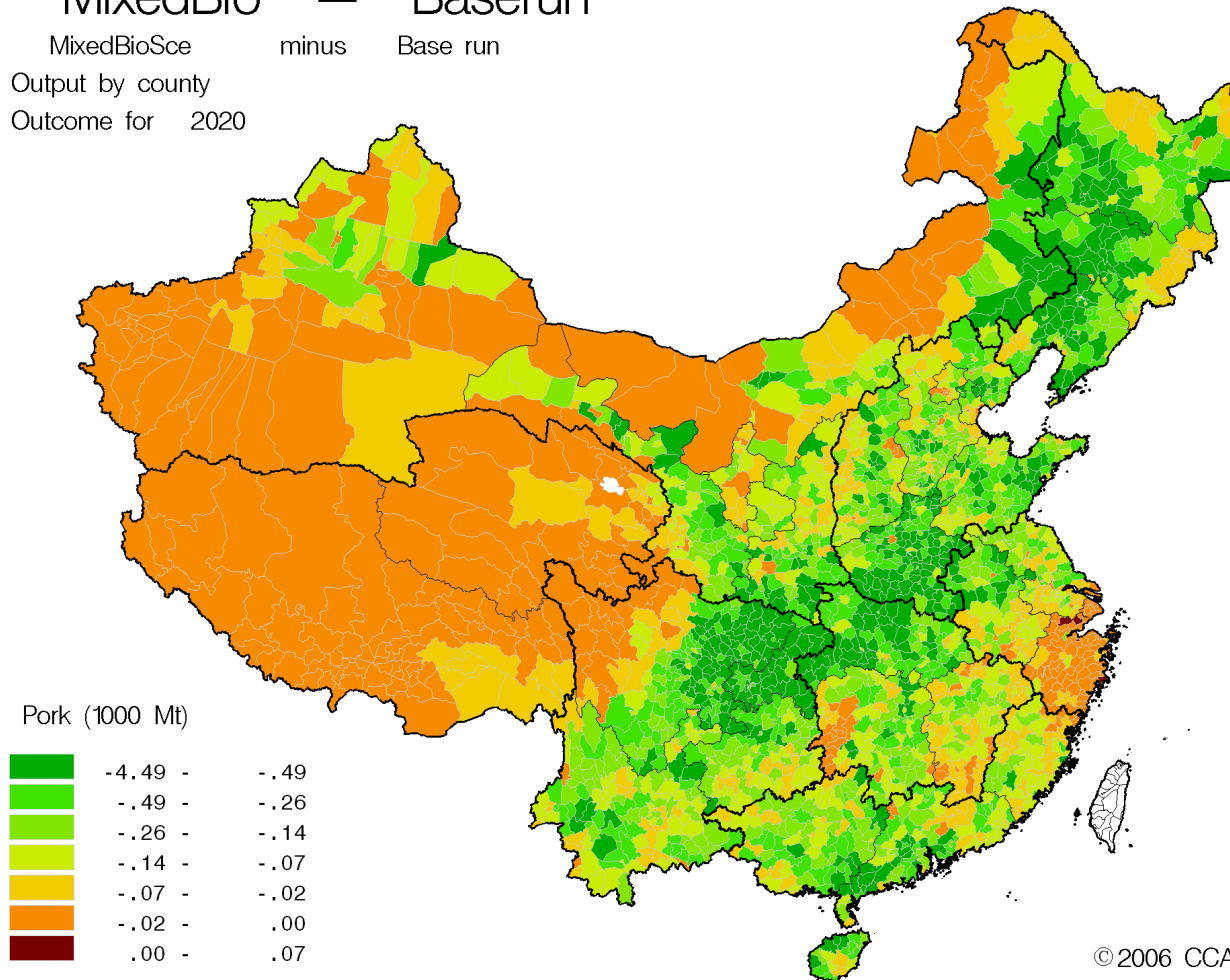
Impacts of biofuel development on China's regional vegetable oil production (S2 - RS)

MixedBio — Baserun
MixedBioSce minus Base run
Output by county
Outcome for 2020



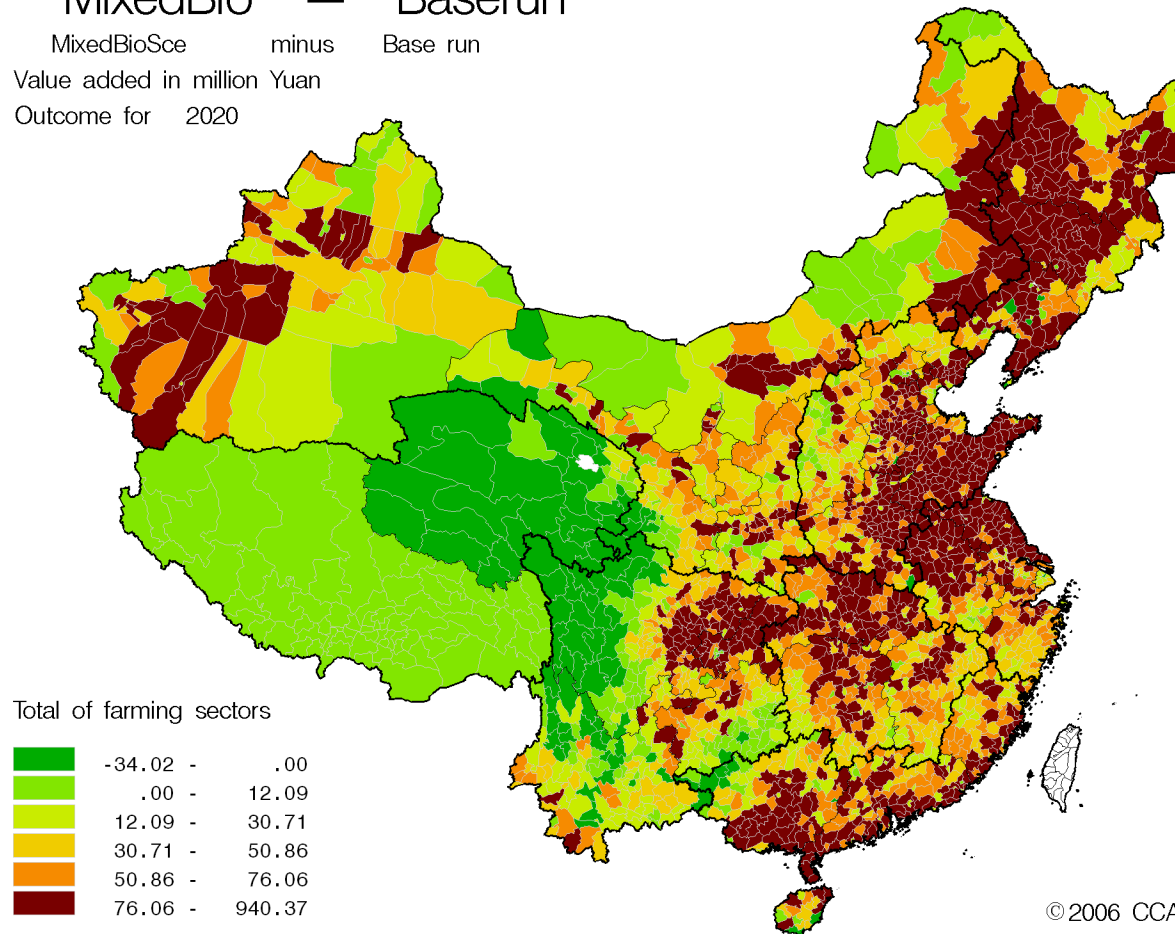
Impacts of biofuel development on China's regional pork production (S2 - RS)

MixedBio — Baserun
 MixedBioSce minus Base run
 Output by county
 Outcome for 2020



Impacts of biofuel development on farmer income in different regions of China (S2 - RS)

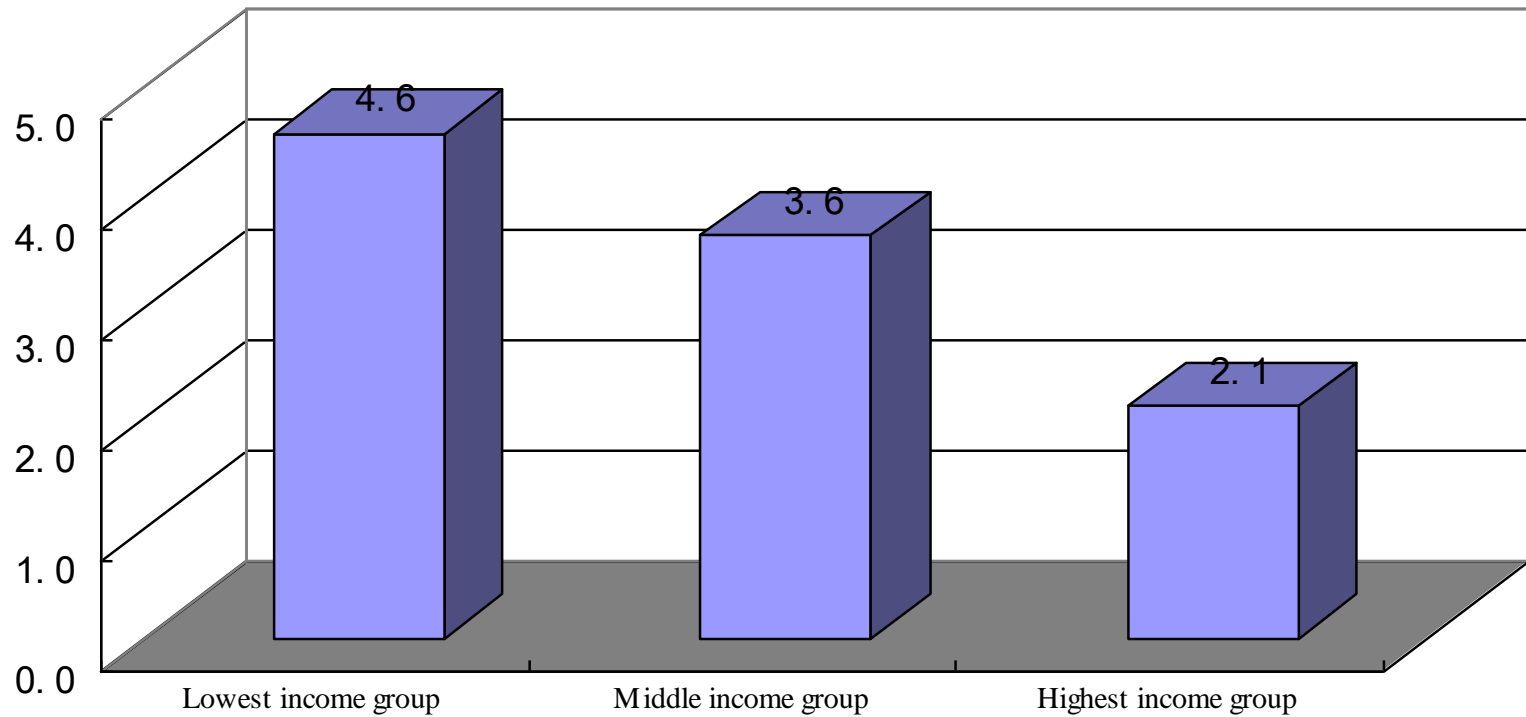
MixedBio — Baserun
MixedBioSce minus Base run
Value added in million Yuan
Outcome for 2020



Results-Household level
(GTAP+CAPSiM)

Impacts of biofuel development on farmers' ag income by income group (%)

(R2-RS)



Impacts of biofuel development on food consumptions of different farmer groups (%)

(R2-RS)

	Lowest income group	Highest income group	Average income group
Rice	-0.8	-0.7	-0.7
Wheat	-1.7	-1.4	-1.5
Maize	-5.9	-4.9	-5.3
Other cereal	-3.6	-2.7	-3.1
Veget. Oil	-7.4	-6.2	-6.9
Sugar	-6.8	-5.9	-6.2
fruit	-6.3	-5.2	-5.6
Vegetable	-2.3	-2.0	-2.2
Beef& mutton	-0.1	0.0	0.0
Pork	-1.3	-1.3	-1.3
Poultry	-2.0	-2.0	-2.1
Milk	-1.8	-1.7	-1.8
Egg	-1.0	-1.1	-1.0
Data source: model simulation			

Impacts of biofuel development on food expenditures of different farmer groups (%)

(R2-RS)

	Lowest income group	Highest income group	Average income group
North	3.0	1.7	2.3
Northeast	2.6	1.6	2.0
East	1.9	1.0	1.4
Central	1.7	1.2	1.4
South	1.4	0.9	1.1
Southwest	1.8	1.2	1.5
Plateau	2.3	1.4	1.8
Northwest	2.6	1.6	2.1
China	2.1	1.2	1.6
Data source: model simulation			

Discussion and Policy Implications (1)

- **Biofuel expansions in countries like US, EU, Brazil, will have pronounced impacts on China's agriculture and poverty**
 - **Agricultural prices**
 - **Food production;**
 - **Composition of food trade;**
 - **Regional agriculture Pattern**
 - **Farmers' income**
 - **Regional income inequity**
 - ...

- **The impacts of China's biofuel development:**
 - **little impacts in global food prices**
 - **large impacts on:**
 - Domestic regional production;
 - Composition of food trade;
 - Domestic prices of less tradable crops such as cassava and sweet potato;
 - Farmers' income and food expenditure of different farmer groups and
 - **Moderate impacts on food security/self-sufficiency**

Discussion and Policy Implications (2)

- **Rising food price due to biofuel expansions in other countries should be looked on as an opportunity to stimulate the rural economy.**
- **Chinese farmers will benefit from the biofuel development, but the impacts on different regions and farmer groups are different.**
 - Good news for feedstock and crop producers,
 - Bad news for livestock producers and consumers
 - The poor farmers may get more benefit from it than other farmers
- **Biofuel development may help to reduce poverty and inequity among regions and farmer groups .**

Caveat:

- **We did not consider technology improvement in this study. It is more complicated and needs more comprehensive analysis.**
- **China is a net exporter of food commodities, the impacts for countries of net importer will be different,**
- **Land tenure system should be considered, landless poor farmers will be hurt more ...**