Spatially Detailed Scenarios of Agricultural Development - Experiences with the CHINAGRO Model

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Sustainable Development:

- increase farmers' incomes and provide rural employment (social sustainability)
- narrow regional disparity (political sustainability)
- improve resource use efficiency and product quality (economic sustainability)
- arrest environmental degradation (environmental sustainability)
- maintain an adequate self-reliance in food supply (state security)
How do China’s WTO accession and WTO’s Doha round influence the agricultural economy and its policy?

Should the fast-rising demand for animal proteins by Chinese consumers be met by import (of feed or meat)?

How to address income distribution given fast changes in income, ongoing urbanization and income disparities between urban and rural regions?

How to deal with natural resource management, changes in land use, scope for expanding irrigation and improving rangelands?
Integrating ecological and socioeconomic factors within a comprehensive economic framework

“Policy Decision Support for Sustainable Adaptation of China’s Agriculture to Globalization”

INCO-DEV, Research for Development
Confirming the International Role of Community Research
China's agriculture has to be analyzed within a broader economic framework that incorporates various policy measures, and is capable of testing a wide range of policy options.

To answer these questions a multidisciplinary research approach is followed.

Natural scientists provide technological information about natural processes that are incorporated into dedicated decision support systems (DSS) with support by economists.
A Regionalized Model-based Assessment

CHINAGRO conducts its analysis within a modeling framework that:

• represents the consumer, producer and government decisions in the various regions,
• represents farm activities at county-level
• builds the supply response on spatially explicit assessment of the resource base and its agro-ecological characteristics
• describes agricultural processing and supply of farm inputs
• accounts for transportation costs in the economy
• allows for interregional as well as international trade
Regionalization in LUC-AGE

CHINA - Economic Regions and Provinces

ECONOMIC Regions
- Central
- East
- North
- Northeast
- Northwest
- Plateau
- South
- Southwest

Provinces
11 Beijing
12 Tianjin
13 Hebei
14 Shanxi
15 Inner-Mongolia
21 Liaoning
22 Jilin
30 Heilongjiang
31 Shanghai
32 Jiangsu
33 Zhejiang
34 Anhui
35 Fujian
36 Jiangxi
37 Shandong
41 Henan
42 Hubei
43 Hunan
44 Guangdong
45 Guangxi
46 Hainan
51 Sichuan
52 Guizhou
53 Yunnan
54 Xizang
61 Shaanxi
62 Gansu
63 Qinghai
64 Ningxia
65 Xinjiang
71 Taiwan
72 Hong Kong
Population density (persons/km$^2$).
Integrated Scenario Assessment

- GIS spatial data (raster 5 by 5 km; now 1 by 1 km)
  - Land cover, climate, soils/terrain, population, infrastructure
- Statistical/survey data at county level
- I-O tables of 1997/2005 at province level
- Province data, macro data to 2003/2007

1. Scenario generation
   - Population, urbanization, migration, consumer preferences, economic growth, policy: land conversion, agriculture/trade, climate change, water availability

2. Agro-ecosystem AEZ assessment
   - rain-fed, irrigated; grassland

3. CHINAGRO Welfare model

4. Downscaling methodology to grid-cell
The scenario formulation distinguishes a broad range of factors affecting demand and supply of agricultural products:

- Demographic change
- Urbanization
- Overall economic growth
- Availability of farmland; irrigated land
- Technological progress in agriculture
- Trade policies
- Conditions on international markets
Scenario H: High urbanization level

Composition of Rural Population by age

Rural/Urban Population

Rural Population change by age class

% Rural
Household Incomes:
Regionalized growth scenarios

Source: CCAP, 2002
Cultivated land changes in recent years 1997-2003 (1000 hectares)

Source: MLR, 2004
China’s Land Policy Trilemma

Land Use Changes, Policies, Regulations

- Ecological restoration, Overgrazing, Erosion, Groundwater depletion
- Conversion of Agricultural Land to Built-up, Urbanization, Income Disparity

- Environment
  - Soil/Water/Air Pollution, Water Diversion

- Economic Development
Farmland converted to forest/grass

(in 6 years, 4% of grainland was converted)

Data sources: MLR

- In scenarios we assume that slopes steeper than 25°, will be transformed into forest, shrub or grassland
Farmland Conversion to Built-up

Farmland occupied by built-up land

(in 6 years, 1% of grainland was lost)

Data sources: MLR

Regression analyses indicates that the annually increased area of built-up land was highly related to the annual growth rate of GDP and population, and negatively related to the degree of land use efficiency.
Proportion of farmland occupied in urban expansion: ~80% experience of the 145 major cities in the 1990s

Urban land in 1990
New urban land from arable land
New urban land from non-arable land

Land use area based on remote sensing
Farmland Conversion to Built-up

- Economic growth and urbanization will forcefully compete for agricultural resources of land and water

- We estimate that another 7 to 9 million hectares of farmland will be converted to built-up land up to 2030, i.e., 5 to 7 percent of farmland in year 2000

- The effect will be much larger for the South (17 to 25 percent) and the East (12 to 17 percent) regions

- Conversion of less than 5 percent of total farmland in year 2000 is projected for all other regions, except the North region (6 to 8 percent)
Total conversion of Farmland during 2000-2030 due to different causes

Regional Changes in Farmland 2000-2030
Central Scenario

N = North
NE = Northeast
E = East
C = Central
SW = Southwest
P = Plateau
NW = Northwest
Farmland Conversion

- Taking various forms of conversion into account (including ecological conversion, conversion to orchards and fishponds, loss due to natural hazards and degradation), we estimate that China’s farmland may decrease from its year 2000 level of 128.2 million hectares to a range of 118.0 to 120.2 million hectares in 2020.

- This may be further reduced to a range of 113.6 to 117.8 million hectares by 2030, i.e., a possible net reduction of 8.2 to 11.4 percent over 30 years.
Integrated Scenario Assessment

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AGRO-ECOLOGICAL ZONES METHODOLOGY

**Land suitability index (rainfed + irrigation)**

\[ SI = 0.9\times VS + 0.7\times S + 0.5\times MS + 0.3\times mS \]

VS = very suitable,
S = suitable,
MS = moderately suitable,
mS = marginally suitable
Irrigated Farmland

- Nearly 45 percent of China’s farmland is irrigated; from county-level data of year 2000 on crop cultivation and production we estimate that 54 percent of all sown area in China is on irrigated land.

- There is a wide variation in this share among regions. The highest estimate was obtained for the East region (74 percent), the lowest for Northeast (21 percent).

- Irrigation water is essential for China’s high grain output from limited farmland.

- As water supply available for agriculture will be stagnant or even declining in the future, the key to maintaining or even expanding irrigated areas lies in more rational and efficient use of water.
Separation of Rainfed and Irrigated Production and Inputs

1. Estimate $MCI_r$, $MCI_i$ and determine $TSOWN_i$ and $TSOWN_r$
2. Allocate crop sown areas to $TSOWN_i$ and $TSOWN_r$
3. Allocate crop production to rain-fed and irrigated sown areas
4. Calculate (reference) demand for inputs of rain-fed and irrigated cropping and scale to statistics
Rain-fed versus Irrigated Wheat Yield
Percent of cultivated land in grid cell
Share of irrigation in cultivated land
## Share of Irrigated Production in China Total in 2000; (percent)

<table>
<thead>
<tr>
<th>Region</th>
<th>RICE</th>
<th>WHEAT</th>
<th>MAIZE</th>
<th>SOYB</th>
<th>COTTON</th>
<th>CEREALS</th>
<th>CEREALS excl.RICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>R1</td>
<td>98.1</td>
<td>94.5</td>
<td>68.5</td>
<td>55.1</td>
<td>83.5</td>
<td>82.8</td>
</tr>
<tr>
<td>Northeast</td>
<td>R2</td>
<td>84.9</td>
<td>23.4</td>
<td>17.6</td>
<td>7.1</td>
<td>67.0</td>
<td>38.8</td>
</tr>
<tr>
<td>East</td>
<td>R3</td>
<td>99.9</td>
<td>86.5</td>
<td>47.8</td>
<td>46.3</td>
<td>70.7</td>
<td>90.6</td>
</tr>
<tr>
<td>Central</td>
<td>R4</td>
<td>100.0</td>
<td>68.1</td>
<td>21.9</td>
<td>36.1</td>
<td>56.3</td>
<td>94.0</td>
</tr>
<tr>
<td>South</td>
<td>R5</td>
<td>98.2</td>
<td>92.7</td>
<td>16.4</td>
<td>34.8</td>
<td>22.6</td>
<td>92.5</td>
</tr>
<tr>
<td>Southwest</td>
<td>R6</td>
<td>96.8</td>
<td>65.4</td>
<td>10.0</td>
<td>8.5</td>
<td>33.3</td>
<td>65.8</td>
</tr>
<tr>
<td>Plateau</td>
<td>R7</td>
<td>86.1</td>
<td>49.9</td>
<td>75.6</td>
<td>79.2</td>
<td>0.0</td>
<td>48.8</td>
</tr>
<tr>
<td>Northwest</td>
<td>R8</td>
<td>100.0</td>
<td>79.6</td>
<td>69.6</td>
<td>28.8</td>
<td>97.7</td>
<td>72.8</td>
</tr>
<tr>
<td>China</td>
<td>TOT</td>
<td>97.9</td>
<td>86.8</td>
<td>44.8</td>
<td>29.4</td>
<td>80.1</td>
<td>78.9</td>
</tr>
</tbody>
</table>

Source: Model-based estimation using county statistics of year 2000
Irrigated Farmland

- We estimate that irrigated land uses 60 percent of farm labor in cropping and over 70 percent of chemical fertilizers and farm machinery used in cropping.

- We estimate that 72 percent of grain output is produced on irrigated land.

- For rice, the share contributed from irrigated land is well over 90 percent, for wheat more than 85 percent.

- On the other hand, major feed commodities, maize (45 percent from irrigated land) and soybeans (< 30 percent from irrigated land), currently come from dominantly rain-fed production.
Integrated Scenario Assessment

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Methodological Challenges

- The scale of China and the extensive set of features must be accounted for;
- The spatial and social diversity to appear in the structure of the model, not only in ‘big’ numbers on population and surface;
- Theoretical background on aggregation and methods in spatial modeling;
  - Requires, facilitates and fosters trans-disciplinary collaboration;
  - Spatially disaggregated economic model for the analysis of Chinese agricultural policy
Incorporate a priori knowledge of

- Present/past situation
- Potential for change

This defines approach in four ways:

1. agricultural potentials
2. physical balances at ‘farm’ level
3. transport flows between markets
4. welfare approach to agricultural policy

Systematic data analysis & preparation is required
The full economy welfare model

Full economy representation needed for analyzing

• Multi-commodity and multi-agent representation
• Substitutability of agricultural inputs and labor affecting prices
• Substitutability between food products on the demand side
• Non-tradability of some feed, nutrients
• Technological interaction between livestock and crop sector (feed requirements and manure output) within limits of agro-ecological conditions
Welfare optimization framework offers transparency

- Maximization of social welfare related to consumption of various income groups (distorted by taxes, tariffs, quotas)

Under the restrictions of

- Prevailing technological relations
- Commodity balances
- National balance of payments
- Regional and world trade

Market clearing prices are endogenous
Classification of actors

In each county (ca. 2300):
- two kinds of crop farmers: rain-fed, irrigated
- four types of livestock farmers
- one fisherman (exogenous output)
- rural population (producers)

In each region:
- non-agricultural producer
- six classes of consumers

(Each producer characterized by their transformation function)
Other economic agents: consumers, traders and Government

- In each of the 8 regions, 3 rural and 3 urban consumer groups purchase consumer goods including food maximizing their consumer surplus, at given prices.

- Traders maximize profits by optimal routing of commodities between regions and by trading with foreign markets, subject to transportation costs.

- and the tariffs and Non-tariff barriers maintained by government.

- Government also imposes producer and consumer taxes/subsidies and redistributes income through direct taxes.
Classification of markets

For tradable commodities:

- spatial aggregation into 8 regions
- commodity aggregation into 17 commodities:
  - food (14)
  - non-agriculture (1)
  - marketed feed (2)

Furthermore, 3 types of (non-tradable) local resources (county markets)

- local feeds
- operating capacity
- plant nutrients (manure)
Methodological results in full economy model

(a) New calibration method

- A fully modular calibration procedure that (almost) exactly replicates base year 1997 for every observed variable, including input and output at county (2432)-level, and also for (8-)regional prices

- Advantages:
  - Interdisciplinarity: Elaborate data set is replicated fully, including the contributions by technical experts (agronomy, geography)
  - Reliability: Full check on programming errors
  - Maintenance of model in future: as long as base-year database is unchanged, model components can be replaced one-by-one without affecting the base year solution
Methodological results in full economy model

(b) A proof that the equilibrium is unique and stable
(c) A fast algorithm with proven global convergence that relies on decomposition:
   1. Given production decisions, 8-region exchange component maximizes social welfare at given level of agricultural output and input
   2. Given (smoothed) shadow prices from 1., profit maximization farm models are solved at county level, terminating at exact solution within a known finite number of iterations
   3. Return to 1. until convergence
The equations of the full economy model

\[ V^* = \max_{\nu_{rr}, \xi_{rr}, \zeta_{rr}, z_r^+, z_r^- \geq 0} \alpha_r^u u_r^u(x_r^u) + \sum_r \alpha_r^v u_r^v(x_r^v) - \sum_r (\xi_r^+ m_r^+ + \xi_r^- m_r^-) \]

subject to

\[ \sum_i x_{ir} n_{ir} + \sum_r \nu_{rr} + g_r \delta^n + m_r^- + e_r^\circ + e_r^\bullet = \frac{1}{1 + \rho_r} \nu_{rr} + m_r^+ + \omega_r^u + q_r^\circ + q_r^\bullet + \omega_r^\circ + \omega_r^\bullet \quad (p_r) \]

\[ g_r = \sum_r \theta_{rr} \nu_{rr} + \tau_r^+ z_r^+ + \tau_r^- z_r^- + \zeta_r^+ m_r^+ + \zeta_r^- m_r^- + \bar{g}_r \]

\[ \sum_r (\bar{p}_r^m - \bar{p}_r^- m_r^-) \leq \bar{B} \quad (\rho) \]

\[ \Gamma_r x_r^v + e_r^\bullet = q_r^\circ + \omega_r^\circ + z_r^+ \quad (p_r^\circ) \]

\[ (1 - \Gamma_r) x_r^v + e_r^\bullet + z_r^- = q_r^\bullet + \omega_r^\bullet \quad (p_r^\bullet) \]

\[ F_c(q_c, e_c) \leq 0 \quad \text{for all } c \]

\[ m_r^+ \leq m_r^+ \leq m_r^- \leq m_r^- \]

\[ e_r^\circ = \sum_{c \in C_r^c} e_c \quad e_r^\bullet = \sum_{c \in C_r^b} e_c \]

\[ q_r^\circ = \sum_{c \in C_r^c} q_c \quad q_r^\bullet = \sum_{c \in C_r^b} q_c \]
CHINAGRO model: A policy analysis tool

- Welfare program is solved for 1997, 2003, 2010, 2020, 2030 under scenario assumptions with respect to trends in
  - Population and migration
  - Growth outside agriculture
  - World prices
  - Farmland, orchard and grassland availability
  - Irrigation development
  - Technical progress in agriculture
  - Trade and taxation policies

- Fully integrated software from basic data to report writing
- Each run is solved in less than 30 minutes on regular PC
- In addition, tailor-made software includes
  - an automatic report writing and run comparison facility
  - an automatic production of maps, for easy communication with geographers and policy makers, comparing runs, and showing changes over time
Model Simulation Policy Variants

(1) **BASERUN**: Central population growth, urbanization, economic growth scenario

(2) **LIBERAL**: Complete removal of border protection beyond currently planned level

(3) **HIGHGROW**: High economic growth and high urbanization level

(4) **TECHPROG**: Higher technical progress in crop and livestock sectors

(5) **IRRIGUP**: Expanded irrigation development
## Land Accounts

### -- North ------------------------

<table>
<thead>
<tr>
<th>Million hectare</th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated crop land</td>
<td>17.232</td>
<td>17.147</td>
<td>16.966</td>
<td>16.595</td>
<td>16.263</td>
</tr>
<tr>
<td>Tree crop land</td>
<td>2.008</td>
<td>2.085</td>
<td>2.235</td>
<td>2.483</td>
<td>2.660</td>
</tr>
<tr>
<td>Sown grass land</td>
<td>0.646</td>
<td>0.655</td>
<td>1.383</td>
<td>2.114</td>
<td>2.848</td>
</tr>
<tr>
<td>Forests and bushes</td>
<td>5.301</td>
<td>5.329</td>
<td>5.298</td>
<td>5.306</td>
<td>5.306</td>
</tr>
<tr>
<td>Built-up land incl. roads</td>
<td>6.919</td>
<td>8.229</td>
<td>9.635</td>
<td>11.302</td>
<td>12.602</td>
</tr>
<tr>
<td>Inland water bodies</td>
<td>4.520</td>
<td>4.520</td>
<td>4.520</td>
<td>4.520</td>
<td>4.520</td>
</tr>
<tr>
<td>Unused land</td>
<td>6.306</td>
<td>5.976</td>
<td>5.490</td>
<td>5.138</td>
<td>4.563</td>
</tr>
<tr>
<td>Total land surface</td>
<td>69.550</td>
<td>69.550</td>
<td>69.550</td>
<td>69.550</td>
<td>69.550</td>
</tr>
</tbody>
</table>
Example: BASERUN

Baserun
Base run
Land use intensity
Outcome for 1997

Rainfed cropland (%)
- 0—6
- 6—18
- 18—31
- 31—49
- 49—100

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Example: BASERUN

Baserun
Base run
Land use intensity
Outcome for 1997

Irrigated cropland (%)
- 0—5
- 5—19
- 19—43
- 43—65
- 65—100

© 2005 SOW—VU
Example: BASERUN

Baserun
Base run
Land use intensity
Outcome for 2030

Irrigated cropland (%)
- 0–5
- 5–20
- 20–43
- 43–64
- 64–99

© 2005 SOW—VU
### Example: BASERUN

#### Regional Budgets

**== South ==**

<table>
<thead>
<tr>
<th></th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value added at factor cost</td>
<td>1350.1</td>
<td>2234.5</td>
<td>3977.7</td>
<td>8079.7</td>
<td>14270.6</td>
</tr>
<tr>
<td>Agricultural value added</td>
<td>158.5</td>
<td>185.3</td>
<td>268.3</td>
<td>411.1</td>
<td>467.8</td>
</tr>
<tr>
<td>Taxes on ag. consumption</td>
<td>2.1</td>
<td>2.8</td>
<td>9.0</td>
<td>22.7</td>
<td>50.4</td>
</tr>
<tr>
<td>Taxes on ag. foreign trade</td>
<td>4.7</td>
<td>1.9</td>
<td>3.3</td>
<td>7.1</td>
<td>23.3</td>
</tr>
<tr>
<td>Taxes on ag. production</td>
<td>23.4</td>
<td>16.9</td>
<td>4.6</td>
<td>8.0</td>
<td>15.5</td>
</tr>
<tr>
<td>Income</td>
<td>1380.3</td>
<td>2256.1</td>
<td>3994.6</td>
<td>8117.5</td>
<td>14359.8</td>
</tr>
<tr>
<td>Private consumption value</td>
<td>851.3</td>
<td>1413.0</td>
<td>2406.1</td>
<td>4775.3</td>
<td>8257.5</td>
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<tr>
<td>Public consumption value</td>
<td>174.3</td>
<td>316.6</td>
<td>551.4</td>
<td>898.2</td>
<td>1267.0</td>
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<tr>
<td>Investment value</td>
<td>427.7</td>
<td>975.7</td>
<td>1837.7</td>
<td>3950.5</td>
<td>6764.5</td>
</tr>
<tr>
<td>Net stock increases</td>
<td>-14.8</td>
<td>-44.3</td>
<td>77.7</td>
<td>151.1</td>
<td>262.7</td>
</tr>
<tr>
<td>Trade and transport losses</td>
<td>11.7</td>
<td>11.4</td>
<td>12.1</td>
<td>13.8</td>
<td>13.3</td>
</tr>
<tr>
<td>Expenditures</td>
<td>1450.1</td>
<td>2672.4</td>
<td>4885.0</td>
<td>9788.9</td>
<td>16565.0</td>
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<tr>
<td>Income surplus</td>
<td>-69.8</td>
<td>-416.3</td>
<td>-890.4</td>
<td>-1671.5</td>
<td>-2205.2</td>
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</tbody>
</table>
## Household Indicators

<table>
<thead>
<tr>
<th></th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>North</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rural population</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Population in millions</td>
<td>210</td>
<td>203</td>
<td>194</td>
<td>179</td>
<td>155</td>
</tr>
<tr>
<td>Consumption value in Y/cap</td>
<td>1931</td>
<td>2071</td>
<td>2167</td>
<td>2322</td>
<td>2333</td>
</tr>
<tr>
<td>Grain consumption (kg/cap)</td>
<td>195</td>
<td>212</td>
<td>206</td>
<td>210</td>
<td>211</td>
</tr>
<tr>
<td>Meat+egg consumption (kg/cap)</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>47</td>
</tr>
<tr>
<td>Energy intake (Kcal/cap/day)</td>
<td>2679</td>
<td>2939</td>
<td>2913</td>
<td>2996</td>
<td>3033</td>
</tr>
<tr>
<td><strong>Urban population</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population in millions</td>
<td>95</td>
<td>114</td>
<td>136</td>
<td>164</td>
<td>193</td>
</tr>
<tr>
<td>Consumption value in Y/cap</td>
<td>5169</td>
<td>5517</td>
<td>5681</td>
<td>6079</td>
<td>6205</td>
</tr>
<tr>
<td>Grain consumption (kg/cap)</td>
<td>130</td>
<td>140</td>
<td>136</td>
<td>137</td>
<td>135</td>
</tr>
<tr>
<td>Meat+egg consumption (kg/cap)</td>
<td>71</td>
<td>80</td>
<td>92</td>
<td>105</td>
<td>123</td>
</tr>
<tr>
<td>Energy intake (Kcal/cap/day)</td>
<td>2591</td>
<td>2809</td>
<td>2856</td>
<td>2974</td>
<td>3085</td>
</tr>
</tbody>
</table>
## Example: BASERUN

### Commodity Balances in Volumes

#### -- China ------------------

<table>
<thead>
<tr>
<th>Milled rice (1000 Mt)</th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production excl seed &amp; waste</td>
<td>124601</td>
<td>122876</td>
<td>137791</td>
<td>146106</td>
<td>146608</td>
</tr>
<tr>
<td>Private consumption</td>
<td>120413</td>
<td>134140</td>
<td>134054</td>
<td>138876</td>
<td>137203</td>
</tr>
<tr>
<td>Net export</td>
<td>569</td>
<td>0</td>
<td>0</td>
<td>3493</td>
<td>5669</td>
</tr>
<tr>
<td>Net stock increase</td>
<td>-117</td>
<td>-15000</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Losses in trade&amp;transport</td>
<td>3737</td>
<td>3737</td>
<td>3737</td>
<td>3737</td>
<td>3737</td>
</tr>
</tbody>
</table>

#### Poultry meat (1000 Mt)

<table>
<thead>
<tr>
<th>Production excl waste</th>
<th>6478</th>
<th>8340</th>
<th>10835</th>
<th>14394</th>
<th>17501</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private consumption</td>
<td>6486</td>
<td>8358</td>
<td>10641</td>
<td>14303</td>
<td>19611</td>
</tr>
<tr>
<td>Net export</td>
<td>191</td>
<td>0</td>
<td>0</td>
<td>-104</td>
<td>-2305</td>
</tr>
<tr>
<td>Net stock increase</td>
<td>-394</td>
<td>-212</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Losses in trade&amp;transport</td>
<td>195</td>
<td>195</td>
<td>195</td>
<td>195</td>
<td>195</td>
</tr>
</tbody>
</table>
Baserun
Base run
Output intensity (volume per total ha)
Outcome for 1997
Example: BASERUN

The model produces detailed Regional commodity accounts and net trade flows

Net Imports from Abroad

<table>
<thead>
<tr>
<th>Sugar (1000 Mt)</th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>25.4</td>
<td>1020.0</td>
<td>1371.0</td>
<td>2468.0</td>
<td>2688.9</td>
</tr>
<tr>
<td>Northeast</td>
<td>35.5</td>
<td>413.4</td>
<td>529.9</td>
<td>652.9</td>
<td>898.2</td>
</tr>
<tr>
<td>East</td>
<td>8.1</td>
<td>279.4</td>
<td>354.2</td>
<td>305.4</td>
<td>478.1</td>
</tr>
<tr>
<td>South</td>
<td>325.1</td>
<td>1315.9</td>
<td>1635.9</td>
<td>1311.8</td>
<td>1609.2</td>
</tr>
<tr>
<td>China</td>
<td>394.1</td>
<td>3028.7</td>
<td>3891.1</td>
<td>4738.0</td>
<td>5674.3</td>
</tr>
</tbody>
</table>
### Regional Market Prices

#### Milled rice (Yuan per kg)

<table>
<thead>
<tr>
<th>Region</th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>2.324</td>
<td>1.923</td>
<td>2.168</td>
<td>2.052</td>
<td>1.865</td>
</tr>
<tr>
<td>Northeast</td>
<td>2.010</td>
<td>1.607</td>
<td>1.850</td>
<td>1.735</td>
<td>1.548</td>
</tr>
<tr>
<td>East</td>
<td>1.922</td>
<td>1.518</td>
<td>1.761</td>
<td>1.646</td>
<td>1.459</td>
</tr>
<tr>
<td>Central</td>
<td>1.760</td>
<td>1.359</td>
<td>1.603</td>
<td>1.488</td>
<td>1.301</td>
</tr>
<tr>
<td>South</td>
<td>2.276</td>
<td>1.875</td>
<td>2.120</td>
<td>2.004</td>
<td>1.817</td>
</tr>
<tr>
<td>Southwest</td>
<td>2.188</td>
<td>1.785</td>
<td>2.028</td>
<td>1.913</td>
<td>1.726</td>
</tr>
<tr>
<td>Plateau</td>
<td>2.377</td>
<td>1.976</td>
<td>2.221</td>
<td>2.105</td>
<td>1.918</td>
</tr>
<tr>
<td>Northwest</td>
<td>2.268</td>
<td>1.867</td>
<td>2.111</td>
<td>1.996</td>
<td>1.809</td>
</tr>
</tbody>
</table>

### Export and Import Prices

#### Milled rice (Yuan per kg)

<table>
<thead>
<tr>
<th>Type</th>
<th>1997</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>export prices fob</td>
<td>2.837</td>
<td>1.938</td>
<td>2.242</td>
<td>2.388</td>
<td>2.199</td>
</tr>
<tr>
<td>import prices cif</td>
<td>3.546</td>
<td>2.647</td>
<td>2.951</td>
<td>3.097</td>
<td>2.908</td>
</tr>
</tbody>
</table>
### Example: BASERUN vs LIBERAL

#### Agricultural Value Added

<table>
<thead>
<tr>
<th>Region</th>
<th>2003</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>0</td>
<td>-1.3</td>
<td>-4.6</td>
<td>-7.9</td>
</tr>
<tr>
<td>Northeast</td>
<td>0</td>
<td>-1.8</td>
<td>-4.8</td>
<td>-6.7</td>
</tr>
<tr>
<td>East</td>
<td>0</td>
<td>-0.8</td>
<td>-3.0</td>
<td>-10.3</td>
</tr>
<tr>
<td>Central</td>
<td>0</td>
<td>-0.7</td>
<td>-3.0</td>
<td>-6.8</td>
</tr>
<tr>
<td>South</td>
<td>0</td>
<td>-0.5</td>
<td>-7.3</td>
<td>-10.5</td>
</tr>
<tr>
<td>Southwest</td>
<td>0</td>
<td>-0.5</td>
<td>-5.5</td>
<td>-3.3</td>
</tr>
<tr>
<td>Plateau</td>
<td>0</td>
<td>-2.3</td>
<td>-8.2</td>
<td>-7.2</td>
</tr>
<tr>
<td>Northwest</td>
<td>0</td>
<td>-1.6</td>
<td>-5.2</td>
<td>-4.1</td>
</tr>
<tr>
<td>China</td>
<td>0</td>
<td>-0.9</td>
<td>-4.9</td>
<td>-7.5</td>
</tr>
</tbody>
</table>

#### Map of China

- **Provinces:** 34 provinces are divided into 11 regions:
  - Central
  - East
  - Northeast
  - North
  - Northwest
  - South
  - Southwest
  - Plateau
  - Central
  - East
  - North

- **Economic Regions:**
  - Central
  - East
  - North
  - Northeast
  - Northwest
  - Plateau
  - South
  - Southwest

The map shows the distribution of the regions across China, highlighting the economic performance and changes between 2003 and 2030.
Livestock Intensification

- Urbanization, expected large growth of per capita incomes, and the ongoing demographic transition in China will bring about major changes in consumption and production of livestock products.

- To meet the growing meat demand, China as many other countries, is rapidly moving from traditional natural resource based management to intensified peri-urban and urban production systems.

- The choice of options how to expand livestock production determines the vulnerability towards disease risk.

- Environmental impacts through nutrient burden from concentrated pig and poultry systems, where insufficient land is available for manure disposal and recycling, can cause land and water pollution.
Change of cultivated land (including orchards)

Nitrogen from manure of pigs and poultry in relation to stock of land for crop cultivation and orchards (kg N per ha)
Nutrient balance calculation

- County-specific supply/demand balances compare nutrients from livestock manure and chemical fertilizers with the requirements and uptake capacity of planted crops.

Total nutrients losses include:

- nutrient losses from livestock housing, from manure storage facilities, liquid manure,
- losses of non-effective manure and fertilizer use,
- losses due to over-supply of nutrients from fertilizers and manure to crops
- manure nutrients produced by pastoral livestock systems
Intensity of nitrogen ‘surplus’ (kg nutrients/ha total land)
Livestock Intensification

- The increasing meat demand can only be met through rapid introduction of intensified livestock systems. Pig stocks in intensified systems are estimated to increase 3 to 3.5 times, broilers 4.4 to 5 times, and layers 2 to 2.4 times.

- With high population and animal densities, in a mixture of still large numbers of backyard producers and a rapidly growing specialized meat sector, disease risks are a great concern.

- Due to further intensification of agricultural production in both crop and livestock sectors, we estimate that with current rates of efficiency the environmental pressures stemming from nutrient concentration and overload would increase by about 1/3.

- It is of high importance to improve fertilizer use efficiency and balance of nutrients, and to plan for environmentally adequate ways of livestock manure treatment and recycling.
Policy Recommendations:

• Support vertical integration of producers, processing, marketing
• Promote farmer associations
• Improve opportunities for rural residents to work off the farm
• Improve land rental conditions of cultivated land
• Invest in agricultural research and technology to sustain productivity improvements
• Enhance productivity through supporting/promoting water-saving technologies and institutional innovations
Policy Recommendations:

Resources:

- Provide incentives to limit conversion/loss of high potential agricultural areas.
- Reduce environmental impacts of agriculture (pollution, erosion, degradation, overgrazing, biodiversity loss, emissions).
- Minimize livestock intensification hazards (nutrient overload; disease risk).
- Foster adaptation to climate change (excess moisture in the South; increased irrigation water requirements in the North).
THANK YOU!

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