Prospects of Chinese Grain Supply and Demand in 2010:

A Regionalized Multimarket Model Simulation and Policy Implication

Wencong Lu

Centre for Agricultural and Rural Development (CARD),
Zhejiang University, Hua-Jia-Chi Campus, 310029 Hangzhou, China
Tel: +86-571-86971587; Fax: +86-571-86971646; Email: wenclu@zju.edu.cn

and

Lutz Kersten

Institute of Market Analysis and Agricultural Trade Policy
Federal Agricultural Research Centre (FAL), Bundesallee 50, 38116 Braunschweig, Germany
Tel.: +49-531-5965333; Fax: +49-531-5965399; Email: lutz.kersten@fal.de

**Poster paper prepared for presentation at the International
Association of Agricultural Economists Conference, Gold Coast, Australia,
August 12-18, 2006**

Prospects of Chinese Grain Supply and Demand in 2010:

A Regionalized Multimarket Model Simulation and Policy Implication[*]

Abstract: Based on China's Agricultural Regional Market Equilibrium Model (CARMEM), the paper projects the production and consumption of rice, wheat and maize in China toward 2010 at both national and regional level under two different scenarios. The results show that China can ensure a stable grain market development under more liberalized internal and external conditions. Transmission of the world market prices as projected by the World Bank (2003) to the Chinese domestic market would lead to a long-run recovery of the growth in grain production. Total production of paddy rice, wheat and maize is forecast to increase from 386 million tons in the base period 2002 to over 420 million tons in 2010. However, the rate of grain self-supply will be 91% due to higher demand. This may be significantly lower than the target of the Chinese government. The corresponding deficit would amount to about 35 million tons, to be compared with 38.5 million tons in 2002 when China had huge grain stocks available. Three fifths of the grain deficit is wheat. China would also become a net importer of maize. The regional results indicate an increasing grain deficit in East and South China. Northeast and North China will achieve higher production growth mainly due to a rapid increase in maize production. The Central South will be able to increase production faster than consumption. The Southwest and Northwest will maintain their current deficit. Finally, some implications for future Chinese grain policies are discussed.

Key words: China, grain market, projection, multimarket model, policy

JEL codes Q11, Q13, Q18

1. Introduction

Stable and sustainable growth in grain production is thought to be of fundamental importance for food security in China where farmland is scarce and the large population continues to grow though at a decreasing rate. In the late 1970s, a comprehensive agricultural market policy reform was initiated. Since then, the policy of grain procurement quota has been abolished in most Chinese provinces and the grain market has been nationally and internationally integrated to some extent. In the late 1990s, Chinese grain market situation changed from long-term deficit to nearly full self-sufficiency, which had once brought an optimistic view on future grain security in China. However, the continuous decrease of domestic grain production since 1998 coupled with rapidly reduced grain stocks, especially

climbing domestic prices since 2003, has triggered new nation-wide concerns about future grain supplies in China. The key question being asked in this context in political and academic discussions is whether grain production can keep pace with expanding demand.

Since Lester Brown (1995) raised the question "Who will feed China"[1], a number of simulation models have been applied to answer this question such as IMPACT（Rosegrant et al., 1995）, CPPA（USDA, 1997）, WFM（FAO, 1995）, OECF（OECF, 1995）, GTAP（Anderson et al., 1996） and GORLS（Kersten, 1998）. A general review with discussion is given in Fan and Agcaoili-Sombilla (1997). The results of the analyses as included in the survey differ widely due to model structure, parameters and other data and assumptions underlying the analyses. Recently, Huang (2004) applied the CAPSiM model to simulate future grain demand and supply in China under some different scenarios, but the analysis model treated China also as only one region. China is a very large country as far as area, population and the agricultural sector are concerned. There are significant regional differences in factors that impact on production, consumption, trade and prices of agricultural products. Therefore, it appears recommendable to take account of regional aspects in the deliberations on agricultural market developments in China. For this purpose, we have developed a regionalized agricultural multi-market model for China called "China's Agricultural Regional Market Equilibrium Model (CARMEM)", in order to project production and consumption of agricultural products in China until 2010. In this paper, only the results for wheat, maize and paddy rice are presented. First, the model structure and data sources are described briefly. Second, the projection results as obtained in two scenarios are presented. Finally, some implications from the simulation results are discussed for future grain security and market policies in China.

2. Model structure and data source

The model CARMEM is based on the Swopsim modeling framework as described in ERS-USDA in 1992 (Sullivan et al.) and on Tyers' GLS model in the form described in Tyers

---

[1] Brown (1995) hold that China's grain production will decrease dramatically due to losing farmland available caused by rural industrialization and water shortage while grain demand will increase much fast than the population. Finally Chinese grain import will rise dramatically and may exceed total supply capacity of the world market.

and Anderson (1992). The model CARMEM covers various products from the grains-oilseeds-livestock sectors in China, including wheat, corn, paddy rice, soybeans, rapeseed, cotton, sugar, roots and tubers, vegetable oils and meals, beef, mutton, pork, poultry, eggs, milk and milk products. Processing is included for oilseeds and milk. The 32 provinces of the PR China are aggregated into seven regions, namely North China (Beijing, Tianjing, Hebei, Shanxi and Inner Mongolian), Northeast (Liaoning, Jilin and Heilongjiang), East China (Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi and Shandong), Central South (Henan, Hubei and Hunan), South China (Guangdong, Guangxi and Hainan), Southwest (Choqing, Sichuan, Guizhou, Yunnan and Tibet) and Northwest (Shanxi, Gansu, Qinghai, Ningxia and Xinjiang). It is variable in terms of both the regional and commodity coverage. The model is embedded in a spreadsheet file, with one worksheet for each region and an additional worksheet for the market clearing mechanism. The seven regional models are first established and then linked by international-national-regional price transmissions to be a regionalized model at national level.

Table 1: Main equations and the variables and parameters in the model CARMEM

Equations	
	(1) Supply: $S_{i,t}^k = S_{i,to}^k \left(1 + a_{i,to}^k\right)\left(1 + r_i^k\right)^t \prod_h \left(\dfrac{R_{i,t}^h}{R_{i,to}^h}\right)^{\eta^{kh}}$
	(2) Demand: $D_{i,t}^k = D_{i,0}^k \left(\dfrac{POP_{i,t}}{POP_{i,0}}\right)\left(\dfrac{Y_{i,t}}{Y_{i,0}}\right)^{\delta^k} \prod_h \left(\dfrac{P_{i,t}^h}{P_{i,0}^h}\right)^{\varepsilon^{kh}} \prod_l \left(\dfrac{S_{i,t}^l}{S_{i,0}^l}\right)^{\varepsilon^{kl}}$
	$D_{i,0}^k = SC_{i,0}^k + RC_{i,0}^k + F_{i,0}^k + I_{i,0}^k + Z_{i,0}^k$
	(3) Price transmissions: $NP_t^k = NP_{t0}^k \left(\dfrac{WP_t^k}{WP_{t0}^k}\right)^{b_j}\left(\dfrac{EXR_t}{EXR_{t0}}\right)$
	$P_{i,t}^k = P_{i,t0}^k \left(1 + \lambda_{i,t}^k \left(\dfrac{NP_t^k}{NP_{t0}^k} - 1\right)\right)$
	(4) Exogenous variables: $Y_{i,t} = \dfrac{GDP_{i,0}\left(1 + GDPR_{i,t}\right)^n}{POP_{i,0}\left(1 + POPR_{i,t}\right)^n}$
	(5) Equilibrium: $\sum_i S_{i,t}^k - \sum_i D_{i,t}^k - \sum_i \Delta ST_{i,t}^k = \sum_i NT_{i,t}^k$

Variables and parameters	S = supply, a = shift factor, r = autonomous growth, R = producer price, to = base period, t = period, k, h = product, i = region, and η = supply elasticity, D = demand, POP = population, Y = income (GDP per capita), P = market price, SL = livestock products supply, f, g = product, δ = income elasticity of demand, ε = price elasticity of demand, γ = feed elasticity of demand, RC = rural direct consumption, SC = urban direct consumption, F = feed use; I = manufactured use and waste, Z = seed use, NP = national price for product, WP= world market price, b = transmission elasticity from the world market to the national market. λ = transmission elasticity from the national to the regional market, POPR = population growth rate, GDPR = GDP growth rate, EXR = exchange rate; ΔST = stock change; NT = net trade.

The model is a system of supply and demand equations, price transmission, exogenous variables and market Equilibrium conditions, totally including more than 840 mathematic equations. The table 1 shows the main functions. The regional supply of a product in period t is a function of supply in the base period, an external shift factor which may stand for a policy measure or an external disturbing factor, an annual growth rate due to technical progress or other external factors, and by changes in own and cross prices according to the respective elasticities. The regional demand functions for the products are established along the same principles, in this case with income Y and population POP as the external shifters of the function and δ as the income elasticity and ε as the price elasticity of demand. The demand for agricultural products, which are fed to livestock, depends also on the development of animal production. The regional producer and consumer prices are linked with the respective world market prices through the "national price" and the international-national-regional price transmissions. In the model, both domestic and world market prices are initialized at one for the base period in all regions. The national price is transferred to the regions in the same manner. The model is solved either for pre-fixed net-trade restrictions using the solver or by transmitting world market prices to the national and regional markets. Therefore, the structure of the model CARMEM highlights the interdependence of agricultural production, consumption, trade and price between different products and regions in China, and thus is capable to service as a research tool in the analysis of regional performance in Chinese agricultural market by changes in economic and policy structure of this country and its regions.

The current version of the model CARMEM is based on the data in the year 2002 which are taken from different official statistics. The regional production of each product is taken directly from "China Statistic Yearbook 2003" of the Chinese National Bureau of Statistics

(NBS). The regional product-specific consumption is a sum of rural direct consumption, urban direct consumption, feed use, seed use, manufactured use and waste which are calculated from the statistical data in "China Statistic Yearbook 2003", "China Rural Household Survey Yearbook 2003" and "Yearbook of China Prices and Survey of Urban Household" of the NBS and "China Domestic Balance of Agricultural Products" of the Chinese Ministry of Agriculture. Despite some Chinese agricultural statistics lack somewhat fidelity, the statistic data used in the model are not revised, in order to keep a comparability of the model results with the statistics. Because official statistic data in terms of grain stocks are not available, the results of the model simulation will not demonstrate here the national net trade, but only the information about grain deficit or surplus at national and regional level. The population growth rates toward 2010 are taken from the Chinese Population Projection by the National Population and Family Planning Commission of China. The elasticities and technical coefficients used in the model are taken from past studies as referred to before and adjusted if felt necessary. Feed demand coefficients and extraction rates are taken from past studies. Table 2 shows some economic and natural characteristics in the model regions.

Table 2: Key indicators for the Chinese regions in 2002

	North	Northeast	East	Central	South	Southwest	Northwest
Total Population (million)	149	108	370	224	136	204	93
Urban population (% of total population)	38.8	52.1	39.7	29.7	44.5	26.3	30.4
Population density (persons/kilometer^2)	95.7	134.7	468.8	396.9	298.0	86.7	30.6
GDP (100 million Yuan)	15138	11587	45090	15485	14829	10425	5466
GDP per capita (Yuan)	10128	10735	12176	6915	10918	5119	5852
Agricultural share of GDP (%)	11.3	12.8	11.7	18.36	12.5	20.5	16.9
Farmland per capita (ha)	0.138	0.199	0.069	0.076	0.062	0.102	0.173

Source: China Statistic Yearbook 2002; own calculations.

3. Model scenarios and simulation results

After a comprehensive agricultural policy reform initiated in the late 1970s, especially the abolishment of the grain procurement quota policy in most Chinese province in 2001 and the reduction of agricultural protection by joining the WTO in 2001, a market-oriented mechanism for grain resource allocation has been established in China to some extent. As further grain market policy reform, Chinese domestic grain market will be further nationally and internationally integrated. Under this background, for China as a country where the

population and economic growth will continue to keep at a high rate in the next decade, it is necessary for a reasonable estimation of its changes in agricultural market supply and demand in the medium to long term to consider the effect of farmland loss [2] due to high economic growth on agricultural production capacity and the impacts of further growing population and increasing income on food demand and its structural shift. Moreover, the impacts of changes in the world market on the domestic market have to be taken into account. Based on this consideration, two scenarios are used to simulate grain market developments toward 2010 (Table 3).

Table 3   Assumptions for the model simulation scenarios

Assumptions	Baseline scenario	Price scenario
1) Annual growth rate of GDP = 7.5%	○	○
2) RMB exchange rate unchanged	○	○
3) 2% farmland decrease in 2010 against the base year 2002	○	○
4) World market price change in 2010 against the base year 2002		○

In the baseline, it is assumed that regional economic and population growth of the recent past continues. The product prices remain unchanged. The second scenario takes the real product prices as projected by the WORLD BANK (GEP 2004, pp 275-276) [3]. The price scenario uses the world agricultural prices in current dollars (current prices deflated by the MUV index, 1990=100) as given by the World Bank. The Table 4 shows the world grain prices for grains with projections to 2010.

Table 4: World market prices for grains with projections to 2010

Product	1970	1980	1990	2000	2002	2005	2010
				(in constant USD)			
Maize	208.2	159.0	109.3	91.0	102.9	97.1	102.6
Rice	450.3	521.4	270.9	208.0	198.9	209.5	215.1
Wheat	195.7	219.3	135.5	117.2	153.5	132.8	141.7

Note: World Bank projections as of June 24, 2003.- As for product definitions, see source.
Source: World Bank (2003): GEP 2004, p. 276.

---

[2] According to the official statistics of the Ministry of Land and Resources of China, farmland totalled 123.4 million hectares by the end of 2003, dropping 6.7 million hectares since 1996. Urban expansion, industrial construction, and highway construction are all shrinking the land available for crops.
[3] According to the World Bank (2003), the world market price for almost all products covered in this model is expected to strengthen over the projection period in nominal terms, but to continue to trend downwards in real terms. Here the projected real world market prices for grains, sugar, soybean, soybeanmeal, soybeanoil, cotton and beef are used as the expected world prices in this model simulation. In addition, a 5% price decrease for pork, poultry, eggs and 5% price increase for milk in 2010 against the base year 2002 are also assumed.

In the following sections, the results of the model simulation in the two scenarios are only presented for the Chinese grain market at national and regional level.[4] In order to show the projected changes against the base year, the real grain market situation in 2002 is also presented in the following tables. It should be kept in mind that the regionalization is a first step only because most of the data are preliminary estimates.

(1) Grain total

Since 1998 China has experienced a remarkably continuous decrease in grain production. Total production of the three important grains which are included here (wheat, rice and maize) has fallen from 442 million tons in 1998 to 386 million tons in 2002. The fall in China's grain harvest is largely due to the reduction of the harvested area from 62 million hectares in 1998 to 54 million hectares in 2002. Yields, after a long period of increasing, have stagnated since the end 1990s. Several trends are converging to reduce the grain area, including the conversion of cropland to nonfarm uses, the shift to higher-value crops, and a decline in double-cropping due to the abolishment of the grain procurement quota policy as started in 2001 in the more prosperous coastal provinces. It is assumed that these changes are lasting. On the other hand, grain consumption in China is expanding. It reached 423 million tons in 2002. The rate of grain self-sufficiency dropped to only 90% with a domestic deficit of 38 million tons, of which 66%, 22% and 2% are wheat, rice and maize, respectively. This implies that Chinese domestic grain supply in recent years has depended considerably on the utilization of the large stocks. Thus, China's grain imports could be limited to relatively small quantities.

As shown in Table 5, production of the three included grains is forecast to rise from 386 million tons in 2002 to 421 million tons in 2010 in the baseline. Aggregate grain demand is projected to reach 477 million tons by 2010. The gap between projected production and consumption implies a rising deficit, so that the rate of grain self sufficiency will fall from 89.4% in 2002 to 88.3% in 2010. In the price scenario, grain production is projected to reach 429 million tons in 2010, so that the deficit will fall below the level reached in 2002 and the self-sufficiency rate will rise at least by 1.5%. It is thus expected that grain production will

---

[4] Due to the structure and specialty of the model CARMEM, the above simulated outcome has included the demand and supply, price and other derivative information of all 18 kinds of agricultural products in China and

recover in China if the domestic grain market is further integrated into the world market. This notwithstanding, a deficit of 42 millions tons will have to be covered by imports from international markets.

Table 5: Chinese regional grain market situation in 2002 and 2010 (million tons)

| | 2002 Basis | | | | 2010 Projection | | | | | | | |
| | | | | | Baseline Scenario | | | | Price Scenario | | | |
	P	C	B	SSR	P	C	B	SSR	P	C	B	SSR
North China	40.7	46.5	-5.8	87.6	46.0	52.4	-6.4	87.8	46.9	52.0	-5.1	90.2
Northeast	52.7	35.9	16.9	147.1	57.2	38.9	18.3	147.0	59.6	38.3	21.3	155.6
East China	109.4	129.0	-19.6	84.8	117.9	141.5	-23.6	83.3	118.7	139.8	-21.1	84.9
Central South	78.4	82.2	-3.8	95.4	86.0	90.3	-4.4	95.2	87.4	89.0	-1.6	98.2
South China	27.9	41.2	-13.3	67.7	30.1	45.9	-15.8	65.7	30.6	45.2	-14.6	67.8
Southwest	52.2	67.9	-15.8	76.8	56.6	75.3	-18.7	75.2	57.3	73.8	-16.5	77.6
Northwest	25.0	29.5	-4.5	84.7	27.9	33.3	-5.4	83.8	28.3	32.9	-4.7	85.9
National	386.3	432.1	-45.8	89.4	421.8	477.7	-55.9	88.3	428.9	471.1	-42.2	91.0

Note: P = production, C = consumption, B = production - consumption, SSR = self-sufficiency rate in %.
Source: China Statistic Yearbook 2002; own calculations

As for the seven regions of China, except the Northeast, all other regions were in a deficit position in 2002. This applies especially to South China and the Southwest where the self-sufficiency ratio was below 70% and 50%, respectively. According to the projections, grain production in North China and Northeast will grow faster than consumption in both scenarios, which results in an increasing surplus in Northeast and a slightly higher self-sufficiency ratio in North China. Only under the price scenario, the production in Southwest, Central South and Northwest is expected to increase more than consumption, so that the Central-South will tend to reach its grain self-sufficiency and the Southwest and Northwest can slightly raise their rate of grain self-sufficiency. In both scenarios, the current gap between supply and demand in East and South China is expected to widen untill 2010. The regional differences in the grain markets will be further exacerbated if increasing labor migration from western to south-eastern provinces is taken into account.

(2) Rice

Rice is the most important grain crop in China contributing more than 40% of total grain output. China's rice production had been decreasing from 199 million tons in 1998 to 175 million tons in 2002. Total consumption in 2002 reached 193.5 million tons, thus a domestic

---

its seven regions in 2010. This essay just concerns the relevant information about grain supply and demand.

deficit of 18.5 million tons emerged (Table 6). Traditionally, China was self-sufficient in rice with small imports and exports. According to the baseline scenario, it is expected that China will produce 187 million tons paddy rice and consume 209 million tons in 2010. The higher growth in consumption will lead to a rice deficit increasing to over 21 million tons. In the price scenario, China's paddy rice production is forecast to increase by 9% to 192 million tons while consumption will slightly rise to 201 million tons in 2010. As a result, an increase in the rice self-sufficiency ratio by about 4% is expected; the total domestic deficit, compared with the baseline, will fall by more than 8 million tons to about 10 million tons. This suggests that China still has a relatively stable potential for the production of rice despite contracting farmland.

Table 6: Chinese regional rice market situation in 2002 and 2010 (million tons)

| | 2002 Basis | | | | 2010 Projection | | | | | | | |
| | | | | | Baseline Scenario | | | | Price Scenario | | | |
	P	C	B	SSR	P	C	B	SSR	P	C	B	SSR
North China	1.3	12.2	-11.0	10.4	1.4	13.4	-11.9	10.6	1.5	12.8	-11.4	11.3
Northeast	17.0	15.7	1.3	108.3	18.3	16.5	1.8	111.1	18.8	15.8	3.0	119.2
East China	60.4	63.6	-3.2	95.0	63.6	68.1	-4.4	93.5	64.5	66.2	-1.7	97.5
Central South	39.3	39.1	0.1	100.3	42.0	42.3	-0.3	99.3	43.4	40.8	2.6	106.3
South China	25.6	25.9	-0.2	99.0	27.6	28.3	-0.7	97.6	28.0	27.5	0.5	101.8
Southwest	28.9	28.9	0.0	100.0	31.4	31.2	0.1	100.4	32.4	29.7	2.7	109.0
Northwest	2.6	8.1	-5.5	31.7	2.8	9.1	-6.3	31.0	2.9	8.8	-5.9	32.8
National	175.0	193.5	-18.5	90.4	187.1	208.8	-21.7	89.6	191.5	201.6	-10.1	95.0

Note: P = production, C = consumption, B = production - consumption, SSR = self-sufficiency rate in %.
Source: China Statistic Yearbook 2002; own calculations

Rice is the main grain crop in East China where more than one third of total Chinese rice output is grown. In this region, its own production has been lower than consumption since the end 1990s. The baseline projection shows that East China will have a limited growth in rice production, but an increasing deficit toward 2010. The self-sufficiency ratio is forecast to fall from 95% in 2002 to 93.5% in 2010. On the other hand, as the price scenario shows, it is expected that the growth in production will be higher than in consumption, so that the projected rice price change in the world market could lead to a 4% increase of the rice self-sufficiency ratio in the region East China.

In 2002, North China had the largest rice deficit of all regions, but its consumption accounted for only 6% of the national demand. According to the model results, the future relation

between production and demand for rice in North China will be constant, and the self-sufficiency ratio will remain at 11%. Similar results are obtained for the region Northwest. As China's only region with a rice surplus in 2002, the Northeast will expand its rice surplus because of higher production growth under the two scenarios. The regions Southwest, South China and Central-South, where supply and demand of rice is almost in balance, will realize a higher production growth and thus achieve a rice surplus in the price scenario.

(3) Wheat

Because of a tendency downward since 1998, China's wheat production dropped to 90 million tons in 2002, about 27% lower than the output in 1997, but consumption was above 115 million tons in 2002. This resulted in a deficit of 25.4 million tons or 57% of the total domestic grain deficit in 2002. The model results show that production will increase slightly faster than consumption until 2010 in both scenarios (Table 7). Changes in the wheat market will be really small so that, more or less, the situation will stay where it was in the base period. However, to cover the expected domestic deficit, more wheat will have to be imported in 2010. In 2002, the gap between domestic production and consumption could be closed by drawing down abundantly available stocks.

Table 7: Chinese regional wheat market situation in 2002 and 2010 (million tons)

| | 2002 Basis | | | | 2010 Projection | | | | | | | |
| | | | | | Baseline Scenario | | | | Price Scenario | | | |
	P	C	B	SSR	P	C	B	SSR	P	C	B	SSR
North China	15.3	16.4	-1.0	93.6	17.6	18.0	-0.4	97.6	17.5	18.3	-0.8	95.4
Northeast	1.1	6.0	-4.9	18.2	1.2	6.3	-5.1	19.8	1.2	6.4	-5.2	19.2
East China	29.2	31.0	-1.8	94.2	32.3	33.6	-1.4	95.9	31.9	34.0	-2.0	94.0
Central South	24.2	19.7	4.5	122.8	27.3	21.2	6.1	128.6	26.9	21.6	5.3	124.5
South China	0.1	7.1	-7.0	1.4	0.1	7.9	-7.8	1.4	0.1	8.0	-7.9	1.4
Southwest	8.0	21.2	-13.2	37.8	9.1	23.2	-14.1	39.1	9.0	23.3	-14.4	38.5
Northwest	12.0	14.7	-2.8	81.3	13.5	16.3	-2.8	82.9	13.4	16.4	-3.0	81.8
National	89.9	116.1	-26.2	77.4	101.1	126.7	-25.6	79.8	100.0	128.1	-28.1	78.1

Note: P = production, C = consumption, B = production - consumption, SSR = self-sufficiency rate in %.
Source: China Statistic Yearbook 2002.- Own calculations.

The Central South is the only region with a wheat surplus in China. The region is projected to have a significant growth of production under both scenarios. Its current 4.5 million tons wheat surplus could be maintained despite in the baseline scenario. North China is expected to achieve a higher growth in production than in consumption, so that its current deficit will

be reduced and the supply and demand will be almost in balance. Northeast, Northwest and East China will keep their own deficit level of the base year until 2010. In the Southwest, where the deficit amounts to 50% of the national wheat deficit in 2002, the rate of wheat self-sufficiency will keep its current level with 38% under two scenarios. Therefore, a production expansion in this region will be of importance for future domestic market stability in China. Wheat demand in South China is expected to expand from 7 million tons in 2002 to 7.6 million tons in 2010, but the supply has to be imported from other regions and the world market since regional wheat production is very small indeed.

(4) Maize

In 2002, China produced 121.4 million tons of maize and consumed 122.5 million tons, which was a well equilibrated market situation. Under the baseline scenario it is expected that total maize production will grow by 10% to over 133.5 million tons in 2010 while demand will expand by 16% to 142 million tons. A domestic deficit of 4 million tons will come up in the price scenario. Therefore, although China's maize production will achieve high growth rates, it will not be able to keep pace with the higher demand expansion. Therefore, China will become a net importer of maize in the projection period mainly due to expanding feed demand.

The existing regional pattern of the maize market in China, which is characterized by a surplus in the north and a deficit in the south, does not change much in the scenarios for 2010. Northeast, North China and Northwest, which produced more than 70% of the national maize output in 2002, are projected to further increase production. Moreover, the projected growth in these three regions will be higher in the price scenario than in the baseline situation, which reveals the price impact on production. On the other hand, the existing maize deficit in the southern regions is expected to widen rapidly as demand is expanding faster than production. This especially applies to Southwest and East China.

Table 8: Chinese regional maize market situation in 2002 and 2010 (million tons)

| | 2002 Basis | | | | 2010 Projection | | | | | | | |
| | | | | | Baseline Scenario | | | | Price Scenario | | | |
	P	C	B	SSR	P	C	B	SSR	P	C	B	SSR
North China	24.1	17.9	6.2	134.8	27.0	21.0	6.0	128.5	28.0	20.9	7.1	133.9
Northeast	34.7	14.2	20.5	244.0	37.7	16.2	21.5	233.4	39.5	16.1	23.5	246.1
East China	19.8	34.4	-14.6	57.4	22.0	39.8	-17.8	55.2	22.2	39.6	-17.4	56.1
Central South	15.0	23.3	-8.4	64.1	16.7	26.8	-10.2	62.1	17.2	26.6	-9.4	64.5
South China	2.2	8.2	-6.0	26.6	2.4	9.7	-7.2	25.1	2.5	9.6	-7.1	26.0
Southwest	15.3	17.9	-2.6	85.5	16.2	20.9	-4.7	77.7	15.9	20.8	-4.9	76.6
Northwest	10.4	6.6	3.8	157.1	11.5	7.8	3.7	147.4	12.0	7.8	4.2	154.2
National	121.4	122.5	-1.1	99.1	133.5	142.1	-8.6	93.9	137.4	141.4	-4.0	97.2

Note: P = production, C = consumption, B = production - consumption, SSR = self-sufficiency rate in %.
Source: China Statistic Yearbook 2002.- Own calculations.

4. Conclusions and policy implication

The model results for the Chinese grain market indicate that production could follow total consumption continually in the next years. Total production of paddy rice, wheat and maize will increase to over 420 million tons in 2010. This implies that a recovery of the growth in grain production could be realised if the World Bank's projected world market prices are transmitted into the internal market. However, the growth in production will be still lower than in consumption. The country's deficit would amount to 43 million tons, to be compared with 46 million tons in 2002 when China had huge grain stocks available, and 56 million tons in the baseline projection. The self-sufficiency ratio will be around 90%, i.e., 88% in the baseline and 91% in the price scenario. China will become a net importer of maize. Three fifths of the grain deficit, however, is wheat. Moreover, the expected changes in Chinese grain market possess also some regional characteristics as far as the regional results are concerned. In East and South China, the gap between grain production and consumption will widen through time, but less so in the price scenario than in the baseline. An increasing grain deficit in East and South China will emerge. Northeast and North China will achieve a higher production growth mainly due to a rapid increase in maize production. The Central South will be able to improve its supply situation. The Southwest and Northwest will maintain the level of their existing deficit. The model results imply that Chinese grain security will remain a serious challenge in the projection period. From the preceding grain market analysis, the

following points may be derived as important components of future Chinese grain market policies:

(1) Though the legal system for farmland protection in China have been improved, high-yielding farmland has still been converted to nonfarm use by rapid urbanization and industrialization during recent years. As the Chinese economy continues to grow at high rates, the assumption of 2% farmland loss toward 2010 in the model simulation is still quite moderate if a loss of farmland on a similar scale as in the last decade will be the result. To stop the loss of farmland, the Chinese government should take legal measures to keep farmland in agricultural production, and it should also establish a market system for farmland exchange in order to raise the efficiency of land use. The last mentioned measure will be not only an important prerequisite for maintaining future capacity of grain production growth, but also a main challenge for Chinese agricultural reform.

(2) The model results show that there is a significant regional difference in Chinese domestic grain market, which suggests that interregional grain market integration in China could contribute to considerably improve future grain supply. The target of grain self-sufficiency at regional level should be abandoned. The government should also remove the existing internal trade barriers and integrate the regional grain markets as fast as possible, in order to allow free grain trade between the regions in China. For this purpose, the government should encourage private traders to enter the market, especially in the surplus regions. On the other hand, China should adapt the regional structure and scale of the state grain stocks to the changing market situation especially in deficit regions to improve the effectiveness of grain market policies.

(3) The model results demonstrate a significant effect of price changes on grain supply and demand in China. In particular in times of production shortfalls there is obviously a conflict between short-term stabilization through releasing stocks and medium- to long-term adjustments through the response of supply and demand to market signals. Government policies should allow the market enough scope for adjustment, viz. less intervention, more reliance on the market solution.

(4) Because it must be expected that China's self-sufficiency in grains will fall below 95% in this decade, it is necessary for China to establish a better international cooperation for its grain supply security. Normally, China will be able to procure the imports to cover the

domestic deficit. However, there may emerge certain circumstances, be it natural, political or otherwise, that could prevent China from importing the required quantities of grains. Therefore, first deliberations could go in the direction to use the WTO import quotas as a favorable starting-point on which to build a strategic cooperation in grain trade with other countries.

References

Anderson, K., et al. (1996): Asia-Pacific Food Markets and Trade in 2005: A Global, economy-wide Perspective. Paper commissioned for the International General Meeting of the Pacific Basin Economic Council, May 20-22, Washington, D.C.

Brown L. (1995): Who Will Feed China: Make Up Call for a Small Planet. New York: W.W. Norton and Company Inc.

ERS/USDA (1996): International Agricultural Baseline Projections to 2005. ERS Staff Paper No 9612, Washington DC.

Fan F., Agcaoili-Sombilla M.: (1997) Why Do Projections on China's Food Supply and Demand Differ? EPTD Discussion Paper No. 22. IFPRI, Washington DC.

Food and Agricultural Organisation of the United Nations (1995): Impact of Uraguay Round on Agriculture. Rome.

Huang, J. K. (2004): Past and Future of China's Agriculture. Management World, No. 3, 2004.

Kersten L. (1997): Spatial and Regional Model Analyses of the World Grain Market. German Federal Agricultural Research Centre. IflM-Arbeitsbericht 97/1, Braunschweig.

Kersten L. (1998): Annotated Illustrations to China's Future Role in the World Grain Market. German Federal Agricultural Research Centre, IflM-Arbeitsbericht 98/1, Braunschweig.

OECF (1995): Prospects Grain Supply-Demand and Agricultural Development Policy in China. OECF Discussion Papers No 6, Overseas Economic Cooperation Fund, Tokyo, Japan.

Roningen, V. (1997): Multi-Market, Multi-Region Partial Equilibrium Modeling. In Francois J.F., Reinert K.A. (eds) Applied Methods for trade Analysis. A Handbook. Cambridge University Press: Cambridge, UK.

Rosegrant, M., M. Agcaoili-Sombilla and N. Perez (1995): Global Food Projections to 2020: Implication for Investiment. Discussion Paper No. 5., IFPRI, Washington DC.

Sullivan J., Roningen V., Leetma S., Gray D. (1992): A 1989 Global Database for the Static World Policy Simulation (SWOPSIM) Modeling Framework. ERS-USDA Staff Report No. AGES 9215. Washington, D.C.

Tyers R., Anderson K. (1992): Disarray in World Food Markets: A Quantitative Assessment. Cambridge University Press: Cambridge, UK.

Tyers R. (1994): Economic Reform in Europe and the Former Soviet Union: Implications for International Food Markets. IFPRI. Research Report 99. Washington, D.C.

World Bank (2003): Global Economic Prospects: Realizing the Development Promise of the Doha Agenda. Washington, DC.