

# Feeding China in

*Although China has a large agricultural resource base and a solid record of productivity increases in past decades, fundamental changes in its national food policies are needed to ensure future food security, accommodate changing urban food preferences, mitigate widening rural–urban and regional income disparities, and prevent massive environmental pollution.*

*In 2001, the year China acceded to the World Trade Organization (WTO), IIASA’s Land Use Change (LUC) Program began a research project, funded by the European Commission, entitled Policy Decision Support for*



*Sustainable Adaptation of China’s Agriculture to Globalization (CHINAGRO).<sup>1</sup> Based on the analysis of a range of development and policy scenarios over a 30-year time horizon, CHINAGRO aimed to establish an informed policy dialogue between Chinese and European Union (EU) institutions to improve food security, farmers’ income, and sustainable agricultural development in China.*

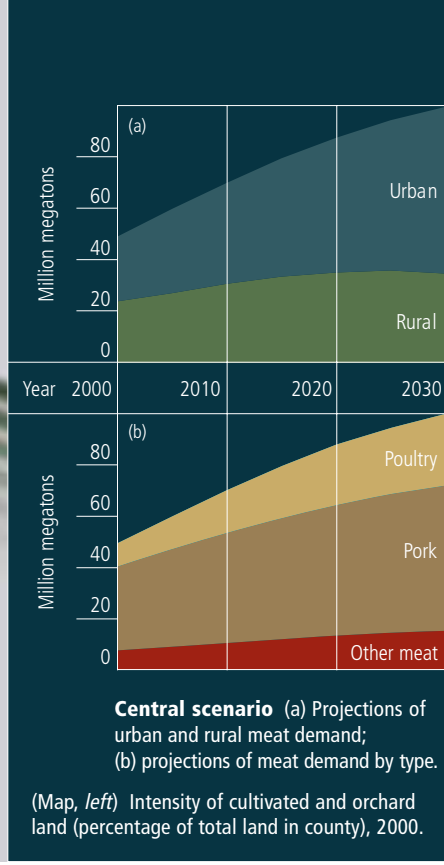
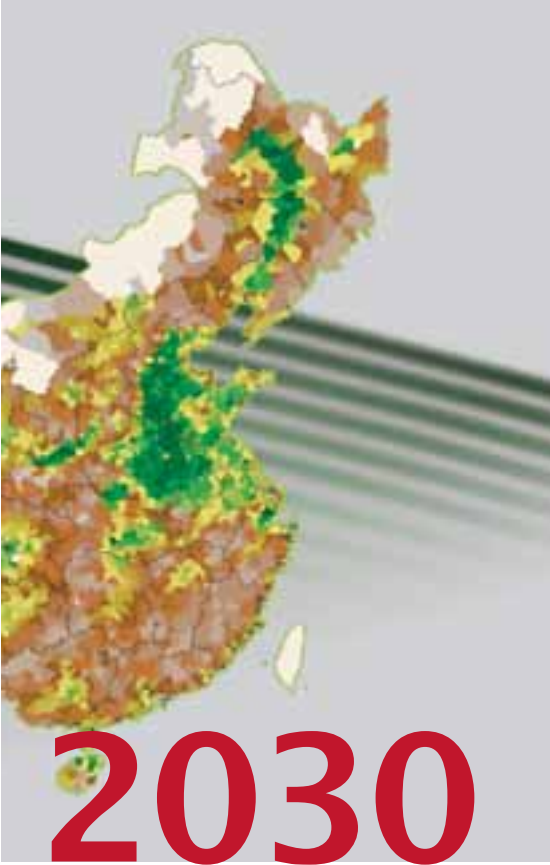
*In this article, Günther Fischer, leader of the LUC Program, looks at the challenges China faces as a result of the removal of international trade barriers, shrinking farmland, rapid urbanization, increasing urban–rural and provincial income disparities, and changes in the food-demand structure—and how these challenges can be met.*

In the past 50 years, China has successfully increased the supply of food and fiber to meet the needs of its rapidly growing population. Since the early 1980s, China has also shifted from being a net food importer to a net food exporter, which has significantly contributed to world food security.

China’s accession to the WTO in 2001 enabled the country to start opening up to international food markets. From a trade perspective, however, and in the light of Chinese consumers’ fast-rising demand for animal proteins, the key policy concern was whether the country should aim at self-sufficiency in cereals and meat, including animal feeds, whether it should import feed, or whether it should import meat.

Another concern was the urban–rural income gap, which has been gradually widening since the 1980s, as has the farm income disparity across provinces. Moreover, the options for improving productivity per farmer are restricted by the limited availability of new arable land, loss of land due to soil degradation and urbanization, and the agronomic limits of conventional technology being reached.

A third concern was that any measures taken must be environmentally sustainable. China’s strides in agricultural production and food security have taken a huge environmental toll, and current pressures on farm incomes in less-developed regions of China are partly the result of degradation of the resource base.



**Central scenario** (a) Projections of urban and rural meat demand; (b) projections of meat demand by type. (Map, left) Intensity of cultivated and orchard land (percentage of total land in county), 2000.

### Food demand and agricultural development

It was extraordinary population growth in China from 1950 to 1980 and the daunting prospects of feeding an ever-increasing number of people that triggered the drastic population planning measures introduced by the Chinese government. Although total fertility rates have declined from 4.2 in the 1970s to well below replacement level today, population growth is predicted to continue during the next two decades, rising from 1.275 billion in 2000 to about 1.45 billion in 2030.

Urbanization, a mighty driver of economic development, is also likely to accelerate to 55–65% by 2030, compared with 36% in 2000. Although the economic growth rate, which has reached 10% in the past two decades, will probably gradually decline to some 5% annually in 2030, increasing per capita incomes, together with urbanization, will have profound impacts on the structure and levels of demand.

In the CHINAGRO simulations, total direct human consumption of cereals and other staple grains changes only modestly from 2000 to 2030. Food consumption in China is already high, and there is little propensity to spend extra income on food grains. The significant differences between rural and urban consumption patterns—lower per capita consumption of cereals in urban compared with rural diets—will mean an average 10% decline in per capita

consumption of cereals, in spite of increasing incomes. Conversely, urbanization is likely to accelerate meat consumption, which responds strongly to income growth. We project that consumption of livestock and fish products is likely to double between 2000 and 2030.

Thus, the basic question is no longer that posed by Lester Brown, founder of the Worldwatch Institute, namely, whether farmers can feed China's vast population; it is how farmers can feed the animals required to meet the accelerating demand for livestock products. The answer lies in the economic geography of China.

China has several major urban agglomerations, situated along the coast and, except in the delta region, separated from the hinterland by hill tracts. As inland transport—especially across rugged terrain—is far more expensive than ocean shipping, importing meat or feed grains from overseas may be cheaper than using internal transportation. Hence, small-sized, remote, inland pork, poultry, and dairy farmers in China may also be at a disadvantage. In Western Europe and the United States, such commodities are generally produced either close to the consumer or near harbors that offer good sites for food processing plants (e.g., oilseed processing) and bulk imports. Hence, the answer to the important question of whether China should import meat or feed grains not only is subtle and highly differentiated geographically speaking, but also has major social ramifications.

### Farmland resources

In recent years, rapid economic growth and urbanization have threatened China's limited farmland resources. According to data from the Chinese Ministry of Land and Resources (MLR), China's farmland decreased by about 0.3 million hectares per year from 1987 to 2000, and the trend is expected to continue to 2030. Some 38% of this lost farmland was transformed into forest and grasslands for conservation purposes, 25% into orchards and fishponds, and 22% into construction land; the remaining 15% became unusable because of severe damage by natural events.

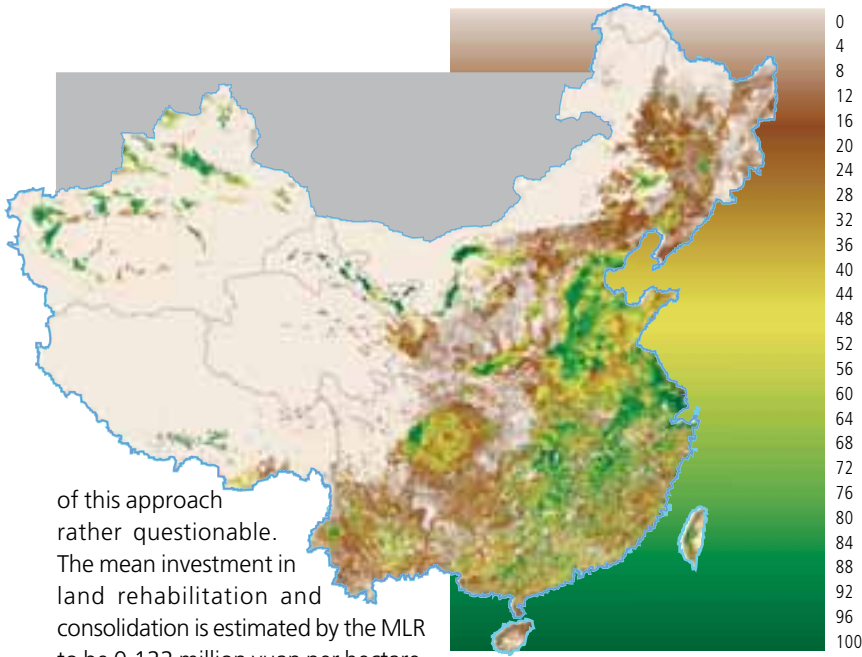
Expansion of construction land to 2030, especially in highly populated urban fringes, will contribute to farmland loss of 6.7–9.1 million hectares (i.e., 5–7% of total farmland in 2000), with great regional variation: 17–25% in the south, 12–17% in the east, 6–8% in the north, and 5% or less in other regions.

According to the Land Management Law of the People's Republic of China and related regulations, there should be full compensation (by land reclamation, farmland consolidation, or rehabilitation) for farmland converted into construction land. However, the expense makes the feasibility

### Key issues and major policy concerns

The Central Committee of China's Communist Party, Ministry of Agriculture, and Ministry of Land and Resources have indicated five areas where improvements vital to China's sustainable agricultural development must be made:

- As China has nearly reached the limit of almost all its agricultural resources (land, irrigation water, and most fertilizers) in terms of conventional technologies, improved resource-use efficiency and new technology development are required to boost agricultural production.
- The main obstacles to improved resource-use efficiency and modern technology use in agriculture—low income of farmers, high agricultural production costs, large disparity in urban–rural and regional living standards, and surplus rural labor—must be addressed.
- Systematic structural adjustments are needed in the agricultural sector, given the oversupply of low-quality food products and shortages of high-quality products.
- Following its accession to the WTO, China needs to be more competitive in world markets for grain, cotton, and other cash crops.
- China's self-sufficiency in grain is under continuous threat from increases in food and feed demand, shrinking farmland stock, difficult-to-enforce land protection legislation, environmental deterioration, and the weakness of research institutions. ■



of this approach rather questionable. The mean investment in land rehabilitation and consolidation is estimated by the MLR to be 0.122 million yuan per hectare, with an annual investment of 33 billion yuan required to achieve the planned aim of obtaining 0.25 million hectares of farmland per year in 2001–2010.

Taking various forms of conversion into account, we estimate that China's farmland will decrease from 128.2 million hectares in 2000 to 118–120 million hectares in 2020, and to 114–118 million hectares by 2030 (i.e., a possible net reduction of 8–12% over 30 years).

### Irrigation

Irrigation water is essential for high output from increasingly limited farmland. Nearly 45% of China's farmland is irrigated, and around 54% of all sown area in China is on irrigated land because of its superior multi-cropping conditions. The highest irrigation use is in the east and the lowest, in the northeast.

An estimated 72% of total grain output was produced on irrigated land in 2000, with irrigated land also accounting for 60% of farm labor and over 70% of chemical fertilizers and farm machinery. Scarce water resources and increasing demand for urban and industrial water in the north are creating pressing problems. As the water supply available for agriculture will remain constant or may even decline in the future, the key to maintaining irrigated areas lies in more rational and efficient water use.

### Intensive livestock farming

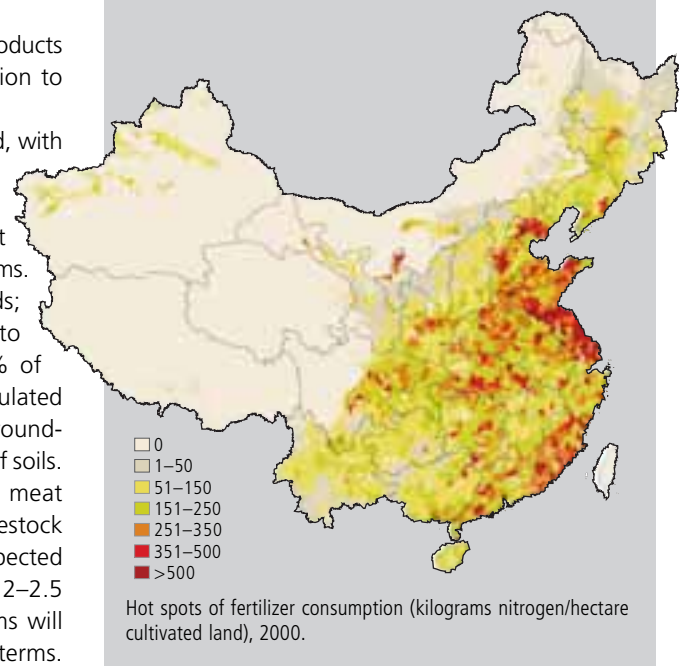
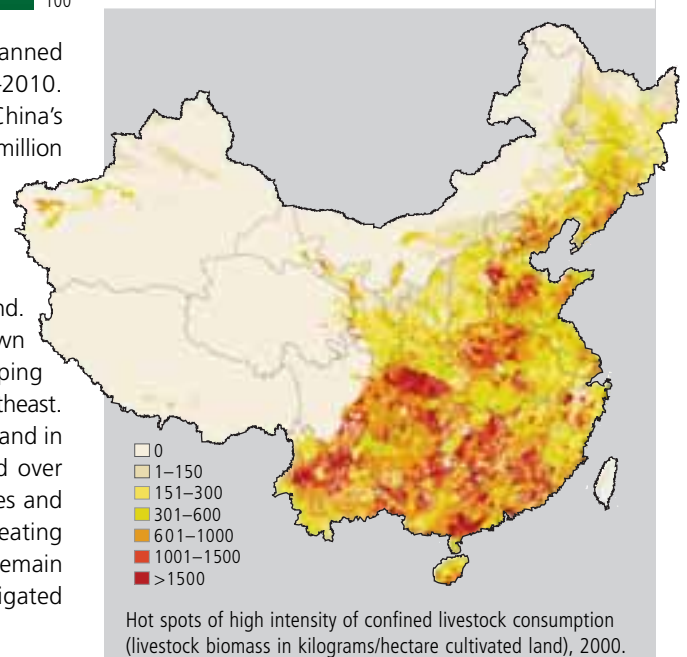
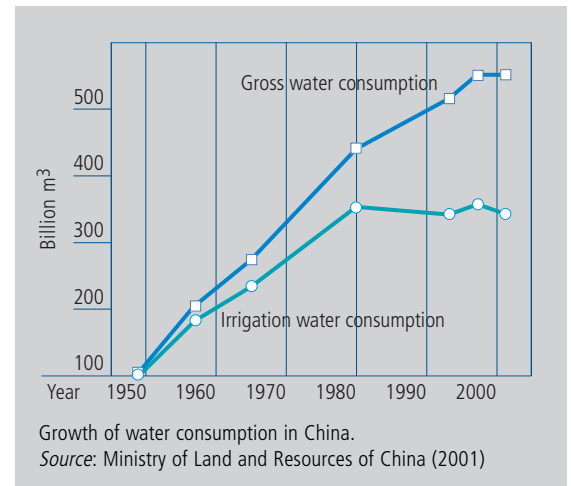
Over the past 20 years, China's demand for and production of livestock products has not only increased remarkably but has also changed in composition to satisfy demand for higher-quality, lower-fat products.

China has one of the highest densities of pigs and poultry in the world, with 335 million pigs and 2.7 billion fowl kept in 130 million and 144 million smallholdings, respectively, according to the 1997 National Agricultural Census of China. In 2000 traditional backyard systems accounted for about 60% of pork production, and 40% of this came from intensive systems.

Livestock production will need to grow further to meet rising demands; but growth will bring about a shift from traditional smallholdings to specialized farms and intensive large-scale bio-industry. About 80% of industrial and specialized livestock farms are located in densely populated areas and around major cities, which is causing severe pollution of ground and surface water—and therefore drinking water—and contamination of soils.

The results obtained in CHINAGRO clearly show that increasing meat demand can be met only through a rapid introduction of intensive livestock systems. Between 2000 and 2030, pig stocks in intensive systems are expected to increase 3–3.5 times, broiling fowl 4.5–5 times, and laying fowl 2–2.5 times. With demographic changes and urbanization, backyard systems will strongly decline as a percentage of the total and decrease in absolute terms.

Proportion of cultivated land that is irrigated (percentage), 2000.





The number of pastoral livestock will grow much less than that of confined livestock, by around 10%. Total livestock (measured in total live weight biomass) is projected to increase by about 30% during the period 2000–2030: this projection includes the counterbalancing effects of the expected 40–50% reduction in large animals used for work and transportation in traditional smallholder systems.

### Environmental and health risks

The locations and methods of expanding livestock production chosen will determine both the vulnerability of socioeconomic and environmental systems to disease risk and the environmental impacts of nutrient burden from concentrated pig and poultry systems.

Problems of environmental pollution and soil loads from intensive livestock production are magnified by the concurrent increase in chemical fertilizer use. China is the world's largest consumer of fertilizers, accounting for about one-quarter of total world consumption. Our study estimates that China's future fertilizer requirements will increase from 35 million tons in 2000 to 42 and 46 million tons in 2015 and 2030, respectively.

The current estimated total amount of manure produced by confined livestock annually is around 1.4 billion tons (approximately 10.3 tons per hectare of cultivated land in 2000) and is anticipated to increase to 1.9 billion tons (15.3 tons per hectare) in 2030. The total amount of manure-related nutrients from confined animals thus increases from 19 million tons in 2000 to about 29 million tons in 2030.

Projected increases in confined livestock coincide with a decrease in the amount of cultivated land available for nutrient recycling, which inevitably leads to a considerable increase in nutrient supply in manure per hectare of cultivated land. For the central scenario, in the period 2000–2030 total amounts of nitrogen (N), phosphate, and potassium increase between 40% and 50%, and by 53–67% in terms of average nutrients per hectare of cultivated land.

Detailed nutrient supply and uptake calculations show that N uptake by crop and fruit production in 2000 amounted on average to 110 kilograms (kg) N per hectare of cultivated and orchard land. The provincial averages vary from 50 kg N per hectare (e.g., in the southwest) up to 200 kg N per hectare (e.g., in the province of Jiangsu). We estimate that crop production in 2000 took up 16 million tons of N, compared with a supply of about 24.5 million tons from chemical fertilizer use and 8 million tons from manure. Hence, the N released to the environment amounts to about 20 kg N per hectare of total land. For Jiangsu, Zhejiang, Henan, and Hubei, this value is well over 100 kg N per hectare, implying very substantial pressure on soils, watercourses, and the atmosphere.

The assessment of current and future environmental nutrient loads highlights the importance of policy measures such as (i) establishing systems to monitor the environmental impacts of excess nutrients, (ii) introducing effective economic and legal policies to encourage farmers to reduce livestock pollution, (iii) improving technology and management of nutrient application to cropland, and (iv) allocating livestock production to large livestock feed production areas with substantial untapped capacity for nutrient recycling in cropland and low livestock densities.

Without adequate measures—technological, financial, and legislative—to handle existing and looming environmental problems, hot spots of nutrient losses may suffer irreversible environmental consequences, especially in densely populated areas where further intensification of livestock and crop production may increase human health risks. ■

1. CHINAGRO is a multidisciplinary and collaborative effort involving IIASA's Land Use Change Program, the Institute of Geographical Sciences and Natural Resources Research of the Chinese Academy of Sciences, the Chinese Agricultural University, and the Centre for World Food Studies of the Free University of Amsterdam.

**Further information** CHINAGRO at [www.iiasa.ac.at/Research/LUC/chinagro.html](http://www.iiasa.ac.at/Research/LUC/chinagro.html)

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## How we forecast the future of China's agriculture

The central tool to support policy analysis in the CHINAGRO project is a multiregional applied general equilibrium model including a detailed representation of the Chinese agricultural sector. The broader context of agricultural development and crucial external factors are summarized in a harmonized set of assumptions, presented in the form of scenarios covering plausible future trends of all important environmental, social, economic, and political processes.

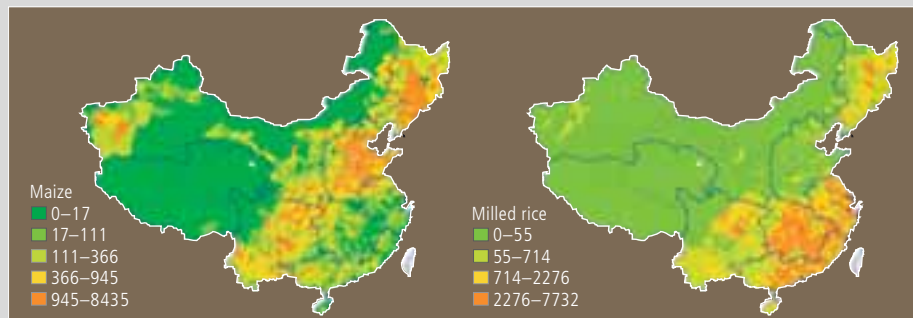
CHINAGRO conducts its analysis within a modeling framework that (i) represents regional consumer, producer, and government decisions, with farmers represented at the county level; (ii) builds the supply

response on a spatially explicit assessment of the resource base and its biophysical characteristics; (iii) describes agricultural processing and supply of farm inputs; and (iv) accounts for transportation costs in the economy.

The model provides a representation of different social agents in different regions, their income levels, preferences, resource constraints, and certain environmental implications of their activities. It covers interactions on regional markets between supply, demand, and prices, both in the absence of and in response to policy changes, while allowing for interregional as well as international trade.

The CHINAGRO project is distinctive in that it acknowledges the enormous spatial and social diversity of the country by carrying out a county-level analysis based on over 2,400 administrative units. There is tremendous variation throughout China in terms of population densities, lifestyles, crop-growing conditions, and cropping patterns and yields. As distances are great, any policy change will affect consumers and producers very differently, depending on their location.

The CHINAGRO project is among the first to apply welfare analysis in a context with strong biophysical linkages and great spatial detail. The model divides China into 8 economic regions comprising some 2,400 county-level administrative units, distinguishing 17 commodities (16 agricultural, 1 nonagricultural) and 6 socioeconomic classes (3 rural, 3 urban). For each commodity, the model has regional markets connected to the international market. Consumer preferences, geographical distribution of supply, and costs of trade and transportation jointly determine the resulting endogenous trade flows. Nonagricultural production and urban consumption are modeled at the level of the 8 economic regions. The economy is opened up to the rest of the world, so that import and export can occur endogenously. Trade between regions and the international market is modeled bilaterally. Model simulations cover the period 1997–2030. ■



Projections for China's production of maize and rice in 2030 (volume per total hectare).