# Wheat in China: Supply, Demand, and Trade in the Twenty-First Century

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Focusing mainly on the transition of China's rural economy during the reform era, Rozelle has published in a wide range of fields. One important strand of his work examines the factors that affect the supply, demand, and trade for agricultural commodities in China. He also closely collaborated with the International Food Policy Research Institute on their work on global food supply and demand. Rozelle and his coauthor, Jikun Huang, have also published more than twenty articles and two books in Chinese on these subjects. Rozelle also has produced a number of other works on poverty policy, inequality, and rural China's evolving rural institutions.

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# Wheat in China: Supply, Demand, and Trade in the Twenty-First Century

by Scott D. Rozelle and Jikun Huang

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The future role of China in world wheat markets is a compelling and important issue for producers in the Northern Plains. Some analysts have estimated that China will continue to demand large quantities of imported wheat. Others have forecast that China will gradually move to a position where domestic supply will meet the nation's demand for wheat.

China's own economists also have conflicting views. Chinese Academy of Agricultural Sciences researchers have predicted that the nation will remain at least self-sufficient and could be a large exporter. China's net imports of grain decreased steadily between 1989 and 1993. Moreover, despite large imports in 1994 and 1995, China has had an overall agricultural trade surplus with the United States during most of the 1990s. In contrast, other economists continue to argue that China will remain a large importer of grain, including wheat.

The overall goal of this paper is to explore the special features of China's wheat economy and increase our understanding of its domestic wheat sector and its current and future participation in global markets. The report establishes a comprehensive, transparent, and empirically sound basis for assessing the future growth of China's wheat supply, demand, and trade needs.

The first steps in creating a framework to assess China's future grain balances are to examine China's current grain balance sheet and to evaluate a series of factors, beyond income and prices, which may have an important impact on Chinese grain demand and supply. Currently, wheat producers still face serious obstacles in maintaining yield increases. Potential for future productivity increase are difficult to gauge since more of China's wheat area is irrigated than that of any other main producing nation. China's research system, which historically produced some of the world's most advanced wheat technology is in disarray. As China's markets develop, its patterns of demand are changing, but pressures move in many directions. China is the only country in East and Southeast Asia that has a large wheat-producing, wheat-consuming rural population, and so future income rises and population shifts may create demand pressures different than those observed elsewhere in Asia.

This discussion also necessarily entails a close look at the impact of recent measures to liberalize China's grain sector.

## S U M M A R Y

A wheat supply and demand projections model is developed. In this model, a series of important structural factors and policy variables are accounted for explicitly, including urbanization and market development on the demand side, and technology, agricultural investment, environmental trends, and institutional innovations on the supply side. After reviewing baseline assumptions and forecasts, the results of the baseline projections are presented. Then, alternative scenarios are examined under different rates of growth in income, population, and investment in research and irrigation, and policy implications are derived from the alternative scenarios.

The projections show that under the most plausible expected growth rates in the important factors, China's wheat imports will rise slightly in the late 1990s to 13 million metric tons before peaking and gradually declining to zero through 2020. Wheat import trends are in stark contrast to those of feed grains, which by 2000 are expected to expand sharply and continue to rise throughout the first two decades of the next century, eventually exceeding 20 million metric tons. Increasing maize imports mainly arise from the accelerating demand for meat and feed grains. Increasing wheat imports in the short run are caused by steadily expanding demand and a slowing of supply due to reduced investment in agricultural research in the late 1980s. After 2000, wheat imports are expected to stabilize, as demand growth slows due to increasing urbanization, declining population growth rates, and changes in the Chinese diet. As supply growth is sustained with the ongoing recovery of investment in agricultural research and irrigation, supply is projected to increase and slowly begin to meet most of the national demand by 2020. This means that China's future role in the world wheat market may be quite different than its role in the past.



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### INTRODUCTION

China has played an important role in world wheat markets, accounting for up to 15 percent of wheat imports in the last decade. Predictions about world wheat markets rest heavily on assessments of China's role; however, the future of China's wheat economy remains difficult to predict due to its unique characteristics. China is the only country in East and Southeast Asia that has a large wheat-producing, wheat-consuming rural population. China's potential for future productivity increases are difficult to gauge by studying other developing countries since more of China's wheat area is irrigated than nearly any other large wheat-producing nation in the world (Stone 1993). China's research system, which traditionally produced some of the world's most advanced wheat technology, is in disarray (Rozelle, Pray, and Huang 1996).

**Predictions about world wheat markets rest heavily on assessments of China's role; however, the future of China's wheat economy remains difficult to predict.**

Looking to the past provides little help since few would have predicted that the rapid expansion of wheat output could have kept up with rising demand. In the past, China's wheat sector was China's most tightly regulated commodity, yet its yield performance surpassed all other major staples. The officially posted sales price of wheat, 355 yuan per ton, did not change in nominal terms for 23 years between 1970 and 1992. Wheat yield increases, however, exceeded those of rice, maize, and other coarse grains, averaging 5.2 percent annually in the 1970s and 8.3 percent annually during the early reform period, 1978–1984. Although wheat imports soared in the early years and have fluctuated since, as leaders relaxed the restrictions of the socialist period, China has met most of the expanding demand from its own supplies.

Currently, wheat producers face serious obstacles for maintaining rates of yield increases. Concerned about stability of domestic staple prices for urban residents (Chen 1994), leaders continue to intervene with procurement measures and import policies to keep wheat prices low. At the same time, the opportunity cost of labor and chemical fertilizer and pesticide prices have risen relatively faster (Huang, Rosegrant, and Rozelle 1996). Environmental pressures have added a new concern for leaders charged with keeping agriculture productivity high.

On the demand side, as markets develop, the patterns of demand are changing but pressures move in many directions. Better retail markets provide consumers with more choice—southerners can get better wheat products and northerners have access to high-quality rice (Huang and

Rozelle 1997a). As labor markets expand, northern rural migrants will consume less wheat as they enter urban society; southern migrants, on the other hand, will eat more. Rising incomes may increase demand to some extent; however, it is likely that consumers will also substitute meat, fruits, and vegetables for wheat consumption.

The purpose of this report is to explore the special features of China's wheat economy and to increase our understanding of the nation's domestic wheat sector and its future participation in global markets. It also seeks to establish a more comprehensive, transparent, and empirically sound basis for assessing the future growth of China's wheat supply, demand, and trade needs.

The first section assesses trends in China's wheat economy, and the second section examines a series of factors, beyond income and prices, that may have an important impact on Chinese grain demand and supply. An econometric model is used to estimate China's wheat demand, supply, and imports. These estimates are heavily dependent on assumptions about the growth rates of income, population, and investment in research and irrigation, and policy implications are derived from the alternative scenarios. After the baseline assumptions and results are presented, alternative forecasts of these variables and their implications are explored.

**Except during the famine years of the late 1950s and early 1960s, China has enjoyed rates of agricultural production growth that have outpaced the rise in population.**

## WHEAT PRODUCTION, UTILIZATION, AND IMPORTS IN CHINA

The growth of agricultural production in China since the 1950s has been one of the main accomplishments of the nation's development policies.[1] Except during the famine years of the late 1950s and early 1960s, the country has enjoyed rates of production growth that have outpaced the rise in population. Even between 1970 and 1978, when much of the economy was reeling from the effects of the Cultural Revolution, grain production grew at 2.8 percent per annum (Table 1, rows 1–3). After accelerating to 5.8 percent per year in the early reform period, 1978–1984, grain yield growth slowed to 1.8 percent in the 1984–1995 decade.

Wheat production in China also has grown steadily throughout the last several decades. Production and yield growth rates have exceeded the average for overall grain in most of the subperiods (Table 1, rows 7–9). In the 1970s and the early reform period, wheat yields increased at annual growth rates exceeding those of rice and maize. Wheat producers also maintained their sown area, unlike rice producers, whose sown area fell 0.6 percent per year between 1970 and 1995. Wheat farmers, however, fell behind maize farmers, who increased sown area in the same period.

Farmers plant wheat in every province of China, but cropping patterns and the intensity and importance varies from region to region. Farmers produce all wheat in tight rotations with other crops, except for the single-season spring wheat in the four northern provinces. North China Plain farmers most commonly plant winter wheat in conjunction with maize or cotton. Because cold climates push back harvesting for the wheat and increase the

need to plant maize and other crops early to avoid early fall frosts, wheat farmers typically space their wheat crops such that farmers will sow or transplant their maize or cotton crop before the wheat is harvested. Yangtze Valley farmers, especially those living north of the Yangtze where two rice crops do not do very well, plant overwintering, wheat varieties in tight rotations with their single-season rice crops.

**Table 1. Growth Rates of Agricultural Production, Sown Area and Yields in China, 1970–1995**

| | ------- Pre-reform ------- | | ----- Reform Period ------ | |
|---|---|---|---|---|
| **Commodity** | **1970–1978** | **1978–1984** | **1984–1995** | **1978–1995** |
| Grain | | | | |
| Production | 2.8 | 4.7 | 1.7 | 2.4 |
| Sown area | 0.0 | -1.1 | -0.1 | -0.4 |
| Yield | 2.8 | 5.8 | 1.8 | 2.8 |
| Rice | | | | |
| Production | 2.5 | 4.5 | 0.6 | 1.7 |
| Sown area | 0.7 | -0.6 | -0.6 | -0.6 |
| Yield | 1.8 | 5.1 | 1.2 | 2.3 |
| Wheat | | | | |
| Production | 7.0 | 8.3 | 1.9 | 3.9 |
| Sown area | 1.7 | -0.04 | 0.1 | 0.2 |
| Yield | 5.2 | 8.3 | 1.8 | 3.6 |
| Maize | | | | |
| Production | 7.4 | 3.7 | 4.7 | 4.1 |
| Sown area | 3.1 | -1.6 | 1.7 | 0.8 |
| Yield | 4.2 | 5.4 | 2.9 | 3.3 |
| Cash-crop-sown area | 2.4 | 5.1 | 2.1 | 3.1 |

*Note:* Growth rates are computed using regression methods.
*Sources:* ZGTJNJ (1980–1996) and ZGNYNJ (1980–1996).

**In the early 1990s total wheat production rose to 99 million metric tons and imports were 11 million metric tons.**

China's wheat production has traditionally been and remains primarily in the North China maize-wheat region. In 1975, 68 percent of wheat was sown in the North China Plain and the Northwest. By 1995, this percentage had dropped to 63 percent primarily due to a slow rise in the rice-wheat acreage. Farmers in the Yangtze Valley increased their proportion of wheat from 29 percent in 1975 to 33 percent in 1995.

Total wheat production rose to 99 million metric tons in the early 1990s, but utilization was even higher. With no changes in stocks and by importing 11 million metric tons, the total annual supply of wheat during this period was 110 million metric tons. Although this supply was used to meet a number of needs—seed, animal feed, and direct consumption for food—wheat used for direct food consumption took up about 96 percent of the total supply in the early 1990s. Farmers used 4 million metric tons as feed in the early 1990s, in part reflecting the relatively low wheat prices during the period.

**The average resident in China currently consumes 85 kilograms of wheat per year, second in Asia in per capita wheat consumption. Unlike other East and Southeast Asian countries, China's farmers produce most of the nation's wheat.**

On a per capita basis, the average resident in China currently consumes 85 kilograms of wheat per year. Rural consumers, on average, consumed 90 kilograms per capita in the early 1990s, more than their counterparts in urban regions who consumed 67 kilograms. China's average consumer places second in Asia in per capita wheat consumption (FAO 1991). Only South Koreans, at 105 kilograms per capita, consume more wheat than the Chinese. Per capita wheat consumption in China surpasses that in Japan (54 kilograms) and Indonesia (12 kilograms).

Unlike other relatively high wheat-consuming East and Southeast Asia countries, China's farmers produce most of the nation's wheat. Between 1985 and 1995, on average, China imported 10 million metric tons of wheat each year, relying on imports during this time for just over 10 percent of its wheat needs. Japan and Korea, on the other hand, import more than 90 percent of their wheat (FAO 1991). Although only a small part of domestic needs, this level of imports still makes China one of the world's largest wheat importers, accounting for 10 to 15 percent of world wheat trade.

## Structural Change and Government Intervention in China's Agriculture

Many forces arising from China's development and transition processes affect the growth and balance of China's wheat economy. China is a country in rapid transition from a socialist system to one where an increasing proportion of its goods and services, including food, are being allocated by market forces (Sicular 1991; Rozelle et al. 1996). It also is a country that is rapidly developing, where institutions are changing fast and incomes and relative prices fluctuate significantly. In contrast to many reform governments, far from giving up its activist role as a major actor in the economy, China's leaders remain deeply involved in guiding the nation's development process. Any attempt to accurately forecast future wheat supply and demand trends must account for these economic forces.

### Factors Influencing Demand: Market Development and Urbanization Income Growth and Demand

#### Income Growth and Demand

On the demand side, recent changes in the urban economy have made urban consumers almost entirely dependent on markets for their consumption needs (Huang and Rozelle 1997b). In urban areas, prices and income changes most likely will be the fundamental forces driving consumption pattern changes. Urban incomes rose at a steady rate of nearly 8 percent per year in the early years of reform (Table 2, column 1). At that time, rising incomes meant an increasing demand for most all food products, including wheat. Real income per capita for urban residents continued to rise in recent years, jumping 6–7 percent between 1985 and 1995. At the current average level of income for most urban residents, consumption of wheat products rises only marginally with new increments in income (Garnaut and Ma 1992; Carter and Zhong 1991); for urban consumers, when income increases 1 percent their demand for wheat increases only 0.1 percent. (Huang and Rozelle 1995b). Although rural incomes have grown more

**Table 2. Important Factors Affecting the Supply and Demand for Grain and Rice in China's Economy, 1958–1992**

| Year | (1) Urban Income per Capita | (2) Rural Income per Capita | (3) Market Development Index | (4) Ratio of Urban Population | (5) Agriculture Research Stock | (6) Agriculture Research Expenditure | (7) Irrigation Stock | (8) Irrigation Expenditure |
|---|---|---|---|---|---|---|---|---|
| 1958 | n.a. | n.a. | n.a. | 16 | n.a. | 165 | 6,766 | 3053 |
| 1965 | n.a. | n.a. | n.a. | 18 | n.a. | 357 | 17,375 | 1314 |
| 1970 | n.a. | n.a. | n.a. | 17 | 239 | 401 | 23,280 | 3256 |
| 1975 | 229 | 101 | 21 | 18 | 352 | 700 | 42,928 | 4526 |
| 1980 | 372 | 167 | 31 | 19 | 408 | 791 | 47,819 | 3209 |
| 1985 | 490 | 298 | 42 | 24 | 573 | 1078 | 49,928 | 2016 |
| 1990 | 593 | 306 | 45 | 26 | 789 | 808 | 53,476 | 3006 |
| 1992 | 778 | 319 | 46 | 28 | 880 | 977 | 59,003 | 5527 |

*Notes and Sources:* (1) and (2) are from ZGTJNJ (1980–1993) and are measured in real 1985 yuan. (3) is from Huang and Rozelle (1995a) and measures the proportion of food purchased by rural households on consumption markets. (4) is from the United Nations. (5) and (6) are in real 1985 million yuan and are from SSTC. (7) and (8) are in real 1985 million yuan and are from MWREP.

slowly since the mid-1980s (Table 2, column 2), demand for food grains has still increased as incomes have risen (Fan, Cramer, and Wailes 1994; Halbrendt et al. 1994). For rural consumers, when income increases 1 percent the demand for wheat increases 0.19 percent. As income of the urban and rural populations grows over the next several decades, the impact of income increases on demand for wheat should fall, and eventually may become negative, as it has in other rapidly developing countries in Asia.

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**Rural Market Liberalization**

Rural consumption markets also are less complete, and farmers who face incomplete markets may not be able to consume the quantities they demand. Farmers in many areas face limited choices in their consumption decisions since many of the products they desire on a daily basis, such as meat and fresh fruit, are not always available, even as their incomes rise. In a sample of households drawn from the national household income and expenditure survey by the authors, a strong and significant correlation was found between the level of consumption of primarily purchased goods, such as meat and fruit, and the level of market development, holding income and prices constant (Huang and Rozelle 1997b). Discontinuous free markets, lack of refrigeration, and generally high transaction costs for procuring food affect the consumption patterns of rural consumers.

In the future as markets develop, rural demand patterns may change. Although changes in rural markets have been rapid, in 1992 Chinese farmers still purchased only 46 percent of the food they consumed. Huang and Rozelle (1997b) predict that as markets develop and rural consumption increases, consumption patterns will be affected. Meat and fruit consumption should rise, and directly consumed food grain and vegetables should fall.

**Urban Migration**

Across Asia, as countries urbanize, the behavior of consumers changes dramatically (Huang and David 1993; Bouis 1989). Outside of China, urban dwellers consume more wheat and other convenience foods and less in the way of staples (or fewer preparation-intensive products). Hence, as populations in Asia have shifted from rural to urban, wheat consumption typically has risen.

The ratio of urban to rural residents in China is also changing rapidly; urban population grew from 19 percent of total population in 1980 to 28 percent in 1992 (Table 2, column 4).[2] The impact of the population shift on food grain demand in China has been documented (Huang and Bouis 1995). In contrast to other countries in Asia, rural-urban migration's impact on wheat may be different because average rural wheat consumption levels are so high. Since rural demand currently exceeds urban demand, China's future migration should be expected to dampen wheat consumption.[3]

## Factors Influencing Supply

**Technology**

On the supply side, many sharp transitions also are underway. Above all, technological change needs to be considered explicitly, since it has been the

engine of China's agricultural economy, in general, and for fine grains, such as wheat, in particular (Stone 1988; Rozelle and Huang 1997b). China's technological base grew rapidly during both the pre-reform and reform periods. In one of the best-known cases, hybrid rice, a breakthrough pioneered by Chinese rice scientists in the 1970s, increased yields significantly in many parts of the country and rapidly spread to nearly one-half of China's rice area by 1990 (Lin 1991). Although less dramatic, continuous and rapid change came to wheat farmers as well. After importing rust-resistant, semi-dwarf varieties from the international agricultural research system in the late 1960s, Chinese breeders incorporated these traits into its own varieties. By 1977, producers cultivated about 40 percent of China's wheat areas in semi-dwarf varieties; by 1984, this number rose to 70 percent. Today in China, it is difficult to see anything but dwarf varieties, especially in the main producing provinces. Certainly this rapid expansion contributed to the rapid growth of wheat yields in the 1970s and 1980s.

Robust growth in the stock of research capital has in part been responsible for these dramatic yield increases (Table 2, column 5; Fan and Pardey 1992). There is concern, however, that China's system maybe suffering from neglect after more than a decade of reform (Rozelle, Pray, and Huang 1997). Real annual expenditures on agricultural research fell between 1985 and 1990, before resuming real growth in 1990 (Table 2, column 6; SSTC 1991, 1993). The slowdown in growth in annual investments in the late 1980s will result in slower growth in the overall stock of research in the 1990s. If economic indicators signal tightening supplies and rising prices, officials may respond by increasing current expenditures (Jin et al. 1997).

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**Irrigation Investment**

China's progress in water control has been another major source of productivity gain (Liu 1992). Irrigated area increased from less than 18 percent of cultivated area in 1952 to nearly 50 percent in 1992 (ZGTJNJ 1993). In the initial years, most of the construction was based on both locally organized small-scale projects and publicly financed large-scale surface projects (Stone 1993). In the late 1960s and 1970s, tubewell development drove the expansion of irrigated area construction, especially in the North China Plain maize-wheat region. Development of the nation's water control infrastructure continued during the 1980s as the government launched a large number of new medium- and large-scale water control projects (Stone 1993). Even though pump set numbers stagnated in the 1980s, the overall quality of water control equipment has been continually upgraded (ZGNYNJ 1990). Irrigation also has been one of the major factors influencing land and labor utilization in the cropping sector in the 1970s and 1980s, as better water control stimulated the increase in double-cropped area (Stone 1993).

Although much of the labor for China's irrigation development was contributed by local residents, public irrigation expenditures financed a big part of the construction of the national water control network. Irrigation investment and the stock of facilities have followed patterns similar to those for research (Table 2, columns 7 and 8). The investment in irrigation

facilities has been by far the largest component of total construction investment in agriculture, and is several times higher than investment in agricultural research. Real annual expenditures on irrigation rose rapidly until 1975, before beginning a ten-year decline. In 1985, however, annual expenditures began to grow again and were at an all-time high in 1992 (Table 2, column 8). Changing agricultural strategies and periods of fiscal control have made public expenditure on water control follow a more variable path.

**Marketing and Pricing Trends and Policies**

**Farmers respond to the level of price risk and liberalization of domestic grain markets is expected to decrease price variability.**

Wheat prices, as well as those for rice and maize, have fluctuated throughout the reforms, peaking in 1980, 1988, and 1994, years preceding strong growth in grain output (Table 3, columns 2–4; Rozelle et al. 1996). Fertilizer price and other input price trends, however, may offset or amplify the rising and falling output prices (Table 3, columns 5–6). For example, although rice and maize prices rose around 30 percent in real terms between 1990 and 1995, fertilizer prices almost doubled. Under such conditions, aggregate output may not have moved as much as one might anticipate given the rising farmgate prices.

In addition to expected price levels, farmers also respond to the variability of expected price and the level of price risk, and it may be that China's farmers could increase (decrease) output as they face less (more) risk. Sicular (1995), Watson (1994), and Rozelle et al. (1996) argue that one of the most significant shifts in China's rural policy in the 1990s, which may have affected price risk, is the effort to liberalize domestic grain markets. Liberalization, in general, is expected to decrease price variability as price variations once caused by local shocks could be dampened by incoming flows of grain from more distant locations not affected by the shock. One of the main results of the early policy efforts in the rice and maize sectors was a sharp and sustained integration of markets as measured by a variety of measures and statistic tests (Rozelle et al. 1996). Output markets became so integrated and competitive that even when the government tried to retrench on its liberalizing reforms, market forces dominated and integration in South China rice markets and coastal grain markets deepened even in the mid-1990s. The governor's responsibility system, a policy that among other objectives was designed to keep grain from flowing indiscriminately among provinces in an effort to keep local grain prices low, was only effective in several inland maize-growing provinces, such as Henan, Shaanxi, and Shanxi. In these provinces, it was thought that the regional government could still exercise its control over grain markets by virtue of its ability to monitor the rail transport system, the sole means of moving bulk commodities in and out of the region as opposed to coastal traders that can move grain by rail, boat, ship, or truck making monitoring grain movements difficult if not impossible.

Major wheat-producing areas appear to closely resemble inland maize producing regions in terms of the record of being isolated from national grain markets. Larger wheat producers in provinces are the same as those inland provinces, Henan, Shaanxi, and Shanxi, which were not integrated with national markets in the mid-1990s. Integration analysis also found that

**Table 3. Factors Affecting Supply in China's Agriculture, 1975–1995**

| Year | HRS[a] | Milled Rice | Wheat | Maize | Fertilizer Mixed Price | Implicit Wage | Soil Erosion Land |
|---|---|---|---|---|---|---|---|
| | | ---------- *market price (yuan/ton)* ---------- | | | *(yuan/ton)* | *(yuan/day)* | *(1000ha)* |
| 1975 | 0.00 | 1040 | 804 | 798 | 484 | 1.94 | 119,202 |
| 1980 | 0.14 | 1395 | 1070 | 734 | 455 | 2.99 | 118,936 |
| 1985 | 0.99 | 1008 | 755 | 600 | 600 | 4.58 | 127,112 |
| 1990 | 0.99 | 1338 | 922 | 690 | 630 | 4.48 | 133,859 |
| 1995 | 0.99 | 1685 | 985 | 921 | 1138 | 5.72 | 163,000 |

[a] HRS variable is reported as proportion of villages that adopted the Household Responsibility System (HRS). Price, wage, and irrigation expenditure/stock are in real 1990 price (deflated by general retail price index).

*Sources:* ZGTJNJ, SSB; State Price Bureau, Ministry of Agriculture, and MWREP.

in the six provinces, for which complete wheat price data series were available from 1988 to 1995, the level of integration fell between the early 1990s and mid-1990s. Top government officials were apparently successful in their efforts to blockade the outflow of grain from their provinces, keeping their local markets insulated from outside supply and demand forces and forcing down local prices. Interviews with traders and government grain officials in these provinces (who typically are against blockades and other measures that erect barriers reducing their business opportunities) found that they believed policies that fluctuated from closing markets to opening them to closing them again reduced the willingness of farmers to grow wheat (or produce at high yield levels). It may be that grain marketing and pricing policies in some of the major, inland wheat provinces have a distinct negative impact on wheat production.

**Other Factors**

**In addition to the factors already discussed, institutional changes, environmental factors, and labor movement out of the agricultural sector induced by rising wage trends may also affect agricultural output.**

In addition to the factors already discussed, institutional changes, environmental factors, and labor movement out of the agricultural sector induced by rising wage trends may also affect agricultural output. This section briefly reviews these forces.

*Institutional Change.* Leaders implemented decollectivization policies in the late 1970s, focusing first on poorer regions of the nation and then gradually extending the policy to the whole country. By 1980, 14 percent of villages had returned land-use rights to farm households, a figure that moved rapidly upward in the early 1980s, reaching and staying at a level of 99 percent of villages in 1984 (Table 3, column 1). McMillan, Whalley, and Zhu (1989) and Lin (1992) argue that the economic reforms generated most of the agricultural growth in the early reform era, although these were one-time effects that were exhausted by the mid-1980s.

*Environment.* Trends in environmental degradation, including erosion, salinization, and loss of cultivated land show that there may be considerable stress on the agricultural land base; erosion has increased since the 1970s, although in a somewhat erratic pattern (Table 3, column 7). This and other factors (e.g., salinization) have been shown to affect output of grain, rice, and other agricultural products in a number of recent studies (Huang and Rozelle 1994; 1996; Huang, Rosegrant, and Rozelle 1996).

*Wages, Opportunity Cost, and Labor Shifts.* Increasing opportunities in the noncropping and off-farm sectors (Table 3, column 6) have led to large shifts of labor use patterns (Table 4). After putting ever-increasing amounts of labor into grain production in the 1950s, 1960s, and early 1970s, labor use on all crops fell substantially from 1975 to 1994 (SPB 1988–1992). Wheat farmers use less than half the level of labor used before reform. On a man-day per hectare basis, labor fell from 402 man-days in 1975 to 180 in 1994 (Table 4, column 2). These results are consistent with recorded trends in other crops (Table 4, columns 1 and 3 to 6) and qualitative information on changes in labor use patterns. Interviews by the

authors with agricultural officials, local leaders, and farmers during extensive field work in a number of China's wheat-producing provinces (Hebei, Shandong, Henan, Hubei, Sichuan, and Shaanxi) have found that large quantities of labor moved out of wheat farming during the 1980s as a result of an abandonment or transformation of marginal lands where mainly low-yielding wheat and other coarse grains had been produced during the collective era.

**Table 4. Labor Use in Agricultural Production in China, 1975–1994**

| Year | Rice | Wheat | Maize | Soybean | Cotton | Rapeseed |
|---|---|---|---|---|---|---|
| | ---------- *major crops (man-days/hectare)* ---------- | | | | | |
| 1975 | 638 | 402 | 375 | 221 | 919 | 453 |
| 1980 | 506 | 347 | 360 | 213 | 818 | 442 |
| 1985 | 347 | 222 | 238 | 141 | 626 | 317 |
| 1990 | 309 | 210 | 259 | 180 | 664 | 279 |
| 1994 | 279 | 180 | 220 | 165 | 649 | 253 |

*Sources:* Labor utilization by crop computed by authors based on data from SPB (1988–96); ZGTJNJ (1980–96).

There also were shifts of labor from farm to nonfarm activities in wheat-producing areas. The increasing gap between the total number of rural laborers and the total number of agricultural laborers demonstrates that labor is flowing out of agriculture (ZGTJNJ 1980–96). Higher wages have attracted tens of millions of workers to the industrial and commercial sectors during the reform period. Some of the biggest flows came out of the highest-producing wheat provinces: Sichuan, Hubei, Anhui, and Henan (Rozelle et al. 1997). This sectoral shift undoubtedly has also caused the allocation of time to farming to drop sharply. In the mid-1980s, rural residents allocated 75 percent of their time to agricultural activities, and the rest went to nonagricultural activities; in 1992, less than 60 percent of labor went to agriculture (Tong and Huang 1995).

**Characteristics inherent to China's developing and transitional rural economy have both facilitated and constrained labor mobility.**

Characteristics inherent to China's developing and transitioning rural economy have both facilitated and constrained labor mobility. The labor-intensive nature of Chinese farm management practices allows labor to enter and exit the cropping sector without incurring high start-up or close-down costs. Employment opportunities in local township and village enterprises and the rapid expansion of the self-employed labor force may make the flow of labor between agriculture and industry more fluid. At the same time, natural barriers, such as moving costs (which exist within all economies), impede flows. China's factor markets also still contain a number of structural imperfections, such as employment priority for local workers, housing shortages, and the urban household registration system (Lin 1991). One of the costs of these kinds of barriers is that they may slow down the movement of factors among alternative economic activities, reducing the efficiency of the sector's producers.

## FACTORS CONTRIBUTING TO CHINA'S WHEAT PRODUCTION GROWTH

Between 1976 and 1995, the output of wheat from the North China Plain maize-wheat region grew on a per annum basis by 4.54 percent. The relative roles of technology, institutions, output rations, and wages in China's increased grain production was investigated using an econometric model by Huang and Rozelle (1997a).

Within key subperiods, wheat production grew faster during the early reform period, 1978–1984 (8.3 percent), and slowed in the late reform period, 1984–1995 (1.9 percent). To identify which factors have made the biggest contributions to the growth of China's wheat sector, the growth rates of wheat during the sample period and key subperiods can be decomposed into their component parts.

**Government investments in research and irrigation have contributed the most to wheat yield growth during the period 1976–1995.**

The results for the North China wheat decomposition (Table 5) show that although institutional innovations are important, government investments have contributed the most to wheat yield growth during the period 1976–1995. Improvements in technology from research expenditures have contributed by far the largest share, augmenting the annual growth rate of output by 2.82 percent (62 percent of the total growth rate). Public investment in irrigation contributed 0.43 percent per year to the growth rate of total wheat during this period (9 percent of the total growth rate). Decompositions for rice in South China and maize in the same North China Plain maize-wheat region (Huang and Rozelle 1997a) show that research investment has created more wheat growth (2.82 percent) than that for rice (1.38 percent); but somewhat less than maize (4.98 percent). Part of the explanation may be that the initial growth from new Green Revolution technology for rice had already taken place; semi-dwarf varieties of rice had been introduced in the late 1950s long before use elsewhere in the developing world (Stone 1988). Although maize improvements had started in the early 1960s with the release of hybrid cultivators, serious corn blight epidemics had reduced yields in the late 1960s, and programs to develop and release disease-resistant single-cross maize hybrids did not really reach the farm level until the mid-1970s. Thus, the impact of maize research could appear to look larger since it started from a lower base and largely occurred during the study period.

The contribution of irrigation investment to the growth of wheat falls well below the return to research investment (0.43 percent). Part of this somewhat puzzling result may come from a failure to identify the complex interactions and necessary sequencing of agricultural investments (Huang and Rozelle 1997a). During the early Mao era, much of the initial, high payoff investment in water control had already taken place, and so the initial high return to irrigation may have already occurred. Also, the contributions from research could be picking up part of the returns from irrigation investment, since modern high-yielding technology requires good water control for realizing its maximum gains.

## Table 5. Sources of Wheat Production Growth in Northern China

| | | 1978–1984 | | 1976–1995 | |
|---|---|---|---|---|---|
| | **Output Elasticity** | **Factor Growth Rate** | **Sources of Growth** | **Factor Growth Rate** | **Sources of Growth** |
| | | *(%/yr)* | *rate* *%* | *(%/yr)* | *rate* *%* |
| Research stock | 0.587 | 5.53 | 3.30 43 | 4.72 | 2.82 62 |
| Irrigation stock | 0.172 | 2.52 | 0.43 6 | 2.49 | 0.43 9 |
| Institutional innovation | | 0.99 | 3.86 51 | 0.99 | 1.63 36 |
| Input and output prices | | | 0.86 1 | | 0.16 4 |
| Land and labor prices | | | -1.34 -18 | | -0.40 -9 |
| Land | -0.002 | 20.75 | 0.04 -1 | 8.91 | 0.02 0 |
| Labor | -0.098 | 13.23 | -1.30 -17 | 3.90 | -0.38 -8 |
| Environment factors | | | 0.31 4 | | -0.10 -2 |
| Disaster | -0.078 | -3.84 | 0.30 4 | 1.07 | 0.08 2 |
| Erosion | -0.021 | -0.27 | 0.01 0 | 0.65 | 0.01 -2 |
| Residual | | | 0.21 17 | | 0.01 0 |
| Total | | | 7.63 100 | | 4.54 100 |

HRS is measured by the cumulative proportion of households adopting production responsibility system in any given year. The impact of the HRS on the growth rate of the output is computed by the following two steps: I) the output change due to the change in the HRS ratio is computed using the estimated coefficient of the HRS variable. II) these changes in the output are then transformed into changes in annual growth rates.

*Note:* Short-run elasticities are used in the analysis. Both output and factor growth rates are computed by a least squares estimate.

Between 1976 and 1995, the implementation of the Household Responsibility System was the second most important factor in increasing yields; institutional changes have increased the wheat output growth by 0.99 percent per year (36 percent of the total). Because its implementation was started in 1978 and completed in 1984, the contribution of the Household Responsibility System is smaller, relative to public investment. The relatively high return to technology, however, has important implications for policymakers in China, who in the 1980s appeared to have believed that China could maintain its rapid growth on the basis of institutional change and thus for a time ignored research and water control investments.

**Between 1976 and 1995, the implementation of the Household Responsibility System was the second most important factor in increasing yields. . . environmental factors have had much less effect.**

The positive impacts of government investment and institutional reform policies have been partially offset by the rises in land and labor prices. Overall, during the 1976–1995 period, growth would have risen by 9 percent more had higher wages, primarily, not induced farmers to move out of wheat farming. The net impact was somewhat larger, 18 percent, in the early reform years when the real wage grew rapidly. However, given the massive shifts of labor out of wheat farming (nearly 50 percent when measured on a labor-days per hectare basis, Table 4), it may be surprising the impact was as small as it was. In contrast, the stagnation of real wages in the late reform period, 1985–1995, has limited the impact of wheat and nonwheat competition for labor; output growth fell by only 4 percent for wheat.

Environmental factors have had much less effect on rice and wheat production than elsewhere in China's cropping sector. Whereas drops in growth rates are as high as 8 percent in the case of maize during the 1976–1995 sample period (Huang and Rozelle 1997a), and reach 47 percent in the case of cash crops in the late 1980s (Huang, Rosegrant, and Rozelle 1996), environmental factors reduced wheat output growth by only 2 percent during the sample period 1976–1995 (Table 6), a rate that was consistent even during the late reform period, 1985–1995. This smaller impact could be expected since rice and wheat are much less likely than maize and some cash crops to be grown in hilly and more ecologically fragile areas. These results suggest that if policymakers give increased attention to the adverse consequences of environmental stresses, the efforts should be targeted on a crop by crop basis.

Perhaps the most important result of our research for understanding the future supply from China's wheat sector is that in recent years, 1985–1995, almost all growth has come from public investment, especially that in research. Deteriorating price ratios, especially, and rising wages and environmental stress, to a lesser extent, have held back the expansion of wheat production. The benefits of one-time institutional reforms in the early 1980s have been exhausted and have not directly contributed to wheat output growth. Investment in research and irrigation have contributed 184 percent (162 + 22) of wheat growth during the past 10 years (Table 6). By exceeding 100 percent, the figures imply that not only can all growth be accounted for by public investment but it compensates for negative factors elsewhere in the economy. If these relationships hold in the future, wheat

supply in the twenty-first century is going to rely heavily on increased investment in agriculture by policymakers.

**Table 6. Sources of Wheat and Maize Production Growth in China, 1984–1995**

| | ------- Wheat ------ Sources of Growth | | ------- Maize ------ Sources of Growth | |
|---|---|---|---|---|
| | *rate* | *%* | *rate* | *%* |
| Research stock | 3.43 | 162 | 6.07 | 124 |
| Irrigation stock | 0.47 | 22 | 0.50 | 10 |
| Institutional innovation | 0.00 | 0 | 0.00 | 0 |
| Input and output prices | -0.75 | -35 | -1.14 | -23 |
| Land and labor prices | -0.09 | -4 | 0.03 | 1 |
| Land | -0.01 | -0.4 | | 8 |
| Labor | -0.08 | -4 | 0.36 | -7 |
| Environmental factors | -0.04 | -2 | -0.38 | -8 |
| Disaster | -0.02 | -1 | -0.03 | -1 |
| Erosion | -0.02 | -1 | -0.35 | -7 |
| Residual | -0.90 | -42 | -0.19 | -4 |
| Total | 2.12 | 100 | 4.89 | 100 |

## A Framework for Forecasting China's Grain Supply and Demand

**Income growth and population growth will remain important determinants of food balance in the future.**

This report uses wheat supply and demand models for China and a world trade model to forecast China's imports of wheat. Further discussion of these models is available in Rozelle and Huang (1997b).

### Demand-Side Assumptions

Income growth and population growth will remain important determinants of food balance in the future. Population growth peaked in China in the late 1960s and early 1970s. Since then, fertility rates and the natural rate of population growth have begun to fall. Relying on the United Nations'(1993) demographic predictions, the growth rate during the first decade of the projection period, 1990–2000, is assumed to be 1.3 percent per annum (Table 7). This annual rate falls during the next two decades to 0.7 percent, a level that is considerably under the world's projected growth rate (about 1.7 percent).[4]

Alternative scenarios simulate the situation where less control is exercised over the population in the future by the Chinese government, and population growth rates slow to approximately 1 percent per annum after 2000 (Rosegrant, Agcaoili, and Perez 1995). The movement of the

population from urban to rural areas is expected to continue and affects the rate of growth of rural and urban populations. Urban population growth rates are expected to rise by 4 percent per year in the 1990s, and this rate will continue at a high level, 2.4 percent per year during the 2010–2020 decade. Rural population growth rates, despite higher fertility, will grow by only 0.2 percent in the 1990s, reflecting high rates of rural to urban migration. The rate of rural population growth will actually became negative in the decade preceding 2020.

**China's wheat price trends are projected to follow world prices.**

**Table 7. Assumptions on the Growth of Factors Affecting Wheat Supply and Demand in China, 1995–2020**

| | Low | Baseline | High |
|---|---|---|---|
| | ---------- *growth rate (%)* ---------- | | |
| Population | | | |
| 1995–2020 | 1.1 | 1.3 | 1.4 |
| 2000–2010 | 0.5 | 0.7 | 0.9 |
| 2010–2020 | 0.4 | 0.6 | 0.8 |
| Per capita real expenditure | | | |
| Rural | 2.0 | 3.0 | 4.0 |
| Urban | 2.5 | 3.5 | 4.5 |
| Agricultural research investment | 2.5 | 3.5 | 4.5 |
| Irrigation investment | 2.5 | 3.5 | 4.5 |
| Wheat price | -1.0 | -0.5 | 0.0 |
| Other grain price | -0.5 | -0.5 | -0.5 |
| Fertilizer price | 1.0 | 1.0 | 1.0 |
| Environmental factors | | | |
| Salinity | 0.2 | 0.2 | 0.2 |
| Erosion | 0.2 | 0.2 | 0.2 |
| | ---------- *percentage (%)* ---------- | | |
| Share of urban population | | | |
| 2000 | 34 | 34 | 34 |
| 2010 | 42 | 42 | 42 |
| 2020 | 50 | 50 | 50 |
| | ---------- *index number* ---------- | | |
| Rural market development index | | | |
| 2000 | 0.6 | 0.6 | 0.6 |
| 2010 | 0.7 | 0.7 | 0.7 |
| 2020 | 0.8 | 0.8 | 0.8 |

*Note:* Population estimates are based on UN demographic predictions. Agricultural research and irrigation expenditures are derived from the Ninth Five-Year Plan and China's Long-Term Plan to 2010. The trends in the deterioration of the environment are based on extrapolations of past trends (Huang and Rozelle 1995a).

Baseline per capita real expenditures are forecast to average about 3 percent in the rural sector and 3.5 percent in the urban sector (Table 7, rows 4 and 5). The impact of higher growth rates, 4 percent per year per capita income growth for rural residents and 4.5 percent for urban residents, will be simulated.

Wheat price trends are projected to follow those of world prices.[5] World wheat prices are expected to fall by 0.5 percent annually throughout the projection period (Table 7, row 8). Although once far out of line with world agricultural prices, in recent years China's market prices have converged with those in international markets (Huang and David 1993).

The development of rural consumer markets also affects the future demand for grain and meat in China's economy because farmers, who have access to a greater variety of goods, will adopt different consumption patterns (Huang and Rozelle 1997b). Currently about 46 percent of food in rural China is purchased on the market. This is expected to rise to 60 percent by the year 2000 and increase by 10 percent in each of the next two decades thereafter (Table 7, rows 16–18). The trend will not affect total grain demand as much as the composition of the nation's grain needs. But as markets develop, even with income and prices held equal, the amount of wheat consumption falls. This reduction is offset by the increased demand for feed grain needed to meet the rising demand for meat that accompanies rural market development.

### Supply-Side Assumptions

Commodity price projections for producers' prices are assumed to be the same as those used in the demand-side analysis (Table 7, rows 8 and 9). Fertilizer prices are expected to grow by 1 percent per year, although in recent years trends have included both falling price levels and rapid price hikes (Table 7, row 10; World Bank 1990 and ERS 1995). In relative terms, the grain-to-fertilizer price ratio is expected to continue to deteriorate as it has since the mid-1980s (Ye and Rozelle 1994). Extrapolation of recent trends in the labor market provided the projection that the opportunity cost of labor for agriculture will continue to rise at 1 percent per year during the study period. A similar growth rate is assumed for the opportunity cost of land.[6]

Investment in agricultural technology and irrigation also should be expected to have a strong influence in China's future grain supply (Huang and Rozelle 1996; Huang, Rosegrant, and Rozelle 1996). As noted previously, annual expenditures on research declined from 1985 to 1990, and irrigation expenditures dropped from 1975 to 1985, but both types of expenditures increased after these periods of decline. The recent recovery in research and irrigation investments, together with the experience of other Asian countries, recent discussions with agricultural leaders and academics, and China's commitment to a strong domestic grain economy, lead to the expectation that China will sustain a long-run rate of increase in these investments (Table 7, rows 6 and 7). The baseline projections of investment growth nevertheless remain well below historical rates of growth. Erosion and salinization are expected to continue to increase at a steady but low pace (Table 7, rows 11–12).

**The recovery in research and irrigation investments, discussions with agricultural leaders and academics, and China's commitment to a strong domestic grain economy, lead to the expectation that China will sustain a long-run rate of increase in these investments.**

## PROJECTION RESULTS

According to our analysis, per capita wheat consumption in China crested in the mid-1990s. From a baseline high of 85 kilograms, wheat consumption per capita remains at that level for the first 15 years of the forecast period, before falling in 2020 to 82 kilograms (Table 8, row 1). The average rural resident will consume greater amounts through the year 2020; expenditure elasticities are positive through 2010, and after which falling prices will stimulate demand more than rising incomes will dampen it (Table 8, row 2). Urban wheat consumption per capita peaks in the year 2010 and declines over the last 10 years of the projection period (Table 8, row 3). Aggregate wheat demand per capita drops faster than either rural or urban demand because the total demand for the product falls as migration occurs.

**Table 8. Projected Annual Per Capita Wheat Food Consumption under Alternative Income Growth Scenarios in China, 1996–2020**

| | ---- Per Capita Wheat Food Consumption (kg) ---- | | | |
|---|---|---|---|---|
| **Alternative Scenario** | **1995** | **2000** | **2010** | **2020** |
| Baseline | | | | |
| National Average | 85 | 85 | 85 | 82 |
| Rural | 92 | 94 | 96 | 97 |
| Urban | 67 | 68 | 69 | 68 |
| Low Income Growth | | | | |
| National Average | 85 | 84 | 83 | 80 |
| Rural | 92 | 93 | 95 | 95 |
| Urban | 67 | 68 | 68 | 67 |
| High Income Growth | | | | |
| National Average | 85 | 86 | 86 | 83 |
| Rural | 92 | 95 | 98 | 98 |
| Urban | 67 | 69 | 69 | 68 |

*Note:* Base year is 1995.

**By the end of the forecast period, aggregate wheat demand will reach 137 million metric tons.**

Although per capita wheat demand is falling in the later projection period, total wheat demand continues to increase through 2020 mainly because of population growth. By the end of the forecast period, aggregate wheat demand will reach 137 million metric tons, over 20 percent higher than the initial baseline demand (Table 9, column 9). During this same period, wheat demand rises at about the same rate as that for rice, but at a much lower rate than coarse grains. Total grain demand is projected to increase by more than 50 percent (Huang, Rozelle, and Rosegrant, forthcoming). Wheat will fall from making up about 30 percent of total grain utilization to only a little more than 20 percent.

Baseline projections of the supply of wheat show that China's producing sector falls slightly behind the increase in demand in the 1990s. Wheat supply is predicted to reach 110 million metric tons by the year 2000. This projection implies a rise in wheat output of only about 10 percent over the

**Table 9. Projections of Wheat Production, Demand, and Net Imports (million metric tons) under Various Scenarios with Respect to Population, Income, Technology, and Price Policies, 2000–2020**

| | 2000 | | | 2010 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Alternative Scenario** | **Demand** | **Production** | **Net Imports** | **Demand** | **Production** | **Net Imports** | **Demand** | **Production** | **Net Imports** |
| Baseline | 123 | 110 | 13 | 132 | 122 | 10 | 138 | 137 | 1 |
| Low population growth | 121 | 110 | 11 | 128 | 122 | 6 | 130 | 137 | -6 |
| High population growth | 125 | 110 | 15 | 136 | 122 | 4 | 144 | 137 | 7 |
| Low income growth | 122 | 110 | 12 | 130 | 122 | 8 | 137 | 137 | 0 |
| High income growth | 124 | 110 | 14 | 134 | 122 | 3 | 140 | 137 | 3 |
| Low investment rate | 123 | 108 | 15 | 132 | 118 | 14 | 138 | 129 | 8 |
| High investment rate | 123 | 111 | 12 | 132 | 126 | 6 | 138 | 144 | -6 |
| Protection domestic | 123 | 111 | 12 | 130 | 123 | 7 | 135 | 139 | -4 |
| Liberalizing wheat market | 125 | 110 | 15 | 135 | 120 | 15 | 143 | 134 | 8 |

early 1990s (99 million metric tons), a figure far below the more optimistic estimates given in recent years by Ministry of Agriculture officials.

The gap between supply and demand is expected to narrow after 2000, however. Production is expected to rise somewhat faster in the second and third decades of the forecast period, mostly as a result of the resumption of investment in agricultural research. Wheat production is expected to reach 122 million metric tons in 2010, an increase of 11 percent during the preceding 10 years; production will reach 137 million metric tons by 2020, an even slightly higher percentage increase for the decade (12 percent over the 2010 level).

Under the projected baseline scenario, the initial widening gap between the forecast annual growth rate of production and demand in the late 1990s implies a rising deficit. Wheat consumption rises at about 1.6 percent per year, 1.3 percent from the rise in population and only about 0.3 percent due to rising per capita wheat demand. Wheat production during this period grows only 1.3 percent annually. Wheat imports rise somewhat in the late 1990s from about 10 million metric tons per year to 13 million metric tons (Table 9, row 1, column 3). Wheat imports peak, however, in this time period and then decline to their recent levels by 2010, approaching zero in 2020 (Table 9, row 1, columns 6 and 9).

**Under the most plausible scenarios, China's wheat imports will rise somewhat in the late 1990s before peaking and gradually declining to zero by 2020. This contrasts with feed grains imports which are expected to expand sharply by 2000 and continue to rise throughout the first two decades of the next century, eventually reaching 25 to 35 million metric tons.**

## CONCLUSIONS

This report examines trends in China's wheat economy, reviews the current trends in supply, demand, marketing, and trade, and then predicts China's future involvement in world grain markets. The authors' framework includes a demand-side model that, in addition to the impacts of income and population trends, accounts for the effects of urbanization and the changing level of the development of rural consumption markets. The supply response model considers the impact of prices, public investment in research and irrigation, institutional change, and environmental factors.

The projections show that under the most plausible expected growth rates in the important factors, China's wheat imports will rise somewhat in the late 1990s before peaking and gradually declining through 2020. Wheat import trends starkly contrast to those of feed grains, which by the year 2000 are expected to expand sharply and continue to rise throughout the first two decades of the next century, eventually reaching 25 to 35 million metric tons, a level many times higher than maize's historic high (Huang, Rozelle, and Rosegrant, forthcoming). Increasing maize imports arise mainly from the accelerating demand for meat and feed grains. Increasing wheat imports are caused by steadily expanding demand and a slowing of supply due to reduced investment in agricultural research in the late 1980s. After 2000, wheat imports are expected to stabilize as demand growth slows due to increasing urbanization, declining population growth rates, and relatively low and falling expenditure elasticities for wheat. As supply growth is sustained with the ongoing recovery of investment in agricultural research and irrigation, supply is projected to speed up and slowly begin to meet most of national demand by 2020.

One of the most important differences between the projections for wheat imports and those for other commodities is in the sensitivity of the predictions (Huang and Rozelle 1997a; Huang, Rozelle, and Rosegrant, forthcoming). Whereas there are considerable ranges in the projections for total grain, mostly maize, when baseline assumptions are varied in both the short and long run, wheat import projections are fairly robust. Substantially lower rates of agricultural investment lead to higher import predictions, a result that should be expected from the factor that has the largest marginal output response. In the case of almost all other factors, however, there are few changes in the assumptions that result in predictions of China becoming a significantly larger wheat importer than it currently is. Most all major demand factors—urbanization, income growth and low or negative expenditure elasticities, and market liberalization—are pushing China's consumers to reduce wheat demand over the next 25 years. Without a catastrophic breakdown in supply which could happen with sharp changes in cropping patterns, or a radical change in agricultural policy and an increase in responsiveness of farmers to prices, supply should be able to keep up with demand, or at least prevent the gap between supply and demand from growing significantly larger than it is at present.

It appears that China will neither empty the world grain markets nor become a major grain exporter. Although China will become a more important player in world grain markets as an importer in the coming decades, its importance will be primarily in world feed markets. In contrast, although in the next several years China should continue to retain its current position as the world's leading wheat importer, if the baseline assumptions hold over the long run, and the structural parameters used in this study remain reliable, China's reliance on world wheat markets may gradually fall. Both potential exporters outside of China and those charged with managing China's food needs through domestic production and imports need to be ready. Exporting nations, especially those dealing with wheat and maize, will undoubtedly be those more affected—some positively and others negatively.

**It appears that China will neither empty the world grain markets nor become a major grain exporter.**

If China's policymakers believe the projected level of total imports is too high, either politically or because they see some other physical or economic constraint, then investment strategies need to be devised in the near future due to the long lags between the period of expenditure and the time when such investments can affect production. Continued investment in wheat technology will help ease these trends. On the other hand, China's leaders may find it acceptable or politically expedient to continue to import at current levels of wheat, and may choose to reduce investment in wheat research, allocating more to other crops, such as maize, which ultimately may be in shorter supply domestically. Investment in and preparation of facilities and institutions needed to handle the increased volume of incoming wheat and grain will smooth the shock of production shortfalls in the short and long run, and will reduce the time and expense of importing grain. China's foresight in dealing with the upcoming challenges will most likely determine whether the production-demand gaps turn into a major agricultural crisis or whether they will become an opportunity to more effectively develop the nation's food economy and to continue to integrate itself into world food markets.

## E N D N O T E S

1. In this article, agricultural production refers to grain crops and cash crops only. Other crops (including tea, fruit, vegetables, and other miscellaneous products) are excluded. Grain and cash crops are planted on over 90 percent of sown area. In accordance with the Chinese definition, in the descriptive section of the paper, grain includes rice, wheat, corn, other coarse grains, soybeans, and white and sweet potatoes (valued at a ratio of 5 to 1). Cash crops include cotton, oil-bearing crops (including rapeseed, peanuts, sesame seed and other oil seed crops), sugarcane, sugar beets, tobacco, hemp-producing crops (such as jute), medicinal crops, and several minor miscellaneous crops. In the empirical analysis, grain is divided between rice and other grains (wheat, corn, and soybeans). These four grain crops accounted for 82 percent of grain-sown area in 1992. Cash crops are restricted to cotton, rapeseed, peanuts, and sugarcane. These crops accounted for 70 percent of total cash-crop-sown area in 1992.

2. This measure does not include a big part of the temporary migrant community (the so-called floating population). In the short run, this part of the population must be ignored since little is known about their consumption patterns. Moreover, there is no reason to expect that by adding them on to the urban population at this time the urbanization impact would be increased. It may be that their consumption patterns are more rural than urban in the temporary living conditions. But to the extent that a part of these residents end up staying in the cities permanently, they will almost certainly eventually adopt some of the urban habits.

3. Although migrants from southern areas may adopt the consumption patterns of their urban counterparts and increase their intake of wheat products like elsewhere in Asia, those from wheat-consuming northern regions will most likely rapidly begin to adopt consumption patterns similar to city residents, a move that probably will mean that wheat demand for this part of the labor force will fall. Based on a recent survey by Rozelle et al. (1997), there are probably about equal numbers of migrants coming from the north as from the south.

4. The baseline assumptions for population growth rates in the three study decades implies an overall projection period population growth rate of 0.89, a level slightly higher than that assumed by Rosegrant, Agcaoili, and Perez (0.74). There are many reasons to believe that with increasing reform, the government's ability to control fertility may lessen and future rates of population growth may be greater than the baseline rates. Rosegrant, Agcaoili and Perez (1995) use an alternative rate of 1 percent per year. In this study's high-population-growth scenario, it is assumed the growth rate in the first decade is 1.413, the second, 0.932, and the third, 0.844, implying an overall study period growth rate of 1.06. In a later section, results are presented showing the sensitivity of the conclusions to the choice of population growth rates.

5. In one sense, the assumption is consistent with China's entry into GATT, where in the long run Chinese producers will not be protected or taxed by border restrictions. Since China's grain prices are nearly the same as world market ones, there is also no obvious one-time effect from liberalization. The case would be different if China went the round of its prosperous East Asian neighbors and began to protect its producers with ever-increasing prices. Even the most ardent grain fundamentalists find this scenario plausible given China's severe fiscal problems.

6. The opportunity cost of land is calculated from China's cost of production data as real resource per mu, net of variable production costs and wages.

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# APPENDIX

## Alternative Projections

To test the sensitivity of the results to changes in the underlying forces driving the supply and demand balances, a number of alternative scenarios are run, altering the baseline growth rates of the key variables, including income, population, and investment in technology. The results, shown in Table 9, indicate that low population growth rates would reduce wheat demand by only 8 million metric tons in 2020, compared to the baseline, with wheat imports completely disappearing (actually becoming negative or beginning exports, which probably will never happen because of the existence of high transaction costs). With high population growth, imports increase to 15 million metric tons in 2000 and remain significantly positive through 2020.

Income growth simulations (Table 9, rows 4 and 5) generate about the same results as the population growth rate simulations. Since expenditure elasticities for wheat are low, import demand rises but does not explode. This relative insensitivity is in stark contrast to aggregate grain import demand and import demand for maize, which varies sharply with the assumed growth rate because the income elasticity for livestock and the indirect demand for grain are much higher.

Perhaps the most important supply-side simulation result shown in Table 9 is the impact of investment in agricultural research and irrigation on wheat production and trade balances (Table 9, rows 6 and 7). The variation due to changing the growth of investment assumption is hardly surprising given the large contribution that agricultural research, and the technology it has produced, has made to agricultural productivity in recent years (Huang and Rozelle 1996; Huang, Rosegrant, and Rozelle 1996). Increases in the rate of growth in investment in agricultural research and irrigation from 3 to 4 percent per year are projected to shift China from an import to an export position by 2020. If, instead, growth in annual investment in the agricultural research system and irrigation fell only moderately, from 3 percent per year, as forecast under the baseline projections, to 2 percent, then by 2020 total production would only be 129 million metric tons. With no change in the assumption regarding the level of food demand, imports under such a scenario would stay just below the level of current imports (about 8 million metric tons).

Hence, continuing high levels of grain imports could be expected only if there was continued decline in the growth of agricultural investment and if the government did not respond with countervailing policy measures as import levels rose. Such a scenario could unfold only if the government was unwilling or unable to undertake policies to stimulate food production growth. However, agricultural research and irrigation investments have already recovered in recent years, and in recent months, as grain prices have risen in response to short-term tightening of grain supplies, govern-

ment policymakers have responded with promises of greater investments in agriculture (Mei 1995). Although most of the investments have been targeted at irrigation, improvements in the operations of research institutes have also been announced. If China's government maintains current investments levels in wheat research, wheat imports under the most likely demand scenario will slowly fall.

In addition to domestic investments, the government could also look to the international arena for technological products that would allow China time to redevelop its agricultural research system. In fact, there are currently several large international seed companies investigating the possibilities of moving into the China market for seeds. Such moves would reduce the expected decline in grain supply and also decrease the expected level of imports even if growth in public investments slowed. The potential for bringing in companies interested in wheat seed production and sales, however, is necessarily going to be less than for maize, since hybrid seeds are easier to protect in a country like China which has weak intellectual property rights.

Table 9, rows 8 and 9, shows that wheat production, demand, and imports are relatively insensitive to price trends. This means that government pursuit of either price protection or market liberalization policies will cause little deviation away from the baseline results. Output price trends do affect China's wheat balances, but the effects are small. From the baseline level, for every 0.5 percent increase (decline) in the annual projected wheat price trend, imports over the next decade fall (rise) by less than 2 million metric tons (row 8). Over the long run, if China supported prices at current levels, demand would fall somewhat, supply would rise as farmers would increase output, and by 2020, China may have annual production levels that exceed supply (but even after 25 years of price supports, the difference between the baseline projections is only 5 million metric tons). Similar magnitudes are observed in the other direction (row 9). If China were to have prices in its own markets integrated with expected world price trends (falling by 1 percent per year), then instead of becoming almost self sufficient (row 1, baseline), China might import about 8 million metric tons annually, a level just slightly under the recent average.

The relative insensitivity of projected imports to price policy depends on low estimated output price response elasticities and the implicit assumption that current production patterns will continue in the future. Any shift in these assumptions could lead to sharp changes to the predicted supply, demand, and imports. China's fairly restrictive policy environment and the subsistence nature of its households may account for the low response of output and demand to prices in the estimations. If the decision-making environment in China evolves as the rest of the economy develops, farmer production and demand responses may vary more with prices in the future. If production were to rise more and demand were to fall more when Chinese leaders implement pricing policies, the projected imports might even be lower than currently projected. Likewise, if the nation's leaders opened the agricultural economy and prices continued falling, as they have

throughout the past century, the nation's imports of wheat could be significantly larger than currently projected.

Changes to the current cropping patterns could also lead to lower predicted output levels and higher future imports, as wages rise and the relative prices of crops change. Currently, the intense rice-wheat and wheat-maize rotations in most of China's wheat-producing areas demand large quantities of labor and may not be conducive to mechanized planting and harvesting. As wages continue to increase, pressures will rise to search for labor-saving cropping patterns. It may be that with a higher projected demand for feed grains, farmers in some areas will abandon two-season rotations and choose to produce single-season maize. If demand for wheat does not change, the concomitant need for wheat imports would increase. The current projections are based on parameters estimated on the basis of past data and historic technologies and cropping patterns. Any fundamental change in the way that wheat farmers cultivate their land may have sharp impacts on future wheat supply, demand, and imports.

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