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Agricultural Development, Nutrition, and the Policies Behind China's Success[1]

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INTRODUCTION

The emergence of China as an economic power is one of the miracle growth stories of the last part of the 20th century and the early part of the 21st century. Its economy has been the fastest growing compared with the economies of the world since 1980 (World Bank 2002). Growth has occurred in all sectors, including agriculture. Poverty has fallen. In the past 30 years, based on China's official poverty line, the absolute level of poverty fell from 260 million in 1978 to 14.8 million in 2007 (NSBC 2008). Moreover, the general welfare of most of the population has increased markedly. Many indicators of nutritional status have improved. For example, the number of children with low body weight fell by more than half (Turgis 2008). In fact, by the end of 2007 China had achieved many of its Millennium Development Goals (MDGs).

While past accomplishments are impressive, there are still great challenges ahead. Income disparity, for example, rose with economic growth. Such disparities are significant among regions, between urban and rural, and among households within the same location (Cai et al. 2002; World Bank 2002). There also are differences among regions in nutritional status (Chen 2004). In China's poorest areas, the incidence of anemia is high, which impedes the educational performance of rural students and leads to long-term behavioral problem and chronic poverty (Chen 2004).

Agriculture is responsible for a big part of the improvements in income and the nutritional status of the poor. However, although the average annual growth rate of China's agricultural sector was much higher than population growth since 1978, high input levels in many areas of China and diminishing marginal returns may mean that increasing inputs will not provide large increases

[1] The statistics and observations in this paper refer to the mainland of the People's Republic of China, excluding Hong Kong SAR, Macao SAR, and Taiwan. Paper produced for the World Food Program, February 2009.

in output. Many have predicted that almost all gains in the future will have to come from new technologies that could significantly improve agricultural productivity (Fan and Pardey 1997; Huang et al. 2003; Huang et al. 2002a, 2002b, 2004). Trade liberalization and tensions between the environment and development will further challenge China's agricultural and rural economy.

How has China achieved this growth? How will it maintain the growth? At a time when the rest of the world has been struggling to keep many of the indicators associated with the MDGs from deteriorating, how has China been able to move so aggressively toward meeting its MDGs? What is the policy basis that has helped produce this success?

The overall goal of this paper is to examine the policies—especially agricultural policies—that China has used to develop its agricultural economy, reduce poverty, and improve the nutrition of the nation. The paper is divided into three parts. First, we briefly describe the progress China has made in developing its agricultural sector and review the nation's achievements in the reduction of nutritional problems. Second, we review a number of the important policy initiatives that China's government has used in its efforts to support agricultural development and poverty reduction. Finally, we discuss the policy implications and lessons of the findings.

CHINA'S AGRICULTURE IN THE CONTEXT OF OVERALL ECONOMIC DEVELOPMENT

Overall Economic Growth

China's leaders implemented various reform measures that gradually liberalized the institutional and market structure of the economy. Although there is a cyclical pattern in China's growth rates, China's economy has had the fastest growth rates in the world since 1980.

In the early reform period[2], annual growth rates of the gross domestic product (GDP) increased considerably from 4.9 percent in 1970-1978 to 8.8 percent in 1979-1984 (Table 1). High growth was recorded in all sectors. Institutional reforms that saw a shift from collective agricultural production systems to individual household production were the main source of agricultural growth in the early reform period (Lin 1992; Huang and Rozelle 1996). The growth of agriculture provided the foundation for the successful transformation of China's reform economy. Meantime, rising income in the initial years of the reform stimulated domestic demand. Moreover, the high savings rate was transferred into physical capital investments in the non-agricultural sectors in both rural and urban areas, which led to annual growth rates of 8.2 percent in industrial GDP and 11.6 percent in services (Table 1). During the same period, family planning lowered the nation's population growth rate, enabling rapid per capita GDP growth. The annual growth rate of per capita GDP more than doubled between the pre-reform period, 1970-1978 (3.1%) and 1979-1984 (7.4%).

Despite the Asian financial crisis, an average annual growth rate of 8.2 percent during the years 1996-2000 was maintained (Table 1). China's economic growth accelerated in the beginning of the 21st century. Annual GDP growth rose from 7.3 percent in 2001 to about 10 percent in 2006-2007 (Table 1). Even during the global financial crisis period, China's

[2] The 'reform period' refers to the years since 1978, when the Government of China instituted its policy of "reform and opening up." The years 1979 to 1984 are considered the 'early reform period.'

Table 1. Annual growth rates (%) of China's economy, 1970-2007.

	Pre-reform 1970-78	Reform period				
		1979-84	1985-95	1996-00	2001-05	2006-07
GDP	4.9	8.8	9.7	8.2	9.9	11.8
Agriculture	2.7	7.1	4.0	3.4	4.3	4.4
Industry	6.8	8.2	12.8	9.6	11.4	13.2
Service	Na	11.6	9.7	8.3	10.1	12.4
Foreign trade	20.5	14.3	15.2	9.8	25.3	19.4
Import	--	12.7	13.4	9.5	24.9	16.2
Export	--	15.9	17.2	10.1	25.7	22.1
Population	1.80	1.40	1.37	0.91	0.63	0.5
Per capita GDP	3.1	7.4	8.3	7.2	9.0	11.3

Note: Figure for GDP (in real term) in 1970-78 is the growth rate of national income in real terms. Growth rates are computed using regression method. Trade growth is based on current value in US dollar.
Source: NSBC, Statistical Yearbook of China.

annual GDP growth still reached 9.6 percent in 2008 and 8.7 percent in 2009 (NSBC 2010).

Structural Changes and the Role of Agriculture in China's Economy

Overall Change in the Economic Structure of Agriculture, Industry, and Service Sectors

Rapid economic growth has been accompanied by significant structural changes in China's economy. Whereas agriculture accounted for more than 40 percent of GDP in 1970, it fell to 30 percent in 1980, 20 percent in 1995, and only 11 percent in 2007 (Table 2). The share of the industrial sector in national GDP fluctuated between 1970 and 1985, gradually increasing after the late 1980s, from 41 percent in 1990 to 49 percent in 2007 (Figure 1). In contrast to agriculture, the service sector expanded rapidly. The share of service sector in the national GDP increased from 13 percent in 1970 to 21 percent in 1980 and 40 percent in 2007. This trend is expected to persist in the coming years as China continues to promote its structural adjustment policies and economic reforms in response to domestic demand and changes in external trade patterns in the coming years.

Structural changes in the economy have also resulted in substantial changes in employment patterns. In 1970, agriculture employed more than 80 percent of the nation's total work force. This declined significantly to 60 percent in 1990 and 41 percent (including part-time agricultural labor) in 2007 (Table 2). The industrial sector's share of employment doubled in 1970-1985, remained at about 20-24 percent in 1990-2005, and reached 27 percent in 2007 (Table 2). The service sector's share of employment rose even more rapidly—from 9 percent in 1970 to 19 percent in 1990 and 32 percent in 2007 (Figure 2).

In rural areas, more than 40 percent of the labor force was employed in the non-agricultural sector in the late 1990s (de Brauw et al. 2002). The expanding non-agricultural employment has contributed substantially to the growth of farm

Table 2. Changes in structure (%) of China's economy, 1970-2007.

	1970	1980	1985	1990	1995	2000	2005	2007
Share in GDP								
Agriculture	40	30	28	27	20	15	12	11
Industry	46	49	43	41	47	46	48	49
Services	13	21	29	32	33	39	40	40
Share in employment								
Agriculture	81	69	62	60	52	50	45	41
Industry	10	18	21	21	23	22	24	27
Services	9	13	17	19	25	28	31	32
Trade to GDP ratio	Na	12	23	30	40	44	64	67
Export/GDP	Na	6	9	16	21	23	34	37
Import/GDP	Na	6	14	14	19	21	30	29
Share of rural population	83	81	76	74	71	64	57	55

Source: National Statistical Bureau, China Statistical Yearbook, various issues; and China Rural Statistical Yearbook, various issues.

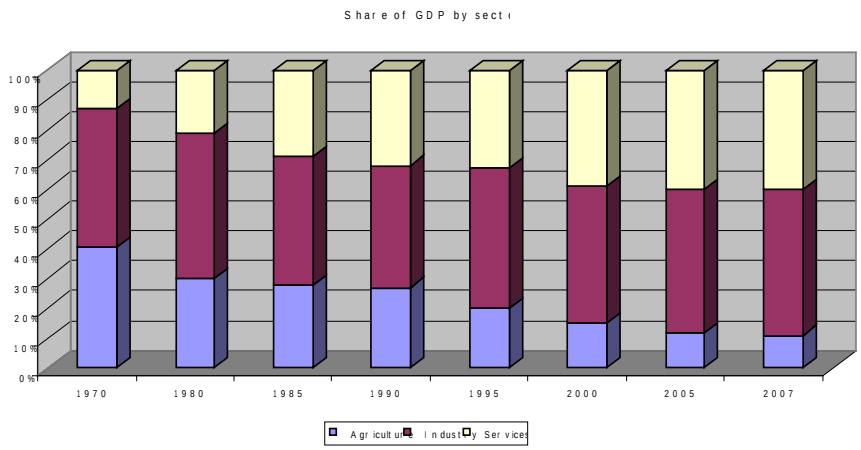


Figure 1. Share of GDP by sector

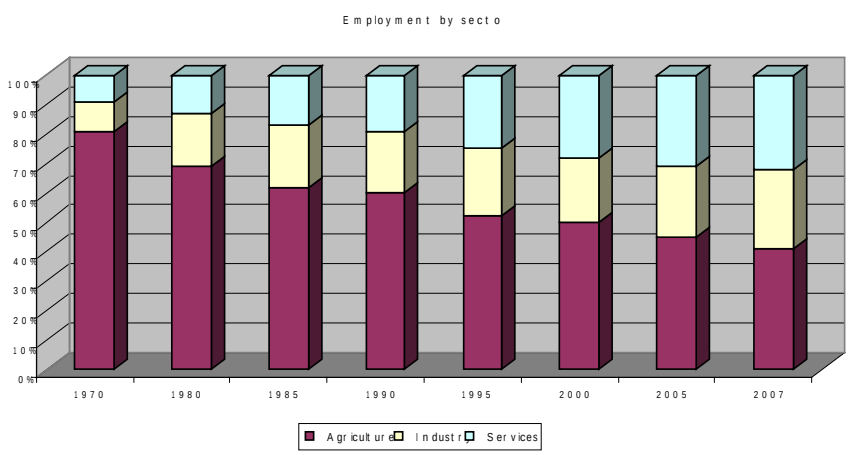


Figure 2. Employment by sector

household income since the late 1980s (Rozelle 1996). Non-agricultural farm household income exceeded agricultural income in 2000 for the first time, with the former's share rising to nearly 60 percent in 2007 (NSBC 2008).

Many factors have simultaneously contributed to China's structural changes in terms of economic composition and employment. Rapid economic growth, urbanization (Huang and Bouis 1996), market liberalization (Lardy 1995; Huang and Rozelle 1998), and China's open-door policies (Branstetter and Lardy 2005), among many others, are found to have significant impacts on consumption and demand (both internal and external) patterns. These, together with the rapid development of factor and output markets, largely explain the changes of China's economic structure in the past two to three decades (Brandt et al. 2005; Sonntag et al. 2005).

Move to More Liberalized Economy and Rapid Growth of External Sector

Rapid economic growth has also been associated with remarkable changes in China's international trade. Throughout the reform era, foreign trade has expanded even more rapidly than GDP. Annual growth rates of foreign trade reached nearly 15 percent in the 1980s and early 1990s (Table 1). It continued to grow at nearly 10 percent annually between 1996 and 2000 when the Asian and world economies were hit by the Asian economic crisis. After China's WTO accession in late 2001, imports and exports tremendously increased. The average annual growth rate of trade reached 25.3 percent in 2001-2005 and 19.4 percent in 2006-2007 (Table 1).

With the rapid growth of China's external sector, foreign trade has played an increasing role in the national economy since the beginning of the reforms. The ratio of China's export to GDP increased from less than 6 percent in 1980 to 23 percent in 2000 and further to 37 percent in 2007 (Table 2, row 8). Over the same period, the ratio of import to GDP also grew from 6 percent to 21 percent and then to 29 percent, respectively. These ratios have placed China among the most open economies in the world.

The rapid expansion of China's external economy is largely explained by the country's long-term development strategy to open its economy. Prior to the economic reform, China adopted a highly centralized and planned foreign trade regime (Lardy 2001). This system, however, has been substantially decentralized by granting more firms direct foreign trading rights. Export subsidies and import tariffs were also significantly reduced after the late 1980s. By 1991, all export subsidies were phased out, though China occasionally applied them to specific products (e.g., maize and cotton) to avoid a large fall in domestic prices before China's WTO accession (Huang et al. 2004). Import tariffs have also been remarkably reduced. China's average tariff was as high as 56 percent in the early 1980s; it was gradually reduced to 47 percent in 1991, 23 percent in 1996, and about 15 percent on the eve of its WTO accession in 2001. Within the agriculture sector, import protection has also been significantly reduced. The simple average agricultural import tariff fell from 42.2 percent in 1992 to 23.6 percent in 1998 to 21 percent in 2001 (MOFTEC 2002).

In fact, China's openness to imports progressed even faster than the decline in formal trade barriers might indicate. This is due to many special privileges that the government has extended to firms involved in export processing and strategic important commodity imports to balance domestic shortages. Thus, actual tariff revenues have been far below the average formal tariff rates. For example, the tariff revenue as a percentage of total import values was about 17 percent in the mid-1980s and only slightly more than 2 percent in 2004 (Lardy 2001; Branstetter and Lardy 2005).

Agricultural Development

Agricultural Production Growth

The growth of agricultural production in China since the 1950s has been one of the main accomplishments of the country's development. Except during the famine years of the late 1950s and early 1960s, the country has enjoyed production growth rates that have outpaced the rise in population. Although yields and total production rose during the pre-reform period, total factor productivity did not and rural incomes were stagnant (Rozelle et al. 2008).

After 1978, the introduction of the individual household responsibility system, price increases, and the relaxation of trade restrictions on most agricultural products accompanied the take-off of China's food economy. Between 1978 and 1984, grain production increased by 4.7 percent per year; the output of fruit rose by 7.2 percent (Table 3).

Agricultural growth was remarkable for all agricultural products except for grain and cotton in 1985-2000. Fishery production experienced the fastest growth in 1985-1995 (13.7 % annually, Table 3 and Figure 3). Over the same period, meat production and vegetable sown areas expanded at 7-9 percent annually. Other cash crops such as oil crops, soybean, and fruits also grew at rates much higher than the population growth.

Overall the agriculture sector maintained an average growth of nearly 4 percent per annum in recent years (Table 3). A comparison of growth rates of individual commodities between the early and late reform periods shows that production (measured in quantity) growth of many individual agricultural commodities fell. This may indicate that China's agricultural production has been shifting from aggregate production to value-added and quality food production.

Structural Changes in Agricultural Production

China's agriculture has undergone significant changes since the early 1980s. Rapid economic growth, urbanization, and market development are key factors underlining the changes. Rising income and urban expansion have boosted the demand for meat, fruit, and other non-staple foods. These changes have stimulated sharp shifts in the structure of agriculture (Huang and Bouis 1996; Huang and Rozelle 1998). For example, the share of livestock output value rose

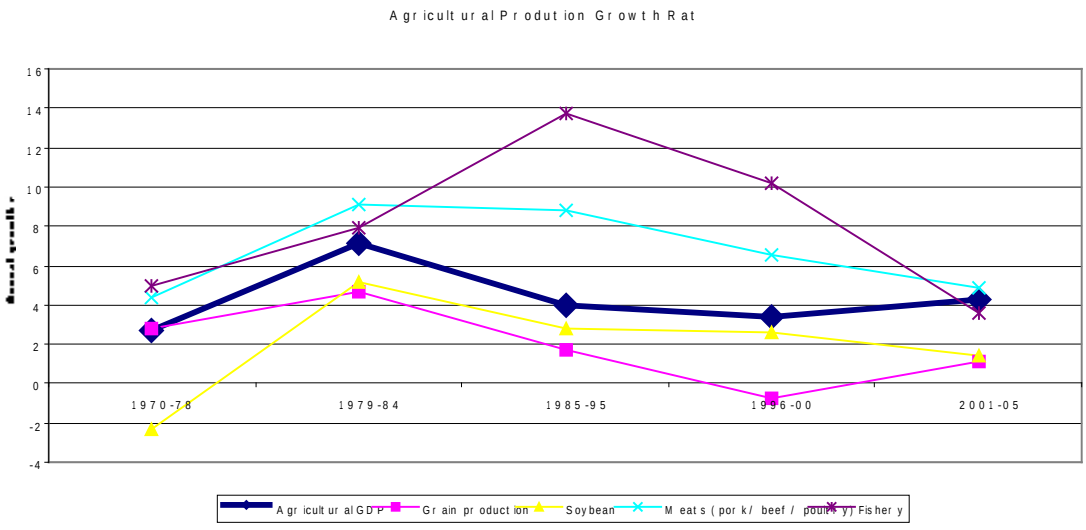


Figure 3. Agricultural production growth rate

Table 3. The annual growth rates (%) of China's agricultural economy, 1970-2005.

	Pre-reform	Reform period			
	1970-78	1979-84	1985-95	1996-00	2001-05
Agricultural GDP	2.7	7.1	4.0	3.4	4.3
Grain production	2.8	4.7	1.7	-0.7	1.1
Rice:					
Production	2.5	4.5	0.6	0.4	-0.8
Area	0.7	-0.6	-0.6	-0.5	-0.8
Yield	1.8	5.1	1.2	0.8	0.0
Wheat:					
Production	7.0	8.3	1.9	-0.6	-0.4
Area	1.7	-0.0	0.1	-1.6	-3.1
Yield	5.2	8.3	1.8	1.0	2.7
Maize:					
Production	7.4	3.7	4.7	-1.3	5.6
Area	3.1	-1.6	1.7	0.8	2.7
Yield	4.2	5.4	2.9	-0.9	2.9
Other production					
Cotton	-0.4	19.3	-0.3	-1.9	5.3
Soybean	-2.3	5.2	2.8	2.6	1.4
Oil crops	2.1	14.9	4.4	5.6	0.8
Fruits	6.6	7.2	12.7	10.2	21.0
Meats (pork/beef/poultry)	4.4	9.1	8.8	6.5	4.9
Fishery	5.0	7.9	13.7	10.2	3.6
Planted area:					
Vegetables	2.4	5.4	6.8	9.8	3.1
Orchards (fruits)	8.1	4.5	10.4	2.0	2.4

Note: Growth rates of individual and groups of commodities are based on production data.
Sources: NSBC, 1985-2006.

2.5 times from 14 percent to 35 percent between 1970 and 2005 (Table 4). Aquatic products increased at an even more rapid rate. One of the most significant signs of structural changes in the agricultural sector is that the share of crops in total agricultural output fell from 82 percent in 1970 to 51 percent in 2005-2007.

Within the crops sector, the importance of the three major crops — rice, wheat, and maize — has waxed and waned. The share of the major cereal grains increased from 50 percent in 1970 to a peak level of 57 percent in 1990 and then gradually declined to less that 50 percent in 2005 (Table 5). Most of the fall has been due to decreasing areas sown to rice and wheat. In contrast, the shares of maize areas nearly doubled from 10.8 percent in 1970 to 19.2 percent in 2007 (Table 5). The rise in areas sown to maize, China's main feed grain, is correlated in no small way with the rapid expansion of the nation's livestock production during the same period.

In addition to maize, other cash crops such as vegetables, edible oil crops, sugar crops, and tobacco have expanded rapidly in area in recent years. In the 1970s, vegetables accounted for

Table 4. Output value shares (%) in China's agricultural economy, 1970-2007.

	1970	1980	1985	1990	1995	2000	2005	2007
Crop	82	76	69	65	58	56	51	52
Livestock	14	18	22	26	30	30	35	34
Fishery	2	2	3	5	8	11	10	10
Forestry	2	4	5	4	3	4	4	4

Source: NSBC, Chinas' Statistical Yearbook, various issues and China Rural Statistical Yearbook, various issues.

Table 5. Shares of crop sown areas, 1970-2007.

	1970	1980	1985	1990	1995	2000	2005	2007
Rice	22.1	23.1	21.9	22.3	20.5	19.2	18.6	18.8
Wheat	17.4	19.7	20.0	20.7	19.3	17.1	14.7	15.5
Maize	10.8	13.7	12.1	14.4	15.2	14.8	17.0	19.2
Soybean	5.5	4.9	5.3	5.1	5.4	6.0	6.2	5.7
Sweet potato	5.9	5.1	4.2	4.2	4.1	3.7	3.0	2.4
Cotton	3.4	3.4	3.5	3.8	3.6	2.6	3.3	3.9
Rapeseed	1.0	1.9	3.1	3.7	4.6	4.8	4.7	3.7
Peanut	1.2	1.6	2.3	2.0	2.5	3.1	3.0	2.6
Sugar crops	0.4	0.6	1.0	1.2	1.3	1.0	1.0	1.2
Tobacco	0.2	0.3	0.9	0.9	1.0	0.9	0.9	0.8
Vegetable	2.0	2.2	3.2	4.3	6.3	9.8	11.4	11.3
Others	30.1	23.5	22.5	17.4	16.3	17.2	16.2	14.9
Total	100	100	100	100	100	100	100	100

Source: NSBC, China's Statistical Yearbook, various issues; China Rural Statistical Yearbook, various issues.

only about 2 percent of total crop area; by 2007 the share had increased nearly six times (Table 5). Fruit experienced similar rates of expansion. The area devoted to edible oil also grew more than two-fold. Field interviews reveal that the livelihood of the poor relies more on crops than livestock and fishery (when compared with richer farmers). Within the crop sector, poorer farmers produce more grains (particular maize) than cash crops. These figures might imply that the poor have gained somewhat less from the diversification of agricultural production during the reform period.

Driving Economic Forces of Agricultural Growth

Past studies have demonstrated that a number of economic factors have contributed to agricultural production growth during the reform period. The earliest empirical studies focused on measuring the role of the household responsibility system (HRS), which gave farmers land use rights, in increasing wealth. These studies concluded that most of the rise in productivity in the early reform years resulted from institutional innovations, particularly the HRS (McMillan et al. 1989; Fan 1991; Lin 1992).

More recent studies show that since the HRS was completed in 1984, technological change has been the primary engine of agricultural growth (Huang and Rozelle 1996; Fan 1997; Fan and Pardey 1997; Huang et al. 1999; Jin et al. 2002). Technological improvements have been by far the largest contributor to crop production growth even during the early reform period. These studies also show that reforms outside of decollectivization also have high potential to affect agricultural growth. Price policy has been shown to have a sharp influence on the growth (and deceleration) of both grain and cash crops during the post-reform period. Favorable output to input price ratios contributed to the rapid growth in the early 1980s. However, this new market force is a two-edged sword. A deteriorating price ratio caused by slowly increasing output prices in the face of sharply rising input prices was an important factor behind the slowdown in agricultural production in the late 1980s and early 1990s.

Irrigation has played a critical role in establishing the highly productive agronomic systems in China (Wang 2000). The proportion of cultivated area under irrigation increased from 18 percent in 1952 to a level at which about half of all cultivated land was irrigated in 2007 (NSBC 2001). However, rising demand for domestic and industrial water poses a serious constraint to irrigated agriculture, and increasing water scarcity has come to be seen as a major challenge to China's future food security and the well-being of people, especially in the northern region.

Agricultural Trade

While agricultural production has grown fast, agricultural trade has been growing faster. The value of food and feed exports increased about fourfold, from about US$3.2 billion in 1985 to US$12.8 billion in 2000, and almost doubled from 2000 to 2005 (Figure 4 and Table 6). However, food, feed, and fiber imports also increased rapidly in the past two decades; exports of food and feed rose faster than imports. Since the early 1980s, China has been a net food and feed exporter. Significant rises in fiber imports and a large deficit of fiber, mainly cotton, has been largely due to the rapid expansion of the export oriented textile industry in China.

In the same way that trade liberalization has affected growth in the domestic economy (Lardy 2001), changes in the external economy have affected the nature of China's agricultural trade patterns (Huang and Chen 1999). As trade expanded, despite the overall positive growth of the agricultural trade, the share of agriculture in total trade fell sharply because the growth of non-agricultural trade was much higher than that of agricultural trade.

Disaggregated, product-specific trade trends in agriculture show equally sharp shifts (Table 6). The data presented in Table 6 suggest that exports and imports are moving increasingly in a direction that is consistent with China's comparative advantages. In general, net exports of land-intensive bulk commodities, such as grains, fiber crop, oilseeds, and sugar crops, have fallen. At the same time, exports of higher value, more labor-intensive products, such as horticultural and animal (including aquaculture) products, have risen. Grain exports accounted for nearly one-third of food exports in the mid-1980s; after the late 1990s, horticultural, animal, and aquatic products accounted for about 70-80 percent of food exports (Table 6).

Food Security and Nutrition

Ensuring national food security is one of the central goals of China's agricultural policy. China feeds more than 20 percent of the world's population with about 9 percent of the world's cultivated land. By producing most of the food it needs for its large population, China contributes significantly to world food security and accounts for much of the decline

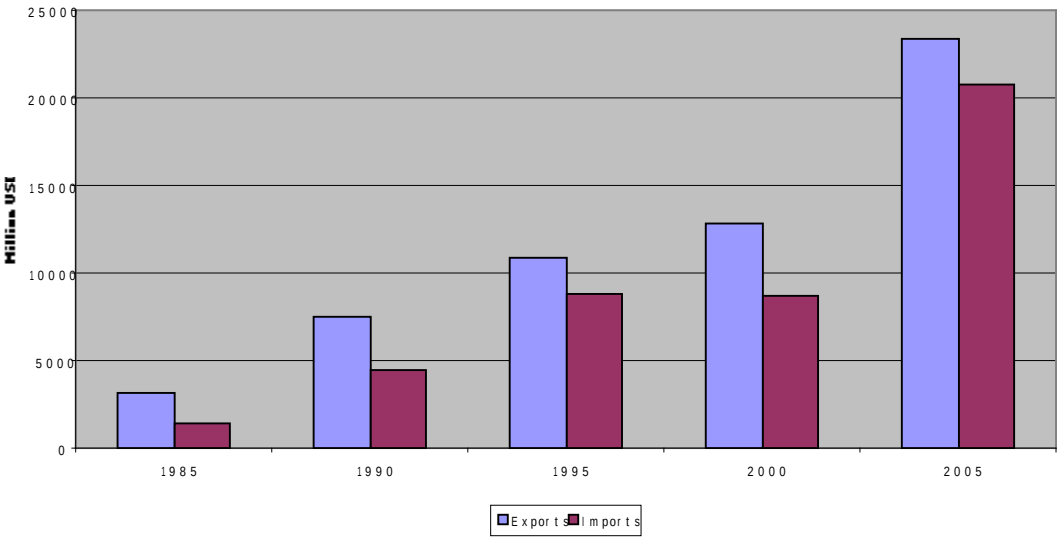


Figure 4. China's food and feed table

in the absolute number and percentage of the world's population who are undernourished. The increase in food availability and decrease in undernutrition was achieved primarily through increases in domestic agricultural production.

China's effort and success in increasing food and fiber supply to meet its growing population in the past 50 years have been well-recognized. Per capita food availability reached 3,040 kcal per day in 2000, a level that is 14 percent higher than the average of developing countries and 8 percent higher than the world average (FAO, 2002). China feeds more than 20 percent of the world's population with about 9 percent of the world's cultivated land.

At the macro or national level, grain security has received the attention of national leaders. Even before the 1990s, China aimed to achieve full self-sufficiency in grain production. In the late 1990s, leaders set a target of 95 percent grain self-sufficiency. To achieve this target, China invested heavily in irrigation and other agricultural infrastructure (Wang 2000), research and extension (Huang et al. 2000), and domestic production and marketing of chemical fertilizer and pesticides (Nyberg and Rozelle 1999).

The country has been a net exporter of grain since the 1990s. Although it imports high-quality indica rice, China also exports japonica rice and has been a net exporter of rice since the early 1980s. Imports of wheat have declined from more than 10 million metric tons (mt) annually in the 1980s to nearly zero in recent years (NSBC 1986-2007). China was one of the world's major maize exporters in the global market during the late 1990s and early 2000s. Annual maize export reached more than 12 million mt in 2002 and 16.4 million mt in 2003. Despite the fact that maize exports declined significantly in recent years, China continues to be a maize net exporter. In the coming decade, the country is expected to import maize to partially meet its growing demand for feed, a result of the expansion of the livestock sector.

At the micro level, household or individual food security depends on a number of factors, which are related, for the most part, to various

Table 6: China's food, feed, fiber, and non-agriculture trade in 1985-2005 (million US$).

	SITC	1985	1990	1995	2000	2005
Exports						
Food and feed		3,183	7,515	10,900	12,804	23,420
Live animals and meat	00-01	429	1,221	1,822	1,619	2,234
Dairy products	02	34	79	75	104	180
Fish	03	154	1,370	2,875	3,661	7,527
Grains	04	917	614	281	1,812	1,836
Fruit and vegetable	05	433	1,760	3,401	3,362	7,431
Sugar	06	65	318	321	257	502
Coffee and tea	07	312	534	512	545	1,061
Animal feeds	08	225	758	351	303	497
Other foods	09	62	82	286	608	1,182
Oilseeds and vegetable oils	22, 04	552	780	975	533	971
Fibre	26	892	1,096	753	1,085	1,186
Non-agriculture		21,557	53,481	137,126	235,314	737,347
Imports						
Food and feed		1,437	4,460	8,825	8,648	20,747
Live animals and meat	00-01	24	68	115	667	691
Dairy products	02	29	81	63	217	461
Fish	03	41	102	609	1,217	2,904
Grains	04	829	2,353	3,631	662	1,640
Fruit and vegetable	05	16	83	185	516	1,349
Sugar	06	262	389	935	177	451
Coffee and tea	07	18	30	73	94	222
Animal feeds	08	79	305	423	909	1,307
Other foods	09	21	46	88	283	354
Oilseeds and vegetable oils	22, 04	118	1,003	2,702	3,906	11,368
Fibre	26	1,023	1,975	4,108	2,846	6,854
Non-agriculture		37,335	46,911	119,150	213,599	632,352
Net export						
Food and feed		1,746	3,055	2,075	4,156	2,673
Live animals and meat	00-01	405	1,153	1,707	952	1,543
Dairy products	02	5	-2	12	-113	-281
Fish	03	113	1,268	2,266	2,444	4,623
Grains	04	88	-1,739	-3,350	1,150	196
Fruit and vegetable	05	417	1,677	3,216	2,846	6,082
Sugar	06	-197	-71	-614	80	51
Coffee and tea	07	294	504	439	451	839
Animal feeds	08	146	453	-72	-606	-810
Other foods	09	41	36	198	325	828
Oilseeds and vegetable oils	22, 04	434	-223	-1,727	-3,373	-10,397
Fiber	26	-131	-879	-3,355	-1,761	-5,668
Non-agriculture		-15,778	6,570	17,976	21,714	104,996

Source: United Nations, Commodity Trade Statistics Database, 2007.

forms of entitlements to income and food-producing assets. Also important are the links between domestic and external markets and the access of small, low-income, and resource poor producers and consumers to external markets.

Access to food in rural China has changed over time. In the early years of the reform, decollectivization policies gave all farm households in China the right to use a piece of land. During that time, however, markets did not function well. Hence, most farmers produced mostly for their own subsistence only. Access to food was primarily through the land that was allocated to farmers by the state.

As the country changed, so has the rural economy: nowhere has the change been more noticeable than in access to food. As will be seen below, from an economy that was mostly subsistence, in recent years China has developed one of the most commercialized rural economies when compared with other developing economies. On the average, the share of marketed products in total production ranges from 54 percent for grain to more than 90 percent for fish (Huang et al. 2004). Even the poorest of the poor also sold most of their produce, though the rate of commercialization is less than that of the richer Chinese farmers.

Still, China's rural consumers face a number of uncertainties regarding food access, the nature of which is most likely to differ from that of the other developing countries, where production risk is often one of the most important sources of risk affecting rural residents. This situation is less likely in China. A much bigger portion of China's land (48%) is irrigated (NSBC 2001). More households (around 80%) have at least one family member earning income in the off-farm market (de Brauw et al. 2004). Giles (2000) showed that risks in China come from a number of non-traditional sources, such as wage and policy risks. With an increasing number of households buying their food (instead of producing it), households also face rising market price risks.

Stability of food supplies and access to food by the poor are the other dimensions of food security. In this regard, the Chinese government has developed its own disaster relief program. It also runs a national food-for-work scheme, although this is less for disaster relief and more for long-run investments. The nation's capacity to deal with emergencies has been demonstrated repeatedly during the reform period. For example, the government responded massively and in a timely fashion during the Yangtze River floods in the 1990s and the Sichuan earthquake in 2008. Through these types of action, China's government has proven that it has adequate capacity to deal with the consequences of natural disasters. During the 1980s and early 1990s, poor marketing and transportation infrastructure were a major constraint affecting the food supply level in China (Nyberg and Rozelle 1999). Since then, the transportation and market infrastructure have improved remarkably. Huang and Rozelle (2006) showed that China's domestic food markets have been highly integrated since the late 1990s. It had only about a 5-percent change in price for every 1,000 kilometers of distance from port, a level comparable with that of the USA.

Improvement to Nutrition and Challenges[3]

China's agricultural reforms had a huge impact on the capacity of farmers to feed the nation's population. The rural standard of living was significantly improved, leading to a dramatic

[3] This section is taken from the material provided by the World Food Program.

fall in poverty. Based on China's official poverty line, the incidence of rural poverty fell from 31 percent in 1978 to 1.6 percent in 2007. Using the US$1 per day PPP-based exchange rate, it fell from 31.5 in 1990 to 10.4 percent in 2005 (UNDP 2008). In 2002, China's households dedicated an average of 40 percent of their total expenditure on food, compared with 55 percent in 1990, indicating a significant improvement in the standard of living.

As such, agricultural reforms had huge positive consequences on the food security and improvement of the nutritional status of Chinese citizens. The number of undernourished people decreased from 304 million in 1979-1981 (equivalent to 30% of the total population) to 123 million people in 2003-2005 (9% of the total population), according to FAO's estimates.

During this time, the nutritional status of the Chinese population has improved substantially. Rapid economic growth and the development of food markets have boosted food demand. They also offered a greater diversity of food production (e.g., vegetables, fruits, and meat) and a higher quality of products.

Although the Chinese diet has always been principally plant-based, significant changes in the dietary pattern have been observed since the economic reforms in the late 1970s. Currently, households generally consume less cereals (49% of total energy consumption) and more fruits and vegetables (7%) than they did previously. Daily fruit consumption reached 38 grams per capita in 2004, compared with only 12 grams per capita in 1990. Daily consumption of animal products also rose both in urban and rural areas, increasing the percentage of good quality protein in the total protein intake from 17 percent to 31 percent between 1992 and 2002. In 2004, the typical Chinese ate about 77 grams/day of meat, 20 grams more than in 1989. These trends usually constitute positive developments in the diets of adults.

Since the 1970s, the average height and weight of children have increased, a clear sign of better nutrition and health. According to the Chinese Health Ministry's National Nutrition Survey, six-year-old children were more than 6 cm taller on the average in 2002 than in 1975. The boys' average height rose from 112.3 cm to 118.7 cm and the girls from 111.5 cm to 117.7 cm during this period. Moreover, in 1998-2005, only 4 percent of infants were born with low birth weight: the average weight of newborn babies reached 3,309 grams in 2002. The prevalence of underweight children under the age of 5 was 19.1 percent in 1990; this decreased to 11.2 percent in 2000. Likewise, the prevalence of stunting among children under 5 fell from 33.4 percent in 1990 to 9 percent in 2005.

Despite major improvements, food insecurity remains a fundamental issue for many poor and remote households. The prevalence of underweight children in rural areas (10%) in 2005 was five times that among children in urban areas (2%). Even within rural areas, the disparities are marked. The Ministry of Health found that 35 percent of one-year old children in the poorest rural counties were stunted. The prevalence of underweight pre-school children (0-5 years) in western China was considerably higher than in eastern China: 5.8 percent in eastern provinces against 12.5 percent in western provinces (Ministry of Foreign Affairs and UN 2008).

Chronic malnutrition in rural areas may be due to insufficient local food production, poor dietary diversity, lack of income, limited access to public health services, lack of market distribution of food, lack of information and technology, inadequate water and sanitation, and poor understanding of nutrition. Improper use of complementary foods for infants is also an issue. Differences in daily intake between urban and rural areas are still significant. In 2004, urban households consumed 80 g/day of pork, compared with 54 g/day in rural areas. While urban inhabitants daily consumed 25 g of milk

and dairy products in 2004, rural households' consumption barely reached 6 g.

Although at the macro level China has achieved food security, micronutrient deficiencies remain a major nutritional challenge, especially in some poor remote areas. For example, anemia rates among children were 19.3 percent in 2005, but as high as 80 percent in the poorest counties. However, the prevalence of anemia has decreased slowly in recent years. Almost half of all children (49.5%) in rural areas have marginal vitamin A deficiency. Moreover, the average calcium intake among city and suburban residents was roughly 430 mg/day in 2004; it was only about 380 mg/day in rural areas and villages.

THE POLICY ENVIRONMENT

The rapid growth and radical transformation of China's economy and its agriculture are linked to government policy. This section explores a number of major policies in five areas that have enabled China's economic change and agricultural development: cultivated land management; agricultural R&D; marketing and pricing; fiscal policy and investments (in infrastructure and public services); and labor mobility.

Land Policies

Prior to the economic reforms in 1978, China's cultivated lands were farmed by groups of farmers (called collectives). There was a single collective head and he/she gave out work assignments to the members. Members jointly carried out the tasks, including plowing, planting, fertilizing, and harvesting. They were given work points for the amount of labor days they put in. At the end of the year, after paying an in-kind tax to the state, the collective members divided the harvest among themselves based on work points earned. While the system was put in place to take advantage of the economies of scale, in fact, during the entire Socialist Period (1950-1978), the increase in total factor productivity in agriculture was essentially zero (Rozelle et al. 2008). Similarly, per capita income in rural China in 1978 was the same as it was in the early 1950s.

In response to the perception that the system of collective agriculture was not working, China initiated the Household Responsibility System (HRS) in 1979. This reform radically altered the organization of production in agriculture and the incentives for rural households (Rozelle et al. 2008). It dismantled collectively run agricultural organizations and contracted agricultural land to households, mostly on the basis of family size and number of laborers in each household. Most importantly, the HRS reforms vested control and income rights to individuals. Land was not privatized, however. Land ownership remained with the village, made up of about 300 households, or a small group of 15-30 households. While they did not own the land, farmers were able to keep all of the grain (earnings) from the harvest. In economic terms, farm households became the residual claimants to their effort.

By 1984, about 99 percent of agricultural land was contracted to individual households for 15 years. Averaging about 0.6 ha, the size of farms varied among regions, ranging from more than 1 ha in the northeast and nearly 1 ha in northern China to about 0.5 ha in southwest and 0.2-0.3 ha in southern China. The number of crop seasons planted per year on a single plot of land ranged from one cropping in the northeast to 2-3 croppings in southern China; thus, variations in sown area among China's regions were less than those of farm size.

The impact of the HRS reforms could not have been more dramatic (Lin 1992). Productivity rose. Output rose. Incomes rose. It is often thought that this rise in the vibrancy of the rural economy was one of the real triggers

to the rest of the economic reforms in China (Rozelle et al. 2008).

During the 1980s and 1990s, there were concerns about the long-term sustainability of the reforms. Some people worried that land rights were not secure. Contracts given in the early 1980s were for 15 years only (expiring in the late 1990s). There was concern that productivity was flagging due to poor land rights. A number of research (summarized in Brandt et al. 2002) show that the system of land rights initiated by the HRS reforms was mostly beneficial to farmers and that the cost of insecure tenure rights was not that serious—at least in the short run—in terms of agricultural output.

After several years of policy debate, leaders seemed to have come to a consensus. One of the most important changes in the late 1990s was the renewal of land use contracts for an additional 30 years. By 2000, about 98 percent of villages had amended their contracts with farmers to reflect the longer set of use rights (MOA 2002). Cultivated land is still not private, but the right to use land was granted through 2028.

With the issue of use rights resolved, the government began searching for a mechanism that permits the remaining full-time farmers to gain access to additional arable land and increase their income and competitiveness. One of the main efforts is a new decree known as the "Rural Land Contract Law." The Standing Committee of the National People's Congress approved the Law in 2006. Although the property rights over the ownership of the land remains with the collective, the Law conveys to the contract holder almost all other rights that they would have under a private property system. In particular, the Law clarifies the rights for transfer and exchange of the contracted land, an element that may already be taking effect as researchers are finding that more land in China is rented in and out. The Law also allows family members to inherit the land during the contracted period. This new set of policies is aimed at encouraging farmers to use their land to increase the short- and long-term productivity of their farms.

Even after the passing of the Rural Land Contracting Law, village authorities in some parts of China have continued to interfere with the legislated rights (Rozelle et al. 2008). On the other hand, others in China wanted to strengthen the rights of farmers with respect to their cultivated land (Zhang et al. 2008). In response to this ongoing debate, China's central leadership has begun to further strengthen the rights of rural families over their cultivated land. The recent pronouncements at the Third Plenary Session of the 17th Central Committee of the Communist Party of China try to push the implementation of the Rural Land Contract Law (RLCL) forward. However, there is a perception that despite the RCRL, tenure security is still weak. With weak tenure, farm size and the quality of investments in land are limited. Without a secure tenure, rural residents lack the asset base to access finance that would permit them to move to the city, improve their land, or expand their off-farm businesses. The debate in China now is over whether or not the rural economy is ready for indefinite, titled land security. Fully secure tenure probably will not occur immediately, but with the continued effort of reformers, land tenure will gradually become stronger.

Development and Dissemination of Agricultural Technology

The importance of agricultural research and extension in increasing agricultural productivity in developing countries is now widely recognized. Successful development has been shown to be tied closely to productivity growth in the agricultural sector (World Bank 2008). In a country like China where agriculture is dominated by small, poor farms, it is even more important.

During the reform era, it was not always clear whether China would be able to maintain the pace of technological advance needed to maintain farm incomes in a dynamic economy. While the HRS played the key role in boosting productivity (Lin 1992) in the early reform stages, it provided only a one-off boost. After 1985, the evidence suggests that technological advances have been the main engine of productivity growth (Huang and Rozelle 1996). China was one of the first countries to develop and extend Green Revolution technology in the 1960s, 1970s, and 1980s. The country's scientists developed hybrid rice in the late 1970s; until the mid-1990s, China was the only country in the world to have commercialized this new technology.

Despite these and other successes, China's agricultural research system faced great challenges by the late 1980s (Pray et al. 1997). Research investment, almost totally publicly funded, was declining. Incentives were poor and funding was being allocated in ways that did not always reward excellence. The system was not responding to many demands for new technologies and the extension system was in shambles.

A nationwide reform in research was launched in the mid-1980s (Pray et al. 1997). It aimed to increase research productivity by shifting funding from institutional support to competitive grants, supporting research useful for economic development, and encouraging applied research institutes to support themselves by selling the technologies they produced. In addition, in the late 1980s and early 1990s, new horticultural seeds, improved breeding livestock (Rae et al. 2006), and new technologies for dairy were all imported (Ma et al. 2006).

After declining between the early 1980s and the mid-1990s (Pray et al. 1997), investment in R&D began to rise. Funding was greatly increased for plant biotechnology, although only Bt cotton has been commercialized in a major way to date (Huang et al. 2002b; 2003). China now ranks among the global leaders in agricultural biotechnology. In the late 1990s, it invested more in agricultural biotechnology research than all other developing countries combined, and its public spending on agricultural biotechnology was second only to the US. Investment in government-sponsored R&D increased by 5.5 percent annually between 1995 and 2000 and by over 15 percent per year after 2000 (Hu et al. 2007). During the past decade, the increase in China's investment in rural research and development has been the most rapid among large nations.

The investment in R&D has paid off. During China's early reform period, the yields of major food crops rose steadily (Table 8, column 1). Although greater efficiency in input use contributed partly to yield increases, technological improvements appear to have accounted for some of this growth; indices of aggregated inputs -- that is, measures of land, labor, and material inputs) for rice, wheat, and maize actually fell for all the crops during the early 1980s (column 2).

Although there was concern about the effect of the slowdown in R&D spending during the 1980s and early 1990s, the analysis shows that the growth of output continued to outpace that of inputs (Table 8, columns 3 and 4). Productivity trends also continued to rise (Table 9, column 2). During this time—and during the early reform period—China's total factor productivity (TFP) has been rising at a healthy rate of about 2 percent per year. Such rises, which occurred in all provinces and with all crops, could not have helped but increase incomes—of all farmers—regardless of whether the crop was being protected or taxed.

While it is possible that the extension of new technologies might have favored wealthier farmers at the expense of poorer farmers, in the case of China this does not seem to have happened. Huang et al. (2002a) show that when

Table 7. Real per capita net income of rural households by province in China, 2000-2005 (in real 2005 Yuan).

Province	2000	2005	Growth (%) in 2005 over 2000	Annual growth rate (%)
Beijing	4,790	7,346	53.36	8.93
Tianjin	3,830	5,580	45.68	7.82
Hebei	2,711	3,482	28.41	5.13
Shanxi	2,127	2,891	35.90	6.33
Inner Mongolia	2,318	2,989	28.97	5.22
Liaoning	2,671	3,690	38.18	6.68
Jilin	2,215	3,264	47.37	8.06
Heilongjiang	2,339	3,221	37.75	6.61
Shanghai	5,809	8,248	41.97	7.26
Jiangsu	3,960	5,276	33.25	5.91
Zhejiang	4,603	6,660	44.70	7.67
Anhui	2,095	2,641	26.08	4.74
Fujian	3,467	4,450	28.36	5.12
Jiangxi	2,255	3,129	38.77	6.77
Shangdong	2,960	3,931	32.80	5.84
Henan	2,195	2,871	30.80	5.52
Hubei	2,526	3,099	22.68	4.17
Hunan	2,452	3,118	27.17	4.92
Guangdong	3,838	4,690	22.22	4.10
Guangxi	1,991	2,495	25.32	4.62
Hainan	2,346	3,004	28.06	5.07
Chongqing	2,015	2,809	39.39	6.87
Sichuan	2,109	2,803	32.90	5.85
Guizhou	1,513	1,877	24.02	4.40
Yunnan	1,615	2,042	26.40	4.80
Tibet	1,414	2,078	46.99	8.01
Shanxi	1,620	2,053	26.68	4.84
Gansu	1,656	1,980	19.53	3.63
Qinghai	1,729	2,151	24.40	4.46
Ningxia	1,891	2,509	32.64	5.81
Xinjiang	1,796	2,482	38.24	6.69
National Average	2,462	3,255	32.21	5.74

Note: values are in real 2005 Yuan using rural consumer price index by province. The exchange rates were: 8.19 Yuan = 1 US$ in 2005, 1.8 Yuan = 1 US$ in PPP in 2003.
Data source: NSBC, Statistical Yearbook of China, 2001-2006.

Table 8. Annual growth rate (%) of yield and total cost of main grain crop in China, 1985 to 2004.

Crop	1985-1994		1995-2004	
	Output	Input	Output	Input
Early Indica	0.05	1.72	0.08	-2.31
Late Indica	1.37	2.12	0.80	-1.16
Japonica	1.79	3.99	0.17	-1.99
Wheat	2.84	2.58	1.38	-0.22
Maize	3.66	1.87	1.04	-0.63
Soybean	0.71	2.24	1.06	-1.36

Data source: Jin et al., 2009.

Table 9. Annual growth rate (%) of main grain crops' total factor productivity (TFP) and decomposition into technical efficiency (TE) and technical change (TC) in China, 1985 to 2004.

	1985-1994			1995-2004		
	TFP	TE	TC	TFP	TE	TC
Early Indica	1.84	-0.03	1.88	2.82	0	2.82
Late Indica	1.85	0.26	1.59	2.92	0.21	2.71
Japonica	-0.12	-0.37	0.26	2.52	0.15	2.37
Wheat	0.25	1.08	-0.83	2.16	1.06	1.10
Maize	1.03	0.61	0.42	1.70	-0.23	1.94
Soybean	0.11	0.19	-0.09	2.27	-0.08	2.35

Data source: Jin et al. (2007)

new technologies are released, poor, small farmers are just as likely to adopt them as better off farmers. Similarly, Jin et al. (2002, 2009) show that TFP in poorer areas also rose very fast. There is no measurable negative impact of the extension of new agricultural technologies on the poor in China.

Policies to Encourage Market Integration and Efficiency

Price and marketing reforms have been key components of China's transition strategy from a centrally planned to a market-oriented economy. These policies were implemented in a gradual way (Sicular 1995). In the initial years, there was little effort to move the economy to one in which most resources and factors were allocated according to market price signals. As officials in charge of the overall economic reforms became committed to using markets as the primary means to allocate resources for the economy, the commitment to allow markets in agriculture also deepened (Sicular 1995).

As markets began to emerge, China's leaders took steps to encourage the efficiency of markets and, perhaps more importantly, stepped aside and allowed them to expand in an environment with minimal distortions. National and provincial governments invested in hardware (roads, landline telephones, and cellular technology), which reduced transaction costs and accelerated the flow of information and goods (Park et al. 2002). Many regional and local governments invested in marketing sites and tried to attract commercial interests to set

up businesses. Finally, except for a short period in the late 1990s, government officials stepped back and allowed the entry of private traders and private transport, doing little to interfere with markets. Licensing fees and taxes are low or non-existent. Markets for both agricultural outputs and inputs were encouraged.

In assessing the health of the rural economy, it is important to understand how China's markets function. Markets—whether classic competitive ones or some workable substitute—increase efficiency by facilitating transactions among agents to allow specialization and trade, as well as by providing information through a pricing mechanism to producers and consumers on the relative scarcity of resources. With better markets, producers can begin to specialize, become more efficient, and increase their incomes.

Price data from private reporting stations and information firms indicate that China's markets function relatively well. For example, maize prices in four different cities in northeast China track each other closely (Figure 5). Soybean prices in markets in different regions of the country move almost in perfect concert with one another (Figure 6). A systematical look at the integration of markets across time shows that the share of markets that are integrated has risen from around 50 percent in the early 1990s to nearly 100 percent in the early 2000s (Table 10). Rice markets also have been shown to function as well as or better than those in the United States in terms of the efficiency of moving commodities around and between China's producing and consuming regions (Huang et al. 2004). Horticultural, dairy, and livestock markets are all dominated by millions of small traders who are operating in extremely competitive environments (Rozelle et al. 2008).

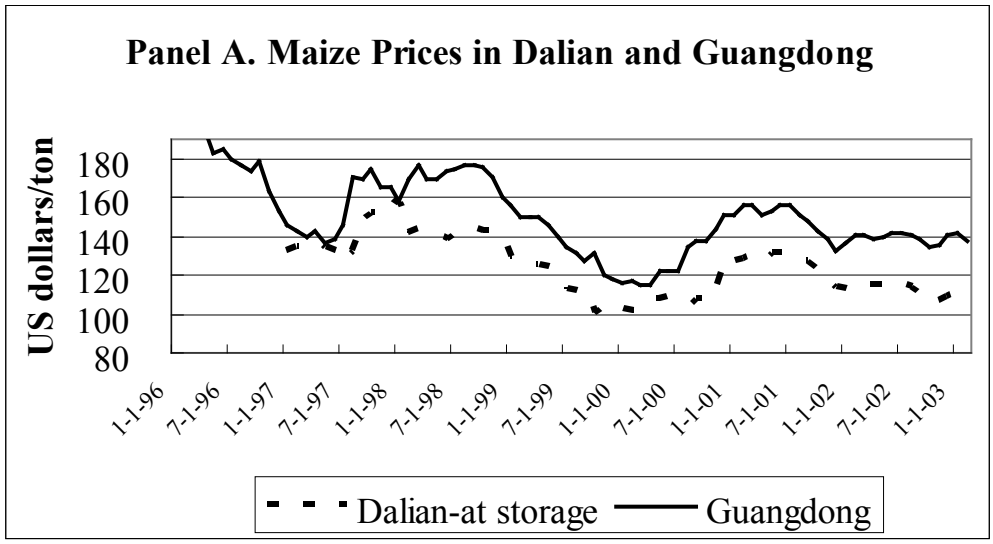
The improvement in markets has allowed individual producers to specialize as never before. According to one national survey, the number of villages that have become specialized producers of a single commodity rose from less than 20 percent in 1995 to nearly 40 percent in 2004 (Rosen et al. 2004). Such integration has allowed relatively small and poor farmers to participate in emerging markets and to accrue the substantial income gains associated with moving from subsistence to a market orientation (Wang et al. 2007; Balat and Porto 2006). In fact, a recent survey of the greater metropolitan Beijing area found that poor farmers living in poor villages were the main beneficiaries of new demands for horticultural commodities.

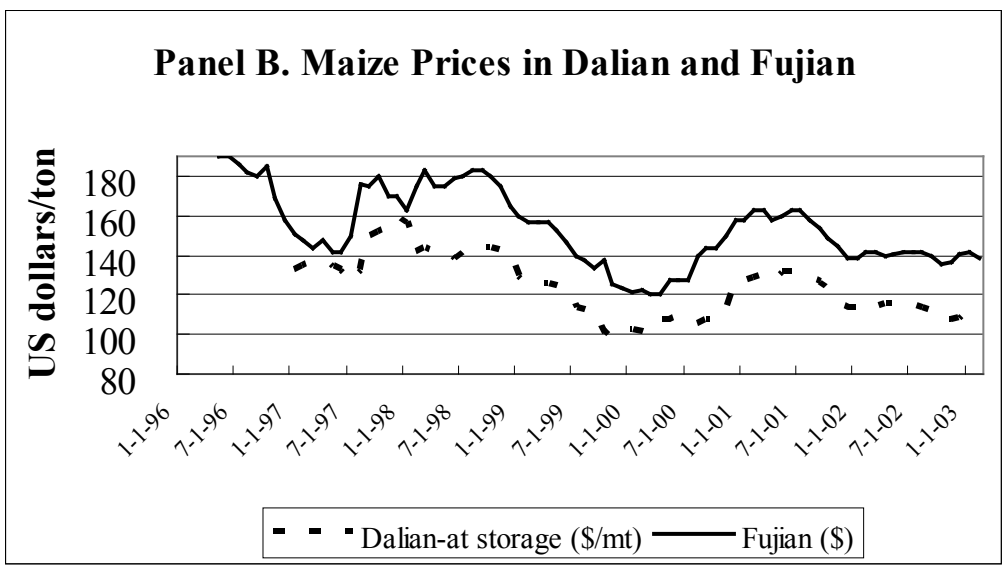
Most importantly, according to de Brauw et al. (2004), as markets in China began to become more competitive and efficient, productivity and efficiency began to rise. Even where market and trade liberalization has reduced protection and adversely affected income, the rising productivity and efficiency effects have at least partly offset these negative impacts. This interpretation is supported by the modeling

Table 10. Percentage of market pairs in rural China that test positive for integration based on Dickey-Fuller Test, 1988–2000.

Commodity	1989–95	2000-2003
Maize	28	98
Soybeans	28	100

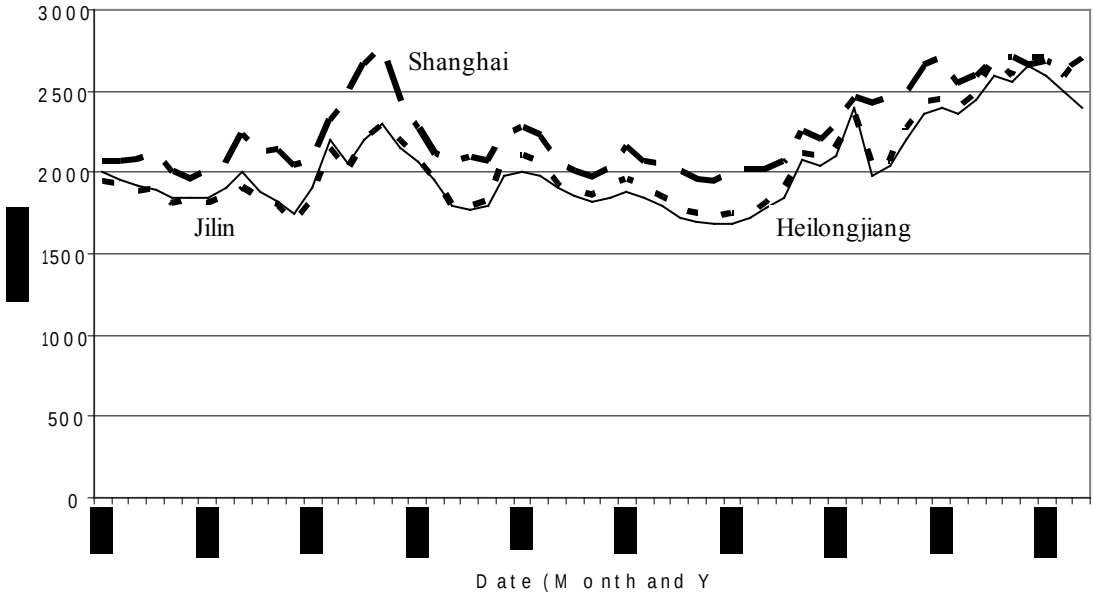
Note: Results are for two periods from same data set. For results for 1989–1995 for maize, see Park et al. (2002). Results for soybeans for 1989–95 and all results for 2000-2003 are from the authors (Huang and Rozelle 2006).





Data source: Huang and Rozelle (2003)

Figure 5. Maize prices in Guangdong, Fujian, and Dalian, January 1996 to February 2003



Data source: Huang and Rozelle (2006)

Figure 6. Soybean prices in key markets across China between 2001 and 2003

work of Huang and Li (2003), which found that trade policy affects some prices both positively (e.g., horticultural crops) and negatively (e.g., wheat), causing farmers to mitigate the downside effects by transferring production into commodities with rising prices.

In recent years (since 2004 or so), in the wake of China's domestic market liberalization, policymakers have been concerned about the possible effects on incomes if there were ever a severe drop in agricultural prices. The fear of the government is that low prices might adversely affect both national food production and farmer incomes. In response, the government began to plan for such a contingency by announcing a "minimum agricultural pricing policy." The policy is supposed to work by authorizing managers of grain reserves to buy grain (rice, wheat, maize) aggressively when the market price reaches a preset minimum. Although the policy does not authorize the grain managers to give farmers a certain price for any grain sold to them (as the pricing policy in the US did historically), it does authorize grain managers to procure grain and store it. With less grain on the market, prices should be stabilized.

Unfortunately, it is impossible to know how well this policy works because it has never been tried. Since its inception, price pressure has been high. The biggest issue in China's agricultural pricing then was how to keep prices from rising. Therefore, it is unclear how this policy will work when prices begin to fall. [Those interested in China's price management during the recent world food crisis may read Yang et al. (2008).]

Public Fiscal Reforms and Investment in Agriculture/Expansion of the Rural Infrastructure and Public Services

China has adopted several reforms to strengthen its fiscal revenue and public investment. The government has made

considerable progress in shoring up public finances since the early 1990s. If extra budgetary and social security funds are included, China's government spending was about 25 percent of GDP by 2006, comparable with the lower income OECD countries and higher than most East Asian countries. Overall, China has maintained a prudent fiscal policy with low deficits and debt in terms of GDP and higher government spending, which stimulated the economy.

Government expenditures in most areas of agriculture increased gradually during the reform period, but the ratio of agricultural investment to agricultural gross domestic product (AGDP) monotonically declined from the late 1970s to the mid-1990s. In 1978, officials invested 7.6 percent of GDP in agricultural sector; by 1995 the proportion of GDP committed to investment fell to 3.6 percent (NSBC 2001). Moreover, a significant capital outflow from agriculture to industry and from rural to urban areas occurred during the 1980s and 1990s through the financial system and government agricultural procurement (Huang et al. 2006; Nyberg and Rozelle 1999). After the mid-1990s, the nation significantly increased its investment in agriculture and rural development, and reduced and eventually eliminated agriculture taxes after 2005/2006.

Investment at the Local Level

Any visitor to rural China's villages is struck by one thing: agriculture is still being carried out in many environments that can only be described as backward. Except in a few suburban and coastal regions, the infrastructure in rural China is extremely poor. Roads and bridges, irrigation and drainage, drinking water, schools, and health facilities are far from modern and decades behind the infrastructure in China's cities. Yet development economists know that for a country to modernize, its infrastructure has to be able to support the production and marketing activities of a complex economy.

Although the infrastructure is poor, there have been, in fact, improvements in recent years. Research shows that, on the average, each village in China had about one infrastructure project during the late 1990s. This is far higher than in most developing nations in Asia. In recent years, the level of investment activity has risen sharply to almost one project per year (Table 11). Most of these projects are public goods (i.e., not activities, such as orchards, in which government frequently invested during the 1980s). Research suggests that this investment is being targeted fairly well, with increasing amounts going to the poor, minority, and remote parts of China.

Although the level of public goods investment per capita has risen from about US$40 to US$100 (in PPP terms), it is still far below the levels enjoyed by rural residents in Japan during the 1950s and South Korea during the 1970s (Luo et al. 2007). Quality, while rising, is still low in many villages (Liu et al. 2007). China is just beginning the process of narrowing the gap between rural and urban infrastructure; it will take an enormous and sustained effort to transform the rural economy.

Education and Health Programs

Rural services—in particular education and health—are perhaps the weakest part of the rural economy, despite the recognition by development economists of their importance. Rural education by any metric is abysmal. While China is close to achieving the universal compulsory nine years of education, until recently fees had been high, including those for elementary school (see below for a discussion of the recent fee exemptions). School buildings and equipment are outdated and poor. Teaching quality is also poor. The poor state of education in the rural areas points to the lack of provision

Table 11. Number and size of public goods projects (regional population, weighted), 1998-2003.

Project	Number of projects	Average size (1,000 Yuan)	Average size* In US$ PPP (1,000 dollar)	Accumulated distribution of projects
Roads and bridges	1,266	112	62	21.2
Grain for Green	892	67	37	36.1
School construction	850	99	55	50.3
Irrigation & drainage	819	65	36	64.1
Drinking water	636	75	42	74.7
Loudspeaker for village committee	379	60	33	81.0
Recreation centre	262	50	28	85.4
Build clinic	163	25	14	88.2
Beautify environment	157	24	13	90.8
Watershed management	151	298	166	93.3
Forest closure	140	34	19	95.6
Land Levelling	124	136	76	97.7
Eco-forest	55	34	19	98.6
Land improvement	52	110	61	99.5
Build pasture	19	134	74	99.8
Other public project	10	244	136	100.0
N / mean	5,975	108		--

*The following conversion rate is used: 1.80 Yuan =1 US$ in PPP terms
Data source: Luo et al. (2007)

for education of the rural population even as the nation accelerates toward industrialization and urbanization, and agriculture is becoming more complex and demanding. Partly because tuition and associated fees were so high—an estimated one-quarter of total expenditure for many poor households— participation rates in high school (grades 10-12) are less than 15 percent for the rural population in China's poor areas. A national survey found that nearly half of rural residents believe education has not improved in recent years (Liu et al. 2007).

There has been a new surge of interest by the government in improving rural education and reducing the cost of education. Fees for elementary schools were eliminated, initially only in poor areas in 2005, then later expanded to the entire rural economy in 2006. By 2007 all compulsory education (grades 1-9) was free. The income effects of such policies are potentially enormous. Huang et al. (2004) showed that the elimination of school fees provided benefits more than twice as large as the losses resulting from tariff reductions for China's protected crops. The nation has also launched a massive investment effort to improve the quality of facilities and teachers. There is still a long way to go, but the progress is building the foundation of the country's future labor force—inside and outside of agriculture.

Both the national and regional governments have also begun to build a rural health care

program. The New Cooperative Medical System, in its initial years and when funding was scarce, was also in high demand. By 2007 the government was investing up to 40 Yuan (US$5.3 or UD$22 in PPP terms) per capita into the program. In 2008, the government announced that the investment would rise even further. However, the program is only covering a small fraction of rural out-of-pocket medical costs. Many rural individuals report that they do not seek health care because it is too expensive. Keeping a healthy and nutritious population is a key part of China's past, present, and future success, and will remain a key challenge. [Interested readers may see Yi et al. (2008).]

Farm Subsidies and Taxes

The government launched a massive program of direct subsidies in 2004, which is projected to expand further in the coming years. Designed in part to boost grain production (for national food self-sufficiency) and in part as a rural income transfer program, the national grain subsidy program is, in fact, a combination of four programs: (a) a subsidy for farmers in areas that grow grain; (b) a nationwide agricultural seed subsidy program; (c) an input subsidy (payment to help farmers cope with the rising cost of fertilizers and other inputs); and (d) a general transfer program.

Nearly 80 percent of farm households receive subsidies. Participation in the program is as high in poor areas as in higher-income areas (Tan et al. 2006). Although the subsidies were relatively small in the first year of the program, by the second year, many farmers were receiving about 20-30 Yuan (US$3-4 or US$11-17 in PPP terms) per mu (15 mu = 1 hectare).

In addition to subsidies, the national government has eliminated almost all taxes and fees in rural villages. In 2001 and 2002, all fees were converted to a single agricultural tax that was not to exceed 8.5 percent of a household's (village's) gross value of agricultural output. However, soon after this had been implemented, the tax was eliminated altogether. Surveys show that by 2007 farmers were paying almost no taxes.

A new low-income program is also being launched nationwide. The intention is to begin to develop a social security system to serve as a safety net for those in the rural economy. The current annual payments—around 200 Yuan (US$26.3 or US$111 in PPP terms) or so—are low but the coverage is quite broad. A recent survey by the Centre for Chinese Agricultural Policy found that 6 percent of rural households nationwide and more than 10 percent of households in poor rural areas are being given these transfers. If the annual amounts are increased in the future, this program will certainly play a key role in eliminating a large portion of the remaining absolute poverty and undernutrition.

When added together, the subsidies from the recent policy innovations in rural infrastructure, free rural school tuition, grain and other agricultural subsidies, tax reductions, and health insurance are substantial. These government programs have contributed significantly to the observed improvements in household incomes in the rural areas.

Improving Mobility of Labor Out of Agriculture

China began the reform period with most of its workforce in agriculture. According to development economists (e.g., Gillis et al. 1996), if China is to be considered successful in modernizing the nation, it will have to reduce the level to just a few percent by the time the country reaches high-income status. In the early years of China's reforms (1980s and early 1990s), there were those who resisted this idea. Some officials thought it would be

more attractive if China could keep most of its rural labor force on the farm and to resist the massive urbanization that has occurred in other successfully developing countries.

In recent years, however, there has been a clear acceptance of the need to shift most of China's rural labor force from the agricultural to the industrial/service sector, and most of the rural population from rural to urban zones. This consensus can be seen in many recent policies such as: policies that provide migrants legal status in the cities; policies that increase protection for the labor force; and policies that facilitate the access of migrants to health and education services. These changes are derived largely from a leadership that has accepted the fact that most of the labor force in modern countries is in the industrial and service sectors and most of the populations are in urban areas.

Can this shift in policy be associated with changes in the rural labor force? The rate of migration out of agriculture is consistent with China's growth path and is one of the most rapid ever observed. A study by the Centre for Chinese Agricultural Policy shows that more than 80 percent of rural laborers have shifted to off-farm employment (Table 12). More and more of the new employment opportunities are in the cities. As such, there are now more than 170 million rural migrants in China's cities. The self-employed sector in rural China—which employs more than 80 million—is becoming more capital intensive and shifting into more sophisticated industrial and service sectors, and is profitable.

Have farmers benefited? Without a doubt migration is one of the driving forces of the increase in the well-being in the rural economy. Rozelle (1996) showed how getting access to an off-farm job is the most effective way for rural households to raise their income. Similarly, de Brauw and Giles (2008) linked migration to rising rural incomes and poverty reduction.

At one time in the 1990s, there was a downside to the rise in off-farm employment and migration. When some families got jobs off the farm and their incomes rose and others did not, inequality within the rural sector grew. Rozelle (1996) clearly demonstrated this linkage for the 1980s and early 1990s. However, the number of households with members in the off-farm sector has risen, with most households now having at least one person working off the farm. Rozelle et al. (2008) report how income inequality within the rural area is now falling due to migration.

But there are still many problems. Although more than 60 percent of the rural labor force already has off-farm jobs, there are still around 200 million that do not. Many of the jobs are low skilled. Wages are low.

Table 12. Off farm employment participation by members of the rural labor force by age cohorts in China, 1990 to 2007.

Age cohorts	Percentage with off farm work in:		
	1990 (from de Brauw et al. 2002)	2004 (from Zhang et al. 2008)	2007 (from Zhang et al. 2008)
16-20	23.7	78.6	93.1
21-25	33.6	82.8	87.5
26-30	28.8	71.0	76.4
31-35	26.9	65.1	67.2
36-40	20.5	54.0	65.7
41-50	20.8	44.0	54.1

Poor human capital is frequently seen as the most serious constraint to making more permanent shifts in labor from rural to urban and from agriculture to industry/service sector. Another is having enough jobs. On the other hand, the usual resistance to labor out-migration is compounded by a number of China-specific factors. One is the hukou residence permit system, which restricts mobility of labor into urban areas (Zhao 1999). Another is the land tenure system, where households leaving the agricultural sector are not able to use their land as collateral. Even worse is that despite official policies that state otherwise, there are still some villages where families migrating to the cities are pressured to relinquish their land (Zhao 1999). Other China-specific resistance comes from institutional barriers that keep rural and urban populations separate. For example, inequities remain in the level of spending on and access to education, health, and welfare between the rural and urban sectors.

Other Policies

There are many other policies aside from the ones discussed above (i.e., cultivated land, agricultural technology, promotion of markets, investment in agriculture and the rural economy, rural labor market initiatives) that this paper will not be able to address because of space limitations. The rest of this section will briefly touch on some of the glaring omissions and suggest to the interested readers other papers that might be of use in understanding them more.

One most glaring omission is probably that of agricultural trade policy. Trade is important because it provides export opportunities to farmers; it is a way of increasing access to better and less expensive commodities as well as of allowing world markets to send signals to China's policymakers, agricultural producers, and others on which commodities the country has and has no comparative advantage. If such signals are allowed to get through to the farmers (through trade liberalization policies—on top of the domestic market reforms as discussed above), the economy can also become more efficient and increase its income. It is well-known and important to note that trade liberalization does hurt some inside the country.

China has been very successful in its efforts to liberalize agricultural trade. Trade barriers have fallen. Rights to import have been extended in the case of most commodities to thousands of private traders and trading enterprises. Non-tariff barriers have also been reduced. On one hand, there is a lot of evidence that China has responded to signals from world markets and made sharp adjustments in its production structure to better reflect its comparative advantage. On the other hand, China has taken actions to try to minimize the impact on those that have been hurt by trade liberalization. [Interested readers may consult Huang et al. (2004) for more details on these shifts.]

A great deal of effort has been given also to water policy. Prior to the economic reforms, the state mostly focused its efforts on building dams and canal networks. China today has one of the most irrigated agriculture in the world. Its surface water management is advanced and flood control is being maintained studiously.

After the 1970s, greater focus was put on increasing the use of China's massive groundwater resources (Wang et al. 2005) – a source that the country had little experience in managing. By 2005, China had more tube wells than any country in the world, except possibly India. Although, initially, investment was put up by local governments with aid from county and provincial water bureaus, by the 1990s, the government was encouraging the huge shift in ownership that was occurring as pump sets and wells and other irrigation equipment went largely into the hands of private farming families (Wang 2000). At the same time, private water

markets (whereby farmers pump water from their own well and sell it to other farmers in the village) were also encouraged. The main policy initiative after the mid-1990s in the surface water sector was management reform (with the goal of using water more efficiently).

This investment in groundwater is really a tale of good news and bad news. On the one hand, new sources of groundwater are increasing agricultural cultivated area, resulting in higher farmers' income and productivity (Huang et al. 2006). The privatization movement has made water management more efficient (Wang et al. 2008). However, today, China's groundwater in many places is in a crisis. Groundwater tables are falling, and many wells are being pumped dry. While China's immediate future (in these areas) is in no danger, certainly in the longer run, these sustainability issues need to be addressed in an effective way. [For the interested reader, Wang et al. (2008) may be the best source to summarize China's agricultural water management policies, policy successes, and the continuing challenges.]

Other rural policies, such as those that govern township and village enterprise emergence and privatization, as well as rural governance, almost certainly have a large, albeit indirect, effect on agriculture. Urban employment policies, residency restrictions, exchange rate management, and many other policy initiatives also affect agriculture by affecting relative prices in the economy, access to off farm jobs, and the overall attractiveness of staying on the farm. [A volume edited by Brandt and Rawski (2008) is perhaps the best source today on the economic reforms and the current and future economic policy issues.]

SUMMARY AND LESSONS

When taken together, these policies have been shown to have a dramatic effect on China's agricultural sector. They have increased output of food, driven prices down, and improved the supply of non-grain food and raw materials for industry. The mix of policies—pricing, improved property rights, market liberalization, investment, and trade—has made producers more efficient and has freed up labor and the resources behind the structural transformation of the agricultural economy, specifically, and the rural economy, generally.

One of the most convincing indicators of the effective role that agriculture in China is beginning to play in the nation's development is that the declining importance of grain in the cropping sector, of the cropping sector in the overall agricultural sector, and of agriculture in the general economy. On the other hand, food prices remain low; calories available for the population are more than sufficient; and rural incomes and productivity are up.

Many of the improvements in welfare, however, are being generated by individuals (more than 200 million of them) that have been able to move from grain into high-value crops; from crops to livestock and fisheries production; and most importantly from agriculture and the rural economy to off-farm jobs in the city.

Main Challenges of China's Development

Despite these successes, many challenges remain, especially to those who have not been able to participate in the miracle of China's overall economic growth. These challenges have to do with equity and income distribution. While the success on the economic front is clear, it is less so with regards the impact on the environment and natural resources. There is also the concern on the impact of these policies on nutrition and access to food in the long run, and ultimately on food security.

Equity and Income Distribution

While the progress in agriculture has been notable, many lessons can be gleaned from it; there are likewise many great challenges ahead. With the transition from a planned to a market-oriented rural economy mostly complete, China's main challenge has shifted to broader development issues. In the coming years, the development process will have to be fundamentally different from the efforts in previous times when meeting the nation's food needs, poverty reduction, and economic growth were the main goals.

China's rapid economic growth and the rise in the nation's overall wealth have been accompanied with a widening income inequality. Regional income disparity has been enlarging since the 1980s (Cai et al. 2002; World Bank 2002). Eastern China grew faster than Central and Western China. After the one-time impact of the rural institutional reforms had been exhausted, urban income growth has been consistently higher than the rural sector's. By 2004, per capita income in the urban areas was 3.21 times that in the rural areas (NSBC 2005). Income disparity within the rural areas has been rising. For example, the Gini coefficients in the rural areas increased from 0.24 in 1980 to 0.37 in 2003 (NSBC-Rural Survey Department 2004).

In the coming years, these concerns will need to be faced. The policies of investment in agriculture and infrastructure, the increase in labor mobility, and the development of a set of public services will play a key role in addressing such concerns.

Natural Resources and the Environment

While successful technology innovation will help China to increase its agricultural productivity, the country needs to come to grips with water scarcity. Water shortages and the increasing competition between industry and domestic use do not provide much hope for large gains in the areas under irrigation and the total output from irrigation expansion (Lohmar et al. 2003). This is particularly important in the North China Plain where most of the wheat and some of the maize are produced. Moreover, while the land policy helped China to increase agricultural productivity in the early reform period and contributed significantly to the reduction of China's rural poverty, land holdings are so small that farming activities alone cannot continue to raise the incomes of most rural households. The challenge now is how China can effectively establish linkages between rural and urban areas and encourage a large labor shift out of agriculture. There is also the danger that poor, under-educated small farmers may not be in a position or have the incentive to make farming decisions that are conducive to long-term, sustainable development.

Trends in environmental degradation suggest that considerable stress is being put on the agricultural land base. While judicious use of modern technologies is essential to the efficient production of food, their inappropriate use -- such as excessive application rates or imbalances in the combination of inputs -- can result in serious environmental problems and food safety concerns. China is now the world's leader in both chemical fertilizer and pesticide consumption. The intensive fertilizer and pesticide use is generating rising concern regarding contamination of farm produce, damage to the agro-ecosystem, and adverse effects on human health. Environmental stresses have also been occurring as evidenced by soil erosion, salinization, loss of cultivated land, and decline in land quality (Huang and Rozelle 1995). Deng et al. (2006) showed that although China did not record a decline in total cultivated land from the late 1980s to the late 1990s, average potential productivity of cultivated land, or bioproductivity, declined by 2.2 percent

over the same period. Meantime, a large decline in cultivated land was recorded after the late 1990s due to industrial development and urban expansion.

There are also concerns regarding future food security considering the extent that the pressures of the environment undermined food production and productivity progress in the past. Therefore, policies have to be evaluated in terms of their balance between current and future food production.

Prospects of China's Agriculture and Lessons for Other Nations

Its nearly three decades of economic reform have enabled China to achieve remarkable economic growth and structural changes. During the 1980s, 1990s, and early 2000s, China has become one of the fastest growing economies in the world. GDP grew at nearly 10 percent annually in the past 30 years. Over the course of the reform period, both rural and urban incomes have increased noticeably. Rising income has also been associated with a substantial reduction of poverty and significant improvement of food security.

The country's rapid growth would not have been possible without its domestic economic transformation and "open-door" policy. Successful growth in the agricultural sector facilitated the economic transition from an agriculture-based economy to an industry/service-based economy and from a rural to an urban economy. The growth in agricultural productivity had enabled China to release its large pool of abundant rural manpower, providing cheap labor for the nation's industrializing economy. Rising international trade and foreign direct investments (FDI) have been the other sources of economic growth, facilitating China's economic structural changes toward the more competitive sectors. The structural changes occurred not only between agriculture and industry, but also within the agricultural sector.

Food security has been one of the central goals of China's agricultural policy. Since the early 1980s, domestic reforms to boost agricultural growth and farm income have covered nearly every aspect of the economy, starting from land reform and then gradually moving to both input and output markets, from agricultural sector specific policies to macroeconomic policies. The reforms have resulted in significant impacts on the economy. China has been able to increase its ability to feed its growing population with extremely limited natural resources and has developed itself as a food and agriculture products exporter. Per capita availability of food, household food security, and nutrition have all improved significantly. Increased domestic production has been almost solely responsible for increased per capita food availability.

China's experience demonstrates the importance of technological development, institutional change, market liberalization, public investment, and other policies conducive to improving agricultural productivity, farmer income, and food security in a nation with limited land and other natural resources. Technology has driven the growth of China's agricultural economy. Institutional arrangements and government policies also played an important role in ensuring the availability of food for the whole Chinese population.

While there are a number of challenges related to China's agricultural sector, there is optimism concerning its future growth. In the past, China put in place various policies concerning land, R&D, marketing, and infrastructure investments. Its future growth rests on the creation of better policies, especially those that would help create the needed balance between efficiency and equity

as well as between growth and equity, and those concerning sustainable food security for China and the rest of the world.

The results presented in this paper suggest significant policy implications for other developing countries. For countries whose agricultural economic structures are complementary to China's, opportunities may be offered by China's increasing imports of land-intensive agricultural products and increasing exports of labor intensive agricultural products. On the other hand, countries with similar agricultural export structures, and therefore compete with China, will have to put extra effort into lowering their production and marketing costs.

One of the challenges in policymaking concerns not only what policies to adopt but also in what order should they be adopted. A look at China's reforms shows a clear order in the adoption of reform and development policies underlying the nation's growth during the past 30 years. These reforms provided incentives for farmers to increase their efforts as they received the main benefits from their work. Although land was not privatized, the farmers were given its full use rights as well as income rights from the produce. Farmers saw and exploited the opportunities to make their lives better. Starting from the early reform period (1980s), the government invested in agricultural technologies and made sure they were available to all farmers—large and small, rich and poor. The second stage of the reform focused on getting markets and domestic prices right. Starting with only a few markets in the 1980s, markets were encouraged throughout the 1990s by removing regulation for entry, building transportation and communication infrastructure, and eliminating the state's activities in domestic trade. Labor markets were also liberalized and farmers were encouraged to find employment off-farm and out of the village in the self-employed sector. As domestic markets developed, it then became clear that even better incentives and clearer price signals would be produced if China's external sector were liberalized. During this second period, the state's investments were mostly focused on regional projects (e.g., inter-provincial roads, communication projects). Finally, as markets began to mature and the economy—one with good incentives and efficient price signals—was emerging in the 2000s, the state decided that China's enormous rural/agricultural sector needed an extra boost. Thus, it initiated local investment projects in poor communities, including local roads, irrigation and drinking water, and public services in education and health, ultimately putting in place a set of direct subsidy programs.

China's experience shows that good incentives, good markets, and support from the state in providing public goods, including technology and public services, are necessary for all economies. However, the order in which they should be implemented is subject to many nation-specific factors. As it is beyond the scope of this paper to discuss these factors in depth, interested readers may look to Swinnen and Rozelle (2006). In this book, the authors examined the development record of more than 20 transitioning nations between the early 1980s and the 2000s, and tried to explain the reasons for their successes and failures. In the process of identifying the factors that have led to the success (or lack thereof), the authors were able to identify various political economy factors—differing from country to country. They aver that at least four groups of factors determine the order and pace of development policy implementation: (a) the nature of a nation's agricultural technology; (b) the extent to which the state commands fiscal resources; (c) the politics of the country and how much political support there is for reform and development; and (d) cultural and other factors such as the nature of ties with developed regions and the

legacy of institutions such as private property, etc. As such, policymaking has become more of an art than a science. But in the end, good governance is a necessary condition for launching the development or transition process and ultimately for achieving success.

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