Meeting World Food Needs with GM Rice?

Agriculture in China - Successes, Challenges, and Prospects

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I. Success

- 1. For the past three decades (1978-2010), China's agricultural GDP has been growing annually at an unparalleled *4.57 percent on average*.
  - Agriculture has been an important contributor to the remarkable economic growth in China, especially during the early stages
  - By raising incomes, agriculture has been the driving forces behind China's massive reduction in poverty (this has been a most important, though widely underappreciated contributor to reducing China's number of $1-day poor people by half a billion between 1978 and 2004).
  - By providing cheap and abundant food, thus keeping wage low, agriculture paved the way for its export-led industrialization

- 2. China almost doubled its cereal production (rice, wheat and corn) between 1978 and 2010 and is now feeding 1.3 billion people, or 20 percent of the world's population, while having less than 11 percent of the world's agricultural land and less than 6 percent of its water. Cereal production increased from 247 million metric tons (MMT) in 1978 to 474 MMT in 2009.

- 3. China's agriculture diversified from being crop dominated (82% of agricultural GDP in 1978) into livestock (35 % of agricultural GDP in 2005) and fishery and aquaculture (10 % of agricultural GDP in 2005), in line with domestic dietary change and its natural comparative advantage.

Figure 3.1 Grain production: 1978-2009

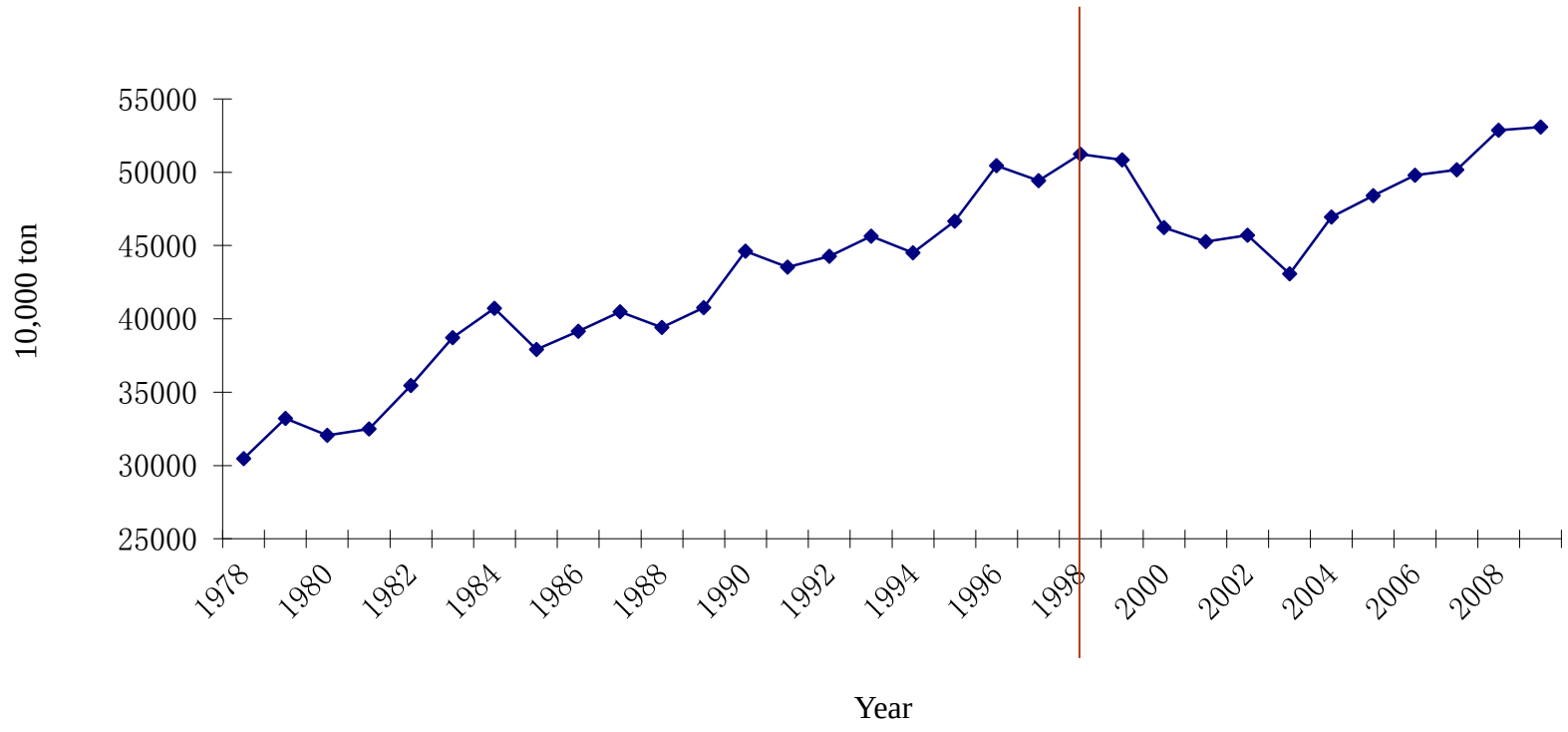


Figure 2: Rice and wheat production peaked around 2000; corn production rising rapidly since

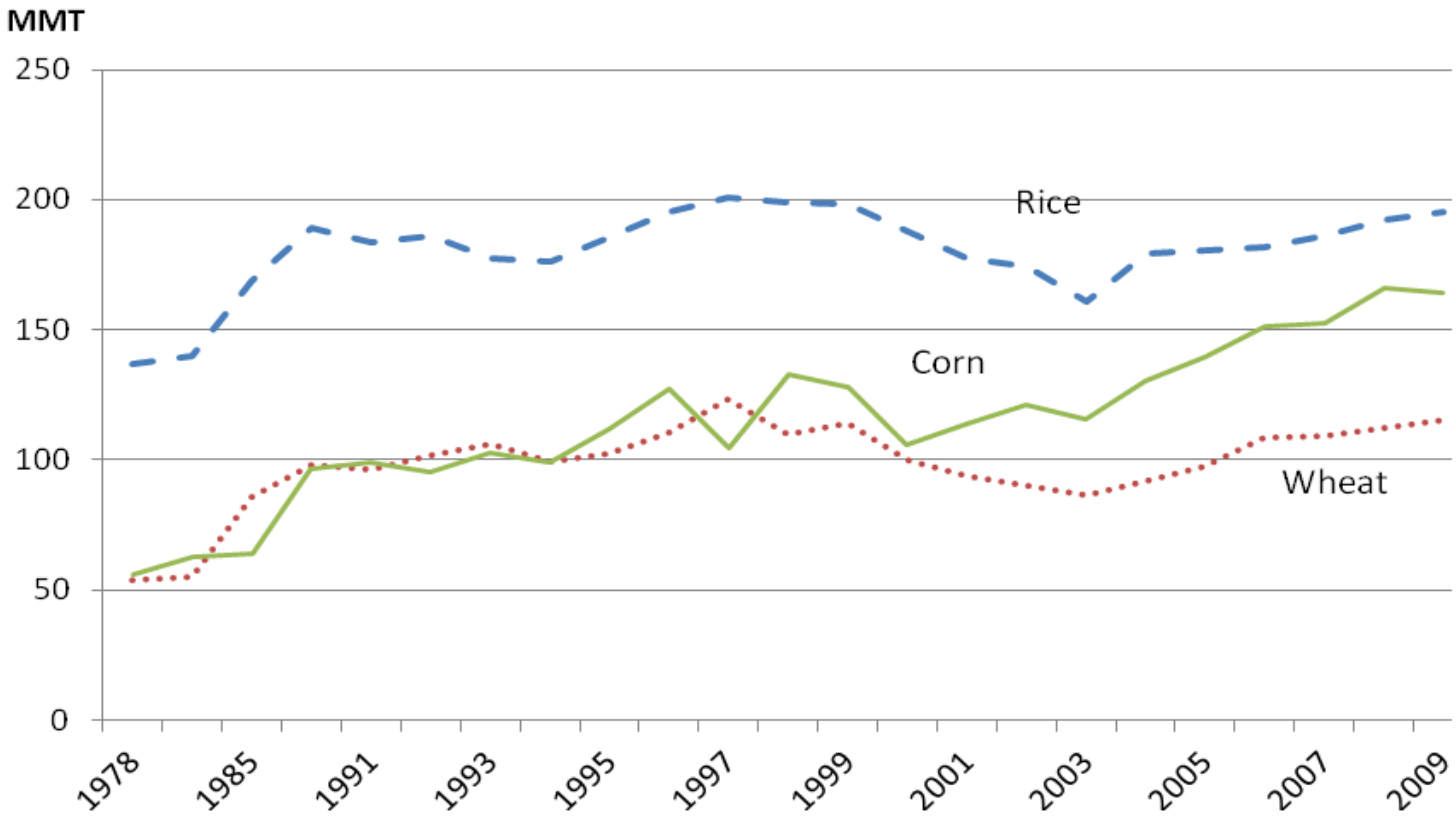


Table 1: The annual growth rates (%) of agricultural commodities, 1970-2010.

Commodity	Pre-reform	Reform period				Post reform
	1970-78	1978-84	1985-95	1996-2000	2001-2005	2006-2009[a]
Agricultural Gross Domestic Product	2.7	7.1	4.0	3.4	3.9	3.5
Grain total						
Production	2.8	4.7	1.7	0.03	1.1	2.3
Sown area	0.0	-1.1	-0.1	-0.14	-0.7	1.1
Yield	2.8	5.8	1.8	0.17	1.8	1.2
Rice						
Production	2.5	4.5	0.6	0.4	-0.8	2.0
Sown area	0.7	-0.6	-0.6	-0.5	-0.8	0.7
Yield	1.8	5.1	1.2	0.8	0.0	1.3
Wheat						
Production	7.0	8.3	1.9	-0.6	-0.4	4.3
Sown area	1.7	-0.0	0.1	-1.6	-3.1	1.6
Yield	5.2	8.3	1.8	1.0	2.7	2.7
Maize						
Production	7.4	3.7	4.7	-1.3	5.6	4.1
Sown area	3.1	-1.6	1.7	0.8	2.7	4.3
Yield	4.2	5.4	2.9	-0.9	2.9	-0.2
Total cash crop area	2.4	5.1	2.1	3.5	1.5	3.4
Cotton						
Production	-0.4	19.3	-0.3	-1.9	6.5	2.8
Sown area	-0.2	6.7	-0.3	-6.1	5.3	-0.5
Yield	-0.2	11.6	-0.0	4.3	1.2	3.3
Edible oil crops	2.1	14.9	4.4	5.6	0.8	0.6
Vegetable area	2.4	5.4	6.8	9.5	3.1	1.0
Fruit						
Orchards area	8.1	4.5	10.4	2.0	2.4	2.6
Outputs	6.6	7.2	12.7	10.2	21.0	6.1
Meat (pork/beef/poultry)	4.4	9.1	8.8	6.5	4.9	2.5
Milk	-	-	-	5.7	25.5	6.8
Fishery	5.0	7.9	13.7	10.2	3.6	3.7

Note: Growth rates are computed using regression method (except for 2006-2009). Growth rates of individual and groups of commodities are based on production data; sectoral growth rates refer to value added in real terms.

Sources: Huang and Rozelle, 2011 and NSBC, 2010.

Table 2: Changes in structure (%) of China's agricultural economy, 1970-2010

	1970	1980	1985	1990	1995	2000	2005	2010
Share in agricultural output								
Crop	82	76	69	65	58	56	51	53.3
Livestock	14	18	22	26	30	30	35	30
Fishery	2	2	3	5	8	11	10	9.3
Forestry	2	4	5	4	3	4	4	3.7

Source: NSBC, Chinas' Statistical Yearbook, various issues and China Rural Statistical Yearbook, various issues from 1980 to 20011.

Table 3.1 Per capita quantities possessed of major agricultural products,1978-2009, China

Year	Grains	Cotton	Oil-bearing crops	Pork, beef, and mutton	Aquatic products	Milk
1978	319.0	2.3	5.5	9.1	4.9	
1980	326.7	2.8	7.8	12.3	4.6	1.2
1985	360.7	3.9	15.0	16.8	6.7	2.4
1990	393.1	4.0	14.2	22.1	10.9	3.7
1995	387.0	4.0	18.7	27.4	20.9	4.6
2000	366.1	3.5	23.4	37.6	29.4	6.6
2001	355.9	4.2	22.5	38.0	29.9	8.1
2002	357.0	3.8	22.6	38.5	30.9	10.2
2003	334.3	3.8	21.8	39.5	31.6	13.6
2004	362.2	4.9	23.7	40.4	32.8	17.4
2005	371.3	4.4	23.6	42.0	33.9	21.1
2006	379.9	5.7	20.1	42.7	35.0	24.4
2007	380.6	5.8	19.5	40.1	36.0	26.7
2008	399.1	5.7	22.3	40.3	37.0	26.8
2009	399.0	4.8	23.7	44.4	38.4	26.4

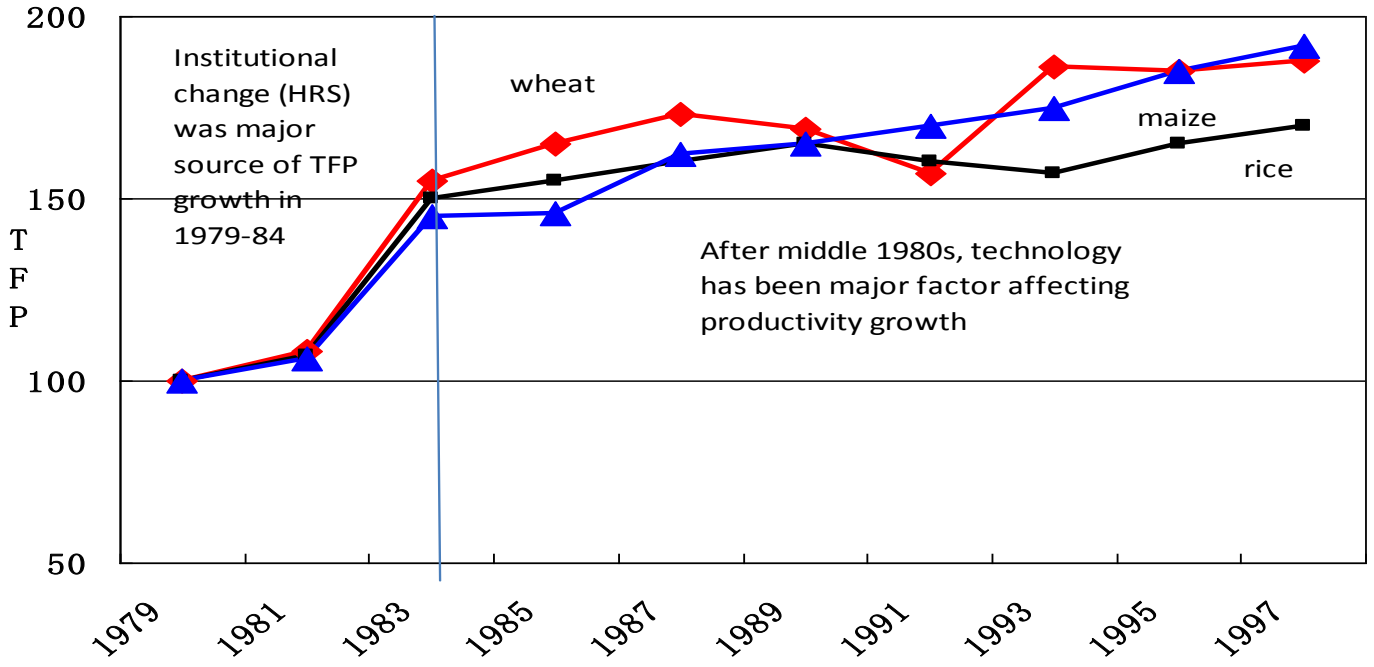
Source: China Statistics Yearbook, various years. Measurement unit is kilogram/person/year.

II. Drivers of Success

- 1. Institutional changes
  - Household responsibility system and re-introduction of independent markets for agricultural products have been credited with the boost in agricultural productivity growth between 1978 and 1984.
- 2. Liberalized input and output market fostered specialization

- 3. After an initial boost through institutional reforms, growth in land saving total factor productivity, at about 2 percent per year, has been driving agricultural growth.
  - Expansion of irrigated areas
  - Fertilizer use
  - Seeds
  - Supporting policies/programs
  - Mechanization

Figure 3: Institutional change drove TFP growth between 1978-1984, technological change thereafter.



- **Figure 4: The amount of irrigated land tripled between 1950 and 1978 to 45 million ha, to gradually increase thereafter to almost 60 million ha in 2009.**

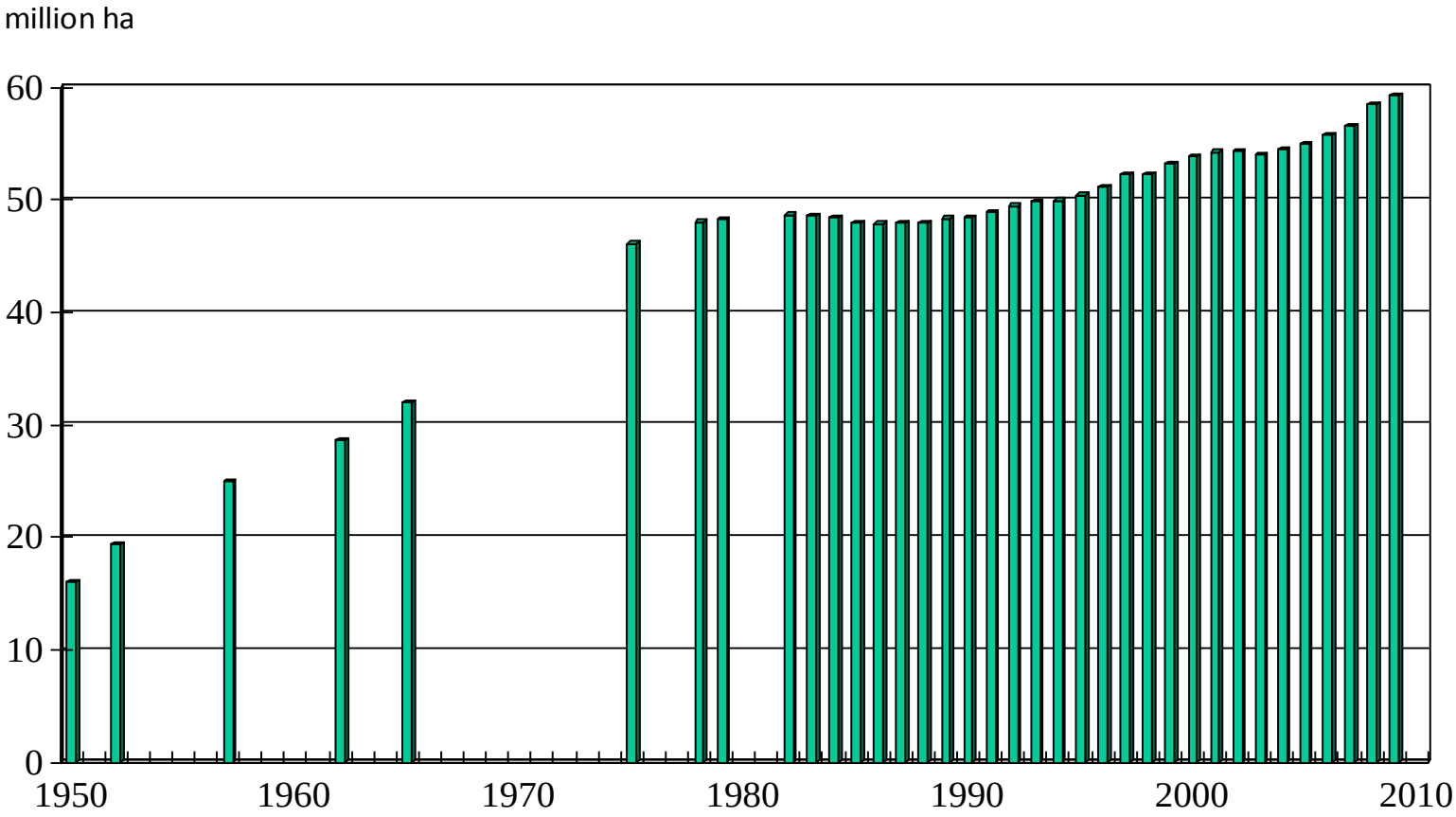
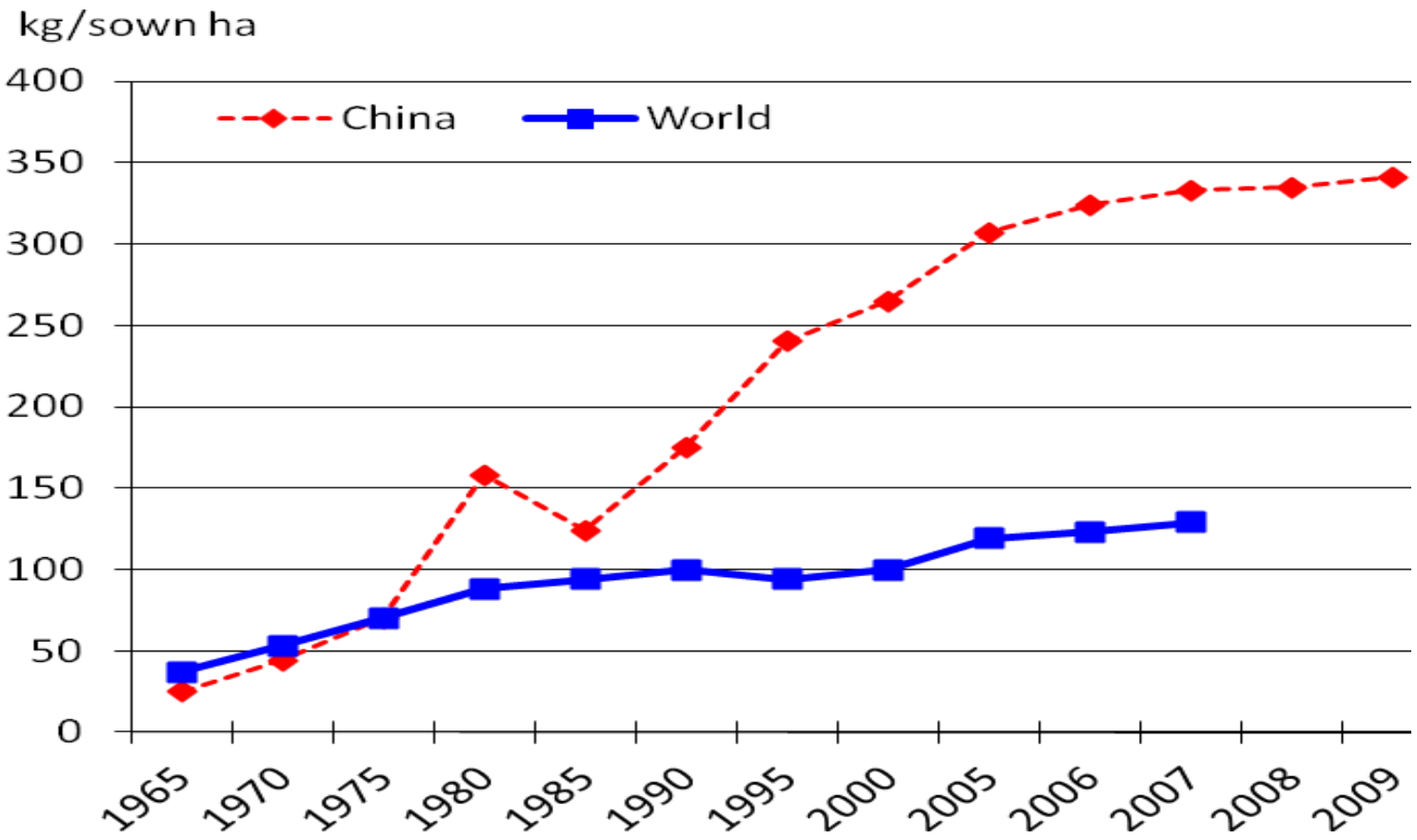


Figure 5: Fertilizer use expanded rapidly to among the highest in the world



- **Figure 6: Agricultural subsidies in China have risen exponentially over the past decades (2002-2010)**

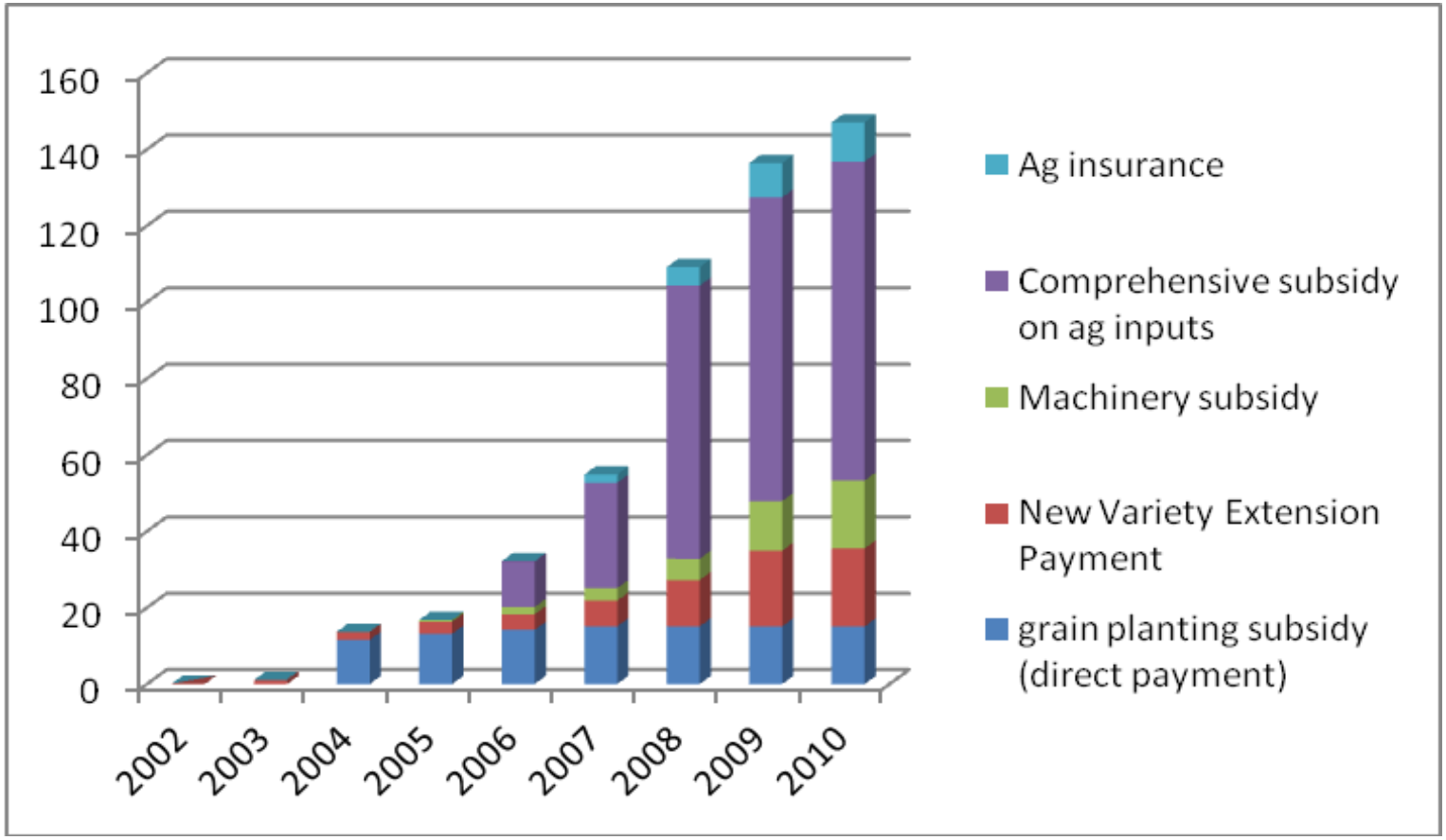


Table 4: Rapid increase in subsidization of agriculture 2002-2010.

billion yuan	grain planting subsidy (direct payment)	New Variety Extension Payment	Machinery subsidy	Comprehensive subsidy on agric inputs	Ag insurance	Total
2002	0	0.1	0	0	0	0.1
2003	0	1.1[a]	0	0	0	1.1
2004	11.6	2.1[a]	0	0	0	13.7
2005	13.2	3.1[a]	0.5	0	0	16.8
2006	14.2	4.1	1.9[a]	12	0	32.2
2007	15.1	6.7	3.3	27.6	2.15	54.9
2008	15.1	12.1	5.6	71.5	4.87[a]	109.2
2009	15.1	19.8	13.0	79.5	9.02[a]	136.4
2010	15.1	20.4	17.8	83.5	10.3	147.1

[a] linearly interpolated due to missing observations

Sources: OECD 2009, 2011; Lei Meng, 2010

- 4. International trade– agricultural production is increasing consistent with China's natural comparative advantage.
  - WTO accession and Renminbi appreciation are aligning China's international trading patterns with its comparative advantage, with both imports of land and water intensive grains (soybeans imports rose from 10 mmt in 2001 to more than 50 mmt in 2008-2010) and exports of labor intensive horticulture increasing rapidly.

Figure 7: China evolved from net food exporter to net food importer following WTO accession in 2001

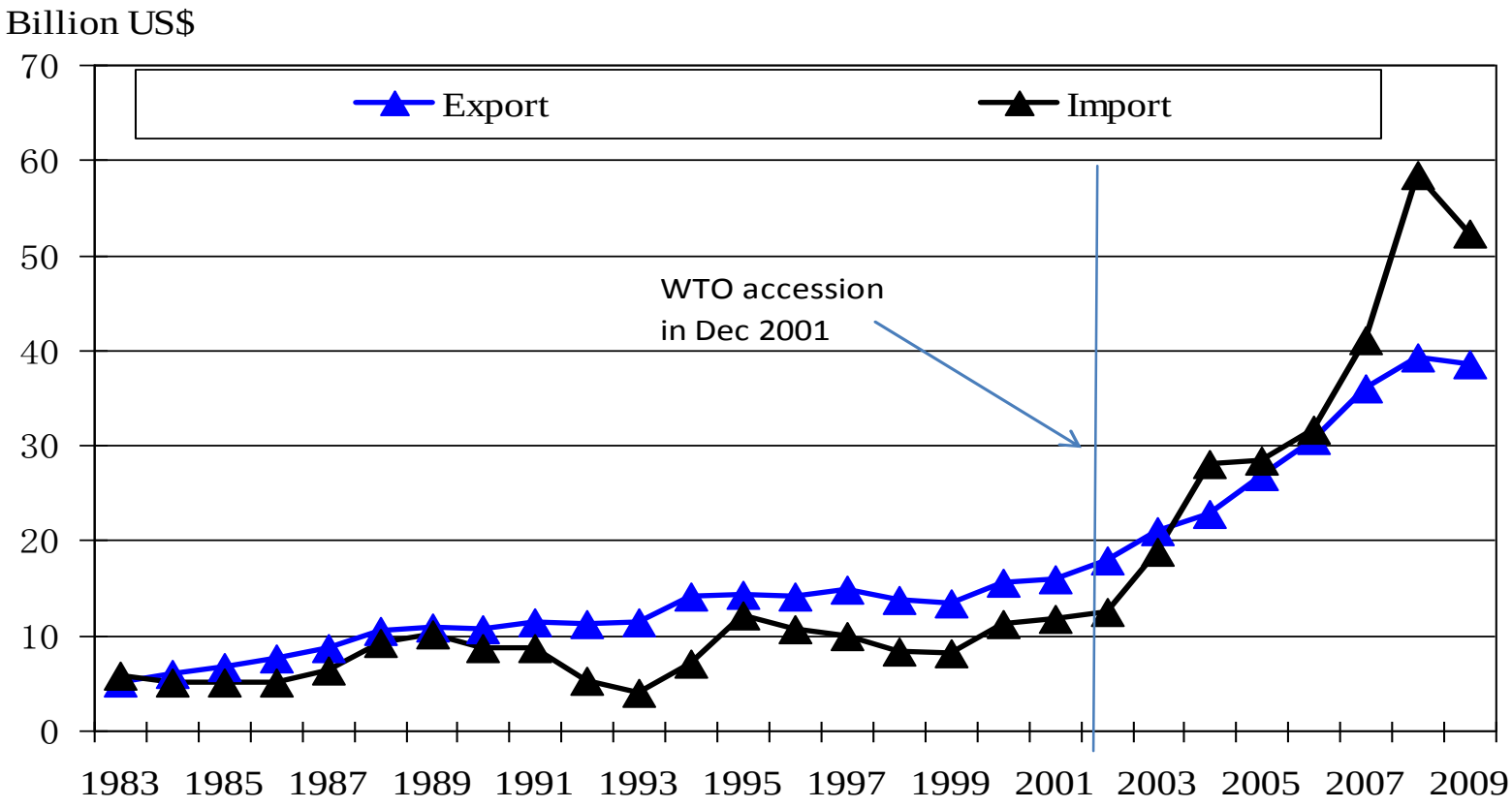


Figure 8: Agricultural and food export by commodities in China, %, 2008

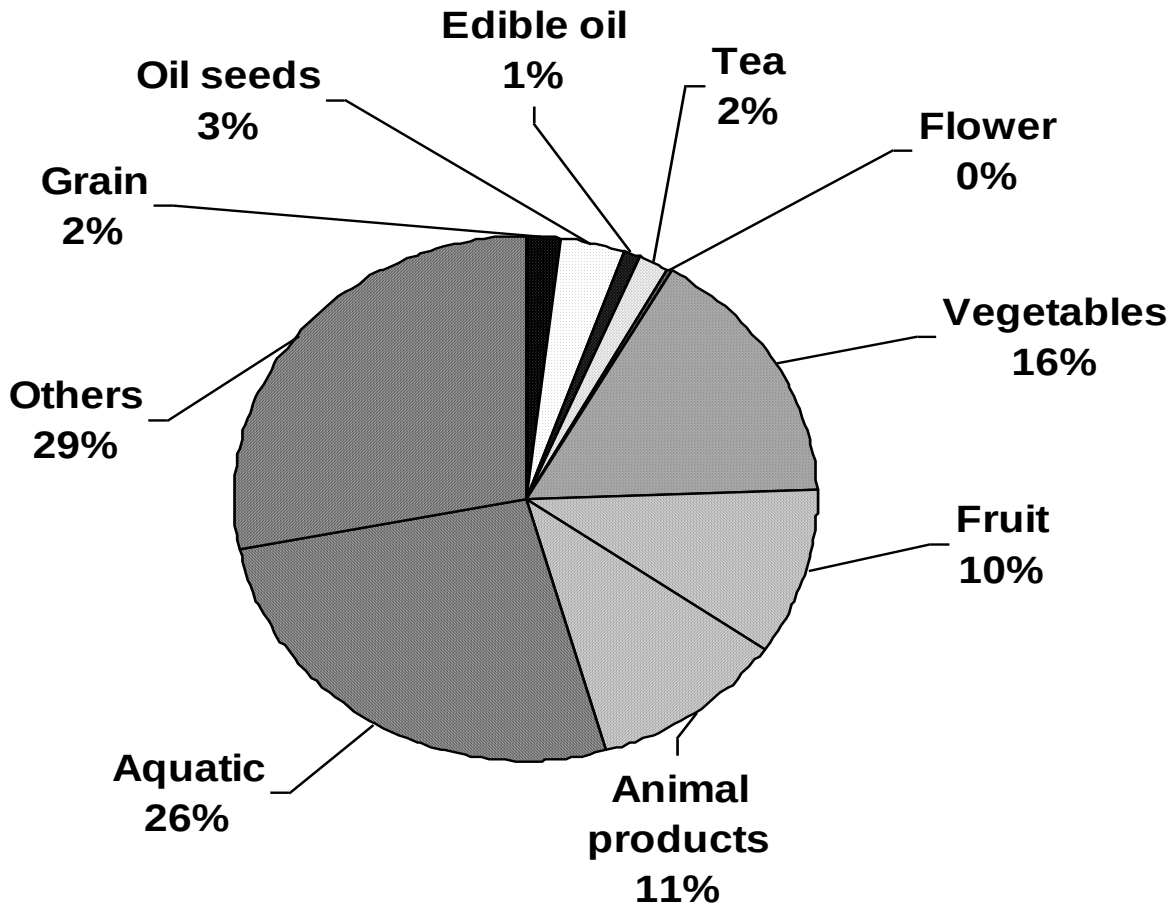
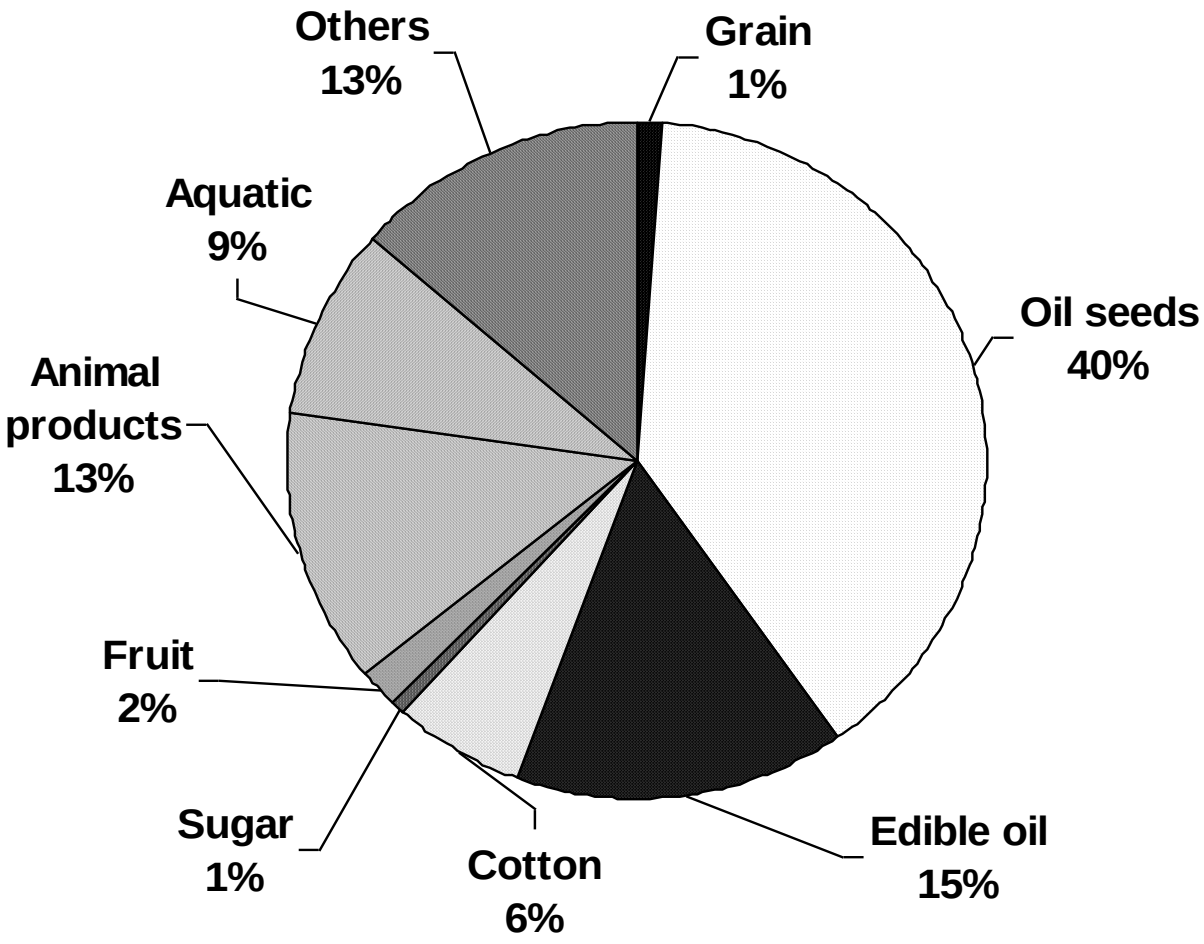


Figure 9: Agricultural and food import by commodities in China, %, 2008



II. Challenges

- **1**. As income grows, the Chinese people will consume more foods with animal-origin and eat less staple foods such as rice and wheat.
  - Grain consumption in 2010 was 389 kg/person while it will be 395 kg/person in 2020
  - Food grain consumption will decrease from 49% in 2010 to 43% in 2020, whereas feed grain consumption will increase from 36% to 41% during the same period.
  - Industrial demand for grain will unchange
  - Edible oil consumption will increase from 17.8 kg/person in 2010 to 20 kg/person in 2020.

Table 4.1 Per capita consumption of major foods by rural households, China

	1990	1995	2000	2005	2008	2009
Grain (Unprocessed)	262	256	250	209	199	189
Wheat	80	81	80	68	63	60
Rice	135	129	127	113	111	106
Soybeans		2	3	2	2	2
Vegetables	134	105	107	102	100	98
Edible Oil	5	6	7	6	6	6
Vegetable Oil	4	4	5	5	5	5
Meats	13	14	18	22	20	22
Eggs	2	3	5	5	5	5
Milk	1	1	1	3	3	4

Source: China statistics yearbook, various years.

Table 4.2 Per capita consumption of major foods by urban households, China

Year	Grains	vegetables	Meats	Eggs	Milk	Aquatic products	Fruits
1990	131	139	25	7	5	8	41
1995	97	117	24	10	5	9	45
2000	82	115	26	11	10	12	57
2003	80	118	33	11	19	13	57
2004	78	122	29	10	19	13	57
2005	77	119	33	10	18	13	57
2006	76	118	32	10	18	13	60
2007	78	118	32	10	18	14	60
2008		123	31	11	15		54
2009	81	120	35	11	15		57

Source: China Statistics Yearbook, various years. Meats include pork, beef, mutton, and poultry.

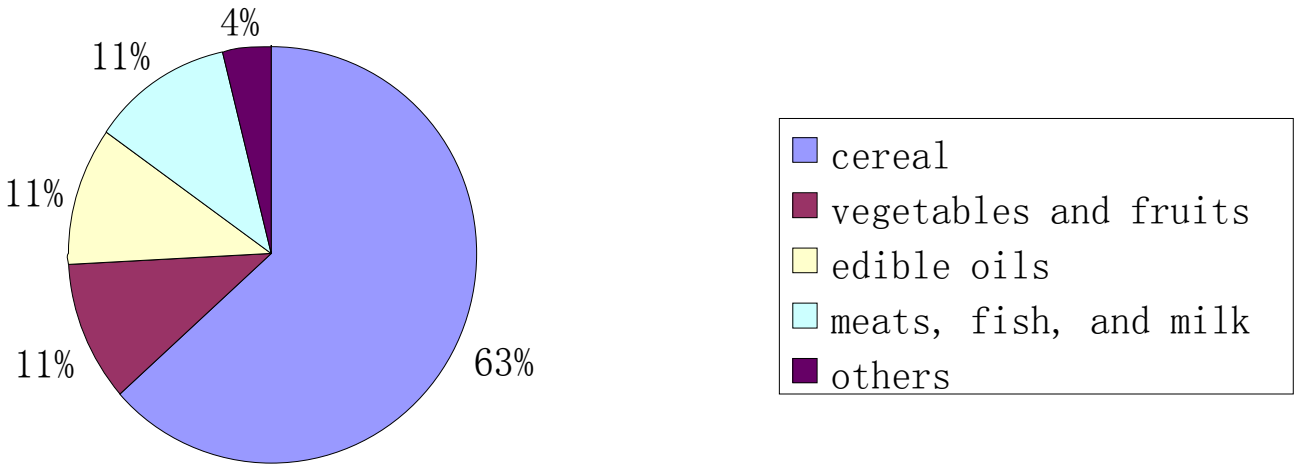
Table 4.3 Food away from home by urban households, 1995-2007

Year	Total food expenditure	Expenditure (yuan)		Expenditure (%)	
		Food at home	Food away from home	Food at home	Food away from home
1995	412	375	37	0.91	0.09
1996	408	368	40	0.90	0.10
1997	403	361	42	0.89	0.10
1998	402	355	47	0.88	0.12
1999	409	356	53	0.87	0.13
2000	414	353	60	0.85	0.15
2001	423	357	65	0.84	0.15
2002	478	391	87	0.82	0.18
2003	504	412	91	0.82	0.18
2004	547	439	108	0.80	0.20
2005	579	458	121	0.79	0.21
2006	609	474	135	0.78	0.22
2007	680	537	143	0.79	0.21

Source: China urban life and price yearbook by the national bureau of statistics, various years. Note that expenditure figures are deflated as being 1978 price level.

- Figure10. The changes in consumption patterns can also be found in terms of nutrients.

Figure 4.1 Energy (2693 kcal.) from food consumption in 1990



- **Figure 11 Energy (2990 kcal.) from food consumption in 2005**

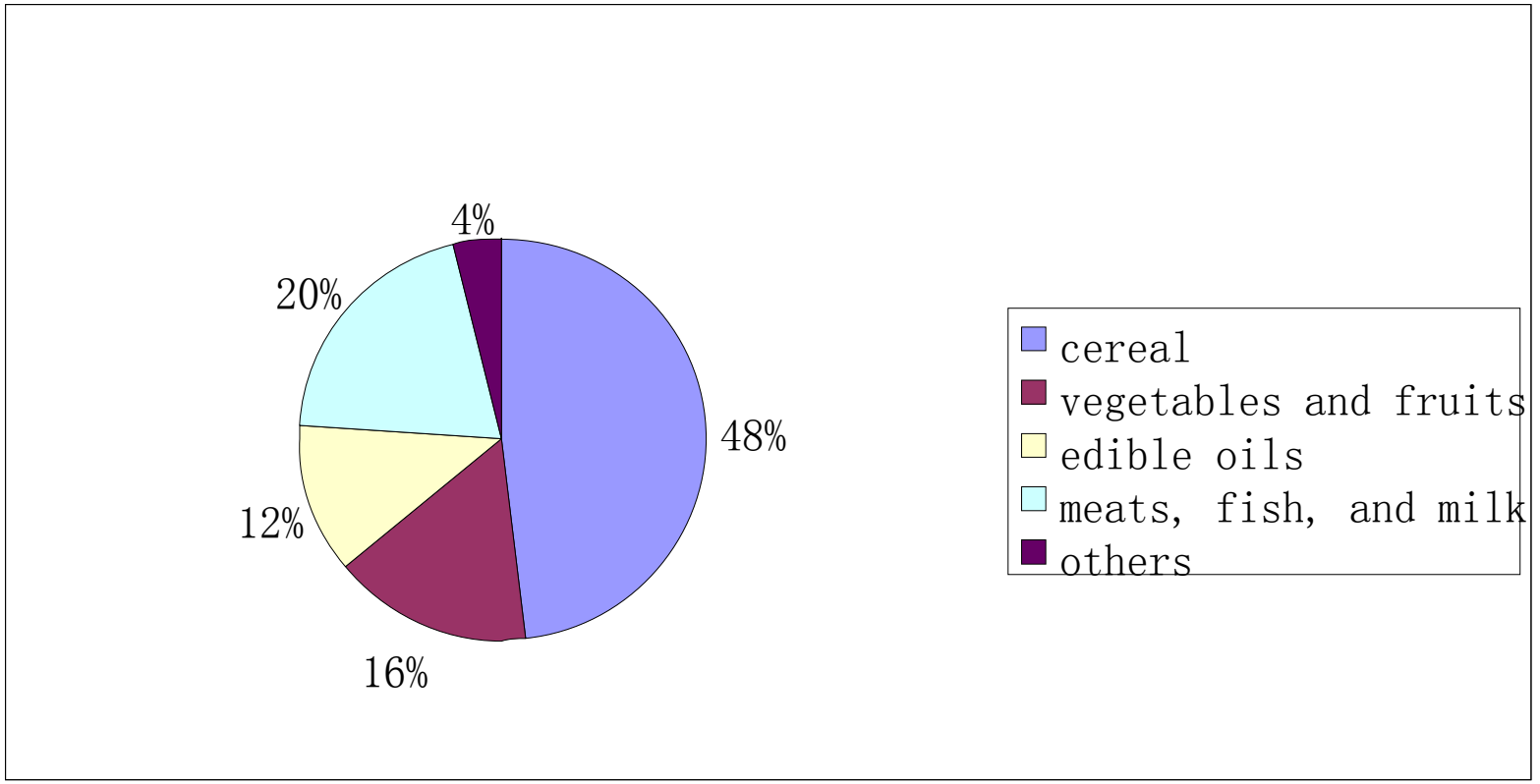
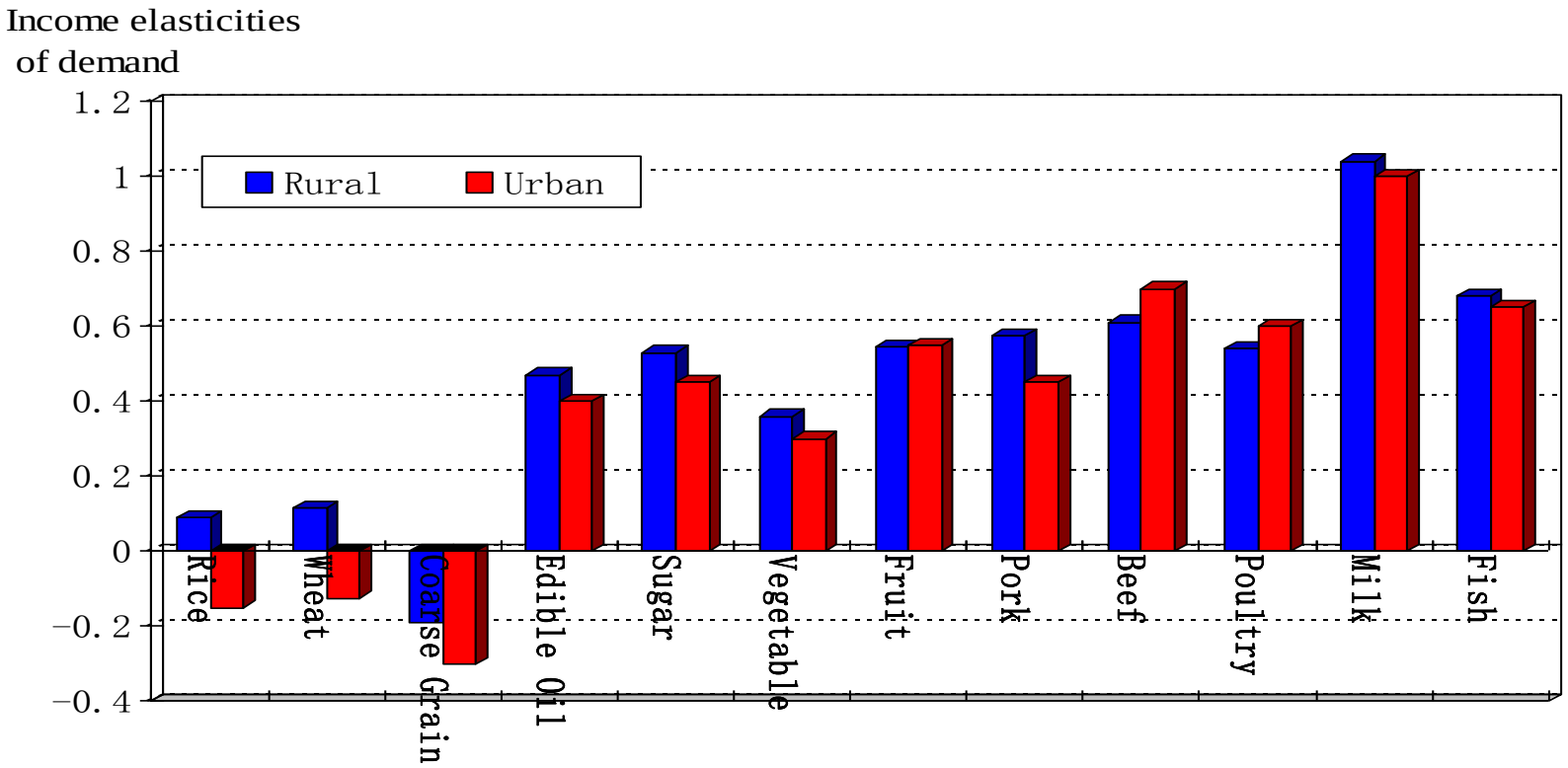
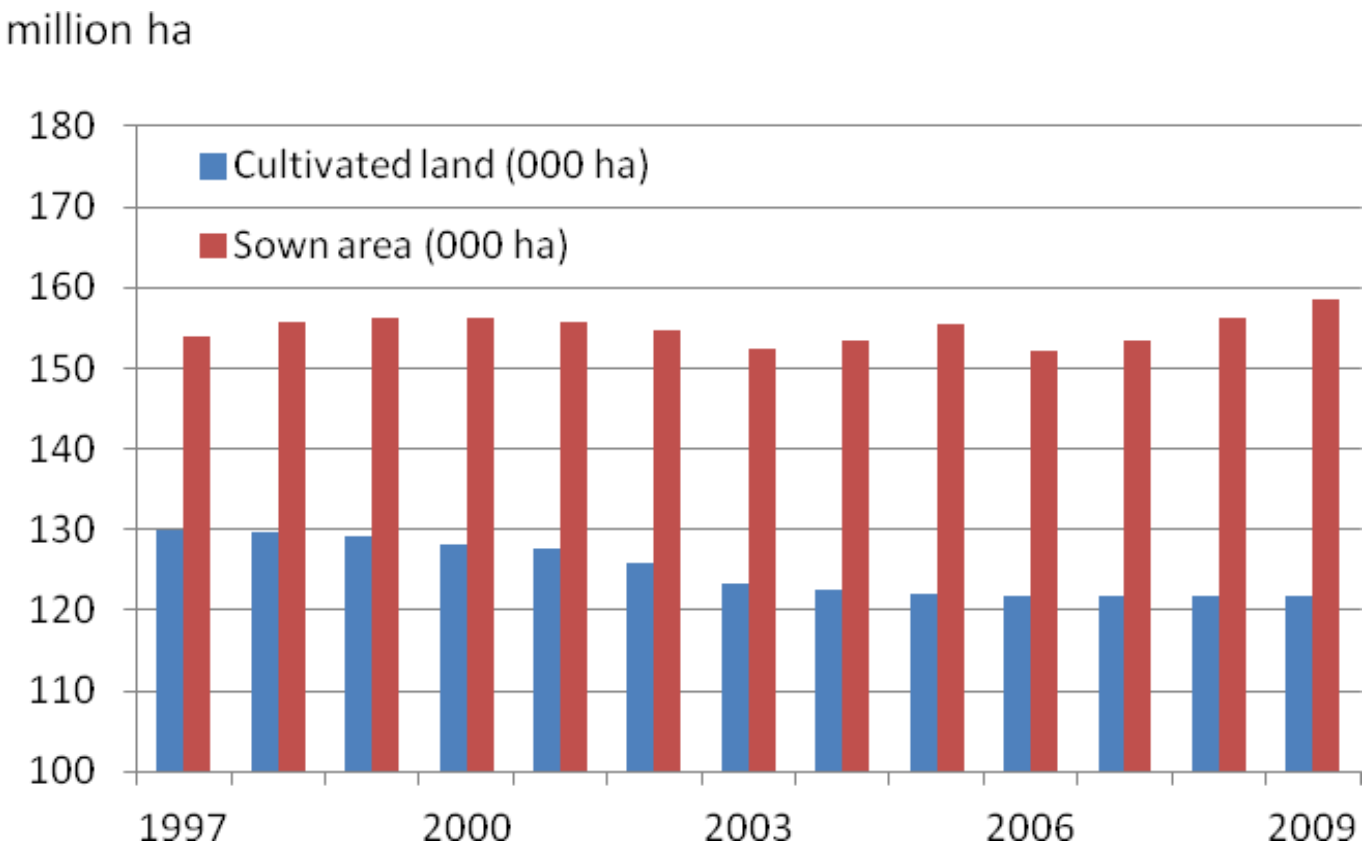


Figure 12: Income elasticity of demand (in 2006) for rice and wheat low and in urban areas negative; income elasticity of demand for high value crops positive, and almost one for dairy.

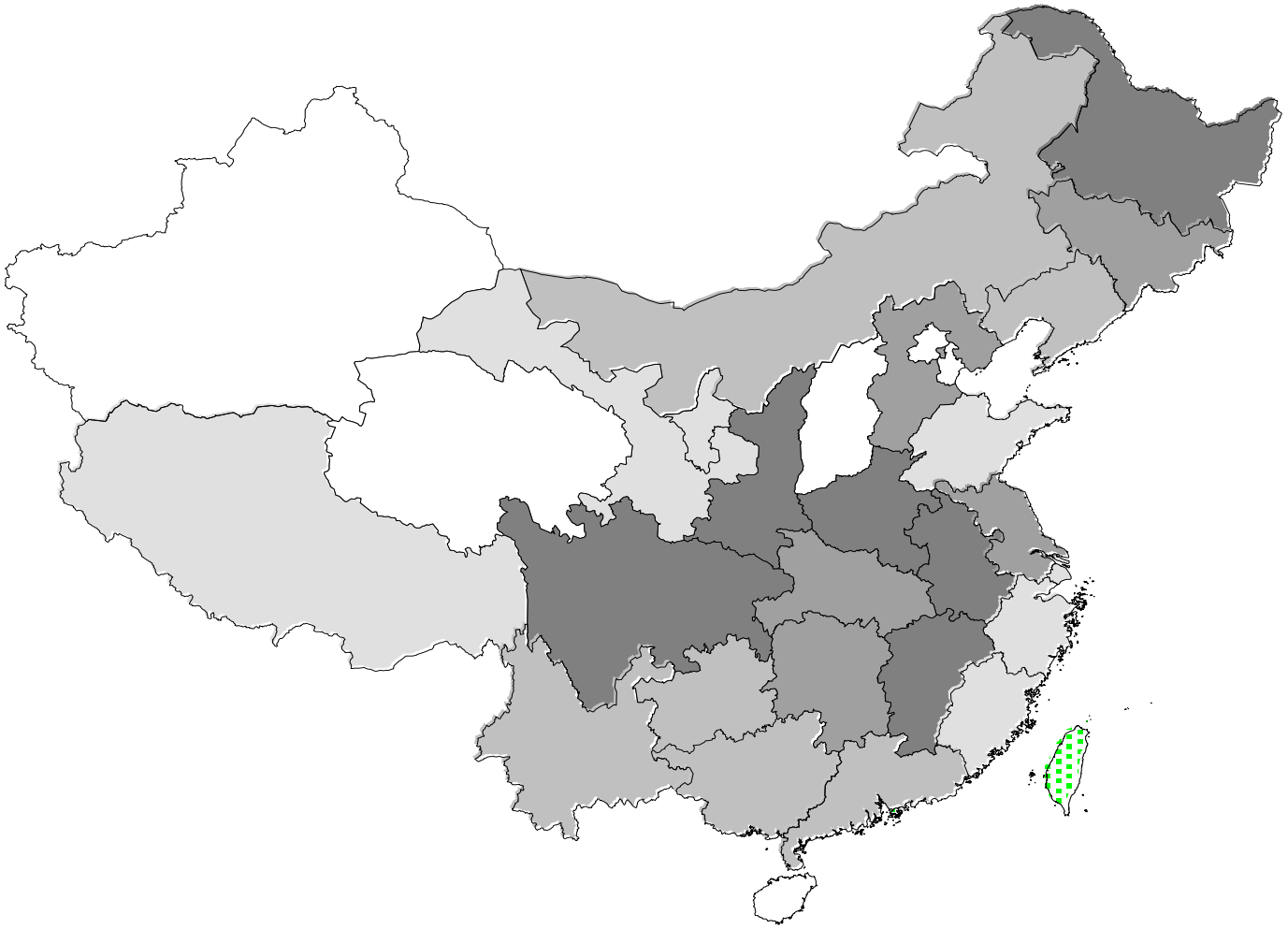


- **2.**Cultivated land and water sources decreased as urbanization process increases; moreover, ongoing soil degradation is further undermining the productive capacity of land, especially in the western parts of the country and where input use is limited
  - In 1996, cultivated land is 1.951 billion mu while it became 1.826 billion mu in 2007, a decrease of 11 million mu per year on average.
  - Soil degradation is serious
  - Water source

- **Figure 13: Cultivated area declines (1997-2009), sown area slightly increases through multiple cropping.**



- **3.** Changes in key grain-producing region.The circulation of grains from the South to the North was in place of the one from the North to the South before 1980s.
  - (1) Regional contradiction between supply and demand will threaten the stability of the national grain market.
  - (2) Most of the thirteen provinces are located in the north, where water shortage is a problem.



- 4. With the decline in the population growth rate due to the family planning policy as well as more rural laborers moving out of farms, the so-called Lewis's turning points are coming.
  - First, rising labor cost drive farm mechanization and farm polarization
  - Second, Profits for growing grain crops are lower as compared with those in the horticultural sector and non-agricultural jobs.
  - Third, labor forces engaging in agricultural sector are aging and femilaiztion.
  - **<u>In sum, incentive for growing crops has been declining</u>**!

- **Figure 14: Rural daily wages (real Yuan) have risen sharply since 2003.**

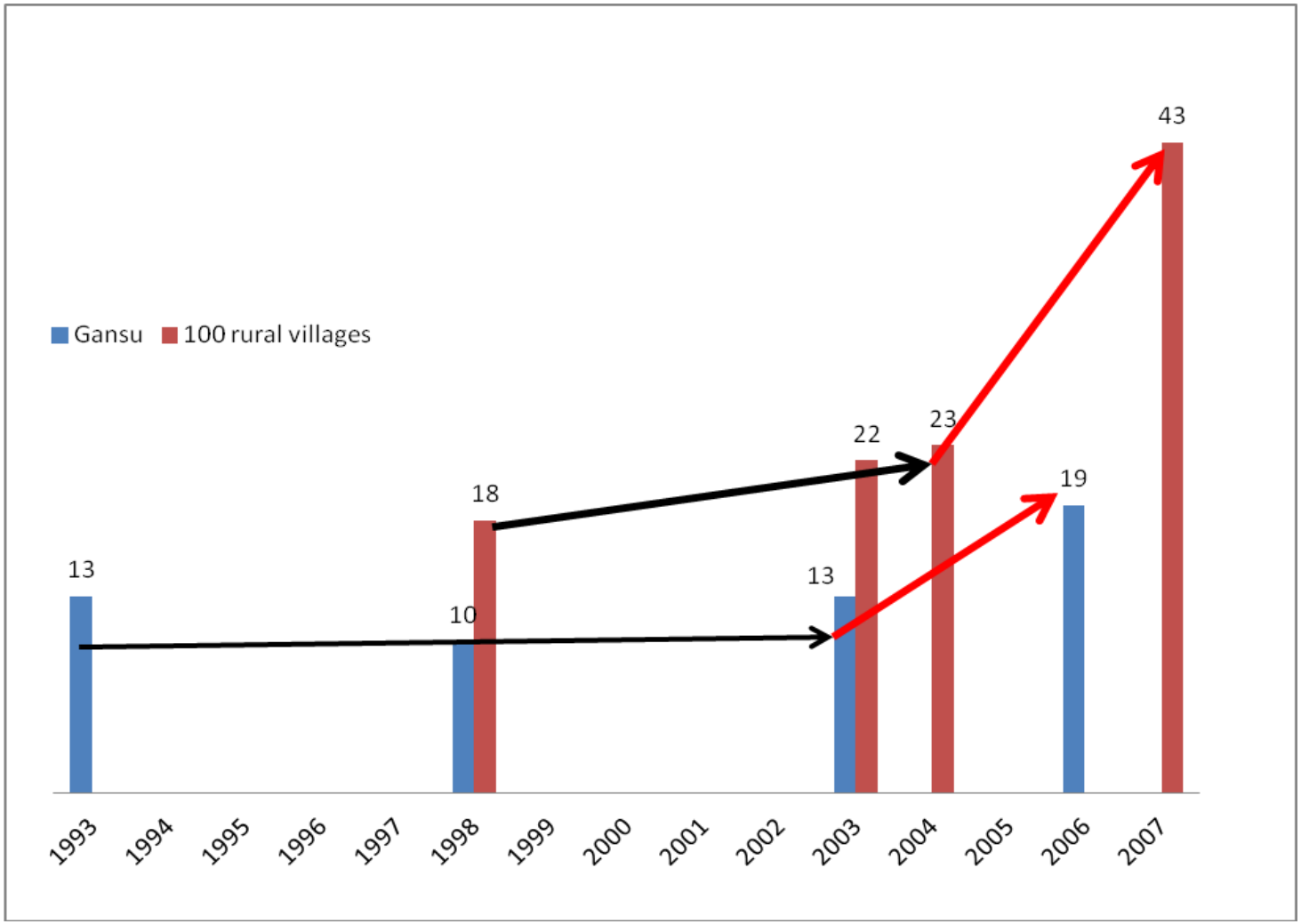


Figure 15: Growth in agricultural mechanization accelerates when the agricultural labor/land declines (negative growth); it decelerates when the agricultural labor/land ratio increases (positive growth)

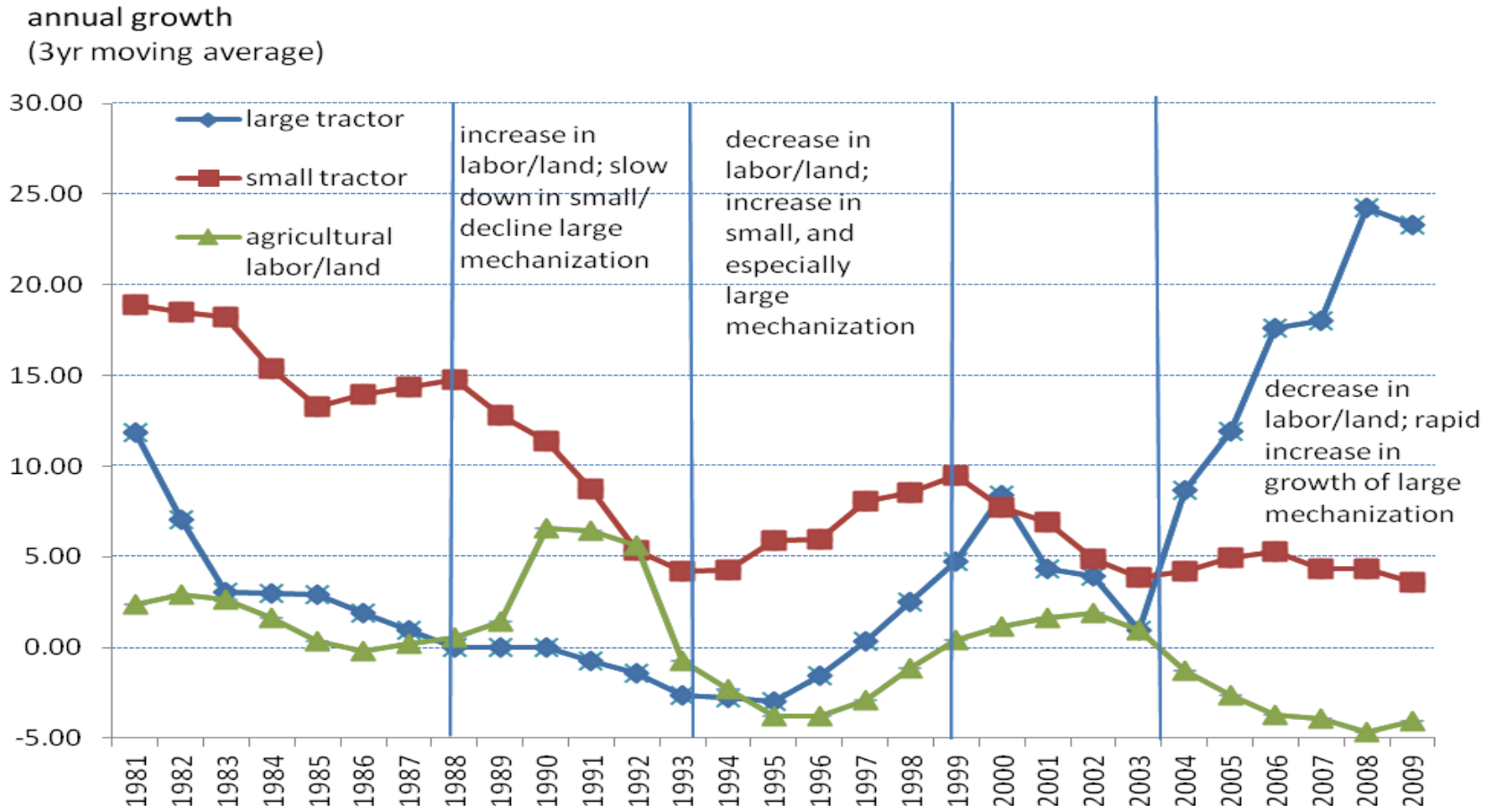


Figure 3.6 Profits from growing major crops in 2007

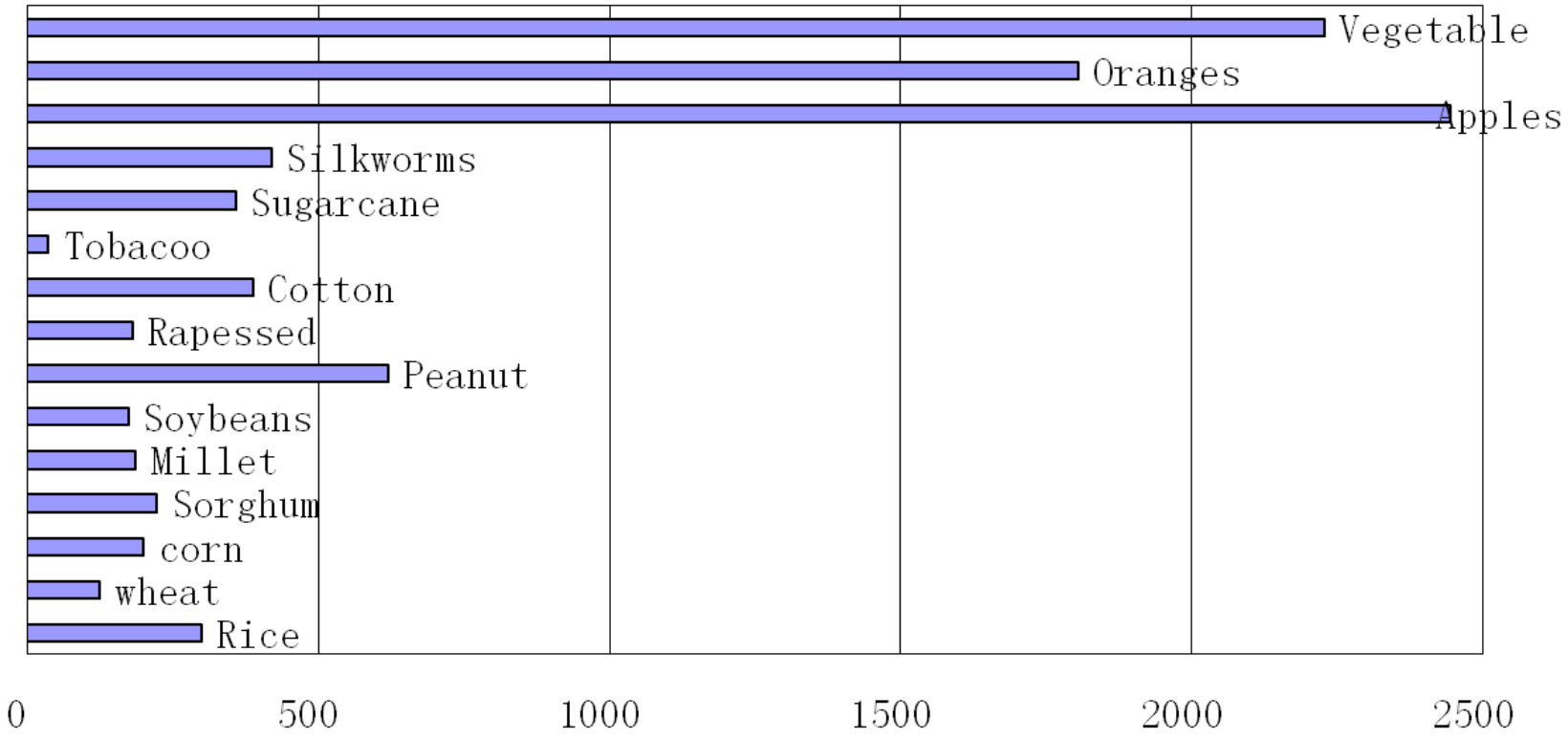


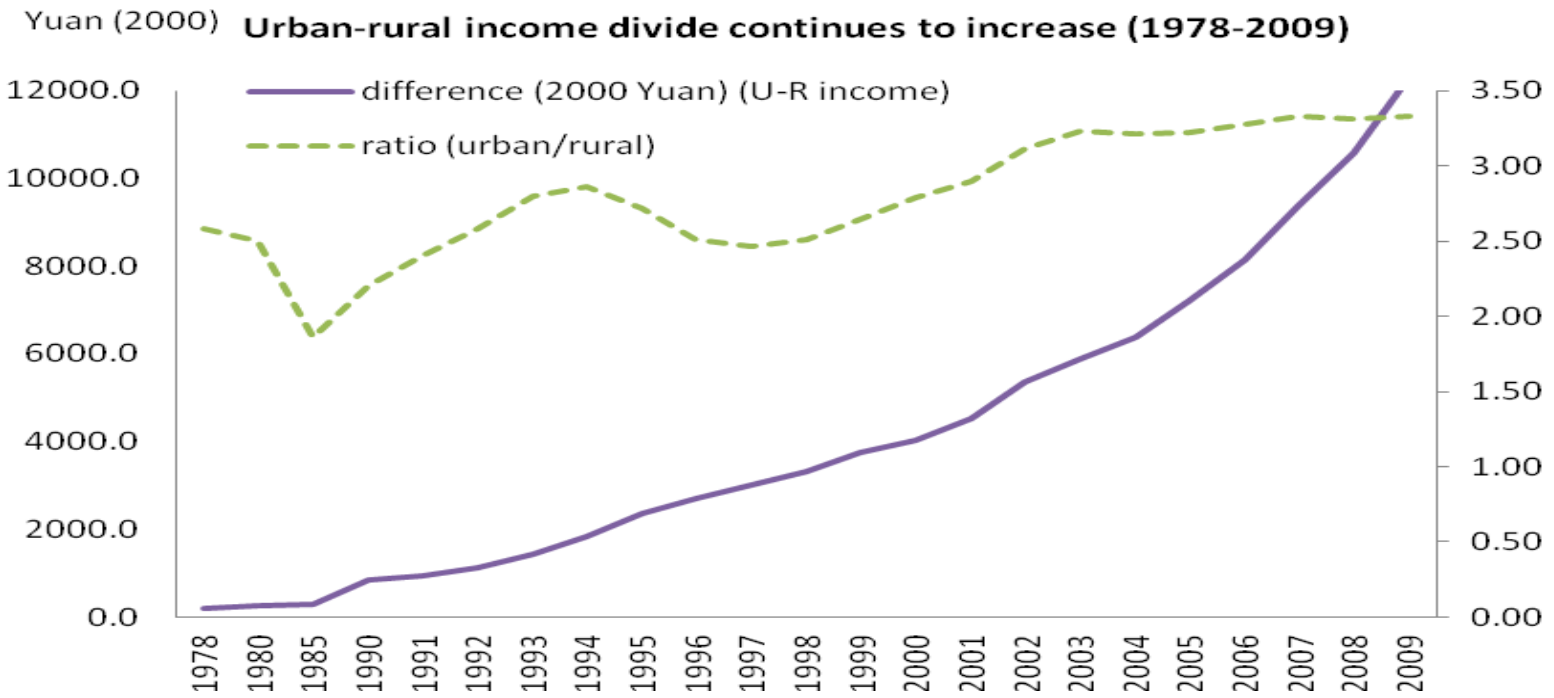
Table 4: Agricultural laborers vs. migrated labors

	Agricultural laborers	Migrated laborers
Total (10,000 persons)	34874	13181
Sex ratio (%)		
	46.8	64
	53.2	36
Age composition (%)		
20 and under	5.3	16.1
21-30	14.9	36.5
31-40	24.2	29.5
41-50	23.1	12.8
51 and above	32.5	5.1
Education composition (%)		
Illiterate	9.5	1.2
Primary school	41.1	18.7
Junior middle-school	45.1	70.1
Senior middle school	4.1	8.7
Universities and above	0.2	1.3

Data sources: China's agricultural census in 2006.

- 5. But urban incomes rose even faster, giving rise to the farm (income) problem, with the real income gap between average urban and rural income rising exponentially (from 211 (2000) Yuan in 1978 to 12305 in 2009

Figure 17: The divergence between average urban and average rural income continues its exponential rise



- In sum: the agrarian structure has been dominated by *smallholder farming*, with farm sizes averaging 0.6 ha spread over 4-6 non-contiguous plots. This has been an important factor in agriculture's success in reducing China's poverty, but the viability of smallholder agriculture is increasingly challenged as nonagricultural wages and incomes, international competition and climatic uncertainty are rising fast.

- **Figure 18: Smallholder farmers even getting smaller, but renting providing opportunities for farm expansion**

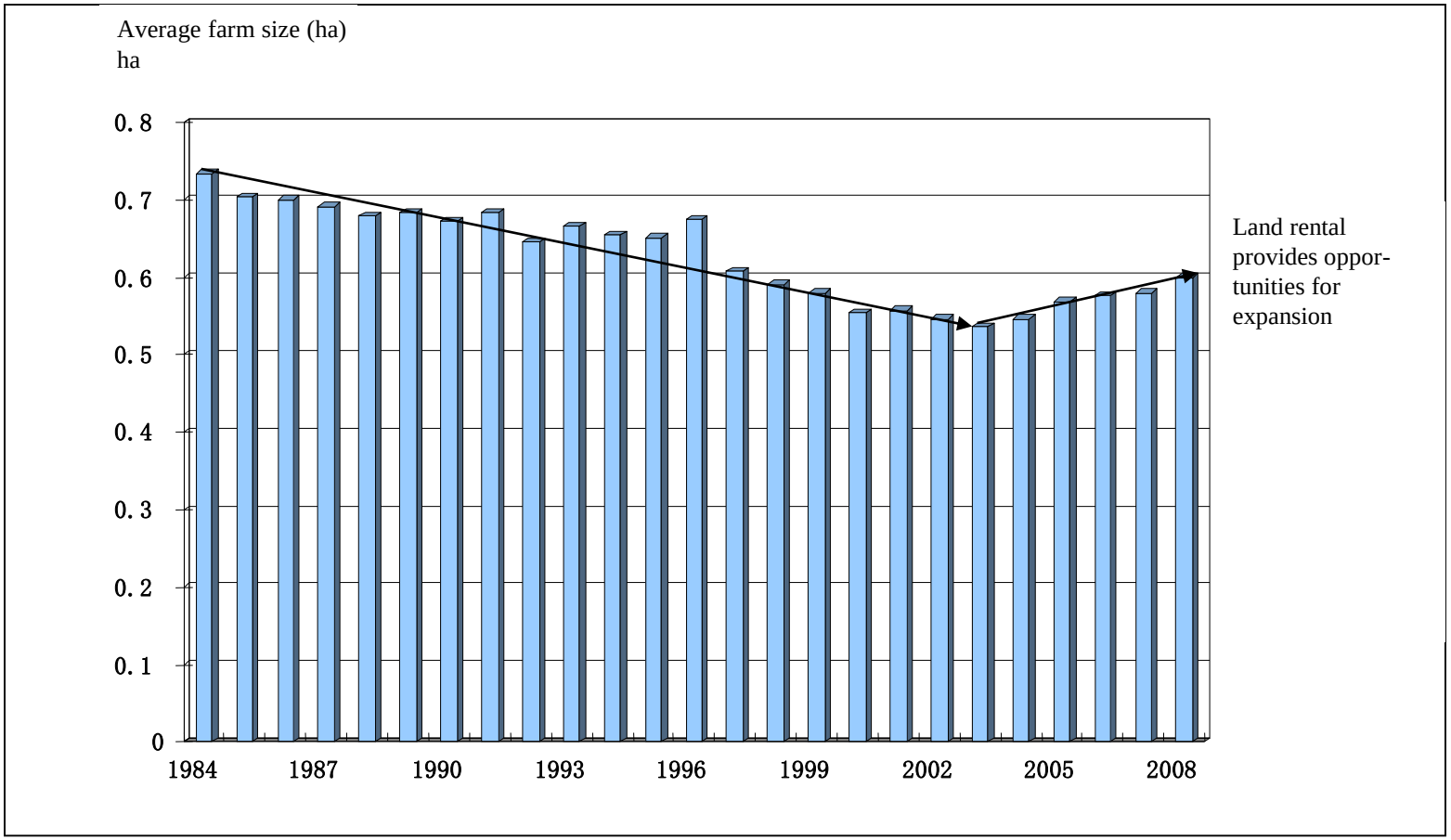
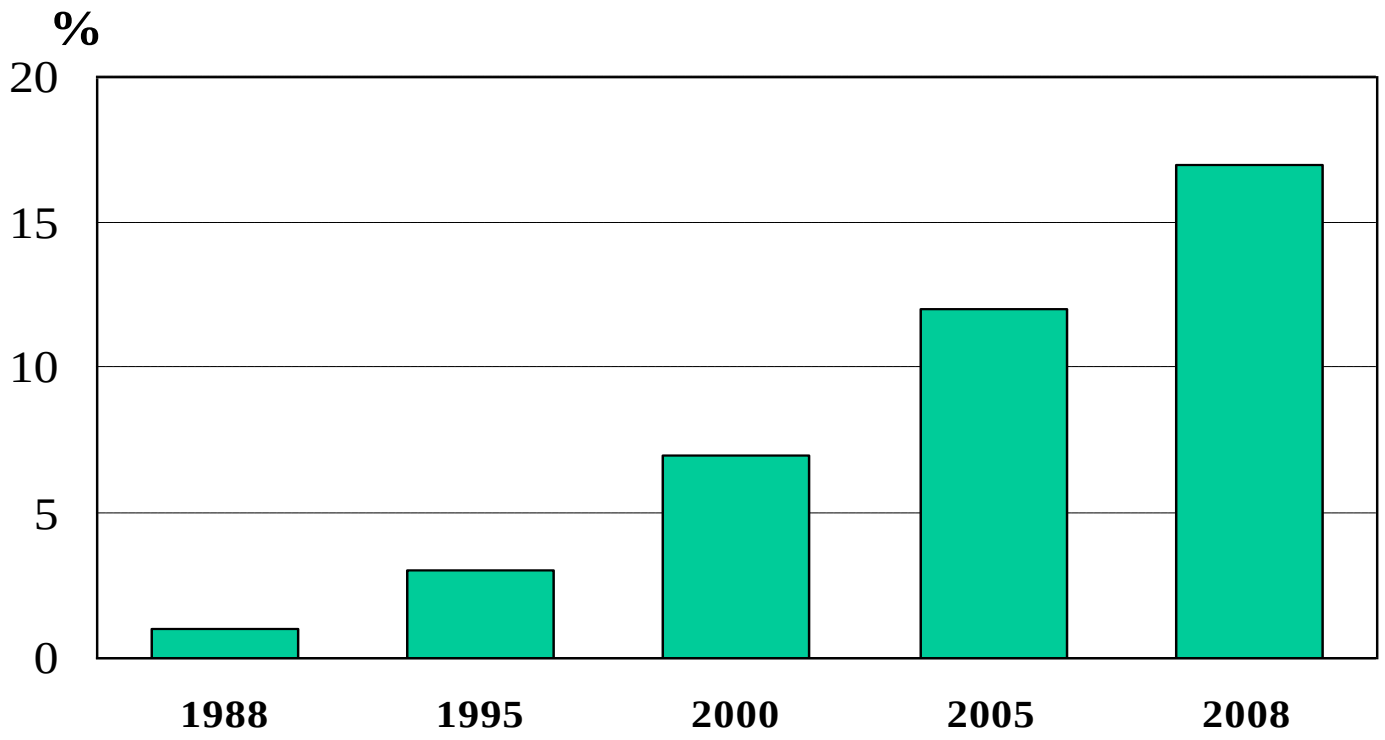


Figure 19: The share of agricultural land being rented is rising rapidly



IV. Prospects

- 1. Food security in China
  - Self sufficiency for grains is set to be 95%
  - Rice and wheat should be 100%
  - Corn should be above 90%
  - Meat and aquatic products should be above 90%

Figure 20: Rice imports and exports (1980-2008), million tons

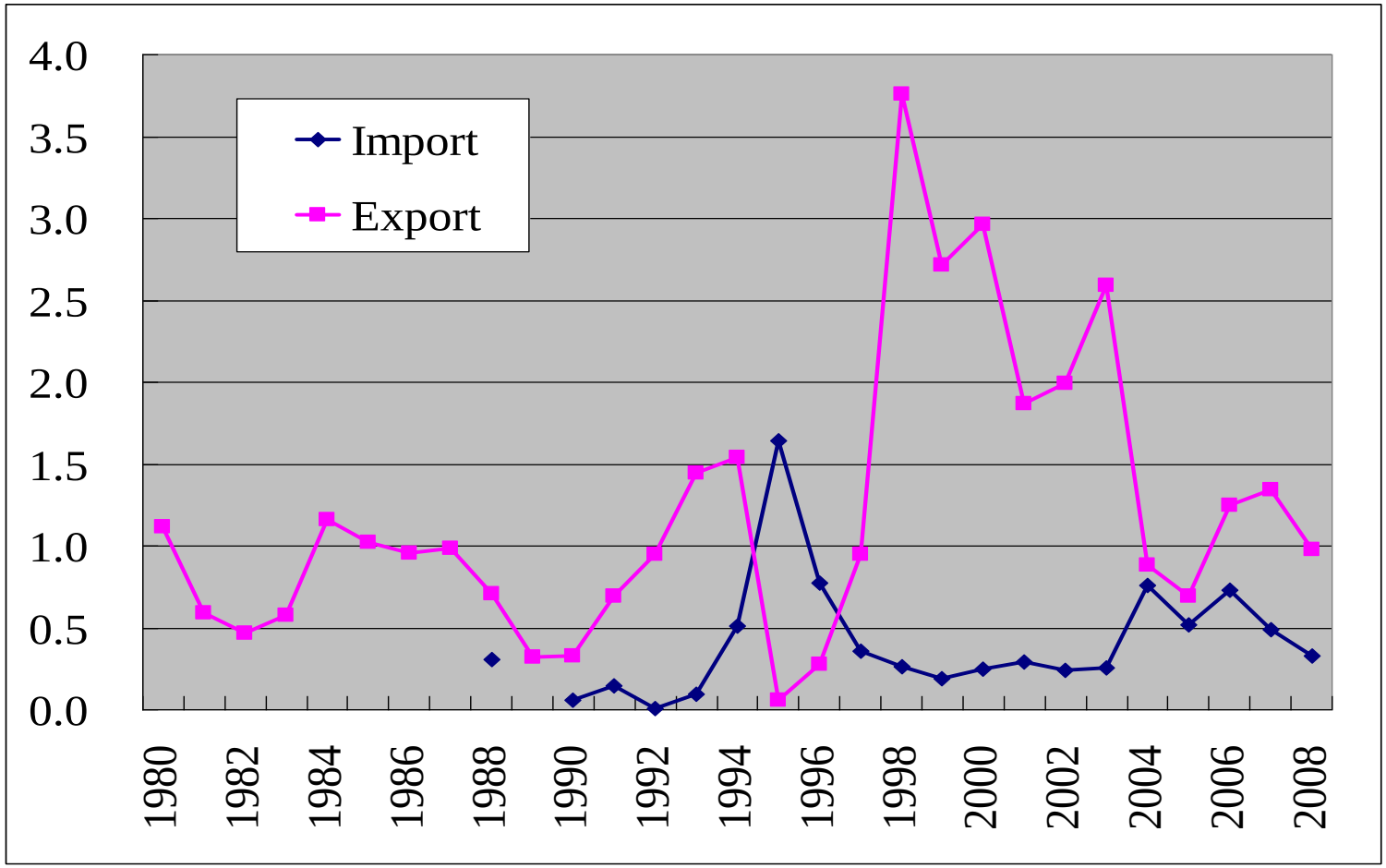
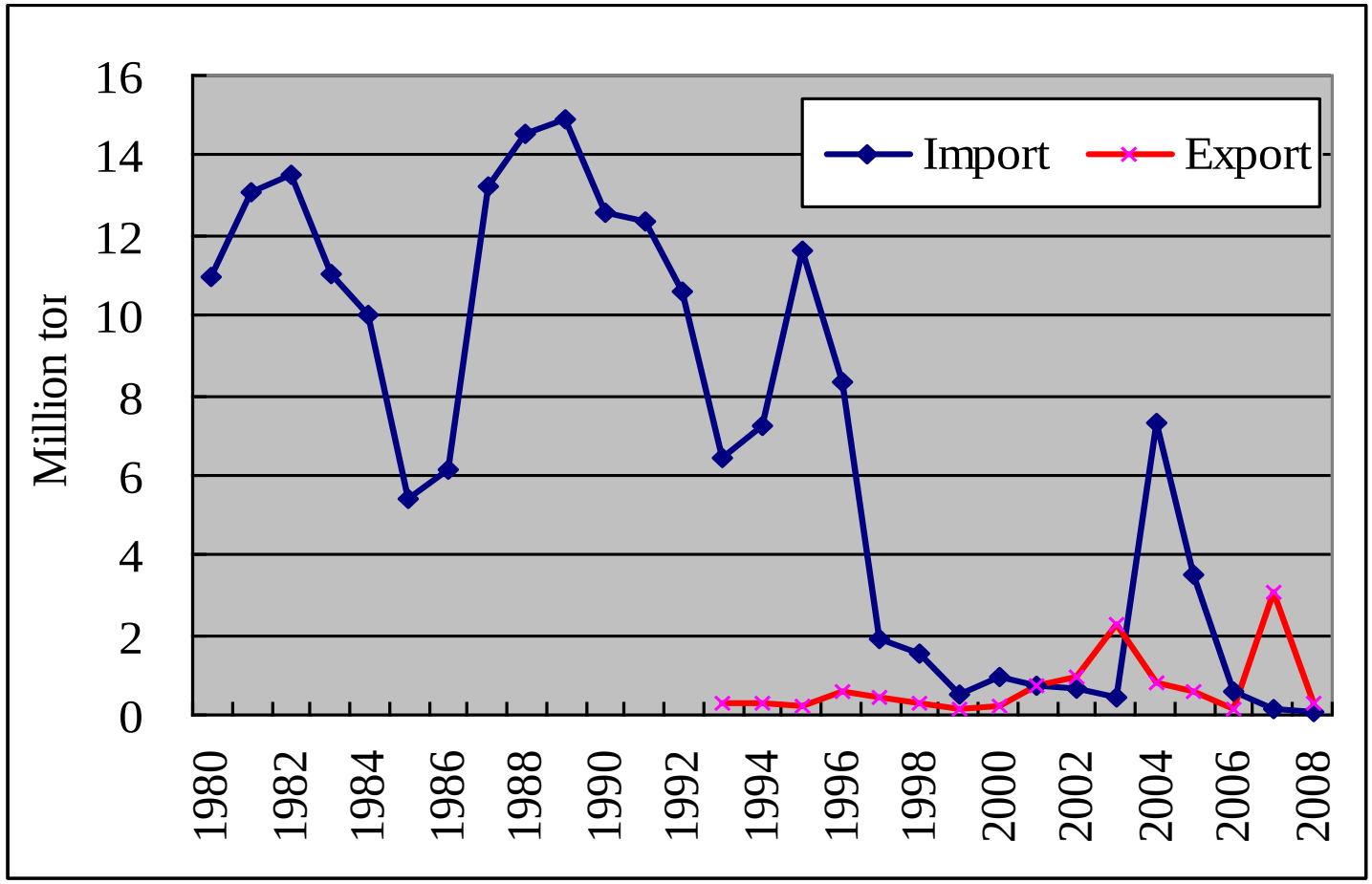


Figure 21: Wheat imports and exports (1980-2008), million tons



- **Figure 23: Soybeans imports and exports (1980-2008), million tons**

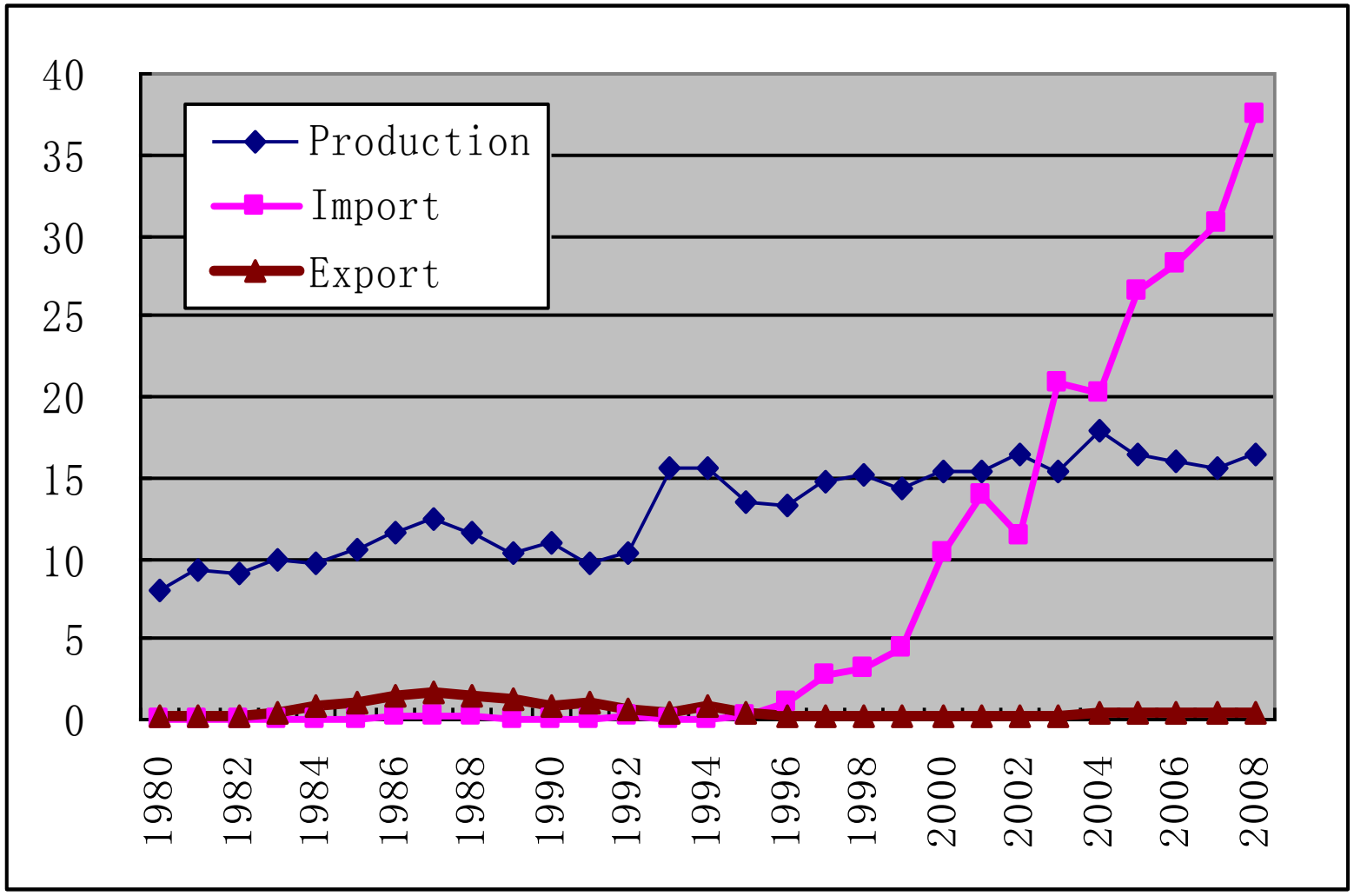
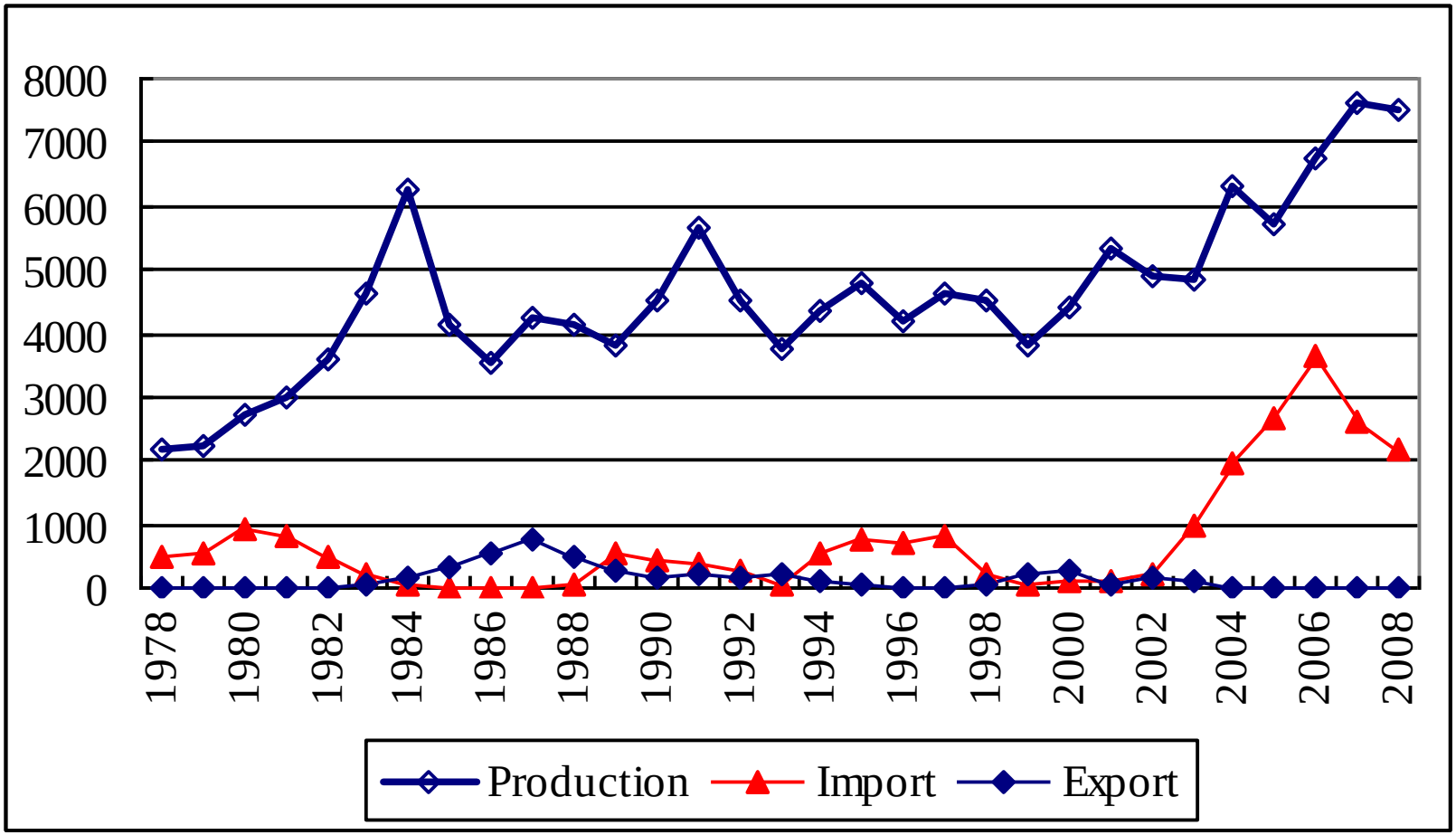


Figure 24: Cotton imports and exports (1980-2008), 1000tons



- 2. Total factor productivity (TFP)
  - Cultivated land area keeps within 1.8 billion mu
  - Technological improvements are key for TFP growth. China is massively investing in biotechnology, most recently supplemented by the 2009-2020 Special Program of 26 Billion Yuan, betting largely on biotech to keep its TFP growth in agriculture up.
  - Supporting
  - International cooperation

- 3. Agricultural labor productivity
  - More rural population moves out farm sector, which depends on the development of China's economic growth in the future

Thanks!