ISBN 0 86396 560 1

NO. 97/4

CHINA'S GRAIN DEMAND AND SUPPLY: TRADE IMPLICATIONS

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January 1997

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This paper was prepared for presentation at the Workshop China's Agriculture at the Crossroads, Organised by National Centre for Development Studies, Australian National University and College of Economics and Management, China Agricultural University, April 15-16, 1997, Canberra. Earlier versions of this paper were presented at the International Symposium on "Food and Agriculture in China: Perspectives and Policies", October 7-9, 1996, Beijing; and OECD Workshop on China's Agricultural Policies, December 12-13, 1996, Paris.

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1. INTRODUCTION

This study reviews research on China's grain demand and supply. The purpose is to comment on the outlook for China's trade in grain and grain-based food, but also to identify the sensitivities of the projections of China's grain demand to key parameters. The paper will therefore 1) review a set of projections of grain demand and trade, 2) examine studies of major factors considered to affect grain demand in China, 3) comment on some trade and production policy issues based on a new projection that takes into account the effect of changes in population structure. A simple supply side assumption is used in this study. Findlay (1996) contains more discussion of supply side issues. Work reported here on the demand side is largely based on the study by Wu and Wu (1994) using official urban household survey data as well as recent results obtained using CERU-MoA rural household survey data (Wu, 1997). Our particular interest in this paper is the sensitivity of the outlooks for consumption and therefore trade to changes in the

- the structure of the population;
- the conversion rates of feed grain into meat.

The paper concludes with comments on possible variations in patterns of trade in grain and processed foods, including meat.

2. PREVIOUS PROJECTIONS OF GRAIN SUPPLY AND DEMAND[1]

There is a variety of scenarios for China's international trade in grain over the next couple of decades. A sample of the assessments are summarised in Table 1.

The outlooks differ significantly. Some project rapid growth in consumption, for example, Garnaut and Ma (1992), as well as the OECF study (1995). Others are pessimistic about the outlook for production growth: 500 mmt is the upper limit in all

[1]This section is based on Findlay and Watson (1996).

the projections for the year 2000. Brown (1994) forecasts a dramatic decline in output, mainly due to the

TABLE 1

VARIOUS PROJECTIONS OF CHINA'S GRAIN TRADE

Source	*Period of projection*	*Consumption at end point (B)*	*Production at end point*	*Net imports at end point (A)*	*A/B*
Tyers and Anderson (1992)	1990-2000	510 mmt in 2000	420 mmt in 2000	90 mmt in 2000	18.0%
Garnaut and Ma (1992)	1990-2000	a) Normal growth (6% p.a. income growth): 547.2 mmt in 2000; b) High growth (7.2% p.a. income growth): 593 mmt in 2000	Upper limmt of 500 mmt in 2020	a)Normal growth (6% p.a. income growth): 50 mmt in 2000 b) High growth (7.2% p.a. income growth): 90 mmt in 2000	9.1% 15.2%
Brown (1994)	1990-2030	a) No rise in consumption per capita: 479 mmt in 2030 b) Rise in consumption per capita and rise in population: 641 mmt in 2030	272 mmt in 2030	a) No rise in consumption per capita: 207mmt in 2030 b) Rise in consumption per capita and rise in population: 369 mmt in 2030	43.0% 58.0%
Huang, Rozelle and Rosegrant (IFPRI) (1995)	Early 1990s to 2000, 2010 and 2020	450 mmt in 2000 600 mmt in 2020	410 mmt in 2000 550 mmt in 2020	40 mmt in 2000, *but not likely to be greater than* 50 mmt in 2020	8.8% 8.3%
OECF (1995)	1993 to 2000, 2005 and 2010	508 mmt in 2000 571 mmt in 2005 645 mmt in 2010	484 mmt in 2000 502 mmt in 2005 509 mmt in 2010	24 mmt in 2000, 69 mmt in 2005 136 mmt in 2010	4.7% 12.1% 21.0%
Mei (1995)	1993 to 2000, 2010 and 2020	511 mmt in 2000 593 mmt in 2010 695 mmt in 2020	500 mmt in 2000 578 mmt in 2010 675 mmt in 2020	11 mmt in 2000 15 mmt in 2010 20 mmt in 2020	2.2% 2.5% 2.9%

loss of arable land associated with salinisation and erosion. Projections differ in the outlook for output beyond the year 2000. Some are optimistic about production growth relative to consumption growth, eg the IFPRI group (1995) but not the OECF (1995), and even more so Mei (1995) (who reports estimates from the Chinese Academy of Agricultural Sciences).

The differences in these scenarios are reflected in their ratios of imports to consumption. These range from less than 3% for Mei by 2020 to over 20% for the

OECF (at 2010) and around 50% in 2030 in the case of Brown. Mei argues that imported grains 'can only play a role in adjusting the production' (p. 3).[2]

In the rest of this paper, we discuss some key parameters on the demand side which will affect the projections and the scale of trade. Our discussion here is limited to a focus on aggregate grain supply and demand. More and more researchers are working on the supply and demand outlooks for each type of grain. It is recognised that the supply and demand forces vary between regions and consequently between grain types and that there are benefits to further research which does not treat this sector as an aggregate. However detailed examination of these issues is beyond our scope in this paper.

3. FACTORS AFFECTING CHINA'S DEMAND FOR GRAIN

There are many factors determining both individual and national grain consumption. Determinants of individual demand include 1) *income* - consumers tend to spend an increasing proportion of additional income upon luxury foodstuffs (eg meat) and a decreasing proportion of it on staple foodstuffs (eg rice); 2) *prices* - utility maximising consumers tend to consume less of one food item and shift to its substitutes when its price rises or the prices of its substitutes fall; and 3) *dietary habits*, - consumers are generally and strongly influenced by culture and religion or belief, though their dietary habits do change when their life style changes (eg. from rural to urban or from traditional to modern life styles).

Determinants of aggregate demand include 1) *population*, which is not only a *quantitative* factor that can be simply multiplied by per capita grain consumption to get total demand for grain, but also a *qualitative* factor that affects both quantity and

[2] These projections do not take into account the infrastructure constraints on trade. Some assessments are that the import volume in 1995 of 19 mmt is about the capacity of the current import grain handling system. This capacity will not expand without further investment which is unlikely to occur without further reform in the infrastructure sector, for example, the creation of opportunities for large private sector projects in grain handling. Transport bottlenecks also constrain the movement of grain within China and lead to the possibility of higher volumes of two-way international trade in the same grains. While we recognise the handling system is a constraint on trade, its likely path of development is also beyond our scope in this paper here.

structure of demand for grain through the changes in age structure, gender ratio and rural-to-urban migration; 2) *feeding efficiency*, determining the use of feed grain for producing meat; 3) *efficiency of industrial use of grain*, determining the use of grain for producing grain-based industrial products (eg grain liquor, medicine, etc.); 4) *seed use*, determined by choices made in seed breeding, selection and sowing; 5) *waste*, determined by the way in which grain is shipped, stored, processed and consumed; and 6) *grain stocks*, largely determined by government policy. Changes in these factors determine changes in total demand for grain.

As discussed below, the large variation in projections of China's demand for grain (Table 1) is due to the enormous difference in 1) research findings on income and price effects from demand function studies for China, and 2) assumptions on exogenous factors. Furthermore, most studies reported in Table 1 do not fully consider the effect of changing dietary habits and the effect of changing population structure.

Research findings from estimation of grain/food demand functions

Food grain

In Table 2, estimated income elasticities of demand for food grain vary from about negative 0.2 to positive 0.6, and estimated own-price elasticities of demand vary from about -0.1 to -1.5, regardless of the residence of the population. Wu and Wu provide much more detailed estimates by three major food grains with breakdown of rural and urban population and of urban areas by city size (Table 2). They have found that rural household consumption of all the three food grains responds little to income change. Their finding is very close to that of Huang et al (1995) for total food grains (Table 2). Different city groups show different income elasticities of demand for grains, suggesting a strong urbanisation effect. Households' response to income change in demand for rice and coarse grain is less in larger cities than in smaller cities, while for flour the result is the opposite. Wu and Wu's findings on own-price elasticities of

TABLE 2

INCOME AND PRICE ELASTICITIES OF DEMAND FOR GRAINS, FINDINGS BY VARIOUS STUDIES

Source	*Region (period) covered*	*Type of grain studied*	*Income elasticity*	*Own-price elasticity*

Wu and Wu (1994)	Rural (1991)	Coarse	0.02	-0.69
		Flour	0.04	-1.04
		Rice	0.07	-1.30
	Large cities (1991)	Coarse	0.04	-0.80
		Flour	0.67	-3.05
		Rice	0.14	-1.41
	Other cities (1991)	Coarse	0.27	-1.17
		Flour	0.41	-3.01
		Rice	0.21	-1.87
	Small towns (1991)	Coarse	1.05	-1.87
		Flour	0.49	-1.80
		Rice	0.29	-1.28
Kapuscinski (1996)	CERU/MoA Grain household survey (1994)	Aggregate grain	0.32	n.a.
		Wheat	0.19	n.a.
		Rice	0.40	n.a.
Rosegrant *et al*. (1995)	Nation (1990-2000)	Wheat	0.20	n.a.
		Maize	-0.19	n.a.
		Rice	-0.04 ~ 0.03	n.a.
		Other grains	-0.16	n.a.
Huang *et al*. (1995)	Rural	Aggregate grain	0.00	n.a.
	Urban	Aggregate grain	0.15	n.a.
Huang and Rozelle (1994)	Rural (early 1990s)	Rice	0.33	-0.20
		Other grain	0.18	-0.30
	Urban (early 1990s)	Rice	0.14	-0.20
		Other grains	0.05	-0.30
Huang (1994)	Two rural counties (1992)	Indica rice	-0.01	n.a.
		Japonica rice	0.14	n.a.
OECF (1995)	Nation (1978-92)	Food grain	-0.27 ~ 0.00	n.a.
		Feed grain	0.25 ~ 1.00	n.a.
		Processed grain	0.39 ~ 1.00	n.a.
Yang *et al.* (1991)	Urban (1987)	Rice	0.47	-0.90
		Wheat	-0.13	-0.31
		Coarse	0.31	-0.24
		Other grains	0.60	-0.76
Pudney and Wang (1991)	Urban (1987)	Aggregate grain	0.02	-0.35
Wang (1989)	Urban (1981-87)	Aggregate grain	0.05	-1.48
Lewis and Andrews (1989)	Urban (1982-85)	Aggregate grain	0.31	-0.26
	Rural (1982-85)	Aggregate grain	0.22	-0.14
Gaag (1984)	Urban (1982)	Aggregate grain	0.11 ~ 0.12	-0.08
	Rural (1981-82)	Aggregate grain	0.21 ~ 0.22	n.a.
Chen and Buckwell (1991)	Urban (time series)	Aggregate grain	-0.15	-0.58
	Rural (time series)	Aggregate grain	0.16	-0.21
Kueh (1988)	Rural (1980-85)	Aggregate grain	0.36 ~ 0.07	n.a.
FAO (1991)	Nation (1965-86)	Aggregate grain	0.18	-0.11
Food study group (1991-93)	Urban (1984-88)	Aggregate grain	0.34	-0.29
	Rural (1986-87)	Aggregate grain	0.39	-0.62
Zhu *et al*. (1991)	Rural (1988)	Aggregate grain	0.03	n.a.
Suzuki (1987)	Nation (1978-84)	Rice	0.27	-0.68
Ito (1991)	Nation (1960-85)	Rice	0.13	n.a.

demand for food grain are generally greater than all other studies. Largely due to data problems, estimates on cross-price elasticities are not yet available.

Almost all studies have suggested that at current income levels, food grain is still a normal good in China. Grain consumption generally rises while income increases. However, by estimating a regional demand function, Wu and Wu have found that food grains, especially rice and coarse grains, tend to be 'inferior goods' in the high-income southern and Yangtze River regions. Using his own survey data on consumption of different rice varieties, Huang J. (1994) has also found that Indica rice has become an 'inferior good' even to rural households with higher income.

A simple examination of time series data on food grain consumption and per capita income would also suggest a strong negative relationship for urban households and nil relationship for rural households. Using per capita food grain consumption data from Table 8 of this study and CPI-deflated per capita income data from SSB (various issues), a simple OLS regression shows that the income elasticity of food grain consumption is -0.55 (adjusted R^2=0.86) for urban households and 0.01 for rural households, but statistically insignificant (adjusted R^2=0). There appears to be a puzzle, however: if this simple exercise reveals correct parameters, why have most cross-sample studies not captured the strong income effect on the decline of food grain consumption in urban China?

As mentioned before, Wu and Wu's study paid particular attention to the effect of urbanisation on demand for grain. The income elasticity increases while moving from smaller cities to larger ones which implies that urban life style does play a role. They argue that demand for flour will be the main source of growth in grain consumption in cities and it will increase as urbanisation level increases. Such an urbanisation effect is used in a long term projection by Lin, Huang and Rozelle (1996).

Meat/feed grain

As in the case of food grain, estimated income and price elasticities of demand for grain-based foodstuffs also differ significantly. For example, the income elasticity of

TABLE 3

INCOME AND PRICE ELASTICITIES OF DEMAND FOR GRAIN-BASED FOODSTUFFS, FINDINGS BY VARIOUS STUDIES

Source	*Region (period) covered*	*Type of food studied*	*Income elasticity*	*Own-price elasticity*

Wu and Wu (1994)	Rural (1991)	Meat	0.91	-0.64
		Eggs	1.50	-0.35
		Fish	2.60	-1.03
		Alcoho1	1.69	-0.45
		Biscuits	0.92	-8.89
	Large cities (1991)	Meat	0.58	-1.06
		Eggs	0.53	-0.55
		Fish	0.87	-0.62
		Alcoho1	0.66	-1.07
		Biscuits	0.82	-1.74
	Other cities (1991)	Meat	1.00	-1.09
		Eggs	0.59	-1.13
		Fish	1.37	-0.99
		Alcoho1	1.09	-0.32
		Biscuits	-1.45	-2.01
	Small towns (1991)	Meat	0.48	-0.83
		Eggs	0.37	-1.15
		Fish	0.82	-1.03
		Alcoho1	0.03	-1.11
		Biscuits	0.88	-2.09
Huang and Bouis (1995)	Rural (early 1990s)	Pork	0.76	n.a.
		Beef & mutton	0.34	n.a.
		Poultry/Eggs	0.85/0.51	n.a.
		Milk	1.56	n.a.
		Fish	1.05	n.a.
	Urban (early 1990s)	Pork	0.78	n.a.
		Beef & mutton	0.69	n.a.
		Poultry/Eggs	0.99/0.46	n.a.
		Milk	1.64	n.a.
		Fish	1.24	n.a.
Pinstrum and Anderson (1991)	Rural (n.a.)	Pork	0.63	n.a.
		Beef and mutton	1.23	n.a.
		Poultry/Eggs	1.16/1.18	n.a.
		Fish	0.86	n.a.
		Milk	1.71	n.a.
Zhu *et al*. (1991)	Rural (1988)	Pork	0.57	n.a.
		Beef and mutton	0.57	n.a.
		Poultry/Eggs	1.46/0.66	n.a.
		Fish	1.34	n.a.
Lewis and Andrews (1989)	Rural (1982-85)	Pork	1.02	-0.23
		Poultry	1.95	-0.09
		Fish	3.65	-0.69
Yang *et al*. (1991)	Urban (1987)	Pork	0.69	-0.77
		Beef and mutton	0.73	-1.36
		Poultry/Eggs	0.74/0.72	-0.72/-0.89
		Fish	1.00	-0.93
Lewis and Andrews (1989)	Urban (1982-85)	Pork	0.92	-0.04
		Beef and mutton	0.32	-0.00
		Poultry/Eggs	0.72/1.04	-0.01/-0.02
		Fish	0.89	-0.01

demand for beef and mutton ranges from 0.32 to 1.23, for pork from 0.57 to 1.02, and for poultry from 0.72 to 1.95, regardless residence of population. There are not many price elasticity estimates available. Estimates by Lewis and Andrew appear problematic as they show that there is almost no income effect on demand for meats in urban areas (Table 3).

Wu and Wu (1994) have found that demand for grain-based foodstuffs like meat, eggs, fish, alcohol, etc., is much more income elastic in rural areas than in cities. They argue that this may be because these foodstuffs are more likely to be luxury goods in rural areas and the current consumption level of these goods in the rural area is much lower than that of the urban area. Their findings are supported by examining the relationship between per capita income (SSB, various issues) and meat consumption (proxied by implied feed grain) in both urban and rural areas over the reform period (Table 8). The income elasticity of demand for feed grain estimated in this way is 0.23 for urban households (adjusted R^2=0.62) and 0.55 for rural households (R^2=0.86).

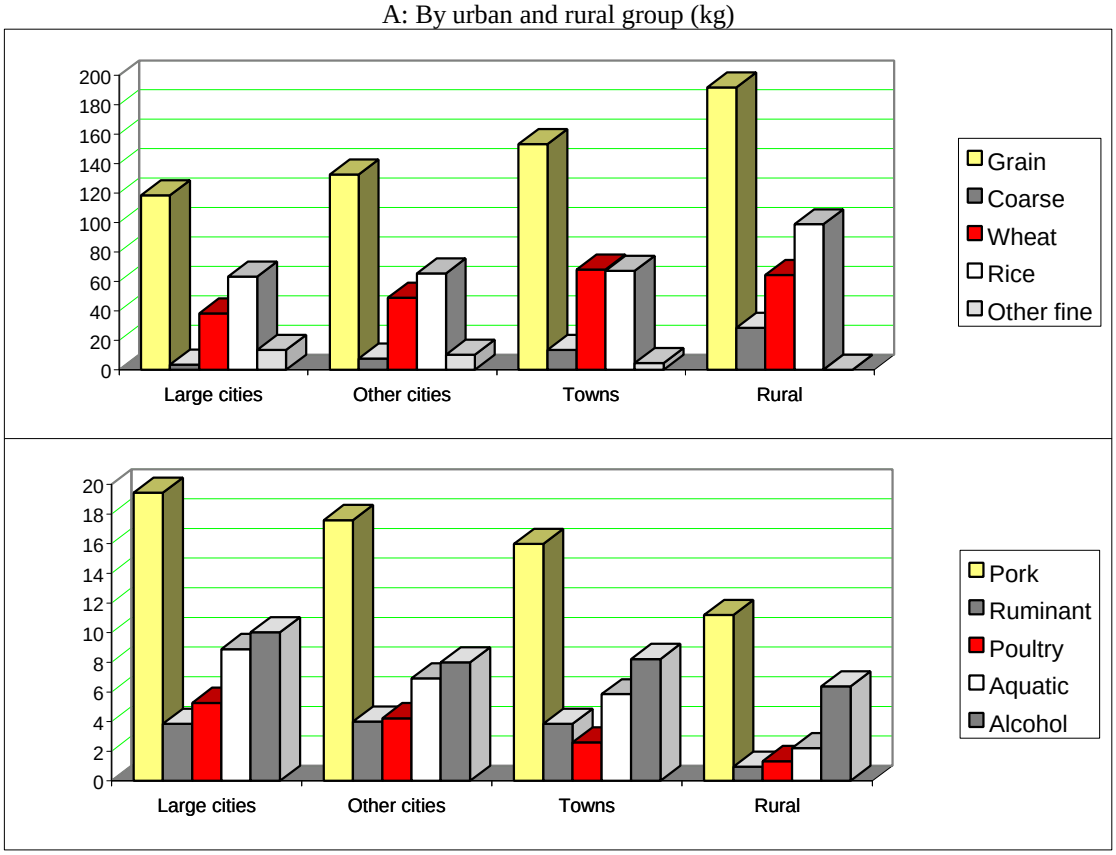
Dietary habits

A clear effect of dietary habits on food consumption due to different cultural backgrounds has been observed. In the regions (south and southwest to the Yangtze River) that are considered to have maintained the *Han* Chinese 'dietary cultural' heritage, much more pork is consumed than in the regions (north and west to the Yangtze) that are considered to have been more or less influenced by non-Chinese 'dietary cultures' (Mongolian, Manchurian, Tibetan and Moslem), where more ruminant meat is consumed (Figure 1). When shifting from a smaller to a larger city group all meat consumption increases except ruminant meat which stays almost unchanged. In alcohol consumption, more beer but less Chinese grain liquor is consumed in larger cities than in smaller cities/towns where the traditional cultural influence is stronger (Wu and Wu 1994).

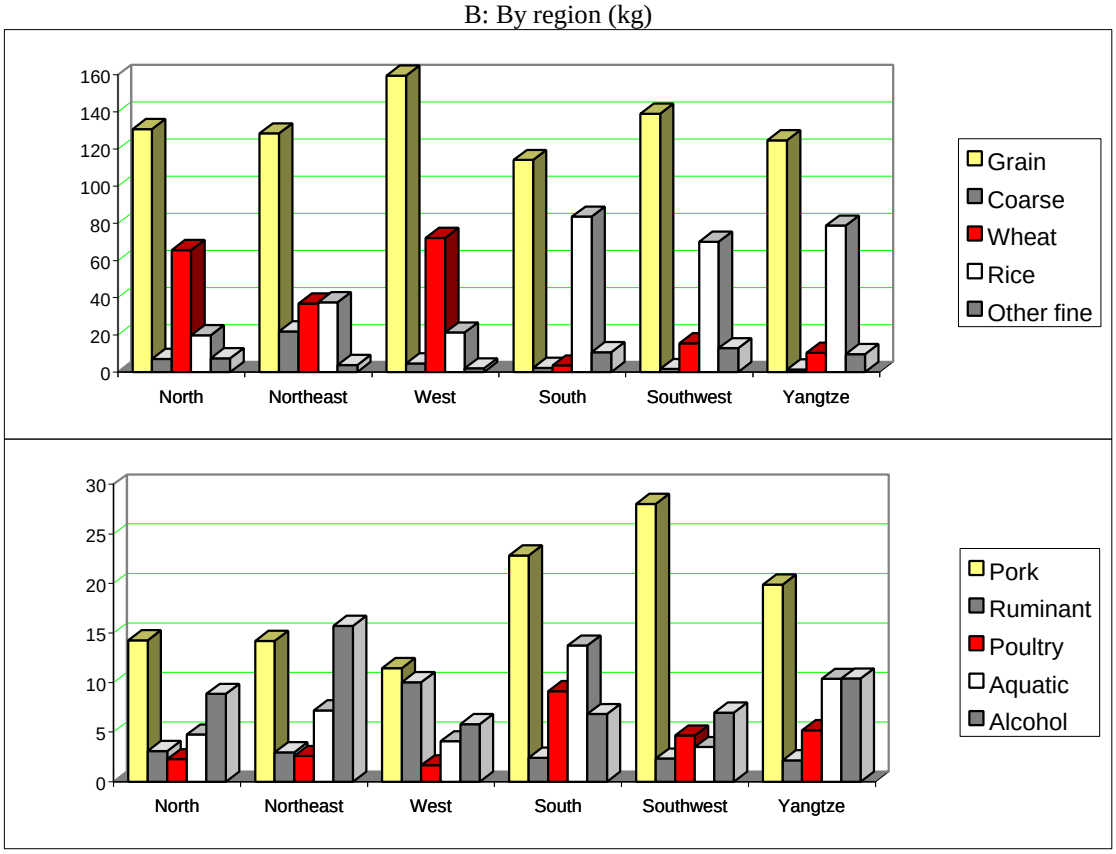
FIGURE 1

CHINA'S PER CAPITA FOOD GRAIN AND GRAIN-BASED FOOD CONSUMPTION, 1991

A: By urban and rural group (kg)



B: By region (kg)



Source: Wu and Wu (1994, Figures 2 and 3)

Studies of factors affecting total grain consumption

Population effect

The population growth rates applied by various projections are different. One half of a percentage point in a large country like China could result in an enormous gap in grain demand between projections.[3] Studies show that there has been no careful calculation of actual population growth rate for the first half of the 1990s. In 1990-95 the actual population grow at 1.16 per cent a year, compared with different rates used by various projections for the 1990s, ranging from 1.3 (Garnaut and Ma, 1992), 1.28 (Lin, Huang and Rozelle, 1996) to 1.45-1.48 (OECF, 1995).

TABLE 4
PROJECTED POPULATION AND THE SHARE OF AGE GROUPS IN CHINA

	1995	2000	2010	2020	2030
Population (billion)	1.2281	1.3121	1.4321	1.5335	1.5988
Within-subperiod annual growth (%)		1.332	0.879	0.686	0.419
Share of age group					
0-14 (%)	27.0	26.2	23.3	21.4	20.5
15-29 (%)	26.7	23.5	22.7	20.4	20.1
30-44 (%)	23.0	24.0	22.4	20.7	20.5
45-59 (%)	13.5	15.5	18.8	20.9	18.0
60 & over (%)	9.8	10.8	12.9	16.5	21.0

Source: Authors' own projection using Life-Table modelling technic. Basic data are from SSB (1996, pp. 74-78) and PCO and DPS (1993, Vol. 2, pp. 2-3; Vol. 3, pp. 539-541).

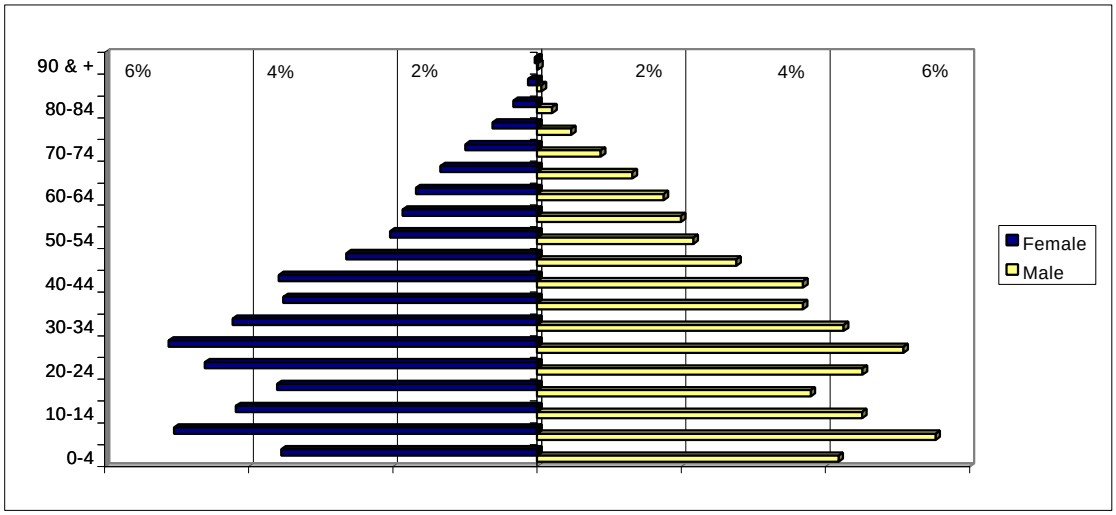
Given per capita grain consumption, the most important factor for a simple projection of total consumption is a reasonable population growth rate. Considering the effect on population growth of changes in age structure, gender ratio, fertility and mortality rates over time and across various age groups, life-table modelling is the most reliable

[3] In Lin, Huang J. and Rozelle's baseline scenario, annual population growth rate is 0.74 per cent for the period 2000-2010, compared with 1.25 per cent (2000-2005) and 1.19 per cent (2005-2010) used by OECF. The gap between the two projections means 67 million more population (assume the population grow from a simply projected population of 1.28 billion in 2000 based on the actual growth rate of 1.16% in 1990-95) and, on a basis of 400 kg grain per capita per year, 27 mmt (million metric ton) more grain consumption in 2010, four times the annual net grain import of 6.4 mmt of 1978-95.

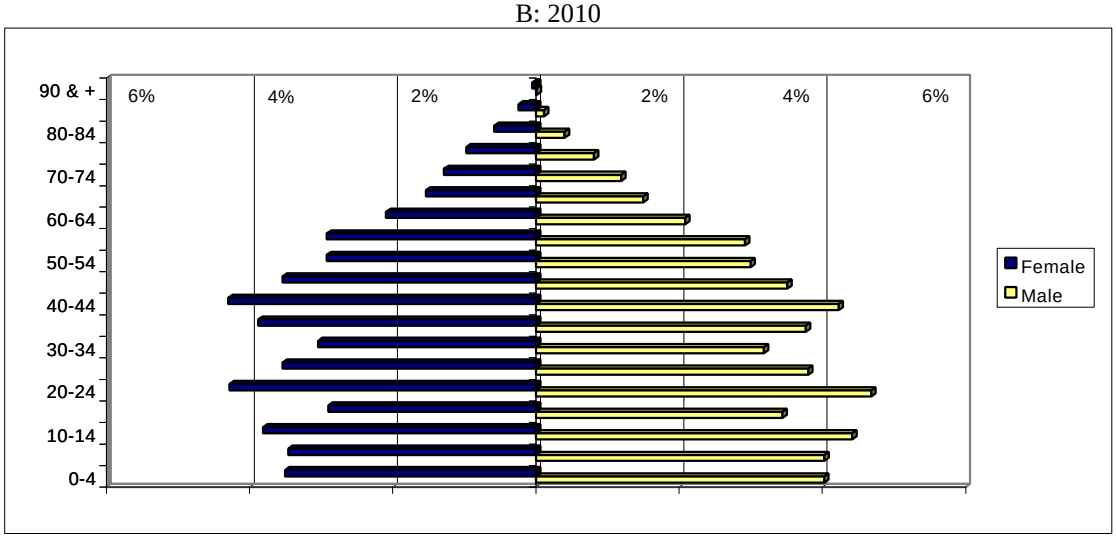
FIGURE 2

POPULATION TRANSATION IN CHINA: PROJECTED AGE AND GENDER STRUCTURAL CHANGES IN 2010 AND 2030, COMPARED WITH THOSE OF 1995

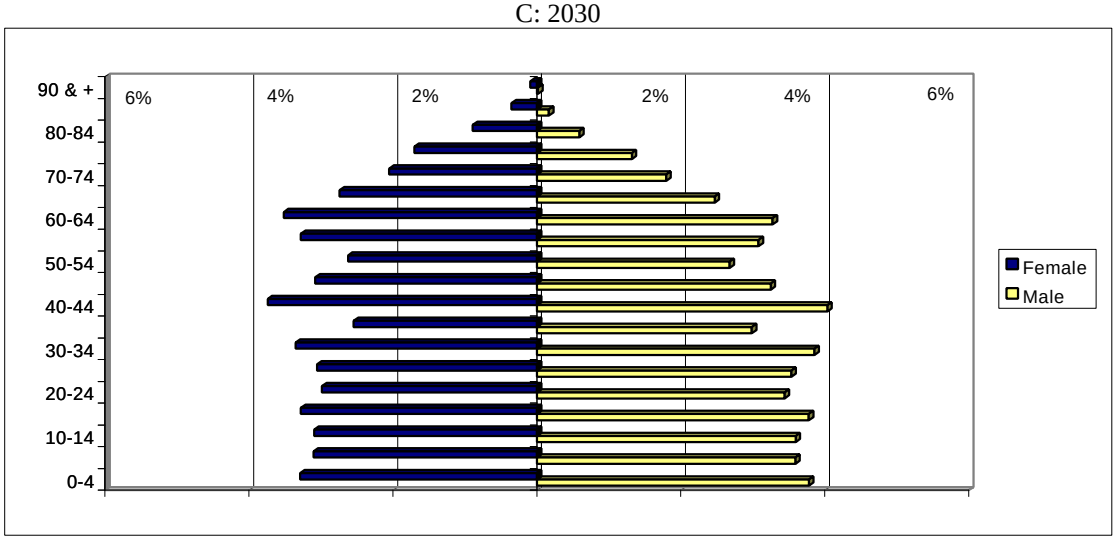
A: 1995



B: 2010



C: 2030



Source: Authors' projection.

way to estimate population growth over a projection period. Using this technique with basic vital statistics available from China's 1990 population census data (PCO and DPS 1993, vols. 2 and 3), we have estimated China's population growth from 1995 to 2030 (Table 4). While our results provide a more realistic population growth in the next 35 years, they also highlight the change in the age distribution in each of the sub-periods. It appears that China's population will grow by 1.33 per cent a year before it slows down after 2000 and reaches 1.43 billion by 2010, 1.53 billion by 2020 and 1.60 billion by 2030.

There has also been a lack of study on the impact of changes in the age structure on demand for grain. For example, other things being equal, a decline in the number of people in their early adulthood will result in a decline in per capita food consumption. In addition, with differences in fertility between urban and rural areas, and with labour migration from rural to urban areas, changes in the age structure will have an impact on food consumption, especially in a long run. Our population projection (Table 4) shows that China will experience a "population transition" over the next 35 years which will significantly affect population growth via changes in age structure. During the period 1995-2030 there will be a decline in the proportion of the population aged below 30 from 54 to 41 per cent, and a rise in the proportion of the population aged 45 and above from 23 to 39 per cent, while an almost unchanged share of those aged 30-44. This effect is clearly shown in Figure 2.

Feeding efficiency

Garnaut and Ma's study (1992) gives a good list of available estimates of the feed-meat conversion ratio by summarising six different studies by Chinese researchers in 1988-91. Table 5 has updated Garnaut and Ma's list. All these estimates differ greatly, ranging from 4:1 to 7:1 for pork (ie. 4 kg to 7 kg feed grain to produce 1 kg pork), 2:1 to 4.8:1 for beef and mutton, 2:1 to 3.8:1 for poultry, 2.5:1 to 3.5:1 for eggs, 0.33:1 to 3:1 for milk, and 1:1 to 2:1 for fish. Clearly, pork is the most 'grain-intensive' and milk and fish are least 'grain-intensive'. Different ratios are reported in recent studies, eg. 3:1 for fish by Jiang et al. (1996) and 7:1 for beef by Du et al. (1995). There has been, however, no serious research in this area using a quantitative approach (eg. a cost function or production function analysis). As will be shown later in our new

estimate of implied feed consumption in China, results can vary considerably if different ratios are used (Table 8).

TABLE 5

CHINA'S FEEDING EFFICIENCY, MEASURED BY GRAIN-MEAT/EGG/MILK CONVERSION RATIO, VARIOUS FINDINGS

Source	*Pork*	*Beef and mutton*	*Poultry*	*Eggs*	*Milk*	*Fish*
Yu (1991)	5.1	3.0	3.0	2.8 ~ 3.0	0.3	2.0
Food Study Group (1991-V5)	5.5 ~ 6.4	4.8	2.5 ~ 3.8	3.0 ~ 3.5	3.0	--
Gao (1990)	6.0 ~ 7.0	3.3	2.0	--	--	1.5
MoA (1988)	5.8	--	3.0	3.0 ~ 3.5	1.0	1.5
MoA (1991)	4.0 ~ 4.5	2.0	2.5	--	--	2.0
Food Study Group (1991-V2)	4.0	3.4	2.5	2.5	0.3	1.0
Jia (1996)	3.5 ~ 4.0	--	2.0 ~ 2.2	--	--	--
Jia, 2020 target	2.6	--	1.6	--	--	--
Yang, 2000 target (1996)	3.0 ~ 3.3	--	1.9 ~ 2.1	2.2 ~ 2.4	--	1.6 ~ 1.8
Jiang (1996)	--	--	--	--	--	3.0
Du (1996)	--	7.0	--	--	--	--
OECF (1995)	4.5	4.5	2.7	2.7	0.3	0.8
Average	4.6	3.9	2.4	2.9	1.2	1.8
Maximum	7.0	7.0	3.8	3.5	3.0	3.0
Minimum	3.5	2.0	2.0	2.5	0.3	1.0

Note: Maximum and minimum values excludes targeted ratios for future.

Seed input

There have been few studies of seed consumption, especially the relationship between seed input quantity and seed quality, price and yield. In some provinces (eg. Shandong), the promotion of a 'precision seeding technique' tends to reduce seed input. It, however, relies heavily on the quality of seeds (ie seed emergence rate) which is determined not only by selection and breeding but also by research.[4]

From the 1995 CERU/MoA farm household survey (Table 6), we have found that on average seed input per *mu* varied considerably among crops (10 kg for winter wheat, 2.1 kg for middle-late Indica rice and 3.4 kg for corn). Seed consumption also varies

[4] It is different from grain loss in sowing which is affected by the way of seeding or drilling. As will be discussed next, China is reported to have enormous grain loss in sowing of 8.4 mmt per year.

greatly across households. For example, the maximum seed input per *mu* for winter wheat was 1.7 times the average, for middle-late Indica rice was 6.6 times the average, and for corn was 7.5 times the average. There are also regional variations. According to these survey results, there is great potential for China to reduce seed consumption.

TABLE 6

CERU/MOA RURAL HOUSEHOLD SURVEY: SEEDS INPUT PER UNIT OF SOWN AREA AND SEEDS INPUT-OUTPUT RATIO

Crop/ province	Sample size	Seed input per mu (kg) Average	Max.	Min.	Seed-output ratio (kg/ton) Average	Max.	Min.
Winter wheat:							
Sichuan	195	10.6 (0.26)	17.0	1.0	41.8 (0.45)	97.2	4.3
Shandong	203	9.48 (0.27)	16.7	1.1	26.3 (0.50)	86.8	2.9
Total samples	398	10.0 (0.26)	17.0	1.0	33.9 (0.45)	97.2	2.9
Middle-late Indica:							
Guangdong	204	2.4 (0.70)	7.0	0.5	7.0 (0.80)	23.5	0.9
Jiangxi	198	1.8 (1.10)	14.1	0.5	4.7 (1.08)	35.2	1.2
Sichuan	129	2.3 (1.19)	10.3	0.5	4.4 (1.13)	20.0	1.1
Total samples	531	2.14 (0.98)	14.1	0.5	5.5 (0.98)	35.2	0.9
Corn:							
Jilin	185	3.4 (0.34)	8.3	1.6	6.3 (0.42)	30.0	3.0
Sichuan	141	2.8 (0.88)	25.0	0.4	9.5 (0.66)	62.5	1.4
Shandong	200	3.4 (0.83)	25.0	1.3	10.0 (0.75)	62.5	3.3
*Total samples**	544	3.4 (0.73)	25.0	0.4	9.1 (0.79)	62.5	1.4

Source: Wu (1996).

Note: *18 Guangdong samples are included. Figure in parentheses is coefficient of variation of samples.

Waste of grain

A number of studies have shown that China has been suffering from a severe waste of grain at various stages of production, handling and marketing, and consumption. The data in Table 7 suggests a great potential for China to reduce grain loss. But these data are not reliable. There is an enormous gap between official and non-official estimates in grain losses, ranging from 50 to over 100 mmt for the former and 8 to 11 mmt for the latter, using 1993 as an indicator. While non-official estimates may appear to be

too high, the official estimates are too low and lack of detail.[5] Non-official estimates are much higher than the international standard. For example, the loss from sowing, harvesting, shipping and stockpiling as quoted by Huang S. (1995) was 58.1 mmt, or 13 per cent of total grain output of 1993, which is much higher than the FAO standard of 5 per cent. Obviously, including or excluding a possible grain loss in projection of demand for grain will make a significant difference to China's grain balance, because a loss of 50 million tons a year is almost eight times China's annual grain net import (6.3 mmt) in 1978-95 (Zhang 1996).

TABLE 7
OFFICIAL AND NON-OFFICIAL ESTIMATES OF CHINA'S GRAIN LOSSES
(in million metric tons and based on 1993 output)

	Non-official estimates			Official estimates	
	Huang S. (1995)	Yu and Zhan (1996)	Zhang (1990)	RDI and RSEST (1996)	Quoted by Garnaut and Ma (1992)
1. Pre-consumption loss:					
Sowing	8.4	--	--	--	--
Harvesting	8.9	22.4	4.6 ~ 13.7	--	--
Threshing	--	--	9.2 ~ 18.2	--	--
Dehydration	--	--	4.6 ~ 13.7	--	--
Stockpiling	37.8	9.6	18.2 ~ 36.4	--	--
Shipping	3.0	3.3	4.6 ~ 9.2	--	--
Milling	4.8	16.3	9.2 ~ 22.8	--	--
2. Consumption loss	4.0	28.8	--	--	--
3. Marketing loss	--	1.5	--	--	--
Total loss	66.9	81.9	50.4 ~ 114.0	11.1	8.0

A new estimate of current food and feed grain consumption in China to 1995

Based on Wu and Wu (1994) and newly released official data (updated to 1995), and taking into account alternative feeding efficiency provided by Table 5, we have estimated per capita food and implied feed grain consumption for both urban and rural

[5] The recent evidence shows that the authorities have begun to accept non-official estimates on grain losses. As quoted by a report by the State Council Information Office, some experts estimated that at least 10 per cent of annual output has lost, amounting to over 45 mmt (China News and Report, No. 24, December 15, 1996).

households (Table 8). All assumptions used in the estimation, including those for low and high feeding efficiency scenarios, are reported in the notes to Table 8.

There are two important points from the new estimates to be noted. Firstly, while urban per capita food grain consumption declined rapidly from above 190 kg in 1981 to about 130 kg in 1995, rural per capita food grain consumption stayed almost unchanged at about 260 kg, although meat consumption for both urban and rural households increased rapidly. This may be because 1) rural households' meat consumption level is only half of the urban, and rural households may not consume much of other nongrain-based foodstuffs (eg vegetables and fruits etc.); 2) rural home-processed grain tends to have a lower conversion ratio;[6] 3) food grain/meat consumed by urban households outside home (eg. at restaurant) may have been underreported by SSB.

Secondly, while meat consumption increased for both urban and rural households, the urban per capita consumption of feed grain peaked in 1986 at about 200 kg, and the rural per capita consumption of feed grain was steady after 1991 at about 100 kg. This may be due to a shift from red meat to white meat which is feed-saving. One hypothesis is that the cost of feed-intensive meat (red meat) has risen more rapidly than that of the while meat, which has driven the shift.[7] Further research on this phenomenon is certainly deserved.

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[6] See Table 8, Note 1 for the ratio of milled to unmilled grain.

[7] This is somewhat supported by the retail price movement of different meat products. For example, from January to December of 1994 in agricultural product fares of 35 cities, the price index (January=100) for pork is 162, beef 151, sea fish (one sample) 112, clear-water fish (one sample) 124, chicken 120 and eggs 107, compared to japonica rice 179 and flour 136 (Editorial Committee of PYC 1995, p. 305).

TABLE 8

CHINA'S URBAN AND RURAL PER CAPITA FOOD CONSUMPTION AND IMPLIED (UNMILLED) GRAIN CONSUMPTION, 1981-1995

(kg)

	Total grain			*Implied feed grain*						
	High GM ratio	*Low GM ratio*	*Food grain*	*High GM ratio*	*Low GM ratio*	*Red meat*	*Poultry*	*Eggs*	*Aquatic products*	*Alcohol*
Urban										
1981	371.6	335.6	196.1	166.2	130.1	18.6	1.9	5.2	7.3	4.4
1982	375.5	338.5	194.9	171.1	134.1	18.7	2.3	5.9	7.7	4.5
1983	391.0	351.2	194.8	184.8	145.0	19.9	2.6	6.9	8.1	5.3
1984	393.9	353.6	191.6	187.9	147.6	19.9	2.9	7.6	7.8	6.8
1985	379.7	340.6	181.7	181.4	142.4	19.3	3.2	6.8	7.1	7.8
1986	407.5	363.9	185.9	201.7	158.1	21.6	3.7	7.1	8.2	9.4
1987	401.7	358.4	180.5	200.1	156.8	21.9	3.4	6.6	7.9	9.9
1988	392.3	351.9	185.0	187.3	146.9	19.8	4.0	6.9	7.1	9.5
1989	390.9	349.7	180.6	191.1	149.9	20.3	3.7	7.1	7.6	9.0
1990	394.7	351.2	176.3	198.8	155.3	21.7	3.4	7.3	7.7	9.3
1991	401.9	356.2	172.5	209.7	164.0	22.2	4.4	8.3	8.0	9.3
1992	382.8	337.0	150.4	211.6	165.7	21.4	5.1	9.5	8.2	9.9
1993	352.3	309.1	132.1	199.6	156.4	20.8	3.7	8.9	8.0	9.7
1994	359.8	316.4	137.1	201.5	158.0	20.2	4.1	9.7	8.5	10.0
1995	350.7	307.9	130.8	198.8	156.0	19.7	4.0	9.7	9.2	9.9
Rural										
1981	332.7	317.7	256.0	69.6	54.6	8.7	0.7	1.3	1.3	2.3
1982	341.3	325.6	260.0	73.0	57.3	9.1	0.8	1.4	1.3	2.7
1983	350.2	332.9	260.0	80.4	63.1	10.0	0.8	1.6	1.6	3.2
1984	364.3	345.7	267.0	86.7	68.0	10.6	0.9	1.8	1.7	3.5
1985	360.3	341.1	257.0	90.0	70.7	11.0	1.0	2.1	1.6	4.4
1986	370.8	350.0	259.0	96.6	75.8	11.8	1.1	2.1	1.9	5.0
1987	372.2	351.5	259.0	96.4	75.8	11.7	1.2	2.3	2.0	5.5
1988	368.5	349.2	260.0	90.3	71.0	10.7	1.3	2.3	1.9	5.9
1989	373.5	353.5	262.0	93.3	73.3	11.0	1.3	2.4	2.1	6.0
1990	376.5	356.0	262.1	95.6	75.1	11.3	1.3	2.4	2.1	6.1
1991	377.9	354.5	255.6	102.8	79.4	12.2	1.3	2.7	2.2	6.4
1992	372.2	349.2	250.5	101.6	78.6	11.8	1.5	2.9	2.3	6.6
1993	387.7	364.6	266.0	101.7	78.6	11.7	1.6	2.9	2.5	6.5
1994	377.0	354.8	260.6	97.9	75.8	11.0	1.6	3.0	2.7	6.0
1995	381.1	358.0	258.9	102.1	79.1	11.3	1.8	3.2	3.1	6.5

Sources: SSB, Statistical Yearbook of China, various issues. Calculations apply, see notes below.

Notes:

1) The published food grain data for urban households are 'processed grain'. They are converted back to 'unmilled grain', as used for rural households, based on a ratio of 0.7416 quoted in Garnaut and Ma (1992).
2) The conversion ratio for animal product is the median value from various estimates provided by Garnaut and Ma (1992, Table 30). For the high grain-meat conversion ratio (GM ratio) 7:1 for pork, 4.8:1 for beef/mutton, 3.8:1 for poultry, 3.5:1 for eggs and 2:1 for fish, and for the low GM conversion ratio, the corresponding figures are 5.5:1 (pork), 3.2:1 (beef/mutton), 2.9:1 (poultry), 3:1 (eggs) and 1.5:1 (fish). Since some estimates use 'unmilled grain' and some use find feed grain', the estimates here may be somewhere in between, but closer to 'unmilled grain'.
3) For urban households, we assume that 10% of red meat is beef and mutton in the 1980s and 15% in the 1990s (based on SSB survey, SSB 1995, p.263), and for rural households the corresponding values are 5% and 10%.
4) The conversion ratio for alcohol drinks is 4:1 for grain liquor and 0.25:1 for beer (Wu and Wu 1994, Table 2). It is assumed that 25% of alcohol comsumption is beer for rural households, and 50% for urban households.

4. A PROJECTION FOR DEMAND FOR FOOD AND IMPLIED FEED GRAINS

In this section we conduct our projection for demand for food and implied feed grain in both urban and rural China. This projection takes into account particularly the effects of 1) changes in age structure and 2) changes in feeding efficiency on grain consumption. The income elasticity of demand for food and feed grains is derived here from the simple relationship between per capita real income and food/(implied) feed consumption for urban and rural households (see discussion above).

Assumptions

1) Income elasticity of demand for grain

	Urban households		Rural households	
Period	Food grain	Feed grain	Food grain	Feed grain
1995-2000	-0.40	0.30	-0.10	0.50
2000-2010	-0.30	0.25	-0.30	0.45
2010-2020	-0.20	0.20	-0.50	0.40

2) Estimated grain consumption levels for different age groups for 1995 are based on per capita consumption data in Table 8, adding a 5 per cent margin to obtain a upper bound projection.

Age group	Adjustment as % of the average*	Urban households		Rural households	
		Food grain (kg/person)	Feed grain (kg/person)	Food grain (kg/person)	Feed grain (kg/person)
Average in Table 8 (raised by 5%)		**137.3**	**186.0*h*/230.9*l***	**271.8**	**104.1*h*/128.3*l***
0-14	70	96.0	130.0*h*/161.4*l*	190.1	72.7*h*/89.7*l*
15-44	120	164.6	222.8*h*/276.7*l*	325.8	124.7*h*/153.8*l*
45-59	100	137.2	185.7*h*/230.6*l*	271.5	103.9*h*/128.2*l*
60+	80	109.8	148.6*h*/184.5*l*	217.2	83.1*h*/102.6*l*
Average after adjustment		**137.2**	**185.7*h*/230.6*l***	**271.5**	**103.9*h*/128.2*l***

Note: '*h*' denoted high feeding efficiency (ie. low grain-meat conversion ratio) and '*l*' denotes low feeding efficiency (high grain-meat conversion ratio). * Age group consumption is assumed.

The age-adjusted consumption level for 1995 is used as the starting point of per capita food and (implied) feed grain consumption in our projection.

3) Population levels and age group shares at each end point of the projection range are reported in Table 4. They are also included in Table 9 presenting the projection results.

4) The change in the urbanisation rate over the projected period 1995-2020 is estimated based on the change of 1.92 per cent a year over 1990-95. The assumed end-period urbanisation levels are given in Table 9.

5) China's real GDP growth is assumed 8 per cent a year for Scenario I and 10 per cent a year for Scenario II. Per capita income growth is calculated based on total GDP growth and population growth (Table 4). Real income growth of 10 per cent a year is unrealistic, but used as a comparison with the growth scenario of 8 per cent a year.

The projection results are reported in Table 9. Key points are the following:

1. our projection of China's demand for grain appears to be lie within most studies made outside China - eg. with an income growth rate of 8 per cent and in the low feeding efficiency scenario, China's demand for total grain will be 523 mmt a year by 2000, 585 mmt a year by 2010 and 643 mmt a year by 2020;

2. the results show that demand for feed grain will be the only major driving force in the growth of demand for grain in China from the year 2000 onwards;

3. the combined effects of income growth and change in population structure leads to a fall in the demand for food grain;

4. the pace of the increase in demand for feed grain and the decline in demand for food grain will be very sensitive to the rate of income growth;

5. a change in feeding efficiency will make a significant difference to China's demand for feed grain.

Projections of this type are clearly sensitive to the grain-meat ratio used and further work in this area is required before more reasonable projection can be made.

TABLE 9

PROJECTIONS OF CHINA DEMAND FOR FOOD AND FEED GRAINS BY 2000, 2010 AND 2020 UNDER DIFFERENT INCOME GROWTH AND FEEDING EFFICIENCY SCENARIOS

		Scenario I: 8% p.a. GDP growth			Scenario II: 10% p.a. GDP growth		
	1995	2000	2010	2020	2000	2010	2020
A. End-of-period population (billion)	1.2281	1.3121	1.4321	1.5335	1.3121	1.4321	1.5335
1. Share of total by age group: (%)							
0-14	27.0	26.2	23.3	21.4	26.2	23.3	21.4
15-44	49.7	47.5	45.1	41.1	47.5	45.1	41.1
45-59	13.5	15.5	18.8	20.9	15.5	18.8	20.9
60+	9.8	10.8	12.9	16.5	10.8	12.9	16.5
2. Share of total by residence: (%)							
Urban	29.0	32.0	39.0	47.0	32.0	39.0	47.0
Rural	71.0	68.0	61.0	53.0	68.0	61.0	53.0
B. Within-period income growth							
Total GDP growth (%)	n.a.	8.0	8.0	8.0	10.0	10.0	10.0
Per capita GDP growth (%)	n.a.	6.3	7.1	7.3	8.3	9.0	9.5
C. End-of-period demand for grain:*							
1. Food grain:							
Urban: Per capita (kg)	137.18	120.26	97.06	83.05	115.41	87.64	72.02
Total demand (mmt)	48.85	50.49	54.21	59.86	48.46	48.95	51.91
Rural: Per capita (kg)	271.52	262.04	211.49	144.71	259.41	197.00	121.51
Total demand (mmt)	236.76	233.79	184.75	117.62	231.45	172.09	98.76
Total food grain demand (mmt)	*285.61*	*284.29*	*238.96*	*177.48*	*279.90*	*221.04*	*150.67*
2. Feed grain:							
a) Low feeding efficiency							
Urban: Per capita (kg)	230.62	252.26	300.41	343.66	259.77	324.74	386.33
Total demand (mmt)	82.14	105.91	167.78	247.70	109.07	181.37	278.45
Rural: Per capita (kg)	128.16	149.06	203.74	268.67	156.43	233.01	331.87
Total demand (mmt)	111.75	132.99	177.98	218.36	139.57	203.55	269.74
Total feed grain demand (mmt)	*193.88*	*238.91*	*345.76*	*466.06*	*248.63*	*384.92*	*548.18*
b) High feeding efficiency							
Urban: Per capita (kg)	185.74	203.16	241.94	276.77	209.21	261.54	311.14
Total demand (mmt)	66.15	85.30	135.13	199.49	87.84	146.07	224.25
Rural: Per capita (kg)	103.94	120.89	165.24	217.89	126.86	188.97	269.15
Total demand (mmt)	90.63	107.86	144.34	177.09	113.19	165.08	218.76
Total feed grain demand (mmt)	*156.78*	*193.16*	*279.47*	*376.58*	*201.03*	*311.15*	*443.01*
3. Total (food and feed) grain:							
a) Low feeding efficiency							
Urban: Per capita (kg)	367.80	372.52	397.47	426.71	375.18	412.39	458.35
Total demand (mmt)	130.99	156.41	221.99	307.55	157.52	230.32	330.35
Rural: Per capita (kg)	399.68	411.10	415.23	413.38	415.84	430.02	453.39
Total demand (mmt)	348.50	366.79	362.73	335.98	371.02	375.64	368.50
Total grain demand (mmt)	*479.49*	*523.19*	*584.72*	*643.54*	*528.54*	*605.96*	*698.85*
b) High feeding efficiency							
Urban: Per capita (kg)	322.91	323.42	339.00	359.82	324.62	349.18	383.15
Total demand (mmt)	115.00	135.79	189.33	259.34	136.30	195.02	276.16
Rural: Per capita (kg)	375.46	382.93	376.72	362.60	386.28	385.98	390.67
Total demand (mmt)	327.38	341.65	329.09	294.71	344.64	337.17	317.52
Total grain demand (mmt)	*442.39*	*477.44*	*518.42*	*554.06*	*480.93*	*532.19*	*593.68*

Source: Authors' projection.
Note: * See text for food consumption assumption for each age group.

5. IMPLICATIONS FOR INTERNATIONAL TRADE: OPTIONS FOR CHINA

In this section, we highlight the significance of these demand projections in another way, that is, by comparing them with a simple supply scenario.

Supply assumptions

A simple but important assumption used in supply projections is annual grain output growth. The assumption may be based on a simple extrapolation of grain output in previous periods, or on the experience of other countries at similar development stages or may be estimated by a sophisticated econometric approach taking all possible factors affecting grain supply. Some supply assumptions consider only technical potential while others take economic factors as well.

Based on other countries' experiences, Brown assumes that China's grain supply will decline by at least 0.5 per cent a year from now to 2030, compared with 1 per cent decline for Japan since 1960, 1.2 per cent decline for Taiwan since 1977 and 1.9 per cent decline for South Korea since 1977 (Brown 1994). Carter and Zhong project zero growth, while all other estimates of grain output are positive. Garnaut and Ma assume 1 per cent for slow growth scenarios, and 1.7 for a rapid growth scenario. The OECF projection assumes that grain land area and yield per unit of land will be continuing to grow at 0.05 and 1.75 per cent a year, respectively, as they were in the period 1984-93 (1995, Appendix II, Tables 2 and 3). Some projections assume a declining growth rate but one which is still positive, such as OECF (from 0.8 in 1993-2000 to 0.6 in 2000-2010), while some assume an increasing growth rate, such as Lin, Huang J. and Rozelle (from 0.7 in 1991-2000, to 1.4 in 2000-2010 and to 1.6 per cent in 2010-2020), which is less likely considering rising opportunity of cost of labour and land.

These assumptions vary greatly. Data constraints are one of the important reasons for the variation but also there are offsetting forces at work in a rapidly growing economy, the relative importance of which is difficult to judge without more detailed modelling work.

TABLE 10

TRADE IMPLICATIONS OF THE PROJECTED DEMAND FOR FOOD AND FEED GRAINS FOR CHINA UI

	Food grain (mmt)				Feed grain (mmt)			
	1995	2000	2010	2020	1995	2000	2010	2020
Demand:								
1) Low feeding efficiency scenario:								
a) Income growth by 8% a year	286[a]	284	239	177	194[a]	239	346	466
b) Income growth by 10% a year	286[a]	280	221	151	194[a]	249	385	548
2) High feeding efficiency scenario:								
a) Income growth by 8% a year	286[a]	284	239	177	157[a]	193	279	377
b) Income growth by 10% a year	286[a]	280	221	151	157[a]	201	311	443
Supply:								
Assumed output growth since the end of the last period (% p.a.)	n.a.	0.0[d]	-1.7[d]	-3.0[d]	n.a.	3.0	3.0	3.0
End-period supply	286[b]	284	239	177	181[c]	210	282	378
Balance:								
1) Low feeding efficiency scenario:								
a) Income growth by 8% a year	0	0	0	0	-13	-29	-64	-88
b) Income growth by 10% a year	0	4	18	26	-13	-39	-103	-170
2) High feeding efficiency scenario:								
a) Income growth by 8% a year	0	0	0	0	24	17	3	1
b) Income growth by 10% a year	0	4	18	26	24	9	-29	-65

Source: Based on Table 9 and supply assumptions.

Note: a. Data are estimated actual demand in 1995 from Table 9, used as a starting point.
b. Assuming food grain supply met demand in 1995.
c. Estimated feed grain supply by subtracting food grain from total grain output in 1995 (467 mmt).
d. Rates are set assuming China will meet its food grain demand as demand declines, at least in net terms.
e. Actual grain output in 1995.

While there is no agreement on reasonable supply growth assumption, a simple supply projection provides a background against which to judge the sensitivity of the trade projections to the variations in demand parameters which we stress in this paper.

Here we assume that in 1995 demand for food grain was met in net terms and that China will be able to meet its (declining) demand for food grain from 2000 onwards at least in net terms - China will show food grain self-sufficiency.[8]

We assume that the growth rate of feed grain production is assumed to be 3 per cent per annum throughout the projection period, based on the growth of maize output in the past ten years.

Under these assumptions, China's total grain supply in the year 2000 will be 494 mmt as projected in Table 10, very close to the government's 500 mmt target (see Luo, 1995, 1996). The implied total grain output growth will be about 1.1 per cent per annum over this period, slightly higher than the growth rate of 0.9 per cent achieved since the reform. This rate falls to about 0.5-0.6 per annum from 2000 to 2020, a decline from the previous trend which may be reasonable given the very likely rise of opportunity cost of increasing grain production in China. As projected China will be producing 521 mmt a year by 2010 and 555 mmt a year by 2020.

Trade implications

The trade implications in quantity terms will rely on the choice of economic growth and feeding efficiency scenarios.[9] If the 8 per cent income growth rate is chosen,

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[8] Food grain output could decline faster than the rate required for self sufficiency in a free trade scenario, depending on the pressures for structural change in food grain producing regions of China and the offsetting effects of new technologies. In that case our assumption of food grain self sufficiency could only be met by subsidies to production and/or protection, the welfare costs of which may be substantial. A number of the CGE studies of China's grain trade have also produced estimates of these sorts of costs.

[9] The projections in Table 10 are described more accurately as the gap between projected production and consumption. There is not necessarily a direct relationship to international transactions because of changes in stocks and also because of the mechanisms for the management for international transactions. The institutional arrangements for those transactions and their implications for observed trade patterns are beyond our scope here.

under the low feed efficiency scenario, China needs feed grain imports of 29 mmt a year by 2000, 64 mmt a year by 2010 and 88 mmt a year by 2020.

Under the high feed efficiency scenario China will still enjoy a surplus by 2000 and balance by 2020, which is unlikely to be possible. If the results under low efficiency are scaled down by 25 per cent to reflect some improvement in feeding efficiency, China will still need feed imports of 22 mmt a year by 2000, 48 mmt a year by 2010 and 66 mmt a year by 2020.

6. COMMENTS

We have concentrated here on the outlook for China's feed grain imports and demonstrated the sensitivity of the projections to changes in income growth, and to the efficiency of feed use. Our projections also incorporate more accurate assessment of population growth compared to other studies, and also take into account the impact of changes in the age structure of the population. Feed grain imports could be nearly 90 mmt by 2020 under the low feed efficiency scenario. However the pattern of feed grain trade is highly sensitive to developments in the efficiency with which feed is used.

There is a number of other factors to consider when assessing the outlook for China's grain trade, and trade in products like meat based on grain, and which suggest a number of topics for further work. These are

- the choice of trade policy regime
- the substitutability between food and feed grain
- the substitutability between grain imports and meat imports.

One issue is the choice of policy regime. The projections reported here are based on the assumptions that the trade policy regime permits the growth in demand for feed grain driven by income increases to be met by import growth while the outcome in the food grain market is self sufficiency. We do this to highlight the sensitivity of the projections to key parameters in the feed grain markets.

The method we use here is not detailed enough to project the path of domestic prices in the grain market. There has been some concern that China may switch to a policy of protecting agriculture, including grain (Garnaut, Cai and Huang, 1996). We noted the possibility that food grain self sufficiency may be a consequence of such a policy. Further work on this issue is also required, including the form in which that assistance might be made available (eg subsidies versus border barriers) and biases in policy between types of grain. Some of these issues are discussed in Cheng, Findlay and Watson (1996).

We have assumed that China is self sufficient in food grain production. The choice of trade policy regime for the grain sector will also have implications for the size of the grain-consuming meat industry and therefore the pattern of trade in meat. A protected grain sector, for example, and a less restrictive meat sector policy will lead to a larger volume of meat imports.[10]

We have also assumed there is no substitutability between feed and food grain, whereas a feature of China is a degree of substitutability between the grains. In that case, a higher feed efficiency which makes available more grain for food use reduces the rate of growth of food grain output required for self sufficiency. Alternatively more rapid food grain output growth (a consequence of technological change perhaps) makes it easier to meet domestic demand for feed grain, even in the low feed efficiency scenario. These interactions could also be examined in a more sophisticated modelling framework.

The possibility of a greater volume of meat imports is reflected in one other piece of modelling work reported by Anderson and Peng (1996). One of their concerns is that none of the standard methods of projection allow explicitly for the impact of events in the non-agricultural sector. As Anderson and Peng point out, this means these

[10] Using the grain-meat conversion ratios of 6:1 (kg) for red meat and 3.5:1 (kg) for poultry meat (average levels of low and high grain-meat ratios) and apply a degree of improvement in feed use efficiency, then feed grain imports could be replaced by 3.7 mmt of red meat or 6.3 mmt of poultry a year by 2000, 8 mmt of red meat or 13.7 mmt of poultry a year by 2010, and 11 mmt of red meat or 18.9 mmt of poultry a year by 2020, or apparently any combinations of the red and poultry meats.

projections do not take into account constraints on the use of resources in other sectors or constraints on China's international transactions. They report the results of an application of a multisectoral model (GTAP) to this problem. One scenario is based on growth of GDP in China of 7.8% a year through to 2005.[11] The result is that China is projected to import 33 mmt of grain in 2005 and a grain self sufficiency rate of 96% (import dependence of 4%).

Anderson and Peng note that these results are relatively low compared to others in Table 1, in part because of the projected growth in imports of livestock and other food products.[12] A tighter set of trade restrictions on those items would raise the level of grain import dependency above 4%, they observe.

These results are also sensitive to the specification of the parameters of the grain value adding to the food processing sectors. The patterns of trade in grain compared to processed products suggested by these modelling results would be sensitive to that specification. A recent paper by Lu Feng (1996) has highlighted the labour intensity of these activities compared to grain production. He observes that meat production requires little land (possibly no arable land) and a relatively large amount of labour input (including some scope to use labour released by the seasonal variation in demand from other activities). Given its resource endowment, China might therefore be a competitive supplier of meat, a major exporter of labour intensive food products and a larger importer of the grain raw materials for those sectors. The quantitative importance of these effects is a topic for further modelling work which captures more accurately the factor intensity of various value adding activities.

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[11]In this scenario, other economies in the rest of the world are also growing, at similar rates to China in the rest of East Asia and at slower rates in the developed economies. The Uruguay Round (UR) outcome of multilateral trade negotiations is also implemented, which removes export subsidies for farm products, thereby boosting world trade in farm products and also prices of those products. This price is not however sufficient to offset the long term structural decline in food prices which is built in to the model. The UR also removes quotas on exports of textile and clothing products which also boosts the trade in those products but lower their prices. For details, see Anderson and others, 1996.

[12]China pays for these imports by expanding net exports of manufactures, even though China is denied full access to the benefits of the UR outcome because of lack of WTO membership. China's export growth is concentrated in light manufactures not including the textiles and clothing category in this scenario.

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