Grain Market Reform in China: Global Implications

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List of Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADBC	Agricultural Development Bank of China
APEC	Asia–Pacific Economic Cooperation
CERU–MoA	Chinese Economy Research Unit (now Chinese Economies Research Centre)–Ministry of Agriculture
CGE	Computable General Equilibrium
FoA	
GDP	gross domestic product
GRDC	Grains Research and Development Corporation Australia
HRS	household responsibility system
IFPRI	International Food Policy Research Institute
MoA	Ministry of Agriculture
mt	million metric tons
mu	unit of measurement of area in China (15mu = 1ha)
OECF	Overseas Economic Cooperation Fund
PGRS	Provincial Governor's Responsibility System
SSB	State Statistical Bureau of China
TVE	township and village enterprises
UR	Uruguay Round
USDA	United States Department of Agriculture
WTO	World Trade Organization

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Preface

The grain marketing system in China has been one part of the economy slow to reform. While over the 1990s there have been considerable shifts in policy, considerable challenges remain. This book reviews the forces for the reform of grain marketing in China and their consequences. Special attention is paid to the international issues associated with reform. Suggestions for next steps in the program are identified and some of their consequences reviewed.

The work is the output of a joint research program between Australia and China, supported by the Australian Centre for International Agricultural Research (ACIAR). It was also funded in part by the Australian Grains Research and Development Corporation (GRDC). This sort of collaborative work is a valuable contribution to the debate in China on these issues. The jointness of the work and the access to materials provide a deeper understanding of the issues and a more realistic assessment of the outlook than does work done at greater distance.

Section 1 contains a review of marketing reforms over the 1990s and identifies major issues in the reform process. One major factor in the reform process has been changes in grain demand, examined in Section 2 with a projection for grain consumption in China. The scope for further growth in output and productivity is a major element in the policy debate in China and in the rest of the world. Our assessment, based to a considerable extent on household survey data collected during our project, is reported in Section 3. This is followed by a review of China's grain trade projections and then of the policy outlook in the grain sector.

The support of Ken Menz and Padma Lal from ACIAR and Stephen Lack from GRDC is acknowledged. The China team was led by Mr Guo Shutian and his successor in the Department of Policy, Law and Reform in the Ministry of Agriculture in Beijing, Mr Luo Yousheng. The China team input was coordinated by Dr Huang Yanxin. To these colleagues we say that we look forward to the next steps in our work together. Our joint work on this project is reflected in the reference list in this volume.

We also acknowledge the support of the East West Centre for a conference which took place at the mid-point of the project. The conference enabled us to gather together research team members from China and Australia with experts in the field from North America. Comments at that meeting on the work to date were critical to the development of the project.

We further thank the members of the committee, led by Professor Robert Lindner, which reviewed the project for ACIAR, for their constructive suggestions on method, output, and marketing.

Christopher Findlay
September 1998

Overview

The grain marketing system in China has become more competitive over the 1990s and domestic and international prices have become more closely aligned. But despite these reforms, some important issues have yet to be resolved.

The purpose of this Report is to document the reforms in grain marketing so far and to identify some of the forces in the political process in China driving those changes. Within that framework we are also able to identify some of the key constraints on reform and key issues in the next stages of reform.

The domestic reforms to date have highlighted a number of conflicts, such as those between exporting and importing provinces, on which we have focus below. Other issues relate to the extent of government support for the marketing system. In the past, attempts to resolve such conflicts have led to a series of cycles of reforms in the domestic marketing system, where intervention leads to crisis, the response to which is another round of liberalisation, to lead only to the discovery of a new set of issues in the way that markets operate. The longer-term trend, however, has been towards a more liberal set of marketing arrangements. A key issue in the process of reform has been the internal transfer system..

Internal transfers

A feature of the internal transfer arrangements is the provincial governor responsibility system (PGRS). The essence of this system is to make provincial governors responsible for balancing the supply of and demand for grain in their areas of responsibility. That includes stabilising areas, raising yields, establishing local stocks as required and managing interprovincial transfers. The patterns of trade in grain within China are affected by the processes of growth and industrialisation. The PGRS was an attempt to deal with some of the consequences. Local governments in relatively richer and industrialised areas, where grain output growth has slowed, were being asked to subsidise grain production and marketing so as to keep the price of grain lower in the local markets. The policy was based on the observation that if prices in relatively richer Southern China were relatively low and stable, then grain price and supply would be stable at the national level. This aspect of the policy dealt with Beijing's concern about higher prices in that area spreading to the rest of China.

Our field work reveals the continuing significance of barriers to trade between the provinces. The exporting provinces can restrict volumes in the long-distance trade because of administrative controls over transfers or taxes which are applied in the congested transport infrastructure. Sometimes border barriers are also applied (e.g. road blocks), although these are easier to evade. While exporters may use these sorts of barriers, importing provinces under the PGRS are more likely to apply subsidies to local producers.

The grain-exporting provinces lose from any policy which reduces demand from their previous customers. The high-income importers may also lose. They are now obliged by the Centre to follow a strategy which is relatively more costly than that used before. It is more costly in terms of loss of the gains from specialisation and trade. The coastal provinces have had long experience in the internal trade in grain and may be less concerned about supply security than policy makers at the Centre. Low-income importers, on whom the Centre has applied less pressure to meet the targets of the PGRS and who were not the focus of its implementation, may gain from lower domestic market prices than otherwise.

The developments in the marketing system emerge from internal debates in China about the appropriate direction of change. A important set of parameters in those debates is prospects for the volume and composition of the demand for grain in China, and the

scope for China to maintain the growth rate of grain output. The research reported here examined both sets of issues.

Demand outlook

The report contains a new projection of grain demand in China. We find that:

- with an income growth rate of 8 per cent and in a low feed-grain use efficiency scenario, China's demand for total grain will be 523 mt a year by 2000, 585 mt a year by 2010 and 643 mt a year by 2020;
- 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;
- the combined effects of income growth and change in population structure lead to a fall in the demand for food grain;
- 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;
- a change in the efficiency of feed grain use will make a significant difference to China's demand for feed grain.

These results therefore highlight the sensitivity of projections to the outlook for income growth, to demographic trends such as the age mix of the population as well as urbanisation, and to changes in feed-grain use efficiency. The sensitivity to changes in feed-grain use rates is even greater in absolute terms in the high income growth scenario, since there the importance of grainfed meat in food consumption is then even greater. One implication is that in the meat sector, new research and technology transfer, the latter associated with foreign investment for example, could have significant implications for the outlook for grain consumption and for China's trade in grain. This point highlights the value of further study not only of the parameters examined here but also China's research and development, the reform of basic research institutions as well as the changes in the extension systems, where significant issues have been identified in other research.

Scope for productivity growth

Given the constraints on land supply in China, the key issue on the supply side is the scope for further productivity growth in agricultural production, in grain production in particular. This issue has been a focus in the policy debate in China. This was highlighted by trends in grain output per head in China. A rising trend in output per head was established in the mid-1960s, but output per head appeared to stagnate around the mid-1970s. The introduction of the reform process in the late 1970s marked a turning point. Grain output per head rose on a new trajectory and reached a peak in 1985. Thereafter, however, once again output per head appears to have stagnated.

Research reviewed here indicates that it is possible to raise the productivity of inputs used in grain production in China, and therefore output per head, but the condition required for this change is an even greater role for markets in the management of grain production. Contributors include:

- plot consolidation, facilitated by the development of land use markets, and by other market mechanisms for dealing with risks that producers may face on consolidated plots;
- development of markets for other purchased agricultural inputs; and
- deregulation of the seed market.

The greater degree of integration of domestic grain markets would also have significant effects on aggregate output, through opportunities for specialisation and trade and the effects on technical efficiency at farm level. Pressures for structural change that vary between regions will at the same time be changing the mix of grain output that China can expect. These pressures will determine the patterns of trade in grain in China that emerge in an integrated national market.

Despite the likely gains in economic terms, there are constraints to the deepening of the role of markets in the grain sector in China. As noted above, market development inevitably leads to substantial redistributive effects, and therefore conflicts, involving growers of grain, trading intermediaries, input suppliers and consumers. A particularly important issue in that context is the role of the grain bureaus which have managed the implementation of policy on purchases and distribution.

It is also possible to shift out the grain production frontier. Substantial increases in yields even beyond those at the frontiers under current technologies appear to be possible. The issue in that case is the management and evaluation of research and development programs that apply to grain. Institutional changes in the research sector and in the seed industry are key objectives. In addition to market reforms, therefore, important issues include:

- the extent of public investment in agricultural infrastructure and in research and development;

- the design of the extension system; and
- the long-run development of farmer education policy.

While China can change its trend in grain output per head, the question to be answered is what it will cost to change the trend. There are reforms, including the development of input markets and the integration of output markets, that may be undertaken through regulatory reform at relatively low cost. Going further could involve more substantial investment and therefore lead to challenges to policy makers to make careful judgments about costs and benefits.

Using the resources available in the rest of the world to supply grain to China is another option to be considered. Integration of the domestic and international markets for grain will also assist the assessment of all those options by providing decision makers with price benchmarks for assessing costs and benefits of project proposals.

International markets

There appears to be a narrowing of the gap between international and domestic prices in China. But is this a stable position and does it reflect a commitment to develop a greater degree of integration of domestic and international markets? Or is it a step along a path from taxing agriculture to another point at which agriculture, including grain producers, receives a much greater level of support from the rest of the community?

One possibility is that the introduction of the PGRS signals the institutional evolution of a change towards a higher level of support for agriculture. However, the domestic political forces in that direction which were observed in other East Asian economies are not so strong at this stage in China. Farmer groups are yet to be come the strong political force they are elsewhere. Field work experience and the observation of the growth of the township and village enterprise (TVE) sector in rural China indicate that alternative employment opportunities are many and nearby. Costs of adjustment out of agriculture are therefore smaller.

The international implications of China's policy choices in agricultural markets also matter in the domestic debate. China can have significant effects on global markets. Those impacts have attracted considerable attention in the world media, and a further objective of this report is to highlight the relevance of a

Trade outlook

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 stressed.

We assume that in 1995 demand for food grain was met in net terms by local supply 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. This is an important assumption about China's policy stance which is examined further, below.

We also assume that the annual growth rate of feed-grain production is assumed to be 3 per cent throughout the projection period, based on the growth of maize output in the past 10 years. Under these assumptions, China's total grain supply in the year 2000 will be 494 mt, very close to the government's 500 mt target. The implied annual total grain output growth will be about 1.1 per cent over this period, slightly higher than the growth rate of 0.9 per cent achieved since the reform. This growth rate falls to about 0.6 per cent from the year 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 mt a year by 2010 and 555 mt a year by 2020.

The trade implications in quantity terms of these projections will rely on the choice of economic growth and feeding efficiency scenarios. If the 8 per cent income growth rate is chosen, under the low feed-grain use efficiency scenario, China needs feed-grain imports of 29 mt a year by 2000, 64mt a year by 2010, and 88 mt a year by 2020.

Under the high feed grain use 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 efficiency, China will still need feed imports of 22 mt a year by 2000, 48 mt a year by 2010 and 66 mt a year by 2020.

substantial body of research to these issues. An important contribution here is to differentiate between types of grain, in particular, between food grain and feed grain. The box below summarises an outlook for China's trade in grain to 2020.

Views of food security

Experience to date has shown that food grain policy has always dominated policy choices — this position is reflected in the projections in the box above. During the rounds of marketing reform and retreat after late 1993, the government acted to ensure food grain supplies, even at a cost to regional specialisation and interdependence. This position, however, has important implications which include the creation in the feed-using sector of a set of political interests which favours the current regime.

The extent of protection for the feed grain sector is likely to be relatively low compared to other food processing sectors, and also low relative to grains which are directly consumed. If so, the diversion of crop land to food grain production would imply greater reliance on world markets for feed grain imports. The feed-using sectors would gain from such a policy regime. They would be able to buy feed at prices which are relatively closer to world prices than are the prices for their outputs, which are likely to be higher. In such a situation, the feed-using sectors are therefore larger than otherwise, and the degree of self sufficiency in those products in China would be higher than otherwise.

A further implication of this situation is that the trade pattern shifts towards trade in feed rather than trade in products which are directly consumed. China in this scenario also shifts its international grain trade in the long run towards imports of feed grains — and to a greater extent than would be the case in a free trade regime. Imports of grains directly consumed — wheat and rice — are reduced. Imports of other agricultural products such as meat ,which use grain are also lower than otherwise.

This trade policy stance also affects the location of investment. More foreign firms than otherwise are likely to invest in the food processing sector in China, including in meat production. They gain from access to the protected local market while being able to purchase inputs at prices closer to world prices than are the prices at which they sell their products. In the longer run, the interests of these foreign firms become more closely identified with local groups arguing the case for self-sufficiency in items finally consumed.

Research reported here highlights the heterogeneity of food products in terms of their factor intensity, and this research suggests an alternative perspective on food security.

There is a common belief that the overall food sector will follow the path of the grain trade and face an increasing volume of net imports. But we observe strong export growth in some food products which might be explained by the consistency between the factor intensities in the production of those items and China's factor endowments. In other words, rapid export growth of those items may be consistent with China's comparative advantage within the agriculture sector. A shift in the focus of policy towards the efficiency objective might therefore lead to the growth of exports of some foods as well as imports of others.

A policy of self-sufficiency in grain as well as the overall food sector is possible but costly in economic terms. Free trade is the alternative. The important observation is that free trade may lead to the exchange of 'food for food'. Exports of other manufactured items may well generate the foreign exchange required to finance the growth in grain imports in free trade. Another scenario is that exports of other foods will also increase. The answer to the question 'who will feed China?' is that China will feed itself but do so through trade. Sources of export income to finance grain imports might actually emerge, not only from the other export sectors of the economy, but also from within the food sector itself.

Liberalisation of the grain trade would also contribute to meeting the concerns about food security in China since it would contribute to economic growth and would widen the margins between food consumption and subsistence levels, lead to gains in economic efficiency and therefore output from greater regional and national specialisation, including in other food sector products, and involve sourcing grain imports from a variety of suppliers which would ameliorate China's sense of vulnerability to threats from world markets.

This perspective suggests substantial gains from regional specialisation and the transmission of world market prices throughout the domestic market. How quickly can China reap those gains? That depends on the progress of the reforms in the grain markets and the capacity of China to deal with the range of issues which history highlights and which are examined in this Report.

1. Grain Marketing Reforms in the 1990s[1]

Developments in the domestic grain market

Marketing arrangements[2]

China's grain market reform has passed through three main phases.

1978–84: initial liberalisation

The first stage combined large increases in state grain purchase prices, continued state control of the bulk of grain distribution and the emergence of small-scale free trading among peasants and urban residents. Once begun, however, the logic of free market development started to take effect. Peasants preferred to sell to merchants than to spend all day sitting in small local markets. Merchants took on the role of aggregation of products to supply to larger markets, and a network of trade began to emerge. Eventually in 1984 the growth of this free market system was approved by the government and peasants were allowed to sell their surplus grain in markets, once they had supplied their quota.

The growth in the subsidies from the central budget over this period was perhaps the most important motive for the reform. As the state was committed to purchase all the marketable grain from producers at increased quota and over-quota prices, the market risks of grain production were actually undertaken by the state. This gave a boost to grain production, and, subsequently, to state subsidies for grain marketing. The system of quota and over-quota prices was also attractive to producers who sought to sell more and more of their grain at over-quota prices. The over-quota state prices after 1980 were higher than market prices. Eventually, it was not possible for the state to pay all the subsidies to the grain bureaus which were responsible for implementing the purchase program, and the grain bureaus in many areas, in turn, refused to purchase grain from farmers at over-quota prices. These issues contributed to the pressure for reform.

1985–92: the contract system

With the successful development of grain production in response to the higher prices, the second stage of reform was launched in 1985. The unified purchase and sales system was replaced by the contract system, state prices were fixed on the 70:30 ratio of quota and over-quota prices, and free markets and negotiated sales were opened up. The state system was thus still concerned to ensure stable supplies at controlled prices.

These price adjustments were, however, a negative signal to peasants. At the same time, the growth of townships and village enterprises (TVEs) and the diversification of production made grain less attractive to producers (discussed further, below). The result was a period of stagnation and fluctuation in grain output. The state responded by enforcing the contracts to a greater degree and by increasing incentives to producers to grow grain. The economic austerity period after 1988 also 'cooled down' the non-agricultural economy, and grain production began to increase again.

Against that background, significant changes in consumption and the shift to better quality and variety was leading to a change in the structure of demand. These changes are discussed in more detail in Section 2. Direct grain consumption was declining and indirect consumption was rising. The significance of grain for many consumers was becoming less important, and more and more people were prepared to pay higher prices for quality food.

[1]This part is an edited version of Cheng, Findlay and Watson (1996). For a review of the pre-reform marketing system see Findlay, Martin and Watson (1993).

[2] This section is based on Watson (1996), and also Watson and Findlay (1995).

During this period, therefore, the level of state subsidies to the grain system began to grow substantially and embraced all areas, including producers, handlers and consumers. In the context of the consumption changes just mentioned, the decision was made to attempt a further stage in market reform.

1992 onwards : marketisation and retreat

The most recent round of reform began in 1991 and 1992 with increases in selling prices which reduced government subsidies to consumers. This was followed by calls to reform the grain bureaus, a decentralisation of grain management and a rapid spread of market liberalisation across the country. The aim was to 'decontrol the purchasing and marketing price of grain, to arouse the enthusiasm of grain producers — and especially the major grain producing areas — to produce more good quality grain and give full scope to these areas' capacity for grain production, so that there will be a rational regional division of labour.'[3]

The optimism for reform was dashed, however, by a grain market crisis. Problems at this time included:

- continuous rises of grain prices, initially in the rice market;
- worsening barriers to internal trade;
- rising concern about lack of control, since state actions such as the release of grain stock and issuing a price ceiling had little effect on the increases in prices;
- complaints from consumers about rising prices of grain, meat, and all other farm goods.

Studies of China's grain trade show that, since 1993, market prices of grain in China have risen substantially and approached world prices. This suggests an increased integration between Chinese and international grain markets (Cheng and Findlay 1995). It has been argued that, with the convergence of Chinese and world grain prices, China has come to a turning point where it risks the shift from a policy of taxing to assisting grain producers (Garnaut, Cai, and Huang 1996).

Changes in nominal rates of protection[4]

Many different methods are used in economic analysis to measure degrees of protection of domestic markets. The nominal rate of protection is the simplest indicator which directly compares the difference between domestic and border prices. A score of zero for the nominal rate of protection implies free trade (no protection), while a number larger than zero implies positive protection of the domestic market (domestic price is higher than the border price), and a number less than zero implies negative protection. The nominal rate of protection is a convenient measure to apply because its calculation requires only limited data. Difficulties often occur when choosing an appropriate border price (considering quality differences and potential transportation costs) and exchange rate (especially if there is not a free market for foreign exchange).

In the calculation of the nominal rate of protection for China's most important agricultural products in 1978–94, the secondary foreign exchange rate was used (see Table 1). A convincing secondary market exchange rate did not exist before 1986. These figures must therefore be examined with caution, especially for the years before 1986.

Table 1. Nominal rate of protection for grain and oil crops, 1978–94 (%).

	Wheat	Rice	Maize	Oil-bearing crops
1978	–51	–6	–45	
1980	25	–43	18	–3
1984	–11	–39	–27	–45
1985	–13	–43	–21	–44
1988	–12	–53	–10	–43
1989	–5	–42	18	–39
1990	–10	–53	–3	–40
1991	4	–58	–20	–46
1992	–14	–44	–19	–49
1993	–12	–31	–15	–33
1994	10	2	8	11

Note: Domestic market prices (and the over-quota prices before 1984) are converted through the secondary market exchange rate.
International prices are average prices reported in Food and Agriculture Organization of the United Nations FAO Yearbook: production, FAO, Rome, various issues.
Sources: Personal communication, Ministry of Agriculture, China; International Monetary Fund, various years, International Financial Statistics, IMF, Washington, D.C.; Garnaut, Cai and Huang 1996; Garnaut, Guo and Ma, (eds), The Third Revolution in the Chinese Countryside, Cambridge University Press, Cambridge:185–200.

The nominal rate of protection for wheat, rice, maize and oil-bearing crops in the second half of the 1980s indicates that all products were heavily and negatively protected, reflecting the continuation of the pre-reform discriminating agricultural policies. Although positive numbers occurred for some products during this period, the nominal rate of protection normally ranged from around –10% for wheat, about

[3] State Council of China, 'Decision on developing a high-yielding, high grade and efficient agricultural system', September 1992.
[4] This section was prepared by Huang Yiping and is based on Chapter 7 of Huang (1996).

–40% for rice, –15% for maize and –45% for oil crops. The first year that China's main agricultural products experienced a unified drop in the nominal rate of protection was 1993. It resulted from the rise in domestic prices over the last quarter of the year. Continued and more rapid increases in domestic prices in 1994 pushed the nominal rate of protection nearer to zero with some positive numbers marking an important historical turning point. By mid-1994, domestic prices exceeded international prices for wheat and maize, and for rice by September 1994, despite large increases in world rice prices following Japan's entry into the market as an importer (Garnaut, Cai and Huang 1996).

In calculating comparative aggregate cereal prices in both domestic and international markets, the commodities included are wheat, rice and maize, accounting for 95.5% of China's total cereal production and 84.7% of its grain consumption (Figure 1). Both international and domestic prices are weighted by the output share of individual commodities in China's production.

While a significant upward movement in the price of rice in 1994 had an impact on the international prices calculated for China, rice accounted for only a small share in world grain trade. Even when a larger-than-usual effect of rice price increase is incorporated into the calculation of international prices, it is still clear that China's domestic cereal prices and international prices converged quickly in 1994. By July 1994, domestic prices were similar to international prices, and outpaced international prices in the months that followed.

According to Lin and colleagues (1996), the increases in prices since late 1993 were caused mainly by the increases in urban incomes and wages, associated with a capital investment boom in 1993 and 1994, and by the intervention of local governments in grain marketing. Others emphasise the influence of the structural change in China's grain supply on prices, namely, the reduction in output of indica rice in Southern China where the comparative advantage of grain production declined rapidly after the economic reform (Chen Xiwen, 1995). The rapid increases in grain prices after 1993 nevertheless sent a warning signal to the Chinese authorities which had considered the stable supply of grain at relatively cheap prices to urban populations an important economic and political issue in China.

Controls over purchases were reintroduced, price management was strengthened again and mechanisms such as the governor production responsibility system (see below) were introduced to encourage greater regional self-sufficiency.

In addition to the question of subsidies in the marketing system, to which we return below, another issue highlighted at this time was the availability of credit in the marketing system.

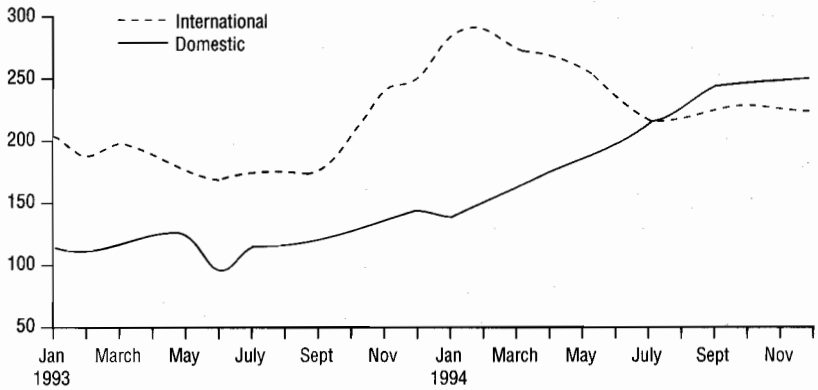

Figure 1. International and Chinese cereal prices, 1993–94 (US$/t).

Note: Cereal prices are average prices of wheat, rice and maize weighted by their output shares in China's production. China's domestic prices are market prices in rural and urban fairs converted using the swap exchange rate, and international prices are f.o.b. Gulf of No. 1 hard red winter (ordinary protein) for wheat, f.o.b. Bangkok, white milled 5% broken for rice and US exports prices are f.o.b. Gulf of No. 2 yellow for maize.

Sources: International Monetary Fund, *International Financial Statistics*, International Monetary Fund, Washington, D.C., various issues; State Planning Commission and Ministry of Agriculture, Beijing.

Commercial credit

One of the continuous problems of the grain system has been that of obtaining enough credit to pay the peasants. The problem of IOUs (*baitiao*) has arisen many times since the mid-1980s. Cheng (1995) has shown that this has been the result of market distortions and the inconsistency of institutional reforms. State price rises and the growth in market and negotiated sales have increased the overall demand for commercial credit. The supply of credit through the Agricultural Bank of China and the grain bureaus has been affected, however, by the diversion of funds for other uses. Grain loans earn low returns and are not popular with the banks. The problems of the grain bureaus, in particular, have been very important. They have used grain purchase funds for other investment, and a large bank debt has been accumulated for past grain-handling which is the subject of dispute. The banks argue that these are commercial losses for which the grain bureaus bear responsibility. The bureaus argue that the losses are policy-induced and should be subsidised by the government. In effect the fact that the grain bureaus and the banks were not fully commercial agencies meant that they could pursue their own interests in seeking both profits and government subsidies. The result was loss of income by producers, misuse of funds, an increase in budget deficits and a slowdown in the formation of a rural credit market. The recent growth of the rural credit funds outside the banking system is an example of how, in the absence of a well-ordered rural credit market, a segmented credit market will grow to try to solve some of the problems of local credit supply.

Subsidies

In a situation where government management of a large proportion of marketing continues and low purchase prices mean producers face low incentives, the provision of budget subsidies becomes important to meet the government's target of maintaining high levels of self-sufficiency. The importance of the subsidies for producers has grown substantially since the late 1980s. The government also aims to protect consumers, especially those on low incomes, by trying to keep selling prices stable, at the same time as having to subsidise the grain bureaus. Watson and Findlay (1995) underline the many problems these high levels of subsidy create. They generate competition between producers, handlers and consumers to obtain the highest benefits. By 1991, the subsidies had reached very high levels and were causing budgetary problems. The selling price reforms of 1991 and 1992 were intended to reduce those by removing consumer subsidies. The market reforms aimed to eliminate subsidies in the handling systems. The retreat from the markets and the introduction of the governor responsibility system have meant, however, that subsidies have not yet entirely disappeared.

Each phase of market reform was thus followed by a crisis. These crises involved economic conflict between producers, handlers and consumers for the benefits of subsidies, and the drain on central government budgets created by the payment of those subsidies. How a response in the longer run to this issue was to relocate the responsibility for the payment of the subsidies to local governments is discussed below.

Patterns of internal trade[5]

An important factor in the changes in the grain sector are the forces from the rest of the economy on the agricultural sector as a whole, and on the composition of agricultural output. Gross agricultural output grew more than 9% annually in real terms in the reform period up to 1984, and at nearly 6% per year thereafter. Agricultural output in total continued to grow although grain output growth slowed down. Contributing factors were the changes in relative prices for different crops and other agricultural products, which were induced, in the short term, by different rates of reform in marketing arrangements, and the reversion of land once used for grain to more suitable uses.

Other forces acting on agriculture are those from growth in the whole economy and from the process of industrialisation. The accumulation of capital and its reinvestment in other sectors shifts the mix of output and draws some of the mobile factors of production out of agriculture.[6] Depending on the pace of technological change in agriculture the agriculture sector is under pressure to decline (relative to other sectors in a growing economy).[7]

The extent of the change in the opportunity cost of agricultural output varies between regions. As a result,

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[5] This section is based on Cheng, Findlay and Watson (1996).

[6] Findlay, Watson and Wu (1994) discuss the growth of the TVE sector in this context.

[7] See Rozelle (1996) for a discussion of current issues in research and development in agriculture and also Anderson (1987) for discussion of forces of agricultural sector decline in association with economic growth.

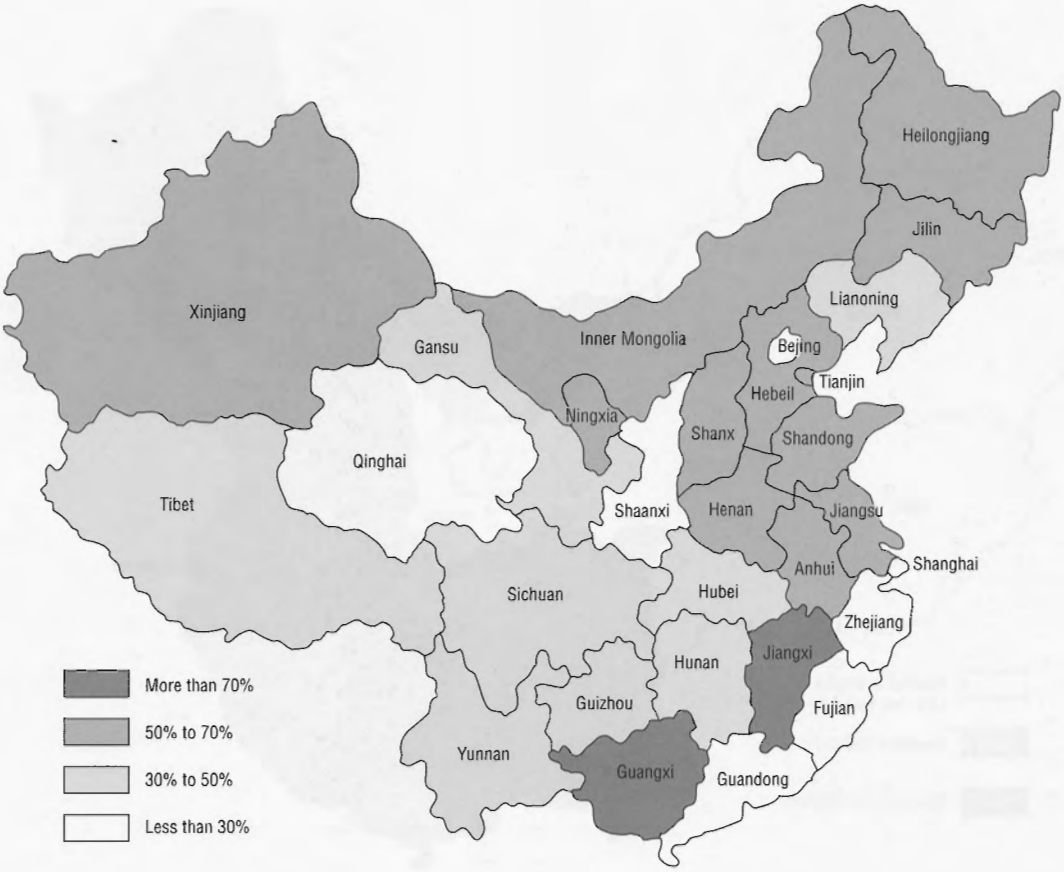


Figure 2. Grain output growth by provinces, 1978–95.

Source: Yang Hong, 1996a, updated.

the comparative advantage in agriculture changes between regions, which affects inter-regional trade patterns. These trends also have interesting implications for the mix of grain output and for China's international grain trade. The extent of the changes in grain specialisation and trade within China illustrates the significance of the processes of the change in the structure of the rest of the economy for the agriculture sector, including grain. The changes also illustrate the scope for gains from trade associated with specialisation within China, including within the agricultural sector.

Yang Hong (1996a, b) has identified changes in the location of grain production in China. She finds significant variation between regions in the rate of output growth. Figure 2 shows the provinces classified by the rate of output growth to 1995. Clearly the faster rates of growth are concentrated in northern China. The areas where output is growing more rapidly are located in northern China. The growth in grain output since the start of the reform program and the early 1990s was more than 70% in Inner Mongolia, Jilin, Heilongjiang, Ningxia and Xinjiang compared to the national average growth rate over the same period of just over 53%. The southern provinces of China remain relatively large in terms of total output, but their share has declined.

One important consequence has been a redirection in the patterns of trade. The country can be divided into different regions, Northeast, North, Northwest,

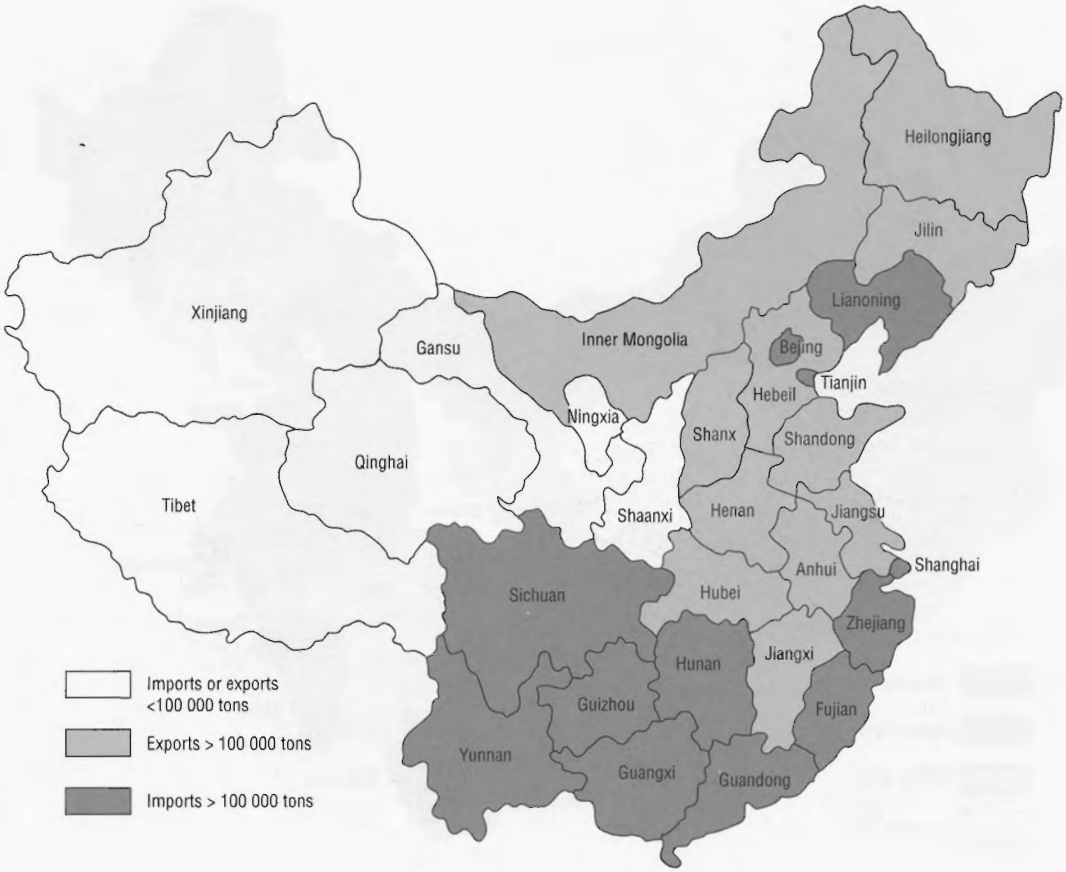


Figure 3. Grain transfers by province, 1993.

Source: Yang Hong, 1996a

Southeast, Southwest, and Middle China. Traditionally, grain flowed from the Northeast and the Southeast to the Southwest, the Northwest and sometimes to the North, while the middle was basically self-sufficient. After the reforms, there was growth of output in the Northeast, the North, and to some extent in the Middle (see Figure 2). There was lower growth in the Southeast. The implication was a redirection of trade towards the Southeast. Figure 3 illustrates the new direction of the flow of grain. The larger net importers in absolute terms are now located in the southern part of China.

Figure 4 shows the net transfers as a percentage of apparent consumption (production plus imports minus exports). The map illustrates more clearly the point that the main issue in the management of internal transactions is in the Southeast, where the comparative advantage declined the fastest. The faster-growing and more rapidly industrialising southern provinces are losing their comparative advantage within China in grain production (see Yang Hong, 1996c, for empirical work on this process).

The composition of the national output of grain and of the grain traded within China is also changing. Maize, in which northern China has a comparative advantage, is now more important in both output, especially since the mid-1980s, and internal trade. In volume terms, maize now accounts for nearly a quarter of total grain output, compared to 18% in 1978.

Another implication, stressed by Yang Hong

Figure 4: Net transfers as a percentage of apparent consumption, 1993.

Source: Adapted from Yang Hong 1996a.

(1996b), is the greater exposure of the production of grain to volatility on the supply side. The share of national maize output in Heilongjiang, Jilin, Liaoning and Hebei has increased. Maize output is becoming more concentrated in those provinces, which may expose maize supply to greater volatility, for example, as a consequence of common shocks from the weather affecting all those provinces.

New patterns of specialisation and internal trade have created challenges for the domestic transport infrastructure. Yang Hong (1995b) quotes research published in China which suggests that constraints in that system have in the past led to international maize exports in preference to sale within China, and have limited the extent of specialisation in maize production in those regions. Self-sufficiency policy targets have reinforced this constraint on the extent of specialisation. But also infrastructure congestion has reinforced the concern at central government level about the risks of relying on the rest of China for grain supplies to deficit areas.

Yang Hong (1996d) has also examined the policy of the so-called 'grain base areas'. The core idea of this policy was to concentrate grain production in areas which have a comparative advantage. But the development of commodity grain base areas has been affected negatively by the impact of government control of prices and inter-regional trade. This concentration is supported by government subsidies to producers in return for agreements to sell grain to the

state system. The problem has been that contract grain prices controls, differentials in prices and taxes between regions caused by the decentralisation of management to local areas, and the low relative prices for contract grains, have created a situation where the grain-producing areas are unable to generate a reasonable return. The base areas are relatively poor, and peasant incentives are low. Government revenues are also therefore limited. The base areas are thus constrained in developing a key role in the production and marketing system.

Finally, it should be noted that grain trade in China is also affected by trends in the composition of demand. Demand composition is changing, but possibly more slowly than the composition of output. This difference has led to issues associated with changes in relative prices, for example, the rising price of rice in the first half of the 1990s.

International trade

The rising domestic prices for grain in China in 1994 and 1995 correspond to the rise in net exports in that period (see Figure 5). Throughout that period, China has been a net importer of wheat. Since the mid-1980s, it has been a net exporter of maize. It is approximately self-sufficient in rice. The growth in maize exports is also related to trends in domestic output and consumption, where in the last few years the growth in domestic demand for maize began to catch up with the growth in output. The chart highlights the growth of imports in 1995.

In terms of grain trade liberalisation, Chinese policy makers have been concerned mainly about food security and incomes of grain producers, especially those in relatively poor areas of China (Du Xiaohong et al.1996).

In their review of the food security issue, Findlay and Watson (1996a) examine the data on China's role in world wheat and rice trade. They report that import share of wheat consumption in China has fluctuated since the late 1980s from a high of nearly 16% to a low of just over 4%, and that China's share of world wheat trade has moved in a similar pattern. Its share of world output (net of its own production) has, however, not exceeded 4% in this period. On the other hand, the world rice market is relatively 'thin', with only a small trade volume relative to output. China's position, however, has swung from net exports to net imports, and at one point (1993–94) its imports accounted for nearly 10% of world rice trade. However, the importance of its trade in world rice output (net of its output) is small and the role of imports in domestic rice consumption is also small. These sorts of assessments, as well as the likely market responses to a rise in Chinese demand, challenge the concern held in China, at least at central government level, about

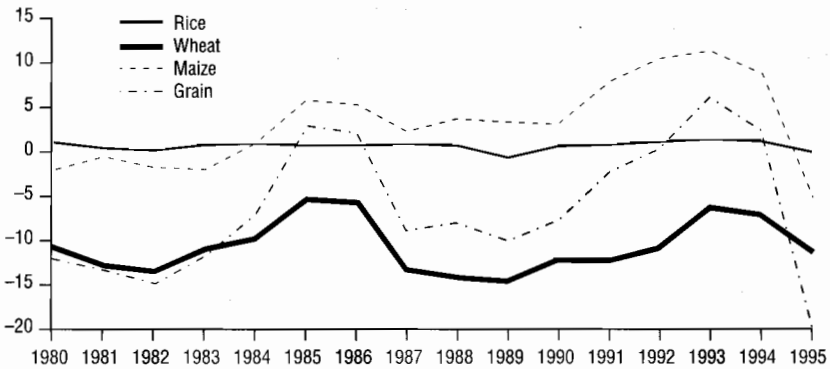


Figure 5. China's net grain exports 1980–95 ('000t).

Source: Customs statistics

the scope for using the world market for supply security objectives. These issues are discussed in more detail in Sections 4 and 5.

We now turn to the question of how the inter-regional transfers of grain were organised within this context, that is, the experience to date of the development of the marketing system, and the impact of the intersectoral forces on patterns of trade within China. Our interest here is the possibilities for intervention created by the new institutional arrangements used to manage the internal transactions.

Local responsibility for grain production and marketing

Inter-regional grain transfers

Before the reforms in 1993, there was a dual system for the interprovincial grain trade in China: transfer at planned prices (lower prices, planned transfer) and transfer at negotiated prices (market transfer). The provincial governments were basically responsible for the supply of grain in local areas given the following two conditions.

(i) Each province was given a quota for interprovincial transfer at planned prices. Grain surplus provinces usually had a quota for the outflow of grain from these provinces at state-set prices, and grain-deficit provinces had a quota for the inflow of grain at state prices. Consequently, grain-deficit provinces (with grain inflows) benefited from the planned grain transfers.

(ii) After fulfilling the quota for planned grain transfers, provincial governments could purchase grain at market or near-market prices from other provinces (*Almanac of China's Commerce*, 1992, 1993).

This system was not particularly hostile to major grain-producing provinces. But these provinces could suffer big financial losses, with misjudgment. For example, some local governments blocked the markets and purchased grain from producers at low prices. Their aim was to speculate on subsequent increases in market grain prices in the rest of China. But after 1989, with consecutive bumper harvests and low market prices for grain, these provinces faced financial problems.

Compared with the reforms in the planned purchases and sales of grain, the reform to the interprovincial transfer of grain was perhaps less visible, but not less significant. Following the reform in 1993, the major grain-producing provinces in China were no longer required to transfer their grain to grain-deficit provinces (and metropolitan cities) at lower-than-market prices. Since then, the interprovincial trade has been undertaken mainly at market prices.

One objective of the reform was to encourage the local governments and producers in both grain-deficit and surplus areas to produce more grain, and, more importantly, to make local governments become more responsible for the grain supply in local areas. Grain bureaus and local governments in major grain-producing provinces were still able to make profits, possibly even more than before, by procuring locally produced grain at low prices (using the retained local powers of procurement) and selling it to grain-deficit areas at market prices (under the new rules applying to inter-regional transfers).

This local responsibility system for grain supply was consistent with the tax reforms in 1994. After the separation of the budget revenues and outlays between the central and local governments, local governments in China were required to pay for subsidies in grain production and marketing in local areas.

At this time, the central government focused its financial resources on the establishment of risk funds to buy grain stocks, to be used in an effort to stabilise grain market prices. In fact, both the central and local governments have been required to establish risk funds for grain stocks. Field work indicates that according to the central policy, local governments have been ordered to contribute 1.5 yuan counterpart funds for every 1.0 yuan contributed by the central government.

A further financial change at this time was that, following the establishment of the Agricultural Development Bank of China (ADBC) in 1994, the ADBC became responsible for the supply of finance for planned grain purchases and storage. The central government also attempted to settle overdue loans from the grain bureaus to the financial institutions in the early 1990s. Interest on overdue loans for policy operations by grain bureaus was paid by the central budget, on the condition that all the overdue loans be paid within five years.

These changes were followed by the increases in grain prices after late 1993 reported above, and which caused great concern among the central authorities. Also as noted above, measures were taken to counter the rise in grain prices, such as the release of grain stocks and regulation of grain prices for grain sold

through grain bureaus, but none of these measures was effective. Finally, in 1995, the provincial governor's responsibility system (PGRS) was introduced by the central government.

Provincial governor's responsibility system

Following the crises in the grain market in 1993 and 1994, and in the context of the current fiscal and financial relations between the Centre and the provinces, the challenge for the Centre was how it could accelerate the rate of growth of grain output in the Southeast. As discussed earlier, output growth had slowed in that region, which had become a net importer. In that role, it had previously benefited from cheap food and materials at state prices from inland provinces under the old inter-regional transfer system. The previous access of this region to cheap grain, at the same time its income rising rapidly, had caused much resentment from the major grain-producing provinces. Following the 1993 reforms, the inland grain producers (including the Northeast) had just started to benefit from higher prices. The provincial governor's responsibility system made that more difficult.

The essence of the PGRS was to make governors responsible for balancing the supply of and demand for grain in their provinces. That includes stabilising sown areas, raising yields, establishing local stocks as required, and managing interprovincial transfers. Officials therefore stress that the system means a devolution of responsibility for transfers within China to a lower level consistent with the development of the grain market. However, the actual focus of the PGRS may have been narrower than that.

A component of the policy was to ask local governments in relatively richer and industrialised areas, where grain output growth had slowed as explained above, to subsidise grain production and marketing to keep the price of grain lower in local markets. The policy, according to some analysts, was based on the observation that if prices in relatively richer Southern China were relatively low and stable, then grain price and supply would be stable at the national level. This aspect of the policy dealt with the centre's concern about higher prices in that area spreading to the rest of China.

Field work in China revealed that associated with the PGRS were a number of other policies also issued by the central government in 1995. In addition to 50 mt of grain procurement at plan prices, local governments and grain bureaus were required to purchase 40 mt of grain at market prices from grain producers. Moreover, procured grain should be sold only to lower-income urban residents, not to all urban residents. The government, however, is caught in a dilemma, since on the one hand it may want to protect grain producers in poor provinces, and on the other hand it wants to supply grain to low-income urban residents at relatively low grain prices. A more targeted policy would help resolve this dilemma, but the legal and institutional framework in China makes it difficult for the government distribution system to reach its target.

In 1995, according to our field work, grain producers in Guangdong were paid higher plan and market prices and lower taxes in order to encourage them to produce grain. For them, however, producing grain was less profitable than producing something else. In contrast, peasants in Jiangxi received lower prices, paid higher taxes and had to pay heavy transport levies to shift grain to the Guangdong market, where they might have earned a higher profit. The barriers to inter-regional trade and the complexity of different local prices and taxes were thus undermining the growth of market relationships.

This work reveals the continuing significance of barriers to trade between the provinces. The exporting provinces can restrict volumes in long-distance trade through administrative controls or through taxes applied in the congested transport infrastructure (as discussed above). Sometimes border barriers are also applied (e.g. road blocks), although these are easier to evade.

Importing provinces could adopt the same policies, although with greater difficulty than exporters. While exporters may use these sorts of barriers, importing-provinces under the PGRS are more likely to apply subsidies to local producers. Furthermore these subsidies are more likely to be related to inputs to grain production. Output subsidies could also be exploited by local producers (e.g. by importing grain from other regions).

The likely attitude of the grain-exporting provinces to the PGRS seems clear. They lose from any policy which reduces their export prices, for example, as a consequence of a drop in demand from their previous customers.

The high-income importers may not favour the scheme, either. They are now obliged by the centre to follow a strategy which is relatively more costly than

that used before, in terms of loss of the gains from specialisation and trade. The coastal provinces have had long experience in internal trade in grain and may be less concerned about supply security than policy-makers at the Centre.

Low-income importers, on whom the Centre has applied less pressure to meet the targets of the PGRS and who were not the focus of its implementation, may gain from lower domestic market prices than otherwise for the protected grains.

One hypothesis is that the PGRS signals institutional arrangements for a major turning point in agricultural policy in China toward more protection. However, the domestic political forces in that direction, observed in other East Asian economies, are not so strong in China at this stage. Farmer groups have yet to become the strong political force they are elsewhere. Field work experience, and the observation of the growth of the TVE sector in rural China, indicate that alternative employment opportunities are many and nearby. Costs of adjustment are therefore smaller. And as some scholars are now stressing (e.g. Lu Feng, 1996a), farmers also have alternative competitive uses of their land, for example, for fruit and vegetable production. This offsets concerns of the effects of structural change in agriculture on incomes of households which lack the mobility to seek employment outside agriculture. Lu's work is reviewed in more detail in Section 5.

At this point, it is important to clarify the management of international trade in grain under this new policy. The central government continues to set a quota on grain imports. This is done in advance of the period to which the quota applies. The assessment is based on prices at the time the assessment is made and on projections of prices over the period of the imports. The bulk of this quota is retained at central level (e.g. 15 mt in 1995). Some is passed to provincial levels (e.g. 5 mt) and some retained by trading companies to supply grain to the processing sector (e.g. 1.5 mt). Quotas allocated to provincial levels can be transferred. Provincial level governments can use that quota if they have the foreign exchange required. Otherwise they must petition the Centre for an allocation from the central quota. These quantitative constraints on imports mean that domestic prices in China can move away from world prices, although depending on the management of the quota that divergence might be corrected in later periods.

Local budget issues

The implementation of the new system in the middle 1990s has led to some interesting developments in terms of subsidies in grain production and marketing in China's coastal provinces.

First, due to variations in the opportunity cost for grain production within a province, it is difficult for a province to set a uniform subsidy level for all grain producers in the province. Consequently, all levels of administration, from the province to the prefecture and county governments, are required to give subsidies for grain production in the local area. The township governments and village administrations are also required to subsidise grain production with their profits from TVEs. The first implication of this development is that identifying the extent of the subsidies paid is difficult because of the number of levels of government involved.

As the richer areas have more economic resources, and as opportunity costs for grain production in richer areas are higher, the system tends to result in the situation where the level of grain subsidy becomes positively correlated with the level of local incomes.

Second, some local governments have tried to shift the burden, or part of the burden, to individual farm households by forcing them to grow more grain. This is done by setting the sown area for grain production (with heavy penalties for not complying). To some extent, then, the application of these quotas means shifting the burden of subsidising production from local governments to the farmers themselves. These households have to produce grain at high cost, or buy grain from the markets, using incomes from elsewhere. But the PGRS, to its credit, actually explicitly precludes the use of administrative means, application of which is bound to cause significant farmer resentment and reaction. So the application of administrative means at farm level is strictly not consistent with the policy.

Of the richer southeast coastal provinces, Jiangsu is the one which has maintained self-sufficiency in grain after the second stage of grain market reforms. The basic self-sufficiency in grain production has been maintained by huge inputs from local governments, especially those in the more developed areas of the province. From 1978 to 1993, about 9 billion yuan was transferred from TVEs to agricultural production in the province, mainly to grain production. Every year, the province spends about 100 billion yuan subsidies on agriculture, using the profits from TVEs and local

budget outlays. These funds have been invested mainly in the 12 counties of the three prefectures in southern Jiangsu Province, where the comparative advantage for grain production declined the fastest (Lin Chenguang 1996).

Changes in domestic marketing since the middle 1990s have important implications for China's grain trade. Some numerical assessments are offered in Section 4.

Increases in output in richer grain-deficit areas and the possible decline in output in major grain-surplus areas (a consequence of any price effect) mean that the volume of domestic trade could be reduced. However, establishing the pattern of this change requires further empirical work, since the mix of crops differs among these regions. The main impact in the short run, however, is likely to be in markets for rice, the output of which is subsidised by southern provincial governments. There may be some effects on wheat output, as a consequence of substitution on the supply side in rice-growing areas, although that also depends on the assistance provided to wheat production.

The effects on maize output are uncertain but less likely to be significant. The introduction of the PGRS coincided with a ban on maize exports. The maize crop in 1996 has grown substantially, but transport constraints mean that it is very difficult to transfer the grain southwards to the large meat production areas where it is needed. Governors in the South face the choice between importing or buying from the Northeast in order to balance local supplies.

These developments depend not only on changes in marketing arrangements, but also on trends in demand and supply. Changes in demand for grain in China are outlined in more detail in the next section, followed by a discussion of the scope to raise productivity growth in the grain sector.

2. Grain Demand[8]

There is a wide range of projections of grain demand in China. Among the studies in China, Huang Yanxin (from the Ministry of Agriculture in Beijing) reports a set of projections of the change in grain demand between 1994 and the year 2000 (Huang 1995). Huang assumes a relatively low annual growth rate of grain demand (of the order of one per cent a year), leading to consumption in the year 2000 of just over 500 mt. A feature of his analysis is the relatively slow growth of feed grain demand. In fact, the share of feed grains in total consumption falls in his projection. This result is partly a consequence of Huang's assumption of the growth in grain yields in the feed sector over the period. While the projection is an outlier compared to those developed outside China (see Section 4), it illustrates a key expectation of one part of the official system in Beijing.

On the other hand, Mei Fangquan (from the Chinese Academy of Agricultural Sciences) argues that direct grain consumption will fall from a high of 251 kg per head in 1984 to less than 215 kg in the year 2000 (lower than Huang's estimate of 220 kg per head in the year 2000) and about 180 kg per head in the year 2010 (Mei 1995). Mei focuses on the change in the structure of demand as income grows, and as direct consumption of grain falls. Overall, however, grain consumption continues to increase in this projection. Mei expects that total grain consumption will rise from 520 mt in the year 2000 (or 400 kg per head per year) to 600 mt in 2010 (or 420 kg per head).

Factors affecting China's demand for grain

There are many factors determining both individual and national grain consumption. Determinants of individual demand include: (i) *income* — consumers tend to spend an increasing proportion of additional income upon luxury foodstuffs (e.g. meat) and a decreasing proportion of it on staple foodstuffs (e.g. rice); (ii) *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 (iii) *dietary habits* — consumers are generally and strongly influenced by culture and religion or belief, though their dietary habits do change when their lifestyle changes (e.g. from rural to urban, or from traditional to modern life styles).

Determinants of aggregate demand include: (i) *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 structure of demand for grain through the changes in age structure, gender ratio and rural-to-urban migration; (ii) *feeding efficiency*, determining the use of feed grain for producing meat; (iii) *efficiency of industrial use of grain*, determining the use of grain for producing grain-based industrial products (e.g. grain liquor, medicine); (iv) *seed use*, determined by choices made in seed breeding, selection and sowing; (v) *waste*, determined by the way in which grain is shipped, stored, processed and consumed; and (vi) *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 differences in: (i) research findings on income and price effects from demand function studies for China, and (ii) assumptions about exogenous factors. Furthermore, most studies reported in Table 1 do not consider fully the effect of changing dietary habits and the effect of changing population structure.

[8]This part is an edited and shortened version of Wu and Findlay (1996).

Food grain

The 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 negative 0.1 to negative 1.5, regardless of the residence of the population. Wu and Wu (1994) provide much more detailed estimates by three major food grains with breakdown of rural and urban population and of urban areas by city size. 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 and Rozelle (1995b) for total food grains. Different city groups show different income elasticities of demand for grains, suggesting a strong urbanisation effect. Household 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 (1994) on own-price elasticities of demand for food grain are generally greater than those in all other studies. Largely due to data problems, estimates of cross-price elasticities are not yet available.

Almost all studies have suggested that at current income levels, food grain demand continues to rise with income in China. Grain consumption generally rises while income increases. However, by estimating a regional demand function, Wu and Wu (1994) 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.

Wu and Wu's study (1994) paid particular attention to the effect of urbanisation on demand for grain. The income elasticity increases from smaller cities to larger ones, which implies that urban lifestyle 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 the urbanisation level increases.

Huang and David (1993) stress the direct effects of the expected increase in the rate of urbanisation on cereal demand. What they call 'the level of market development' has an important effect on patterns. In rural areas, where markets are not developed, where there is a relatively low rate of access to refrigeration and where there are high transactions costs for buying processed products, consumption patterns remain relatively more concentrated on direct grain consumption. In urban areas, the availability of these services and the lower transactions costs lead to lower relative prices for processed products at the household level and a relatively greater rate of consumption of those products (for given incomes and market prices). This pattern will change even in households which continue to live in rural locations, as the marketing infrastructure develops, but the process of urbanisation accelerates the change.

Meat/feed grain

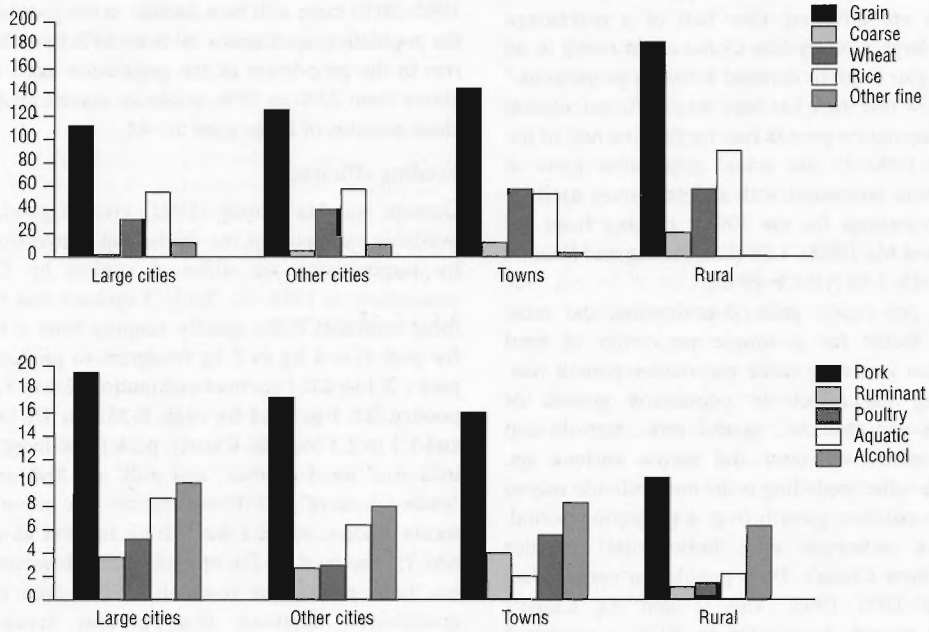
As in the case of food grain, estimated income and price elasticities of demand for grain-based foodstuffs also differ significantly. For example, the income elasticity of demand for beef and mutton ranges from 0.32 to 1.23, for pork from 0.57 to 1.02, and for poultry from 0.72 to 1.95, regardless of the place of residence of the population.. There are not many estimates available of the price elasticity of demand.

Wu and Wu (1994) have found that demand for grain-based foodstuffs like meat, eggs, fish and alcohol 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.

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 of 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 of 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 6). 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 or towns where the traditional cultural influence is stronger (Wu and Wu 1994).

a) by urban and rural areas



b) by region

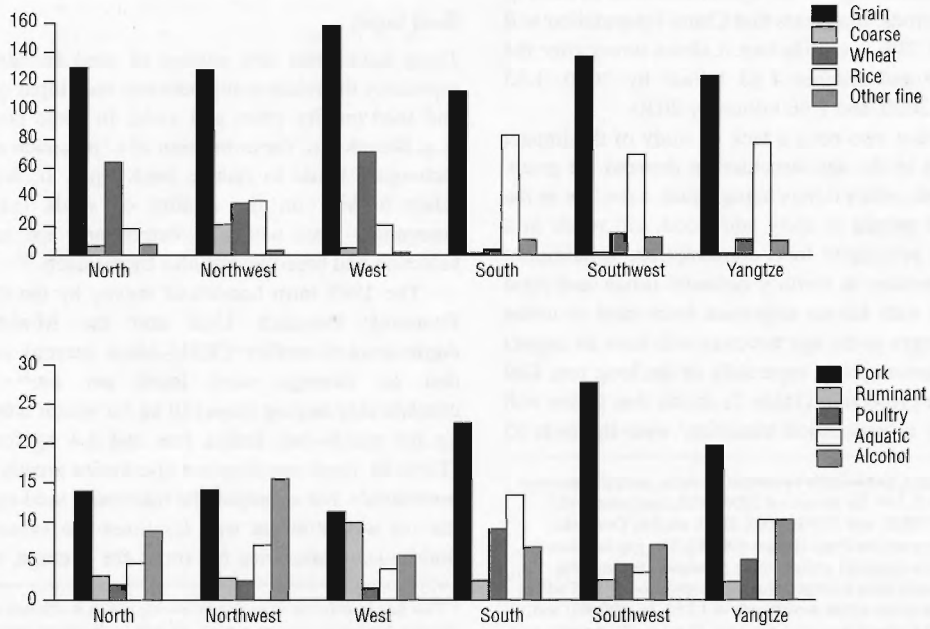


Figure 6. China's per capita food grain (Kg) and grain-based food consumption, 1991.

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.[9] 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 grew at 1.16% 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).

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 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), China's population growth from 1995 to 2030 is estimated (Table 2). While the 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% a year before it slows down after the year 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 of 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 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 the long run. Our population projection (Table 2) 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%, and a rise in the proportion of the population aged 45 and above from 23% to 39%, while an almost unchanged share remains of those aged 30–44.

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 3 updates that list. All these estimates differ greatly, ranging from 4:1 to 7:1 for pork (i.e. 4 kg to 7 kg feedgrain 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' meat product, and milk and fish are least 'grain-intensive'. Different ratios are reported in recent studies, e.g. 3:1 for fish by Jiang et al. (1996), and 7:1 for beef by Du et al. (1995). However, there has been no serious research in this area using a quantitative approach (e.g. a cost function or production function analysis). As shown later in our new estimate of implied feed consumption in China, results vary considerably if different ratios are used.

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 (e.g. Shandong), the promotion of a 'precision seeding technique' tends to reduce seed input. It, however, relies heavily on the quality of seeds (i.e. seed emergence rate) which is determined not only by selection and breeding but also by research.[10]

The 1995 farm household survey by the Chinese Economy Research Unit and the Ministry of Agriculture (hereafter CERU–MoA survey) suggests that on average, seed input per mu[11] varied considerably among crops (10 kg for winter wheat, 2.1 kg for middle-late indica rice and 3.4 kg for corn) (Table 4). Seed consumption also varies 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 6.6 times the average, and for

[9]In Lin, Huang J. and Rozelle's baseline scenario, annual population growth rate is 0.74% for the period 2000–2010, compared with 1.25% (2000–2005) and 1.19% (2005–2010) used by Overseas Economic Cooperation Fund (Japan) (OECF). The gap between the two projections means 67 million more population (assume the population grows 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 mt (million metric ton) more grain consumption in 2010, four times the annual net grain import of 6.4 mt of 1978–95.

[10]This loss is different from that in sowing which is affected by whether seeding or drilling is used. As will be discussed later, China is reported to have an enormous sowing grain loss of 8.4 mt per year.

[11]Mu is a unit of are a measurement in China: 15 mu = 1 ha.

Table 2. Projected population and the share of age groups in China to 2030

	1995	2000	2010	2020	2030
Population (billion)	1.2281	1.3121	1.4321	1.5335	1.5988
Within-period 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 and over	9.8	10.8	12.9	16.5	21.0

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

Table 3. China's efficiency of use of feed grain in the 1990s.

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, vol. 5)	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, vol. 2)	4.0	3.4	2.5	2.5	0.3	1.0
Jia (1996)	3.5–4.0	–	2.0–2.2	–	–	–
Yang (1996)	3.0–3.3	–	1.9–2.1	2.2–2.4	–	1.6–1.8
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.

corn 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.

Waste of grain

Some studies show 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 5 suggest great potential for China to reduce this grain loss. But these data are not reliable. There is an enormous gap between official and non-official estimates in grain losses, ranging 50–100 mt for the former and 8–11 mt 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 detail. 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 mt, or 13% of total grain output of 1993, which is much higher than the FAO standard of 5%. Obviously, including or excluding a possible grain loss in projecting demand for grain will make a significant difference to China's grain balance, because a loss of 50 mt a year is almost eight times China's annual grain net import (6.3 mt) in 1978–95.

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 3, we have estimated per capita food and implied feed grain consumption for both urban and rural 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 6.

Table 4. Seed use rates, 1995.

Crop and province	Sample size	Seed input per mu (kg)			Seed-output ratio (kg/ton)		
		Av.	Max.	Min.	Av.	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

Table 5. Official and non-official estimates of China's grain losses, 1993

	Non-official estimates			Official estimates	
	Huang S. (1995)	Yu and Zhan (1995)	Zhang (1990)	RDI and RSEST (1996)	Quoted by Garnaut and Ma (1992)
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	–	–
Consumption loss	4.0	28.8	–	–	–
Marketing loss	–	1.5	–	–	–
Total loss	66.9	81.9	50.4–114.0	11.1	8.0

Table 6. China's urban and rural per capita food consumption and implied (unmilled) grain consumption, 1981–95 (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. 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 'fine 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 consumption is beer for rural households, and 50% for urban households.

There are two important points to be noted from the new estimates. Firstly, while annual urban per capita food grain consumption declined rapidly from more than 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: (i) rural household meat consumption level is only half that of the urban, and rural households may not consume much of other (non-grain based) foodstuffs (vegetables, fruits, etc.); (ii) rural home-processed grain tends to have a lower conversion ratio;[12] (iii) food grain and meat consumed by urban households outside home (e.g. at a restaurant) may have been underreported by SSB.

Secondly, while meat consumption increased for both urban and rural households, the annual 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 saves feed grain. One hypothesis is that the cost of grain feed-intensive meat (red meat) has risen more rapidly than that of the white meat, which has driven the shift.[13] Further research into this phenomenon is certainly deserved.

A projection of grain demand to 2020

This section conducts a projection for demand for food and implied feed grain in both urban and rural China. This projection takes into account particularly: (i) the effect of changes in the age on grain consumption; and (ii) changes in feeding efficiency. 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 (discussion earlier).

Assumptions

- Values assumed for the income elasticity of demand for grain are reported in Table 7.

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

[13]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 7. Assumed income elasticities of demand.

	Urban households		Rural households	
	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

- Estimated grain consumption levels for different age groups for 1995 are based on per capita consumption data from Table 6, adding a 5% margin to obtain a upper bound projection, and reported in Table 8.
- The age-adjusted consumption level for 1995 is used as the starting point of per capita food and (implied) feed grain consumption in this projection.
- Population levels and age group shares at each endpoint of the projection range are reported in Table 2. They are also included in Table 9 which presents the projection results.
- The change in the urbanisation rate over the projected period 1995–2020 is estimated based on the change of 1.92% a year over 1990–95. The assumed end-period urbanisation levels are given in Table 9.
- China's real GDP growth is assumed 8% a year for Scenario I and 10% 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% a year is unrealistic, but used as a comparison with the growth scenario of 8% a year.

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

- This projection of China's demand for grain appears to be lie within most studies made outside China — e.g. with an income growth rate of 8% and in the low feeding efficiency scenario, China's demand for total grain will be 523 mt a year by 2000, 585 mt a year by 2010 and 643 mt a year by 2020.
- 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.
- The combined effects of income growth and change in population structure will lead to a fall in the demand for food grain.

Table 8. Assumed per capita grain consumption by 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 (up 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	$83.1^h/102.6^l$
New average		137.2	$185.7^h/230.6^l$	271.5	$103.9^h/128.2^l$

Note: 'h' denotes high feeding efficiency (i.e. low grain to meat conversion ratio), and 'l' denotes low feeding efficiency (high grainmeat conversion ratio).

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

Table 9. Projections of China's demand for food and feed grains for 2000, 2010 and 2020 under different income growth and feed grain use 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 (mt)	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 (mt)	236.76	233.79	184.75	117.62	231.45	172.09	98.76
Total food grain demand (mt)	**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 (mt)	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 (mt)	111.75	132.99	177.98	218.36	139.57	203.55	269.74
Total feed grain demand (mt)	**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 (mt)	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 (mt)	90.63	107.86	144.34	177.09	113.19	165.08	218.76
Total feed grain demand (mt)	*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 (mt)	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 (mt)	348.50	366.79	362.73	335.98	371.02	375.64	368.50
Total grain demand (mt)	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 (mt)	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 (mt)	327.38	341.65	329.09	294.71	344.64	337.17	317.52
Total grain demand (mt)	*442.39*	*477.44*	*518.42*	*554.06*	*480.93*	*532.19*	*593.68*

(mt) denotes: million metric tons
Source: Authors' projection.
Note:*See text for food consumption assumption for each age group.

3. Productivity Growth[14]

Introduction

Grain output per head in China (with the exception of corn) has changed little over the last decade. The early gains from reform therefore appear to have been exhausted. But has China really reached a frontier which is limiting the growth of output, either in terms of technology or in terms of the organisation of production? This section reviews recent research into this question. The issue is of great interest to Chinese policymakers, who continue to be concerned about the relative importance of domestic compared to import sources of grain. It is of great interest to the rest of the world, which, given the size of the economy, might expect that events in China might have substantial effects on China's trade and therefore on world markets for grain.

The next part of this section of the report reviews the trends in grain output and notes some of the key shifts in direction. It highlights the developments of the 1990s. We then examine in more detail the context in which farmers are making their output choices, and report work on mechanisms by which events in the rest of the economy affect farm-level decision-making. A number of factors, some subject to change by government policy, which might have effects on trends in output are then discussed.

Trends in grain output

Figure 7 shows the trend in grain output per head in China since 1949. A rising trend in output per head was established in the mid-1960s, but output per head appeared to stagnate around the mid-1970s. The introduction of the reform process in the late 1970s marked a turning point. Grain output per head rose on a new trajectory and reached a peak in 1985. Thereafter, once again output per head appears to have stagnated.

The trends in output relative to population in China vary among types of grain. Figure 8 shows the trend in output per head of wheat over the same period. The growth in output per head accelerated in the reform period, but since 1985 the trend is flat. Rice output per head (Figure 9) shows a similar trend to wheat up to the mid-1980s, but since then rice output per head appears to have fallen, especially over the 1990s.

The exception to these patterns is provided by maize output per head (Figure 10) which in absolute terms has maintained the rate of increase established in the early 1970s. The trend in maize output per head appears to be immune both to the impact of the reform program and to the events driving the flat growth in the other crops since the mid-1980s.[15]

The next section provides more information on the context in which farmers are making output choices in China.

The economic context

Growth and structural change

Section 1 notes that the impacts of growth and internationalisation in the rest of the economy have a significant effect on agriculture, including the grain sector. They are powerful contributors to the trends in grain output. Section 1 therefore argues that there is a rising opportunity cost of agricultural output, especially in some regions of China. An agricultural system operating at frontier efficiency levels would still face rising costs of maintaining that level of output. The outcome is then likely to be greater reliance on the world market for grain supply.

[14] This part was originally prepared as Findlay (1997).

[15] These data may even also understate the rate of growth of maize output if that type of grain is being increasingly diverted to animal feed and not counted in the reported output. The likelihood that output is underreported is discussed later.

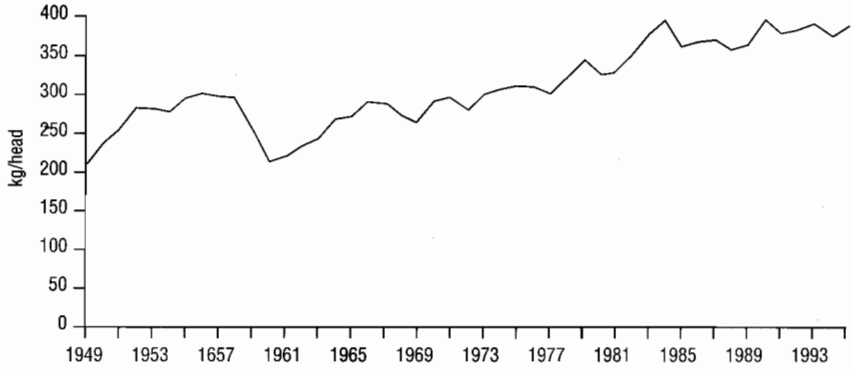


Figure 7. Total grain output per capita, 1949–95.

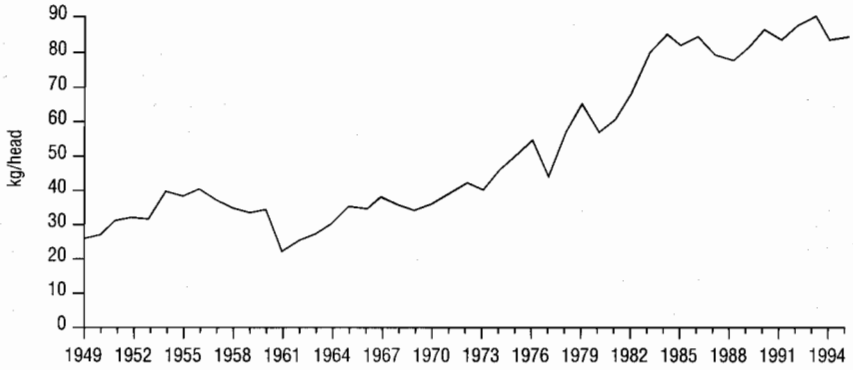


Figure 8. Wheat output per capita, 1949–95.

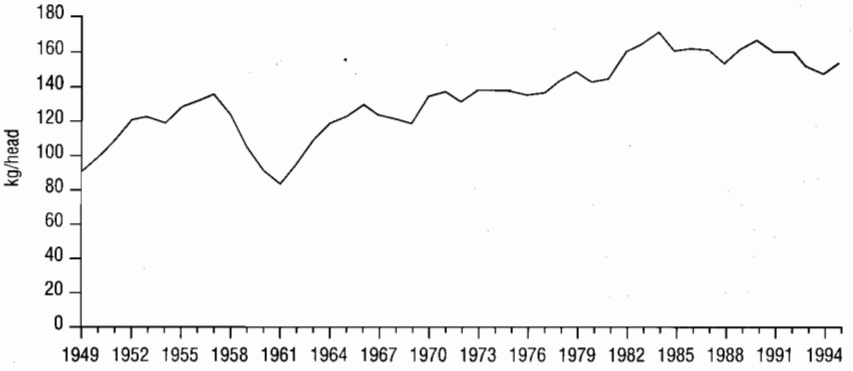


Figure 9. Rice output per capita, 1949–95.

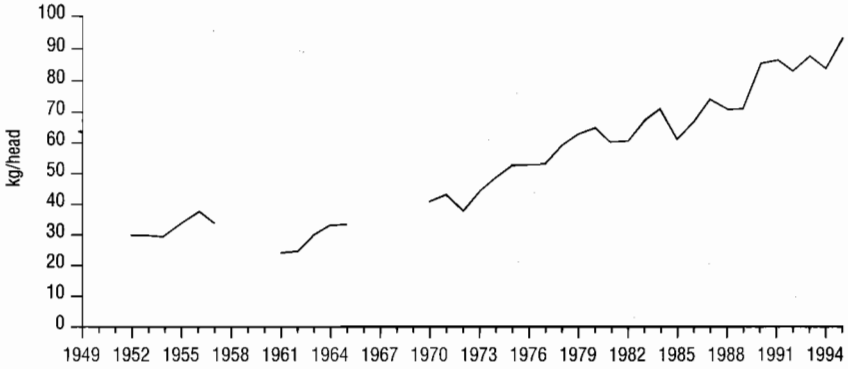


Figure 10. Maize output per capita, 1952–95.

However, there may be scope to increase output at relatively low cost when the agricultural sector, and grain production in particular, lies within the existing set of production possibilities. These circumstances are discussed below.

Impacts of labour mobility

Wu and Meng (1996a,b) note that the rapid creation of jobs in other sectors of the rural economy has led to a concern about the relocation of labour on the output of agricultural products, and of grain in particular. They use household survey data on grain specialist households[16] to examine the effects of labour relocation on grain output.

Wu and Meng (1996a) first examine the contribution of labour to grain output. They find that the return to labour time is relatively low (a doubling of labour input in terms of time would raise grain output by 6%). But the actual labour input is a bundle of worker time combined with farm worker experience and worker education. When these factors are taken into account, the elasticity of grain output with respect to incremental labour input rises to 26%. Farm worker experience is twice as important as worker education in their model. The contribution of education to grain output growth, and to household income growth, is further discussed below.

Wu and Meng argue that an important effect of the relocation of labour is likely to be from the change in the mix of the characteristics in the agricultural labour force in terms of its experience, education and sex. They simulate the effects of the relocation of labour by changing the composition of the agricultural workforce, holding everything else constant. They assume that in its absence of labour mobility the agricultural work force in the household would have the same characteristics as the whole household on average. Generally they find that, according to this method, in the short run the direct effects of the relocation of labour on grain output will not be significant. That result occurs in part because the more important contributors to grain output are experienced and older male workers. The labour that moves tends to be younger workers with more education.

Wu and Meng (1996a) note that the withdrawal of labour from agriculture will also lead in the long run, as the relative cost of labour rises, to the substitution of other inputs for labour, including capital and other purchased inputs. They also argue that current farm sizes in China limit the range of technological options and that larger farm and plot sizes will be required to facilitate the substitution of other inputs for labour. As that happens, they suggest, the education level of farm workers may become a more important determinant of grain output.

Investment

Grain production may also be affected not only by the substitution of purchased inputs for labour but also by the investment that follows the rise in household income which is associated with the relocation of

[16] These data were collected as a part of the project whose results we reported here. See Wu (1997) for details. Hereafter these data are referred to as the CERU–MoA household survey data.

labour. Wu and Meng (1996b) find that the stock of capital in grain production (in grain specialist households) does rise faster than total household income, but only as all other factors are held constant. They find that as the share of non-agricultural income in total income rises, households tend to invest less in grain production, indicating the lack of profitability of grain production compared to the alternatives. This issue of the distortion of farmer incentives that are a consequence of government intervention in the marketing system is discussed in other work in this project (see e.g. Findlay and Watson, 1996a). Fan (1996a) reports that government investment in agriculture reached a peak in 1978, then nearly halved in real terms by 1987 and rose again in the first half of the 1990s. However, the value in real terms in 1994 was nearly a third lower than in 1987. Nor has the slower rate of farmer investment in agriculture been offset by public projects. The state had for some time been using the pricing system applying to grain in particular to transfer resources out of agriculture. Thus agriculture was not only under pressure from the structural change in the economy, but was also subject to deliberate taxation by the state (Findlay and Watson, 1996a). Fan (1996a) also stresses the fluctuations in investment, the decline in investment in research and development and, during the slump in investment after 1978, the rundown in the capacity of the irrigation and drainage systems.

Current issues in the agricultural research system are discussed in more detail below. Issues in other agricultural infrastructure sectors, such as irrigation, are topics for further work.

Land losses

Concern is often expressed about the loss of agricultural land in China. Various estimates are available of the extent to which land is being transferred to other sectors, which appears to be large in absolute terms. However, the rate at which land is being transferred to other uses appears to be relatively low. Dong (1996) reports data which suggest that between 1958 and 1993, arable land area fell by 12%. Dong's data even suggest that the rate at which arable area is falling has been less since 1978 (0.31% a year) compared to the pre-reform period (0.36% a year). Lindert (1996) also provides a similar estimate of the rate at which land is being transferred to other sectors. At this estimated rate, it would take two decades for Chinese agriculture to lose 10% of its land area.

There are also offsetting forces. Some commentators argue that new arable land areas can be developed (Dong 1996) so that the area of arable land can respond to rising land values. Grain-sown area in China can also follow a different trend to general arable area, not only because of the composition of agricultural output, but also because within the grain sector there is scope to increase the rate of double-cropping. Its growth has contributed to the increase in total output even though the amount of arable area has fallen.

The extent of multiple cropping over time depends on the regional distribution of the loss of arable land — those areas where the multiple cropping rate is high are also losing arable land at a faster rate. The implications of regional variations in the impacts of forces for structural change are discussed in the next section.

Actual land area in China has in the past been underreported. Even so, the changes in the rate of decline of arable areas may still be reliable unless incentives for underreporting have changed over time. The implications of underreporting of land area are discussed below.

Another offsetting factor to the loss of land to other uses is that other inputs can substitute for land in the production process, for example, irrigation and fertiliser. Lindert (1996) raises the related issue of whether the process of the loss of land to other uses has the effect of the lowering the quality on average of the land remaining. One hypothesis is that the best land is converted to urban use. But Lindert argues that industrialisation and urbanisation could have offsetting effects since more effort is put into improving the quality of the land remaining in agriculture. This is a question for further work. Lindert provides some estimates (his Table 8) which suggest the net effect of industrialisation and urbanisation on average soil quality could be positive, particularly in terms of its content of organic matter and nitrogen.[17]

Policy reactions

These patterns of structural change are not independent of policy reactions, for example, to the rise in or expected rise in the import penetration of the market for grain. Grain prices in China since later 1994 have been higher than world prices, which is a

[17] Another question is whether agricultural use itself is degrading soil quality. Lindert (1996) finds little supporting evidence for this in China, particularly for those soil characteristics which matter for agricultural production.

consequence of the trends in supply noted in Figures 7–10 compared to the growth in demand, in the context of restrictions on trade. The origins of and risks associated with this position are discussed in more detail in the final section of this report.

A more immediate issue is the change in the management of grain sector policy, particularly the devolution of responsibility to provincial and lower levels of governments. Some implications of this change, in terms of the use of subsidies for grain production and the lack of transparency in grain sector policy, were discussed earlier in Section 1.

Grain sector performance

There has been debate over the effects of the agricultural reforms in China. Watson (1994) has reviewed the literature in general, and Carter (1995) focused on econometric work on the sources of agricultural output growth. Input growth is obviously one contributor to output growth. Studies of the other sources of growth can be divided into different schools. Some put more stress on technological change, others favour the importance of institutional change, such as the household responsibility system (HRS), and others stress the contribution of and continuing importance of market reform and 'getting prices right'.[18] Recent work, particularly papers using the CERU–MoA household survey data, are now reviewed under these three headings.

Technological change

Some of the work on accounting for sources of growth in Chinese agriculture has put more weight on the contribution from technological change, especially after the first-round effects of institutional change have been exhausted (see e.g. Huang, Rosegrant and Rozelle, 1996).

An issue in the assessment of the scope technological change plays in that role is the estimate of the current grain yield in China. Estimation of yields is complicated by errors in the data on land area. Reported land area in China has been understated, at least according to the latest official land survey in China, which revealed a figure significantly higher (20%) than previous estimates of arable areas. Underreporting does therefore appear to have been a problem. Its presence reflects the incentives created at the local level by the land tax system and by the requirements the state imposes on the grain sector to supply grain at lower prices to the state marketing system. Concealing the amount of land available may reduce tax commitments imposed on any one community.

If on the other hand grain output is measured correctly then the estimated yield (output divided by area) will be overstated.[19] Assessments of the scope to increase yields based on comparisons of actual yields in China with those defined to be 'frontier' levels, according to overseas experience, for example, will therefore be biased toward the conclusion that there is little scope for such an increase in yields in China. The correct measurement of yield, however, may lead to a more optimistic view of scope for its improvement. In that case, further technological change has a larger role to play than would be suggested by yield estimates based on underreported land areas.

Yang Hong (1996d), using the CERU–MoA survey data, found that the average land area reported by households is approximately 17% larger than the figure reported by villages. This appears to be another piece of evidence that in previous years reported areas have been understated. Yang Hong also found that the village appears to have reported a figure close to actual yields to higher levels. This result suggests another possibility which is that rather than yields being underreported, it is output, at least at the village level, that is likely to be underreported. Some grain output is therefore concealed from higher levels of government. This output could be diverted into the animal sector and not appear in the marketing system in its raw form. If this diversion has increased over the last decade, as demand for animal products increased and as the marketing system for those products has been reformed, then the official data may also understate the rate of growth of grain output.[20]

A comparison more relevant than comparing aggregate average yields in China with some assessment of potential based on experience in the rest of the world is the assessment of actual versus

[18] There is also other work, including by Zhong and Carter (1995), which stresses the importance of the weather in patterns of grain production over time, and by Huang and Rozelle (1995a), who highlight the contribution of an increased inability of production to withstand the effects of natural disasters, rising salinity and soil erosion.

[19] Crook and Hunter Colby (1996) suggest that the State Statistical Bureau overstates yields (which it also measures using sample survey cuttings) in order to compensate for the understatement of land area.

[20] This result might also help explain part of the apparent inconsistency between the growth in grain output in China and the growth in meat output. For a discussion of other contributors including the role of grain imports, see Lu Feng (1996a,b).

potential yields in Chinese conditions at farm level. The problem is to find an estimate of potential yield.

Lin and Shen (1994) have undertaken a study of the potential to increase rice yields by comparing actual farm yields with assessments of what is possible provided by agronomists and scientists working in the industry. Lin and Shen distinguish between two yield gaps. The first is the gap between the maximum experimental yield and the best possible farm yield. The second is the gap between the best possible and the actual farm yields. They find a significant combined gap, for example, cases where the maximum yield is three times the actual farm yield. Most of the gap (about 70%) is due to the first type of gap. Lin and Shen argue that there may be high returns to research into how to reduce the factors they identify as contributors to both gaps. Biotechnological research, they suggest, may offer the highest returns.

Other work uses different methodology to evaluate the returns to further investment in research and development in China. As noted above, work on accounting for the growth in grain output in China reveals that in the past technological change has played an important role. A more recent paper tries to find a direct link to research effort, rather than inferring the contribution of technological change from the unexplained part of the trends in output growth. Fan (1996b) includes a research variable in a production function study of the trends in grain output over time. By making assumptions about the lagged structure of the effects of research, Fan is able to estimate returns to agricultural research in the range 44–169%.

Even if there are high returns to agricultural research, would the investments be made? Rozelle (1996) and Fan (1996a,b) have reviewed the reforms, including commercialisation, in the agricultural research and development system in China and the fall in real spending on research. Research in recent years does not appear to be contributing to an increase in the yields of commercially used grain varieties. The number of new varieties has increased but the rate of increase is lower in the first half of the 1990s than in the second half of the 1980s. These results raise some questions about the benefits of the reform process in this sector. Rozelle and others also note that a remaining issue in the reform process in this sector is the strengthening of the property rights regime.

The evaluation of the research sector is an issue. As Rozelle notes, the result that yields of new varieties are constant could conceal other features. The data used to evaluate research performance refer to varieties in commercial use. Market and profit-oriented farm households may now be selecting varieties which contribute more to household income than to output. The new varieties may require fewer inputs, for example. This question is a topic for further work, and could indicate success in the commercialisation process in the research sector rather than poor performance.

Pray, Rozelle and Huang (1996) also review some of the related issues in the reform of the seed industry in China and stress the returns to easing barriers to entry into the market for seeds to raise to the extent of competition in the market and the returns to removing residual controls on seed prices.

The household survey data available in this project reveal some features of seed use in grain production. Grain for seeding is an important use of grain output. The ratio of seed input to grain output, according to the CERU–MoA survey data, is 3.4% for winter wheat, 0.6% for middle-late indica and 0.9% for maize. Some estimates indicate that there is also a significant loss of seed in the sowing process. Greater efficiency in seed use could make available millions of tonnes of grain for other uses.

Harry Wu, in work in progress on farmer choices about seed use, has identified the following testable hypotheses:

- farmers tend to choose high-yield varieties if they are subject to sales quotas with fixed state prices, that is, they emphasise quantity rather than quality; at the same time, under central government pressure to meet output targets, local governments have strong incentives to develop and promote high-yield varieties;
- the nature of varieties that have been used in the past determines the frequency of change of varieties — hybrid rice varieties often require more frequent changes in seeds;
- farmers' response to the availability of high-yield varieties is subject to their budget constraint, the parameters of which are seed quality, the prices of new seeds/varieties and the cost of associated inputs (many new varieties require higher input of fertiliser and/or labour; in fact, many high-yield varieties are developed to be more responsive to fertiliser and intensive labour input: quality matters, since farmers have to use more seeds or have to reseed if the emergence rate is low).

Preliminary survey findings using the CERU–MoA data include the following points.

- Almost all grain farmers surveyed have changed varieties since the introduction of the HRS, not only for the major crop, but also for other crops, e.g. 95% of rice farmers in Guangdong and 92% of rice farmers in Jiangxi have changed varieties for the same crop since HRS.
- For the major crop, 82% of the households changed varieties at least three times since HRS, 60% at least four times, and 37% at least five times, and 20% of households changed varieties 6–10 times.
- More importantly, most (75%) households changed varieties in 1994–95 when the government re-emphasised quantity control over grain production through the governor responsibility system.
- For their latest change of variety, new varieties increased yield per (sown) mu by 43 kg for wheat, 36 kg for early indica, 45 kg for late indica, 35 kg for japonica and 67 kg for maize.
- The survey also found that seed input (per mu) is positively correlated with yield and negatively correlated with the price of seeds (statistically significant, the two factors can explain 30–40% of the quantity of seeds used).

These results suggest that farmers do consider the effects of seed price and quality on yield. The rate of change to new varieties is also an indicator that farmer decision-making is not necessarily a barrier to the introduction of new technologies at farm level. On the other hand, as reported in Section 2, there appears to be significant variation within the sample in the rate of use of seeds so that, while it is subject to economising behaviour by farmers in general, this input appears to be one in which there is considerable scope for technical efficiency gains. A side effect of greater efficiency in the use of seeds will be an increase in the availability of grain for other uses.

In summary, research and development can clearly play an important role in driving output in the grain sector. The major policy issue is therefore the management and evaluation of research and development programs that apply to grain. Key elements in achieving an efficient outcome will be institutional changes in the research sector and in the seed industry. A more developed seed market may also contribute to improved performance in terms of seed use at farm level. Choices of research effort in China will also be more efficient if they take into account the cost of China's alternative sources of grain, such as purchases from the rest of the world.

Institutional change

Estimates of productivity gains

Huang and Kalirajan (1996) argue there is scope for yield increases which appear to be higher for maize than for other crops, and higher in Sichuan compared to other provinces in the sample. This argument is based on their assessment of the gap between actual output and an assessment of potential output of between 33% and 50% of current yields.[21] These estimates are considerably less than those of Lin and Shen (1994) whose type II gaps range between 50% and 65% of actual yields. Perhaps the explanation is the assessment by scientists of 'yields under favourable conditions', which are the source of the Lin and Shen estimates of potential yields, and which exceed the observed best commercial practice in the household survey data.

Huang and Kalirajan find that the gap between actual and the estimated potential performance is smaller for each of rice, wheat and maize:

- if the household average education level is higher;
- if the household head has longer agricultural experience;
- if the total land area being farmed is larger;
- if the proportion of the grain output sold to the market is higher;
- the higher the proportion of days spent working off the farm.

Huang and Kalirajan use these results to stress short-term gains in productivity that might be associated with larger farm sizes, a greater market orientation in grain output (the marketing rate in the sample is still only just over one-third), and the growth of off-farm work. They stress, however, that in the longer run, after the immediate productivity gains are exhausted, some of these changes may not have net positive effects on total output. One example is structural change, including the growth of rural industry, the impact of which is discussed in Section 3.

These results highlight both the role of the extent of use of markets and other institutional changes, for

[21] Potential output is derived from an estimate of the production frontier which is estimated by including only factors of production in the regression equation. Other contributors to variations in output are considered in the second step of the analysis applied by Huang and Kalirajan.

example, those affecting land area, in the performance of the grain sector. The rest of this section concentrates on input markets, noting not only the output effects but also other consequences of reform. The impacts of output market developments on productivity growth are discussed in the following section.

Plot consolidation

Issues associated with the scale of production are examined by Nguyen, Cheng and Findlay (1996). According to their results, there is a statistically significant positive relationship between plot size and output for all three crops — maize, wheat and rice. However, the positive relationship for rice is obscured by differences in varieties, by the labour-intensive nature of rice production and by the very small plot size in southern China where rice is mainly grown. The elasticity of wheat and maize yields (and all other inputs constant) with respect to plot size is estimated to be 17%.

The generally observed positive relationship between plot size and output for major grain crops in China (Nguyen, Cheng and Findlay argue) suggests that fragmentation involves a significant cost. Further, they stress that they tested for the effects of both farm size (total area) and average plot size (total area divided by the number of plots). Immediate gains are associated with economies in plot size rather than farm size.[22]

Given fixed land areas and the pressure of continuing population growth, the already very small plots of land in many areas of China are being fragmented further. The results of Nguyen, Cheng and Findlay indicate this outcome could be expensive in terms of output foregone. The literature on this issue suggests that avoiding this outcome will require a deepening of the reform process. Experiments involving these practices, which are already underway, will have to be promoted actively in other areas of China before problems of falling plot size are resolved.

From an economic perspective, land consolidation in China involves not only gains, but also costs. The possible costs include, first, the exposure of small households to extra risks caused by land consolidation. For example, following land consolidation, the losses of crops in one plot due to floods or other natural adversities are less likely to be palliated by a good or normal harvest from plots in different locations.

An issue related to these questions of scale, and interest in either consolidating plots, increasing farm size, or both, is the land tenure system. The debate on land tenure in China is reviewed by Zhang, Huang and Rozelle (1996). The collective land of the village is still controlled by the leadership but can be allocated in a variety of ways. The mechanisms involved are characterised by a lack of security of tenure which can weaken the incentive to invest, reduce the ease of access to credit and, in the absence of a market for land-use rights, deny gains from specialisation. The empirical significance of these effects is a topic for further work. A market in land-use rights (even without private ownership) would facilitate both consolidation and the achievement of greater scale if they were profitable. Some models of or experiments with new land tenure arrangements in Zhejiang are examined by Fahlbeck and Huang (1996).

Farmer education

Another variable stressed by Huang and Kalirajan is the impact of education, or the quality of the labour input, on productivity. The impact of formal education is examined by Nguyen and Cheng (1996), who question its importance in the performance of grain-producing households. They report regression results using farm income as the dependent variable which suggest that:

- the returns are statistically significant for the education of household heads but not for the education of farm workers generally;
- the returns are considerably higher for the first three years of education of the household head than for subsequent years.

Wu and Meng (1996a,b) and Cheng (1996) report other regression equations using grain output as the dependent variable in which the education level as well as work experience of household heads is important.

Nguyen and Cheng argue their results confirm that household heads, who are decision-makers within each farm, are handicapped in getting the best of the improved seeds and modern agricultural practices if they cannot read or write.

The problem is to measure accurately the size of the link between education and income. Even if that link is now small, the importance of education is likely to rise. Wu and Meng (1996a) also argue this case.

[22] Huang and Kalirajan found that total area was significantly related to productivity, although they did not include a plot size variable in their equation, and there is a correlation between total area and average plot size.

Cheng (1996) observes that with the increased use of chemical fertilisers, new seeds and other modern inputs, grain production becomes increasingly capital-intensive, and hence demand for quality labour inputs rises (that is, more educated labour becomes more productive). More attention should be given, he argues, to further education and training for those household-heads aged in their forties and fifties who are usually the major decision-makers in China's grain production and marketing and who are less likely to move out of grain production completely.

A further question is that, if education is significant, how much is required? At present, returns to education beyond a basic level may be small. That was the main finding of Nguyen and Cheng (1996), whose concern about econometric qualifications to their assessment of the relationship is not likely to affect this conclusion. However, for reasons discussed by Cheng (1996) and others, the returns to longer-term education are likely to rise over time.

Off-farm work

Another interesting issue in household management is the role of off-farm work by household heads. The results are mixed. Huang and Kalirajan (1996) argue that the extent of off-farm work in industry is positively related to productivity in grain production. While families for whom off-farm work is more important may spend less time on farm work, they may work more productively when they are spending time on the farm. Yang Hong (1996c), on the other hand, finds a negative relationship between grain output and the share of non-farm income in total household income (all other inputs constant).[23]

Cheng's 1996 study examined a particular form of off-farm work. He found that there is an association between the official position of the household head and grain output. Cheng argues (based on his field work) that there is no systematic relationship between official positions and better quality of land. The positive effects of official position on grain output are more likely to be caused by the collective ownership of some large farm equipment and privileged access to state-subsidised farm inputs, public goods such as irrigated water, and technical information and supporting services.

One interpretation of this outcome is that it represents a form of compensation for undertaking an official task in the village. Cheng notes the problems associated with this approach. He prefers instead a market solution of both higher prices to grain producers to encourage on-farm productivity, and direct compensation to officials for time spent in that role. One option he suggests would be the creation of one or two full-time positions for village officials and a reduction in the total number of village officials (currently there are about three to five part-time village officials paid from the land-use fees).

Fertiliser

Efficiency of fertiliser use is discussed by Cheng, Nguyen and Findlay (1996). They examine the allocative efficiency in the use of urea (the main component of which is nitrogen) and an aggregate of all other fertilisers (e.g. phosphates) in production. They apply the profit-maximising firm's rule on input use to find that urea is underutilised in all but one of the counties in the sample, while other fertilisers were underutilised in Jiangxi but overutilised in Guangdong.[24]

Field work by Cheng suggests that a contributor to the allocative inefficiency of rice producers was the risk involved in the adjustment of input use, which was related to the lack of knowledge of the technical relations between input and output for rice production. For example, following an increase in the price of urea, households may not reduce their use of urea accordingly, if they were uncertain about the output effects of such a reduction. They may be concerned, for example, that a small decrease in fertiliser use might lead to a large fall in output. They are therefore conservative and base their input choices on their own limited experience of the technical relationship.

The responsiveness of rice producers to changes in input and output prices in southern China could have been influenced as well by other factors, the range of which includes:

- the lack of price information for small rice producers;
- the exaggeration of price fluctuations associated with the barriers to trade between two provinces and between counties in a province; and
- messages from central and local governments urging farmers to increase rice output following a fall in rice output since late 1993.

[23] The difference in results could reflect the statistical methods used which treat in different ways the measurement errors likely to be associated with the input variables.

[24] There are qualifications to these results because of omitted variables problem (related to the exclusion of a soil quality variable and organic fertlisers, data for which were not available) and also because of the aggregation of the fertiliser types. Huang and Kalirajan (1996) also found that overall fertilisers were used relatively inefficiently.

The inefficiency of fertiliser use could also be due to local shortages of fertilisers (particularly urea), or credit to pay for them. Policy implications therefore include the value of more technical information to farmers, but provided in the context of economic decision-making, not output targets. There are also some interesting technical issues in the impact of urea use in southern China, and about the benefits of other methods of fertiliser application compared to those currently in use.

Review

Markets for inputs, including land, labour, and purchased items such as fertiliser matter for productivity growth. Current restrictions on some agricultural input markets reflect the absence of other markets, for example, for dealing with risks in agricultural production. The data suggest that institutional changes in these areas can have a significant effect on productivity. For example, significant benefits would be available, according to this research, from institutional changes which led farmers themselves to consolidate their plots of land. It is stressed, however, that changes in markets other than those for farm land would be required in order for consolidation to be efficient. There may also be high returns to information about the effects of fertilisers in grain production and about methods of application. Longer-term issues include decisions on the extent and funding of farmer education in China.

Market development

The development of the grain marketing system is discussed in more detail by Findlay and Watson (1996b) and Watson (1996). Obviously, changes in relative prices that emerge from market reforms affect trends in grain output. Findlay and Watson (1996b) document examples of the supply response of grain output to relative price changes associated with marketing system reforms.[25] In this section, focus is on the way that the development of markets affects the productivity with which resources are used, rather than on volumes of inputs applied to agricultural production.

Marketing rate

Huang and Kalirajan (1996) tested the effect of the rate at which households sold their grain on the market on the productivity of the household. They found that more market-oriented households use inputs more productively in the case of all three crops. Huang and Kalirajan also expected that a higher state share in a household's marketed output may not encourage farmers to produce that output efficiently. A relationship in this direction was found in the case of wheat but not for rice and maize.

Other researchers have found a positive relationship between the size of the quota and output, for example Sicular (1995) finds first that quotas do affect the allocation of resources at farm level: quotas are not inframarginal. She finds also that quotas have the significant effect of taxing household income. But quotas in her results appear also to have a positive effect on productivity. One explanation is that other services are provided alongside the quotas, for example, the provision of new techniques, access to fertilisers which might otherwise be constrained, access to credit to buy inputs in an efficient combination, supervision by local officials of on-farm choices, and provision of farm services at lower costs on a collective basis.[26]

One interpretation of these results is that the quota system is a second-best method of achieving an efficient allocation of the available inputs into the production process among households. The quota system is acting as an assessment of the appropriate degree of specialisation by households in grain production. Available inputs are being allocated accordingly, and access to those inputs has effects on total grain output of the household, not just the quota component. However, these effects are likely to be larger in richer counties which provide subsidies for grain production.

The alternative to this use of the quota system is not only to let households make their own choices of their specialisation in grain production but also to reform input markets so that the market mechanism can achieve the efficient allocation of inputs into grain production. The net effect is likely to be, according to results reported here, higher grain output. Concerns about food supply security, which is one origin of the

[25] A recent example is the very high grain output expected in 1996, the result not only of good weather in some parts of China but also the increase in sown area. The increase in sown area is likely to be the result of expectations of higher prices for grain based on prices received in 1994 and 1995, and incentives that emerged from the application of the governor responsibility system. The large output and the accumulation of stocks in 1996 is likely to lead to expectations of lower future prices and a reduced sown area next year.

[26] One explanation for the difference between the results of Sicular (1995) and those of Huang and Kalirajan (1996) about the impact of quotas is that they use different data sets. Sicular uses data from one county in northern China.

quota system, can be met through the development of a more market-oriented production process.

Barriers to market integration

Another marketing issue is the set of barriers to inter-regional trade in China. These barriers could be due to the presence of bottlenecks in the transport infrastructure or to deliberate policy choices such as the governor responsibility system (see Cheng, Findlay and Watson, 1996), to cause each region to be more self-reliant. If those barriers were significant, then the consequence is a lack of specialisation by region within the grain sector. The failure to pursue specialisation means that some output is foregone. When regions specialise they concentrate on grains with lower opportunity costs in terms of other types of grain foregone. When regions differ in their opportunity costs of production of various types of grain, as is the case in China, then the output foregone in one region can be more than offset by increments to output in other regions. The grain output of the whole economy is increased as a consequence.

Of course the same issues arise with respect to choices between grain and other goods and services. In particular, there is the question of whether the prices to which Chinese farmers are responding are divorced from world prices, and therefore from the point of view of the whole economy whether an inefficient volume of grain is being produced, compared to its real cost of procurement from the rest of the world.

Barriers to market integration have a second important consequence from the point of view of output decisions. While demand for grain is relatively stable within any one region, the supply within a region can fluctuate significantly as a result of changes in weather, in relative prices of other crops which affect supply decisions, or in local policy. The consequence is likely to be a greater degree of price instability. In more integrated markets there is also a lower degree of correlation between prices and yields in any one region. Market development also lowers the costs of making transactions.

Park (1995) models the effects of these dimensions of market development on household behaviour in the presence of yield and price uncertainty. Market development involves a number of offsetting effects. Park finds that the effects on grain storage on the farm and on grain sown area are ambiguous. Complications arise from the dual role of households as both consumers and producers, in which roles price fluctuations have different implications. There is scope for further work to identify the empirical importance of the various effects in order to model more accurately grain producer output and storage decision-making.

Conclusion

Research reviewed here indicates that it is possible to raise the productivity of inputs used in grain production in China, but the condition required for this change is an even greater role for markets in the management of grain production. Contributors include:

— plot consolidation, facilitated by the development of land use markets;
— development of markets for other purchased agricultural inputs;
— deregulation of the seed market.

The greater degree of integration of domestic grain markets would also have significant effects on aggregate output, through opportunities for specialisation and trade and the effects on technical efficiency at farm level. Pressures for structural change that vary between regions will at the same time be changing the mix of grain output that China can expect. These pressures will determine the patterns of trade in grain in China through an integrated national market.

Despite the likely gains in economic terms, there are constraints to the deepening of the role of markets in the grain sector in China. Market development inevitably leads to substantial redistributive effects, involving growers of grain, trading intermediaries, input suppliers and consumers. The sensitivity of the progress of and path of market development to the political reactions to these redistributive effects has been documented by Findlay and Watson (1996a). As they explain, a particularly important issue is the role of the grain bureaus.

It is also possible to shift out the position of the grain production frontier. Substantial increases in yields even beyond those at the frontiers under current technologies appear to be possible. The issue in that case is the management and evaluation of research and development programs that apply to grain. Institutional changes in the research sector and in the seed industry, as noted above, are key objectives. In addition to market reforms, therefore, important issues include:

- the extent of public investment in agricultural infrastructure and in research and development;
- the design of the extension system; and
- the long-run development of farmer education policy.

China can change its trend in grain output per head reported earlier. The question to be answered is what it will cost, to change the trend. There are reforms, including the development of input markets and the integration of output markets, that may be undertaken through regulatory reform at relatively low cost. Further output growth could involve more substantial investment and therefore lead to challenges to policy makers to make careful judgments about costs and benefits. Using the resources available in the rest of the world to supply grain to China is another option to be considered. Integration of the domestic and international markets for grain will facilitate the assessment of all those options by exposing decision makers to world prices.

4. Grain Trade Prospects[27]

Review of projections

There is a variety of scenarios for China's international trade in grain over the next two decades (see Table 10).

Outlooks differ significantly. Some are pessimistic about production growth: 500 mt is the upper limit in all projections for the year 2000. Brown (1994, 1995) forecasts a dramatic decline in output, mainly due to arable land loss 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, e.g. the IFPRI group and Mei (1995), but not the OECF.

These scenario differences are reflected in their ratios of imports to consumption. These range from less than 3% for Mei (1995) by the year 2020 to more than 20% for OECF (at 2010), and around 50% in 2030, Brown. Mei argues that imported grains 'can only play a role in adjusting the production' (p. 3).

None of these projections allow for the impact of events in the non-agricultural sector. As Anderson and Peng (1996) point out, this means these 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 to this problem. One scenario is based on growth of GDP in China of 7.8% a year through to the year 2005.[28] The result is that China is projected to import 33 mt of grain in 2005 and have a domestic 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 10, in part because of the projected growth in imports of livestock and other food products.[29] A tighter set of trade restrictions on those items would raise the level of grain import dependency above 4%.

In the early 1990s, the bulk of China's grain imports was wheat. But the studies reviewed above suggest a change in the import mix toward feed grain. This switch is associated with growth in demand for meat, egg and aquatic products, while the direct consumption of grain is expected to fall.

The OECF study suggests that the bulk of import grain will be feed grain at the end of the projection period. China will maintain its self-sufficiency in rice, according to the OECF projections, and remain a net importer of wheat while maize imports boom.

The IFPRI study notes that the rise in meat and other product consumption will raise the share of feed grain in total consumption from 20% in 1991 to nearly 40% in 2020. In its projections, feed grain demand rises from 76 mt in 1991 to 108 mt in the year 2000 and 232 mt in 2020. The study also reports that that by 2020 'wheat will still account for most imports'.

Garnaut and Ma (1992) concluded that the outcome would depend on Chinese trade policy. In 1992, the Chinese grain market was closed off from the world market to a considerable extent, and domestic prices were below what were then low world prices (see Figure 1). They anticipated that either the relationship between domestic and international prices or the closed nature of the grain economy would

[27] This part is based on an extract from Wu and Findlay (1996).

[28] 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 into the model. The UR also removes quotas on exports of textile and clothing products which also boosts the trade in those products but lowers their prices. For details, see Anderson and others, 1996.

[29] China pays for these imports by expanding net exports of manufactures, even though China is denied fulll 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.

Table 10. Review of projections of China's grain trade to 2030

Source and year	Period of projection	Consumption at end point (B) (year)	Production at end point	Net imports (unit) at end point (A)	A/B %
Tyers and Anderson 1992	1990–2000	510 mt in 2000	420mt in 2000	90 mt in 2000	18
Garnaut and Ma 1992	1990–2000	Normal growth (6% p.a. income growth): 547.2 mt in 2000	Upper limt of 500 mt	Normal growth (6% p.a. income growth: 50 mt in 2000	9.1
		High growth (7.2% p.a. income growth): 593 mt in 2000		High growth (7.2% p.a. income growth): 90 mt in 2000	15.2
Brown 1994	1990–2030	No rise in consumption p.c.: 479 mt in 2030	272 mt in 2030	No rise in consumption p.c.: 207 mt in 2030	43
		Rise in consumption p.c. and rise in population: 641 mt in 2030		Rise in consumption p.c. and rise in population: 369mt in 2030	58
Huang, Rozelle and Rosegrant (IFPRI) 1995	Early 1990s to 2000, 2010 and 2020	450 mt in 2000	410 mt in 2000	40 mt in 2000, *but not likely to be greater than*	8.8
		600 mt in 2020	550 mt in 2020	50 mt in 2020	8.3
OECF 1995	1993 to 2000, 2005 and 2010	508 mt in 2000	484 mt in 2000	24 mt in 2000,	4.7
		571 mt in 2005	502 mt in 2005	69 mt in 2005	12.1
		645 mt in 2010	509 mt in 2010	136 mt in 2010	21.0
Mei 1995	1993 to 2000, 2010 and 2020	511 mt in 2000	500 mt in 2000	11 mt in 2000	2.2
		593 mt in 2010	578 mt in 2010	15 mt in 2010	2.5
		695 mt in 2020	675 mt in 2020	20 mt in 2020	2.9

change rapidly with continued rapid economic growth through the 1990s. China would soon face a choice between Northeast Asian-style grain protectionism (the earlier choice for food grains in Japan, Taiwan and Korea), and the linking of domestic into international markets.

It was technically possible, they argued, for China to remain self-sufficient in grain with Northeast Asian-style protectionism. If this were the choice, domestic grain prices would rise well above the then current world prices. High prices would encourage grain production and hold back consumption. Chinese economic growth would be held back, and the people's standard of living would not rise as much as the country's economic performance would otherwise be able to support.

Alternatively, China could choose to open its agricultural economy to foreign trade, while maintaining the liberalisation of domestic grain markets that had recently been implemented.

In these circumstances, continued rapid growth in incomes would lead to strong expansion of grain use, especially for animal feed and industrial purposes. Two approaches to estimation of demand were utilised by Garnaut and Ma — one based on published estimates of income elasticity of demand, and one on the Taiwan experience at a similar stage of its economic development. The two approaches suggested broadly similar outcomes: use of 550 mt with normal economic growth, and 590 mt with high growth. Garnaut and Ma (1992) noted that the starting point for the quantitative analyses preceded, and therefore abstracted from, the major upward adjustments in China's grain prices in 1991 and 1992, and therefore may have overestimated net imports in 2000 by an amount that could not be calculated on data then available. Garnaut and Ma (1996, p. 61) later adjusted their expectations of net imports under free trade and stable world prices (1990 levels) to 30–70 mt to take account of this factor.

On the supply side, Garnaut and Ma (1992) undertook less detailed analysis. They concluded that, while there was biological potential for much larger increases, it was unlikely that grain production would grow more rapidly than population, that is, that it was unlikely that production would exceed 500 mt with free trade and world relative prices remaining near the levels of 1990. They noted that higher levels of production would be induced at higher prices.

Garnaut and Ma also discussed in detail the likely change in the mix of grain demand in China. In their high growth scenario, the share of feed grain in total grain consumption rises from 25% in 1990 to 33% in the year 2000 (30% in the lower growth scenario) (see their Table 42, p. 98). They note that the mix of grain output is highly sensitive to shifts in relative prices, but expect the growth in imports would be concentrated in feed grains and to a lesser extent in wheat and barley (p. 118).

Food grain self-sufficiency

This section highlights the significance of the demand projections reported in Section 2 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 the experiences of other countries, Brown (1994) assumes that China's grain supply will decline by at least 0.5% a year from now to 2030, compared with 1% decline for Japan since 1960, 1.2% decline for Taiwan since 1977 and 1.9% decline for South Korea since 1977. Carter and Zhong (1988) project zero growth, while all other estimates of grain output are positive. Garnaut and Ma (1992) assume 1% for the slow-growth scenario, and 1.7% for a rapid-growth scenario. The OECF projection assumes that grain land area and yield per unit of land will continue to grow annually at 0.05% and 1.75%, respectively, as they did in the period 1984–93 (OECF 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 and Rozelle (from 0.7% in 1991–2000 to 1.4% in 2000–2010 and 1.6% in 2010–2020), which is less likely, considering rising opportunity cost of labour and land.

Table 11. Trade implications of the projected demand for food and feed grains for China under various scenarios to 2020.

	Food grain (mt)				Feed grain (mt)				Total grain (mt)			
	1995	2000	2010	2020	1995	2000	2010	2020	1995	2000	2010	2020
Demand												
1. Low feeding efficiency scenario												
Income growth by 8% a year	286[a]	284	239	177	194[a]	239	346	466	480	523	585	643
Income growth by 10% a year	286[a]	280	221	151	194[a]	249	385	548	480	529	606	699
2. High feeding efficiency scenario												
Income growth by 8% a year	286[a]	284	239	177	157[a]	193	279	377	443	477	518	554
Income growth by 10% a year	286[a]	280	221	151	157[a]	201	311	443	443	481	532	594
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	n.a.	1.1	0.5	0.6
End-period supply	286[b]	284	239	177	181c	210	282	378	467[e]	494	521	555
Balance												
1. Low feeding efficiency scenario												
Income growth by 8% a year	0	0	0	0	–13	–29	–64	–88	–13	–29	–64	–88
Income growth by 10% a year	0	4	18	26	–13	–39	–103	–170	–13	–35	–85	–144
2. High feeding efficiency scenario												
Income growth by 8% a year	0	0	0	0	24	17	3	1	24	17	3	1
Income growth by 10% a year	0	4	18	26	24	9	–29	–65	24	13	–11	–39

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 mt).
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.

These assumptions vary greatly. Data constraints are one important reason for the variation but also, in a rapidly growing economy, there are offsetting forces, the relative importance of which is difficult to judge without more detailed modelling work. The previous section of this report identified a number of policy changes which could make a contribution to productivity. A more detailed assessment of their impact is also a topic for further work.

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 stressed.

Here we assume that in 1995 demand for food grain was met in net terms by local supply 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.[30]

We assume that the annual growth rate of feed-grain production is assumed to be 3% throughout the projection period, based on the growth of maize output in the past 10 years.

Under these assumptions, China's total grain supply in the year 2000 will be 494 mt as projected in Table 11, very close to the government's 500 mt target (see Luo 1995, 1996). The implied annual total grain output growth will be about 1.1% over this period, slightly higher than the growth rate of 0.9% achieved since the reform. This rate falls to about 0.5–0.6% 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 mt a year by 2010 and 555 mt a year by 2020.

The trade implications in quantity terms will rely on the choice of economic growth and feeding efficiency scenarios.[31] If the 8% income growth rate is chosen, under the low feed efficiency scenario, China needs feed grain imports of 29 mt a year by 2000, 64 mt a year by 2010, and 88 mt 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% to reflect some improvement in feeding efficiency, China will still need feed imports of 22 mt a year by 2000, 48 mt a year by 2010 and 66 mt a year by 2020.

These projections for total grain are summarised in Figure 11 which illustrates the sensitivity of the projections to assumptions about feeding efficiently and about income growth.

Comments on the projections

We concentrate here on the outlook for China's feed grain imports and demonstrate the sensitivity of the projections to changes in income growth, and to the efficiency of feed use. The projections also incorporate a more accurate assessment of population growth compared to other studies, and also take into account the impact of changes in the structure of the population. Feed grain imports could be nearly 90 mt 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, such as:

- 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. This highlights the sensitivity of the projections to key parameters in the feed grain markets.

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

[30] 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 foodgrain-producing regions of China and the offsetting effects of new technologies. In that case our assumption of food grain self-sufficiency could be met only 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.

[31] 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.

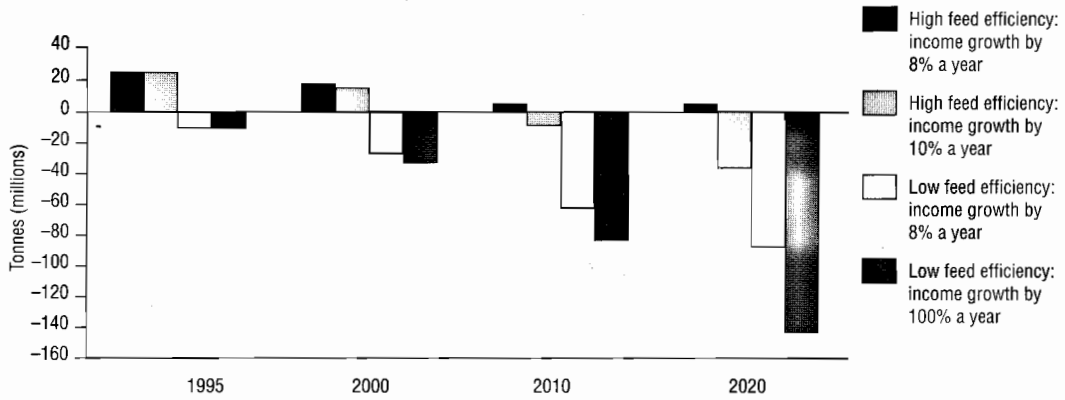


Figure 11. Grain trade scenarios: net exports to 2020.

grain sector, for example, and a less restrictive meat sector policy will lead to a larger volume of meat imports.[32]

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.

[32] 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 applying a degree of improvement in feed use efficiency, then feed grain imports could be replaced by 3.7 mt of red meat or 6.3 mt of poultry a year by 2000, 8 mt of red meat or 13.7 mt of poultry a year by 2010, and 11 mt of red meat or 18.9 mt of poultry a year by 2020, or apparently any combinations of the red and poultry meats.

5. Policy Outlook

Factors influencing the outlook for grain policy

From the producers' point of view, the growth in purchase prices after the market crisis of 1993 represented only a necessary recovery of the increases in production costs in recent years. But producers are faced with a government which tries to enforce deliveries to the state at administratively determined prices, and a grain bureau system that is subsidised but attempts to maximise its trading profits. Not surprisingly, therefore, producers are beginning to look toward higher prices from market traders, holding on to stocks to affect market prices, and trying to process more output for themselves in order to capture the value added.

From the household consumer point of view, growth in incomes and the shift to quality foods have made basic grain prices less significant. But consumers are concerned about inflationary expectations and have growing real incomes. While current overall output may be close to total demand (Zhu Xinwu, 1995), the regional distribution and output mix is not. Quality grains and grains in short supply are thus likely to increase in price, while poor quality grains will have a poor market. There is already a broad perception that the grains people want to eat are only available at higher prices on the free market, and that the state-supply of grain is not welcome. Furthermore, as grain prices rise, the prices of processed foods and meat also rise, though often at rates substantially above those of raw grain. Particularly sensitive consumers such as students, the unemployed, people on low and fixed incomes and the army are also likely to exert political pressures. These dilemmas invite government administrative intervention, even though that intervention may not solve the underlying problem.

To grain bureaus, the state-owned organisations in the grain distribution system, the underlying problems of the 1990s remain clear. These are being asked to become more efficient and more profitable, yet at the same time are expected to carry out policy roles which need subsidies and may not reflect market pressures. They are thus in a position to trade between plan and market roles to maximise profits, and to find their commercial aims conflict with the policy role. They may seek to increase prices in order to improve profits, when they are being asked to sell grain cheaply in order to bring down costs. They may prefer to use capital for higher-value trading than in building and holding stocks of grain for market stabilisation policies. Their position is thus a confused one. It also faces different pressures at the purchasing end (where prices may have to rise in order to obtain any stocks at all) and the selling end (where government pricing measures, consumer demand and market supplies may exert contradictory pressures).

Finally, the problems of the relationship between production and consumption regions and central and local government continue to play a role. The production regions tend to have lower incomes and smaller budgets. They want to maximise their profits and revenues from grain. The consumption regions are anxious to maximise any subsidies for grain supplies and to minimise any costs of purchase. And the central and local governments dispute the relative shares of subsidies and costs of maintaining the managed part of the grain system.

Overall, therefore, China's grain system reform is still constrained by the fundamental issues of the government's concerns for urban consumers, the pressures to maintain stability in supplies and prices, and constraints on involvement in world trade stemming from the self-sufficiency goal.

Reactions to these forces of political economy have led to considerable debate in China on grain sector policy and to a variety of positions on trade and

other aspects of grain marketing policy. Elements of these positions include the following:

- *Trade can only be used to fix the grain mix*
  The role of trade is to adjust the mix of grain types available in China, e.g. by exporting maize and rice while importing wheat, while overall a high degree of self-sufficiency is maintained, China, because of its size, cannot rely on the world market.
- *Domestic market integration is the key issue*
  A greater degree of self-sufficiency will be possible, and the role of imports reduced, if the government withdraws from regulation of the domestic market and encourages the integration of the market within China.
- *There has been too little investment in research and development*
  There are significant returns to further investment in research and development that will raise the degree of self-sufficiency by raising yields of both grain output per unit of land area and of meat and other products per unit of feed.
- *Output would increase if the production system was reorganised*
  The most important domestic reform is the redesign of agricultural production systems so as to yield greater scale economies.
- *Grain market issues are macro-policy issues*
  The link between macroeconomic performance of the Chinese economy and movements of grain prices is the current key issue.

Mei's 1995 set of projections provides an example of one view of policy makers in China on prospects for the grain trade. The share of imports in consumption remains tiny. While consumption continues to grow rapidly, there is substantial scope, in Mei's view, to increase grain output. Luo (1995) makes a similar set of observations concerning the scope for output growth. Contributors in Mei's case include mainly return to research and development. Investment in research and development also plays a key role in promoting output growth in the IFPRI projection.

Guo (1995b) provides an example of the view that stresses gains from domestic market reform. He argues for a liberalisation of the state purchase price, the extension of subsidies to producers for inputs, the development of a national grain market and separation within the market of administrative and commercial functions, a 'balanced' trade in grain (exports and imports offsetting), and special provision for low-income households to have access to grain. People supporting this position stress the role of government as managing some sort of reserve scheme or stabilisation mechanism (see Tang Renjian, 1995).

The analysis by Brown (1994) summarised above reinforced the position of those who are concerned about China's reliance on world markets for grain. World grain trade is currently of the order of 200 mt. Brown was forecasting imports by China of at least that (by 2030) and possibly of twice as much. This perspective has been challenged. China may well be a relatively large trader but what matters is: (a) the comparison of its consumption with world consumption, and (b) the supply response from the rest of the world following the growth in China's imports. A protectionist policy is actually more likely to be destabilising in the domestic market than is a strategy of combining domestic supply with the larger supply from the world market.

Some commentators in Beijing now accept, however, that imports will increase — the OECF 1995 report, conducted in conjunction with MoA officials, appears to have had some impact. The debate in this case moves on from outright rejection of use of the world market. The issues instead are the ability of China to export other products to earn the foreign exchange required to pay for grain imports, and the composition of the imports of grain, in particular, the choice between food and feed imports.

The link between grain prices and inflation has been a topic for debate in China and the issue has had some influence on policy.

One view being argued in Beijing is that the price of grain is a key component of movements in the general price level. Rising grain prices in other words lead to higher inflation rates. The policy implication drawn from this model is that grain prices should continue to be capped, or caps should be applied when appropriate. Price caps, however, can only be enforced alongside the reconstruction of the a marketing system in which state intervention and coercion play key roles.

This argument is assessed by Johnson and Song (1995) who argue that the more important relationship operates in the opposite direction. They argue that changes in the general price level can affect the relative prices of some commodities. The mechanism is that when households expect the rate of inflation to be high or increasing, they increase their grain stocks. Supply of grain in the market is reduced when stocks

increase and the price of grain rises (in both nominal and real terms). Grain stocks are held as a hedge against inflation in the absence of well-developed alternative forms of holding wealth. The use of grain for this purpose does affect grain prices in China: however, this effect would not be observed if domestic and international prices were more closely connected. Guo Shutian (1995b) also argues that the source of inflation is the level of investment in fixed assets, and that grain price rises merely reflect the response to this situation.

The implication of the Johnson and Song model is that intervention to cap grain prices will actually make worse the situation that the intervention is trying to control. Intervention of this type reinforces the expectation of higher future inflation rates. Grain stocks are further increased and the price of grain in the market place rises yet again.[33]

The analytical aspects of these positions and the forces from the interest groups reviewed above are boiled down in the political process to produce a grain sector strategy. In their review of the emphasis in policy shifts over time, Garnaut, Fang and Huang (1996) identify what they call a turning in the Chinese policy debate on grain marketing arrangements.

Turning point?

Garnaut, Fang and Huang argue that previous policies which discriminated against agriculture are coming to an end. They go further to argue that there is a possibility that the Chinese will follow other high-income Northeast Asian economies into a regime which provides subsidies to producers. This policy could be operated by raising border prices of importable agricultural inputs, by the imposition of tariffs and quotas, rather than by paying explicit fiscal subsidies.

A change in policy in the direction of protection is a common one (see Anderson and Hayami, 1986). There is a strong positive correlation across a very large number of economies between the rate of change in discrimination in favour of farmers in agricultural pricing policy and (a), the growth of the level of incomes and (b), the loss of agricultural comparative advantage. Contributors to this outcome are the differences in the costs of collective action by various interest groups in the policy-making process.

At the early stages of development, farmers face relatively high costs compared to urban employers and their workers. The result is a food pricing policy biased in favour of consumers. But as development occurs, these relative costs change and the policy regime shifts.

Garnaut, Fang and Huang observe data which show domestic prices of maize crossing over world prices (see Figure 1). They note in other East Asian economies the pattern of policy development, which is characterised by rapid increases in the rate of agriculture sector protection, and argue that in real terms China's income per head is now at levels similar to those at which the East Asian economies started to accelerate the protection of agriculture. So they say 'this is suggestive at least that this may be a time when China might face pressures to turn from taxing to subsidising agriculture'.

A fundamental factor associated with this tendency is the loss of comparative advantage in agriculture which occurs as a result of the growth in incomes, and the accumulation of factors of production used intensively in other activities such as manufacturing. The implications of this process for grain output were noted earlier. Shifts in output mix are also reinforced by reforms in the non-agricultural sectors; again, the development of markets for industrial products is an example. Others are the freeing-up of the foreign exchange market, the demonopolisation of the trading system, and the reduction in the use of quantitative restrictions on imports and exports, as well as the general reduction in the schedule of tariff rates. The benefits to producers of border protection for their products also depend inversely on the extent to which similar policies are applied to industries that produce agricultural inputs. For example, highly protective arrangements for other sectors such as energy or steel would reduce the gains to producers from agricultural protection.

Events in the world market also matter — for example, the removal of the multifibre arrangement, and China's eventual accession to the WTO, would also strengthen China's comparative advantage in manufacturing. WTO accession would also have implications for the protection which China could apply to the agricultural sector.

An important part of the political equation — the loss of agricultural comparative advantage — is

[33] Of course, the relationships could operate in both directions. Cheng Yuk-shing (1995) has argued that an upward spiral in the general price level can be triggered by an increase in the foodgrain price, in consequence of a wage indexation mechanism built into a model which he has constructed. This model also highlights the relationship between changes in grain prices and farmers' stockholding decisions.

certainly present in the Chinese case. There are, however, some substantial regional variations in the rate at which agriculture is losing its comparative advantage. The implication is that political pressure for a reversal of pricing policy is likely to vary between provinces.

A further qualification to this analysis is the extent to which China can increase yields (per unit of land area) in grain production (see Section 3). The various projections differ in their assessments of the scope to increase output, despite the pressure to reallocate arable land areas to other uses. Greater scope to raise yields will reduce the urgency with which other strategies designed to achieve a greater degree of self-sufficiency are pursued.

Garnaut, Fang and Huang also note some qualifications to the possibility of rising agricultural protectionism. China has relatively much larger endowments per capita of agricultural inputs than those of other East Asian economies. Agriculture's share of the Chinese economy is much higher than it was in other East Asian economies when protection accelerated. The share of the agricultural labour force in the total is also relatively high. These characteristics are offsetting factors in the political economy processes, which stress the ability of producers to organise to form an effective lobby and in which the burden on consumers of the transfers involved is a key parameter. Consumer willingness to pay the taxes on agricultural products depends on their significance in consumer budgets. The shifts in consumption bundles and the falling food share in income combine to reduce the significance of agricultural output taxes in consumer incomes.

A vision of Chinese food security[34]

China over the period of economic reform has enjoyed large benefits from movements part of the way toward the use of markets for the allocation of resources and distribution of commodities in the agricultural sector. It has enjoyed an increase in the value of agricultural output from greater specialisation in each locality or region (Lin 1996). Production has also increased from more efficient allocation of scarce inputs across and within agricultural activities.

China's people have enjoyed an expansion in consumption possibilities across regional and seasonal specialities, through growth of wholesale markets and long-distance trade (Xu 1996; Watson 1996). Market exchange and long-distance trade have contributed to stabilisation of the availability of food in each area, balancing with less cost and risk the inevitable variation in agricultural production. Also, the internationalisation of agricultural markets, despite being limited in extent, has given China a taste of the advantages that would come from going further: the role that larger grain imports took in dampening domestic price increases in 1995 and the contribution that large variations in cotton imports and exports have played in balancing fluctuations in domestic supply.

Each of these benefits has been limited by the highly constrained and cyclical nature of the movement towards a market economy. Local governments have placed myriad barriers against inter-regional trade within China, now reinforced by a return to emphasis on a high degree of regional self-sufficiency in grain. The price movements, which are central to the role of markets in equilibrating supply and demand for agriculture commodities, have been constrained from time to time by the re-imposition of controls and state purchase requirements. Officials have observed the rising or falling prices of markets at work, encouraging or discouraging production and consumption, and concluded that markets are not working. The role of markets in allocating agricultural inputs has been limited. Also, integration into international markets is greatly limited by central controls and the policy roles of state trading enterprises.

How would the completion of the process of market reform and integration into the international economy affect Chinese agriculture? How would a thoroughly market-oriented Chinese agriculture come to look? What additional improvements would be achieved in Chinese economic performance? What problems could be expected to arise?

To pose these questions is not to presume that the completion of market reforms would be easily, smoothly or cheaply achieved. Indeed, the stops and starts, the periodic retreats and the incomplete movements forward in the reforms are testimony to the difficulties experienced to date. Vested interests in central and local bureaucracies and interest groups which stand to lose from changes that bring benefits to the country as a whole have demonstrated that they have important roles in decision-making. Nevertheless, to answer the questions about the effect

[34] This section is an edited version of parts of Garnaut (1996).

of full movement to market exchange in the agricultural sector is to provide for the Chinese who hold responsibilities for the national interest a guide to the gains to be had from overcoming pressures from sectional interests.

A Chinese agricultural economy in which allocation and distribution were regulated by internationally open domestic markets would produce more economic value (with inputs and outputs appropriately measured in international prices). Some land that is still locked by regulatory arrangements into grain production would shift into higher-value cash crops of various kinds. Fertiliser production would expand until further increases were no longer justified by factory profitability at market prices; fertiliser use would expand until no further increase would raise farm profitability at market prices; and the market would allocate fertiliser to those activities that could use it profitably at market prices (Zhang and Zuo, 1996). Inter-regional specialisation and exchange would increase: in each locality, production of some items would expand and some contract.

Such an agricultural economy would be able to handle at lower cost, and with less price instability and less political tension, the fluctuations in demand that are inevitably associated with the cycle of weaker and stronger incomes growth, and the variation in supply deriving from flood, drought and other movements in seasonal conditions. The stocks held in one region would be varied in response to expectations of price movements in others, or in the country as a whole. There would be some balancing of excess demand for some product in one region with excess supply in others, diminishing the extent of equilibrating price movements in both.

In a Chinese agricultural economy the parts of which were linked to each other and to the rest of the world through markets, there would be large regional variations in prices of agricultural products, reflecting differences in economic conditions and high costs of transport and exchange. Some regions would have large surpluses of grain above the requirements of domestic production, with lower food prices, and strong advantages as locations for processing industries. Prices would be higher in provinces with poorer per capita endowments of agricultural land — in some cases perhaps above international levels. Prices in the major coastal cities would be closely linked to international levels, influencing prices throughout China only when domestic conditions tended to move local prices away from international levels to an extent beyond the bounds of China's high internal transport costs.

Internationally, specialisation and trade would also increase, with production in China tending to fall and net imports to rise of commodities that use land relatively intensively. Production would tend to rise and net imports to fall at least for a number of years, for relatively labour-intensive agricultural products. It would probably be the case that net imports of grain would rise and net exports of at least some other foods rise at the same time.

The internationalisation would ease price instability associated with fluctuations in demand and supply within China of particular commodities or of total agricultural output.

China would share in the changes in prices, consumption and incentives for production that would follow from a large surge in demand or shock to supply anywhere in the world. Because the adjustment was spread so widely, some shocks would cancel out each other. The residual effect of any shock would generate proportionately smaller economic fluctuations in each part of the international system than it would in the region of primary impact if that region were closed to the rest of the world.

In a Chinese agricultural economy linked to the rest of the world through markets there would be important national international roles for government.

It is a mistake to think of an efficient market economy having none or a minimal level of government intervention, in agriculture at least as much as in other areas of economic activity. An efficient, market-oriented agricultural economy would assign a larger role to government in China than exists at present in some activities, and a smaller role in others. A larger role is required in setting and enforcing the commercial laws of commodity exchange, in the retail, wholesale, futures and other markets (Xu 1996). A larger and more effective role for government is required in agricultural research, extension, and provision of infrastructure including irrigation services. The role of government would diminish in setting and controlling prices, levels of foreign trade, and the amount of commodity composition of production.

Government roles, too, would be important in establishing conditions for efficient international cooperation. The arrangements between states that govern international trade would need to promote

confidence in secure supply. The role of government in research to extend the technological frontiers of agricultural production is often efficiently performed internationally, as there are large international spillovers from research activity. The international systemic benefits of China's opting for free trade in agriculture also justify some special efforts of international cooperation that increase incentives for China to move in this direction.

Detailed empirical research is required to define in more detail the shape of a market-oriented Chinese agricultural economy. In the nature of things, there would be surprises, although there is no reason to expect the surprises to be more bad than good. Nevertheless, uncertainty about outcomes generates concern about adverse development, and caution in reform.

In 1987, in the course of a long interview subsequently published in full over successive editions of the *World Economic Herald* in Shanghai, Ross Garnaut responded to questions about the future of Chinese reform with examples from agricultural policy.

'If China retains its current level of self-sufficiency in food and other agricultural products', he was accurately recorded as having said, 'China's people will have to accept a standard of living that is in some important respects low, even when the economy is productive in other ways. Much better results for the Chinese people would be possible if domestic price reform for agricultural products were accompanied by much closer links between domestic and international markets. With this solution, workers could enjoy the higher overall standard of living that they will expect to accompany successful modernisation in China'.

These and related comments gave rise to discussion among senior members of the Chinese Government. Garnaut (1996) refers to the views of Mr Du Runsheng who (in 1987) was Director of the influential Research Centre for Rural Development, following a long and distinguished role in agricultural policy, including in relation to the reforms starting in 1978. According to Garnaut, Mr Du identified two concerns. First, would an open Chinese agricultural policy generate net imports of grain that were so large that they led to a substantial increase in world prices, reducing radically the gains from trade for China, and creating problems for poor grain-importing developing countries elsewhere? Second, would the additional foreign exchange requirements of an open agricultural policy be larger than China could expect to be able to meet securely by expansion of labour-intensive manufactured goods?

The answer to the first question required answers to several others. How would Chinese demand and production expand in the course of future reform and economic growth? How would these developments be affected by changes in prices? What prices would need to be offered in international markets to induce the expansion of production that would be necessary to meet the requirements of an open Chinese agricultural policy?

The answer to the second question required assessment of China's capacity to supply manufactured goods competitively onto world markets, and of the rest of the world's capacity and willingness to absorb the required additional amounts of Chinese manufactured goods.

The consequences of integrating Chinese and international markets for agricultural products have been discussed a great deal in China and abroad since those early conversations. Three other major concerns about deep integration into international markets have been frequently raised in China. Would the incomes of farmers and the rural population generally be lower within an open agricultural policy? Would high levels of food imports make China vulnerable to decisions by supplying countries to restrict trade for political reasons? And would food prices be more unstable if there were deeper integration into the international agricultural economy? Generally concern has focused on the grain situation, and especially on good grain, rather than food generally, reflecting China's long history of concern for security and price stability in grain supply.

Du Runsheng was deeply concerned for farmers' incomes, and in 1987 was mindful of several ways in which the opening of the Chinese agricultural economy to international trade would be favourable for income distribution. There was considerable scope for raising farmer incomes through greater internal specialisation within a domestic market economy, and through greater export specialisation in some labour-intensive agricultural products that were likely to expand in an open economy. Further, in 1987, domestic grain prices were well below international levels, so that internationalisation was likely to lead to higher farm prices.

Grain and other agricultural products

Lu Feng (1996a) has broken new ground in analysing the relationship between changes in the net exports of grain and of other agricultural products in the process of thorough-going market reform and integration into the international economy. Lu's analysis leads him to the view that an open trade policy in China, supporting specialisation in line with comparative advantage, is likely to lead to China becoming a large net importer of grain, but not a large net importer of food. Net imports of grain would be balanced to a considerable extent by net exports of their foodstuffs. Free trade is unlikely to generate a monotonic decline in the 'self-sufficiency' ratio for all food, 'let alone the alarming scenario of China starving the world'.

Lu presents data that demonstrate that China's comparative advantage is much stronger in fruit and vegetables, aquatic products and meat than in grain. China has a very low per capita endowment of arable land compared with the rest of the world, with about 22% of global population and only about 7% of global arable land. The relatively high proportion of China's work force still in farm employment makes the relative scarcity of land even more acute. At the same time, China has a relatively low per capita endowment of capital, with a long history of urban bias making the relative scarcity of capital even more acute in rural areas. Vegetable, fruit, meat and aquatic products are much more labour-intensive than grain. Fruit and vegetables utilise almost five times as much labour per acre of land as grain. Meat and freshwater fish utilise much labour and little arable land. In addition, demand for labour in grain is highly seasonal, and the other food production can be organised to increase demand for labour in off-peak times. Moreover, some of the other foods can utilise land that is unsuitable or marginal for grain production.

Lu observes that for all of these reasons, China's comparative advantage is, as the currently relevant margin, generally much stronger in fruit, vegetables, meat and aquatic products than in grain. The value of farm production, valued at international prices, would be greater to the extent that resources were shifted from grain production to other foods.

Lu demonstrates that his propositions have an empirical and not merely a theoretical basis by examining Taiwan's participation in international food trade in the course of its rapid industrialisation from the 1960s. Taiwan, like the Chinese mainland, only more so, began its rapid economic growth with relative abundance of labour and relative scarcity of arable land. As industrialisation absorbed labour from the countryside, farm labour per unit of land became less abundant, and is now much lower than the mainland, while remaining considerably higher than in other advanced economies. As is now expected for mainland China, Taiwan's net imports of grain increased rapidly with industrialisation and integration into the international economy, despite increasing rates of protection for rice production. From a small net exporter of cereals in 1965, annual net imports of grain were around $US one billion in the early 1990s and $US 1.2 billion in 1995. Net imports of dairy products also rose to about $US 250 million.

Over this same period, net exports of fruit, vegetables, aquatic products and meat rose rapidly. Taiwan's overall food self-sufficiency in calorific terms declined from well over 100% in the 1960s to about 40% in 1990. Remarkably, in *value* terms Taiwan remained a net exporter of food, albeit by declining amounts, until the 1990s. Net export revenue from fruit and vegetables peaked in 1980 and aquatic products at around $US one billion in 1990. Net exports of meat continued to rise through the 1990s to $US 1.35 billion in 1995.

Overall, Taiwan's net exports of food have declined late in its industrialisation process as real labour costs have increased. Taiwan now would have considerable comparative disadvantage relative to the mainland in many food products of which it remains a net exporter.

Lu notes that the partial internationalisation of China's food economy is already generating patterns of trade that resemble Taiwan's at an earlier stage in its own rapid growth. Grain and sugar imports have reached new peaks in the mid-1990s, with the highest level of net grain imports in 1995 at 20 mt. At the same time, net exports of all food have increased from near zero early in the reform period to $US 2.3 billion in 1985 and $US 3.8 billion in 1995. As in Taiwan, net exports of meat, fruit, vegetables and aquatic products have grown especially rapidly.

Lu acknowledges that more research is required to define the likely pattern of overall food trade in the process of rapid growth and internationalisation of the Chinese economy. He nevertheless is able to conclude that Chinese specialisation in line with comparative advantage is likely to generate high levels of other food exports alongside grain imports, easing the process of adjustment to internationalisation in the Chinese countryside.

Food security: self-sufficiency or international cooperation

We conclude by returning to the question raised by Du Runsheng and others, about the effects of integration into the world economy. Should increases or instability in world prices, shortages of foreign exchange, vulnerability to political blackmail, or concern about farmers' incomes inhibit movement toward greater use of markets in domestic or international trade? Would greater use of markets, including the world market, lead to more or less food security?

None of the recent work on the Chinese grain economy raises doubts about the presumption that the removal of barriers to internal and external trade will increase average output and incomes in China. The economic growth, to which trade liberalisation would contribute, strengthens food security by deepening the margins between consumption and subsistence.

Recent work has tended to raise expectations of gains in economic efficiency and output from greater regional and national specialisation within the grain sector.

Is there a danger of greater specialisation in international grain trade lifting world prices to levels that negate the gains? That depends on likely levels of net imports (and therefore of production and consumption) at various grain prices, and on the international supply and demand responses to variations in world prices.

On Chinese grain supply, earlier expectations that grain production would be highly sensitive to price increases have been borne out in the experience of the mid-1990s. Research reviewed above has indicated considerable technical capacity substantially to raise yields with current frontier technology, but has not yet thrown much light on the economic costs of unlocking this capacity. The evidence suggests that considerable public investment is warranted in research related to extending the technological frontier, in adapting to Chinese conditions innovations from abroad, and in extension to assist farmers to move closer to the technological frontier. Some combination of increased public and private investment in locality-specific research to define best practice is justified. What would these measures do to total supply? The measures appear necessary to raise total output in line with population over the next decade.

Total demand growth for grain has been interrupted and obscured by massive changes in relative prices in the first half of the 1990s. Relative prices could continue to increase, slowing consumption growth, if China continues down the path of Northeast Asian protectionism, or if world prices remain well above the levels of the early 1990s and continue to rise. Otherwise, strong demand growth along the lines of mainland China in the 1980s or Taiwan from the mid-1960s to mid-1970s can be expected.

Virtually all analysts now expect high and rising levels of net imports under 'free trade' assumptions, from the considerable (well above last year's 20 mt) to the startlingly large. The serious modelling and informed eclectic analysis suggest that the international economy can meet the range of possibilities without increases in world prices that are so large as to seriously diminish Chinese gains from trade. The large and rapid global grain supply response to the temporarily high prices of the mid-1990s underlines the point.

Short-term world price instability is perhaps a greater concern. However, inspection of the data reveals that in recent years of high world price instability, Chinese domestic prices have varied even more widely. World grain markets will become more stable as more large grain economies, China most important of all, are integrated into them. Nothing in recent analysis or experience weakens the economists' presumption that a wider, global market is likely to be more stable than an efficient domestic market.

Foreign exchange concerns are less important in Chinese grain policy discussion now than in the 1980s. Chinese labour-intensive industry has sustained strong export growth over long periods. International markets have revealed a considerable capacity for adjustment, and the regional and international trade environment looks more favourable for the accommodation of increased Chinese exports than at any time in the reform period.

The modelling, empirical examination of Chinese comparative advantage and the experience of comparable economies suggest that farm incomes are likely to be higher with free trade than with 'self-sufficiency'. Lu Feng's work suggests gains for farm incomes beyond those previously anticipated, through respecialisation in labour-intensive activities. It should be noted as well that grain protectionism would diminish opportunities for potentially large exports of grain-intensive on-farm and processing activities that utilise farm and other rural labour.

The concern about political conditions being attached to grain trade has deep roots in China's history of the past half-century. It is worth examining carefully the experience of food sanctions in the post-war period, and analysing the realities of China's vulnerability. The United States of America, during the height of the Cold War, was unable to stem the flow of grain from its alliance partners (variously Australia, Canada and the countries of Western Europe) to China (the early 1960s) or the former Soviet Union (the late 1970s). There is currently considerable diversification of the sources of grain supply into the world economy, and this will continue with reform in South Asia, Latin America, Eastern Europe and the former Soviet Union. All the serious economic analysis suggests that, under free trade, Chinese domestic grain production would be well above the requirements of subsistence, and a smoothly functioning domestic market would facilitate adjustment to the highly unlikely restriction of supply.

If there is continued concern about the political reliability of international grain supply, various steps could be taken to reduce the risk. The mutual interest with supplying countries could be expected to generate cooperative approaches. One option might be to establish supply security provisions in multilateral and bilateral trade agreements. A first step could be to examine whether rules on export embargoes that now apply in the WTO[35] would be sufficient to meet China's concerns or whether a strengthening is required. Another step is to establish and agree to a set of non-binding principles relevant to food supply security in the APEC process. Perhaps even more convincingly for China, supplying countries could be asked to make a proportion of sales to China from locally held stocks, which would come under Chinese control in the event of irreconcilable breakdown in political relations.

The mutual interest in Chinese grain trade liberalisation suggests other international cooperation. Internationalisation of grain markets would be more productive for China if world markets especially for labour-intensive foodstuffs were opening-up at the same time. The effective coverage of agriculture in the APEC free trade commitments of Japan, Taiwan and Korea is of special importance.

Finally, in the context of mutually beneficial Chinese grain trade liberalisation, it would be reasonable for China and its partners to expand cooperation in international public-good research in agriculture. The ACIAR programs in China are one mode.

[35] Article XI of the GATT rules out quantitative restrictions on exports, with some exceptions, and Article XIII rules out discriminatory application of such restrictions.

References

Anderson, K. 1987. On why agriculture declines with economic growth. Agricultural Economics, 3, 1, 197–207.

Anderson, K. and Hayami Yujiro, 1986. The Political Economy of Agricultural Protection. Sydney, Allen and Unwin.

Anderson, K. and Peng Zhaoyang, 1996. The challenge of feeding and fueling China in the 21st century. Paper prepared for the China Department of the World Bank.

Anderson, K., Dimaranan B. Hertel T. and Martin W., 1996. Asia–Pacific Food Markets and Trade in 2005: a global, economy-wide perspective. Seminar Paper 96–05, Centre for International Economic Studies, University of Adelaide, July.

Brown, L. R. 1994. Who will feed China? World Watch, September–October, 10–18.

—— 1995. Who Will Feed China?: Wake-up Call for a Small Planet. New York, WW Norton.

Carter, C. 1995. Research on institutional reform and agricultural productivity growth in China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Carter, C. and Zhong Funing, 1988. China's grain production and trade: an economic analysis. Westview Special Studies on China, Westview Press Boulder.

Chen, L. and Buckwell A. 1991. Chinese Grain Economy and Policy. Melksham, Redwood Press Ltd.

Chen Xiwen 1995. 'Supply, demand and prices of grain In China', Chinese Rural Economy, 1, 3-8.

Cheng Enjiang, 1995. 'Financial issues and the forces for grain marketing reforms in China', CERU Working Paper, No. 94/13.

—— 1996. Household heads, non-economic factors and grain production in China in the 1990s. The conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Cheng Enjiang and Findlay C. 1995. Trade reforms and the integration of China's domestic and international markets since the mid 1980s — the case of wheat and maize. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Cheng Enjiang, Findlay C. and Watson A. 1996. Internal reform, budget issues and the internationalisation of the grain market in China. In OECD, Agricultural Policies in China, Paris OECD, 1997.

Cheng Enjiang, Nguyen Tin and Findlay, C. 1996. Economic efficiency of fertiliser use in Guangdong and Jiangxi provinces of China. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Cheng Yuk-shing, 1995. Food grain stocks, wage indexation and inflation in a semi-industrialised economy: the case of China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Chinese Academy of Agricultural Sciences 1988. Zhongguo Liangshi zhi Yanjiu [Research on China's Grain Issues]. Beijing, Chinese Agricultural Scientific and Technological Publishing House.

Crook, F. and Hunter Colby W. 1996. The future of China's grain market. Agricultural Information Bulletin Number 730, USDA, October 1996.

Dong Suocheng, 1996. On China's grain demand-supply and its regional changes. Mimeo, Commission for the Integrated Survey of Natural Resources, Chinese Academy of Sciences and the State Planning Commission, Beijing.

Du Shougu, Liu Yu and Guo Xiaoming, 1995. Grain: Empirical analysis and assessment. Nongcu Jingji Wengao [Rural Economic Papers], 10, 16–23.

Du Xiaohong, Sun Liwei and Xu Mingde, 1996. 'Protection or Internationalisation', Essay submitted for the Graduate Diploma in International Economics and Trade, the University of Adelaide.

Editorial Commitee of the Prices Yearbook of China, 1995. Prices Yearbook of China, 1995, Beijing, China Statistical Publishing House.

Fahlbeck, E. and Huang Zuhui, 1996. The property right structure of farmland and family farming in China: an analysis of developing options. Paper presented to the workshop on agricultural policies in China, OECD Headquarters, Paris, December (SG/CHINA/CA(96)10).

Fan Shenggen, 1996a. Public investment in rural China: historical trends and policy issues. Paper presented to the workshop on agricultural policies in China, OECD Headquarters, Paris, December (SG/CHINA/CA(96)14).

—— 1996b. Research investment, input quality, and the economic returns to Chinese agricultural research. Paper presented to the workshop on agricultural productivity and R&D policy in China of the conference conducted by the Crawford Fund for International Agricultural Research on Global Agricultural Science Policy for the Twenty First Century, Melbourne, August.

Findlay, C. 1997. Grain sector economic reform in China. Paper was prepared for presentation at the Australian Agricultural and Resource Economics Society Conference, Gold Coast, January.

Findlay, C. and Watson A. 1996a. Economic growth and resource dependency in China. Chinese Economy Research Unit, Working Paper 96/5.

—— 1996b. Food and profit: the political economy of grain market reform in China. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Findlay, C., Watson, A. and Wu, Harry X. 1994. Rural Enterprises in China. London, Macmillan.

Findlay, C., Martin, W. and Watson A. 1993. Policy Reform, Economic Growth and China's Agriculture. Paris, OECD.

Food Study Group, 1991. A Study of Medium- and Long-term Strategies of Food Development in China. Beijing, Agriculture Press.

Gaag, J. van der, 1984.. Private household consumption in China: A study of people's livelihood. World Bank Staff Working Papers, 701. Washington D.C., World Bank.

Gao, R. (ed.) 1990. Symposium of China's Fishery Economy. Beijing, Agriculture Press.

Garnaut, R. 1996. Food security in China: self-sufficiency or international cooperation. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Garnaut, R. and Ma Guonan, 1992. Grain in China. Canberra. East Asian Analytical Unit. Department of Foreign Affairs and Trade.

Garnaut, Ross and Ma Guoanan, 1996, 'China's grain demand: recent experience and prospects to the year 2000'. In Garnaut R., Guo Shutian and Ma Guonan (ed.), The Third Revolution in the Chinese Countryside, Cambridge: Cambridge University Press.

Garnaut, R., Cai Fang and Huang Yiping, 1996. A turning point in China's agricultural development. In Garnaut R., Guo Shutian and Ma Guonan (ed.), The Third Revolution in the Chinese Countryside. Cambridge, Cambridge University Press.

Guo Shutian, 1988. Zhongguo Liangshi: Duojiaodu Yanjiu yu sikao [Grain in China: different perspectives]. Beijing, People's University Publishing House.

Guo Shutian, 1995a. The evolution of the grain distribution system in China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

—— 1995b. Liangjia shang zhang bing fei tonghuo pengzhang de yuantou [The rise in grain prices is not the source of inflation]. In: Jiage Lilun yu Shijian [Price Theory and Practice], 11, 14–16.

Huang Jikun, 1994. Income growth and changes in rural rice consumption. Nongcun Jingji Wenti [Rural Economic Problems], 1994, 8, 49–52.

Huang Jikun and Bouis, H. 1995. Structural changes in demand for food in Asia. Food, Agriculture and the Environment Discussion Paper, International Food Policy Research Institute, Washington D.C.

Huang Jikun and David, C.C. 1993. Demand for cereal grains in Asia: the effects of urbanisation. Agricultural Economics, 8, 107–124.

Huang Jikun, and Rozelle, S. 1994. Income, quality, and the demand for food in rural China. Working Paper, Food Research Institute, Stanford University, 1994.

—— 1995a. Environmental stress and grain yields in China. American Journal of Agricultural Economics, November, 853–864.

—— 1995b. Urban life, urban consumption. Working Paper, Food Research Institute, Stanford University, 1995.

Huang Jikun, Rosegrant, M. and Rozelle S. 1996a. China's food economy to the 21st century. Paper presented to a seminar at the Chinese Economy Research Unit, University of Adelaide, January 1996. [summarised in Huang, Rozelle and Rosegrant, China and the Global Food Situation, IFPRI 2020 Brief, 20 May 1995].

—— 1996b. Public investment, technological change and reform: a comprehensive accounting of Chinese agricultural growth. Paper presented to the workshop on agricultural productivity and R&D policy in China of the conference conducted by the Crawford Fund for International Agricultural Research on Global Agricultural Science Policy for the Twenty First Century, Melbourne, August.

Huang Shihong, 1995. On Lester Brown's view on grain issue in future China. Nongcu Jingji Wengao [Rural Economic Papers],10, 24–29.

Huang Yanxin, 1995. Current demand for grain in China and the forecast to 2000. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Huang Yiping, 1995. Economic reform and the changing pattern of agricultural trade in China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Huang Yiping, 1996. Getting Institutions Right: China's Agricultural Reform, Cambridge Universit Press, Cambridge.

Huang Yiping and Kalirajan K.P. 1996. Potential of China's grain production: evidence from the household data. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Ito, S. et al. 1991. An economic analysis of rice consumption in the People's Republic of China. Agricultural Economics, 6, 67–78.

Jia Youling, 1996. Supply of and demand for animal products: development and policy. Paper presented at International Association of Agricultural Economics and MoA, China, International Symposium on Food and Agriculture in China: Perspectives and Policies, Beijing, 7–9, October.

Jiang Yuming, Tang, S., Yao, C., Luo, Y., Lu, Z., Qian, Q., Yu, H. and Tong, H. 1996. The key method to the problems of China's food supply in the long run. Nongcu Jingji Wengao [Rural Economic Papers], 5, 13–19.

Johnson, D. Gale, and Song Guoqing, 1995. Inflation and the real price of grain in China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Kalirajan, Kali, and Huang Yiping, 1996. Does China have a grain problem?: an empirical analysis. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Lardy, N.R. 1990. China's interprovincial grain marketing and import demand. US Department of Agriculture, Agriculture and Trade Analysis Division, Economic Research Service, Staff Report No. AGES 9059, September 1990.

Lewis, P. and Andrews, N. 1989. Household demand in China. Applied Economics, 21, 793–807.

Li Qingzeng, Watson A. and Findlay, C. 1996. Grain production and regional economic change. In: Garnaut R., Guo Shutian and Ma Guonan (eds), The Third Revolution in the Chinese Countryside. Cambridge, Cambridge University Press, 219–244.

Lin Chenguang, 1996. The Grain Problems in Southeast Coastal Developed Areas of China and Resolution, Chinese Rural Economy, 1, 22–25.

Lin, Justin Yifu, 1996. Success in early reform: setting the stage. In: Garnaut R., Guo Shutian and Ma Guonan (eds), The Third Revolution in the Chinese Countryside. Cambridge, Cambridge University Press, 13–26.

Lin, Justin and Shen Minggao, 1994. Rice production constraints in China: implications for biotechnology initiative. Paper prepared for the International Workshop on Rice Research Prioritization in Asia, sponsored by the International Rice Research Institute, Los Baños, Philippines, February.

Lin, Justin, Huang Jikun and Rozelle, S. 1996. China's food economy: past performance and future trends. Paper presented to the OECD Forum for the Future Conference on China in the 21st Century: Long Term Global Implications, Paris January.

Lindert, P. 1996. Soil degradation and agricultural change in two developing countries. Paper presented to the workshop on agricultural productivity and R&D policy in China of the conference conducted by the Crawford Fund for International Agricultural Research on Global Agricultural Science Policy for the Twenty First Century, Melbourne, August.

Lu Feng, 1996a. China's grain trade policy and food trade pattern. Paper tabled at the conference on Output Growth Potential, Market Development, and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

—— 1996b. Feed demand and its impact on the grain economy in China. Paper presented to the workshop on agricultural policies in China, OECD Headquarters, Paris, December (Room document no. 9).

Luo Yousheng, 1995. China's grain production capability. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

—— 1996. China — capable of realising the basic equilibrium of grain supply and demand in the mid to long term. Paper presented at the conference on Output Growth Potential, Market Development, and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Luo Yousheng and Huang Yanxin, 1994. 1993 nian Zhongguo liangshi shichang bodong de yuanyin yu qishi [The causes of and lessons from the fluctuations in China's grain market in 1993]. Nongcun Jingji Wengao [Papers on the Rural Economy], 5, 7–15.

Mei Fangquan, 1995. Sustainable food production and food security in China. Paper presented to the FAO 1995 World Food Day Symposium, October 16, Bangkok.

Ministry of Agriculture (MoA) 1988. Study of the Development Strategy of China's Animal Husbandry. Beijing, China Outlook Press.

—— 1991. Proceedings of International Symposium on Food, Nutrition and Social Economic Development, Beijing, Science and Technology Press.

Nguyen, Tin, and Cheng Enjiang, 1996. Productivity gain of farmer education — fact or fiction. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Nguyen, Tin, Cheng Enjiang and Findlay, C. 1996. Land fragmentation and farm productivity in China in the 1990s. China Economic Review, 7, 2, 169–180.

Overseas Economic Cooperation Fund Japan (OECF) 1995. Prospects for grain supply-demand balance and agricultural development policy in China. Press release, September 25, Beijing.

Park, A. 1995. Household grain management and precautionary saving in China's poor areas. Mimeo, Food Research Institute, Stanford University, November.

PCO and DPS (Population Census Office and Department of Population Statistics, SSB), 1993. Tabulation of the Fourth Population Census of China, 1–4.

Pinstrum-Anderson, P. et al. 1991. Changes in incomes, expenditures, and food consumption among rural and urban households in China during the period 1978–88. In: Proceedings of International Conference on Food, Nutrition, and Social-Economic Development, Beijing.

Pray, C., Rozelle S. and Huang Jikun, 1996. Incomplete commercialisation of the Chinese seed industry: the need for further reform. Paper presented to the workshop on agricultural productivity and R&D policy in China of the conference conducted by the Crawford Fund for International Agricultural Research on Global Agricultural Science Policy for the Twenty First Century, Melbourne, August.

Pudney, S. and Wang, L. 1991. Rationing and consumer demand in China: Simulating effects of a reform of urban food pricing system. The Development Economics Research Programme Working Paper CP, 15, London School of Economics.

RDI and RSEST (Rural Development Institute, CASS, and Rural Social Economic Survey Team, SSB), 1996. The 1996 Economic Green Paper: China's Rural Economic Development Report 1996. Beijing, China Social Science Press.

Research Group on the Development Prospects for the Food Industry, 1991. Zhongguo Shipin Gongye Fazhan Qianjing [The Development Prospects for China's Food Industry], (Beijing, Nongye Chubanshe).

Rosegrant, M., Agcaoili-Sombilla, M. and Perez, N. 1995. Rice and the global food economy: projections and policy implications of future food balances. Presented at the Final Conference on the Medium- and Long-term Projections of World Rice Supply and Demand, sponsored by the International Food Policy Research Institute and the International Rice Research Institute, Beijing, 23–26 April.

Rozelle, S. 1996. Agricultural research policy in China: testing the limits of the commercialisation led reform. Paper presented to the workshop on Agricultural productivity and R&D policy in China of the conference conducted by the Crawford Fund for International Agricultural Research on Global Agricultural Science Policy for the Twenty First Century, Melbourne, August.

Sicular, T., 1995. Why quibble about quotas?: the effects of planning in rural China. Paper presented to the conference on Grain Market Reform and its Implications, East West Centre Hawaii, September 1995.

SSB (State Statistical Bureau of China). Statistical Yearbook of China, various issues. Beijing, China's Statistical Publishing House.

Suzuki, N. 1989. Rice demand and supply in China and other countries. In: K. Ogha (ed.), International Rice Market and the Impact of Japanese Rice Import Liberalisation, Kenkyu Sosho.

Tang Renjian, 1995. The reform of grain policy. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Tyers, R. and Anderson, K. 1992. Disarray in world food markets: a quantitative assessment. Cambridge, Cambridge University Press.

Wang, Z. 1989. The rationing effects on consumption structure change of Chinese urban households during 1981–1987. Paper presented at The Fifth Annual Conference of Chinese Young Economists Society, University of Pittsburgh.

Watson, A. 1983. Agriculture looks for shoes that fit. World Development, 11, 8, 705–730.

—— 1994. China's economic reforms, 1987–1993: growth and cycles. Asian-Pacific Economic Literature, 8, 1, 57–65.

—— 1996. The logic of market reform: the development of grain wholesale markets in China. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Watson, A., and Findlay, C. 1995. Food and profit: the political economy of grain market reform in China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

Watson, A., Findlay, C. and Du Yintang, 1989. Who won the wool war?: a case study of rural product marketing in China, The China Quarterly, 118, June, 213–41.

Wu Guobao, Richardson S. and Travers, P. 1996. Rural poverty and its causes in China. Chinese Economy Research Unit, Working Paper 96/2.

Wu, Harry X. 1996. A note on the CERU–MoA grain farm household survey in China, China Economic Review, 7, 2, 97–194.

Wu, Harry X. and Findlay, C. 1996. China's grain demand and supply: trade implications. Paper presented to the workshop on agricultural policies in China, OECD, Paris, December (SG/CHINA/CA(96)23).

Wu, Harry X. and Meng Xin, 1996a. Do farmers reinvest in grain production? China Economic Review, 7, 2, 123–34.

—— 1996b. The direct impact of the relocation of farm labour on Chinese grain production. China Economic Review, 7, 2, 105–22.

Wu, Yanrui and Wu Harry X. 1994. Urban household grain consumption in China: effects of income and urbanisation. Asian Economic Journal, 11, 3, 299–323.

Xu Boyuan, 1996. Agricultural wholesale markets. In: Garnaut R., Guo Shutian and Ma Guonan (eds), The Third Revolution in the Chinese Countryside. Cambridge, Cambridge University Press, 113–119.

Yang Hong, 1995a. Regional specialisation and the development of commercial grain bases in China. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

—— 1995b. Trends in regional grain production and the impact on inter-provincial trade. Paper presented to the conference on Grain Market Reform in China and its Implications, East West Centre, Hawaii, September.

—— 1996a. Trends in regional grain production and their implications. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

—— 1996b. China's maize production and supply from a provincial perspective. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

—— 1996c. Sources of productivity disparities in regional grain production in China. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

—— 1996d. Under-reporting of China's village land and its implications for grain yields: an analysis of farm household survey data. Paper presented to the conference on Output Growth, Market Development and Internationalisation in China's Grain Sector, Ministry of Agriculture, Beijing, October 4 and 5.

Yang et al. 1991. Food consumption and food acquisition behaviour among urban households in China. In: Proceedings of International Conference on Food, Nutrition, and Social-Economic Development, Beijing.

Yang Tingkai, 1996. Feed Industry in China: Development and Policy. Paper presented at International Association of Agricultural Economics and MoA, China, International Symposium on Food and Agriculture in China: Perspectives and Policies, Beijing, 7–9 October.

Yu, J. (ed.) 1991. Study of Rationalisation of China's Food Structural System. Beijing, The 710 Research Institute of Aerospace Ministry.

Yu, Jiabao and Zhan, Yurong, 1995. An analysis of the sample survey on China's post-production grain loss. In: Guo, Shutian and Min, Yaoliang (eds), Liangshi Zhengce: Lilun yu Shizheng — Zhongguo Nongyebu yu Shijie Yinhang de Baogao [Grain Policy: Theoretical and Empirical Analyses — A Joint Report by Ministry of Agriculture of China and the World Bank], Beijing: Xinhua Press, 367–374.

Zhang Bin and Carter, C. 1994. Rural reforms, the weather and productivity growth in China's grain sector. Chinese Economy Research Unit, Working Paper 94/2.

Zhang Linxiu, Huang Jikun and Rozelle, S. 1996. Land policy and land use in China. Paper presented to the workshop on agricultural policies in China, OECD, Paris, December (SG/CHINA/CA(96)9).

Zhang Liuzheng, 1990. Grain Situation and Policy: China's Grain Issue [Liangqing, Duice: Zhongguo Liangshi Wenti Yanjiu]. Sichuan, Chongqing Press.

Zhang Wenbao and Zuo Changsheng, 1996. Fertiliser price. In: Garnaut R., Guo Shutian and Ma Guonan (eds), The Third Revolution in the Chinese Countryside. Cambridge, Cambridge University Press, 100–112.

Zhu Xinwu, 1995. Bixu gaodu zhongshi liangshi he liangjia wenti [We must pay great attention to grain and grain prices]. Zhongguo Nongcun Jingji [China's Rural Economy], 2, 21–25.

Zou Wenhui, 1994. Liangjia tiaozheng hou de gouxiao xingshi [The purchase and sales situation since the adjustment in grain prices]. Zhongguo Wujia [China Prices], 19, 26–28.