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GRAIN SECTOR REFORM IN CHINA

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Abstract

The stagnation of grain output per head in the 1990s in China raises questions about grain sector performance. This paper discusses the scope for further reforms to contribute to output growth. Opportunities for further reform in both input and output markets are identified. The potential contribution of research and development is also noted. The discussion is presented in the context of the forces for structural change in the economy associated with its rapid growth and industrialisation.

1. 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.¹ 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? The aim of this paper is to review recent research on this question. The issue is of great interest to Chinese policy makers, 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 section reviews the trends in grain output and notes some of the key shifts in direction. It highlights the developments of the 1990s. The following section examines in more detail the context in which farmers are making their output choices and reports work on mechanisms by which events in the rest of the economy affect farm level decision making. The following sections review a number of factors, some subject to change by government policy, which might have effects on trends in output. Conclusions are summarised in the final section.

2. Trends in grain output

Figure 1 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 population in China vary between types of grain. Figure 2 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 3) 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 4) which in absolute terms has maintained the rate of increase that was established in the early 1970s. The trend in maize output per head appears to be immune both to the impact of the

¹ More careful decomposition of the sources of the growth of output over time is possible, including an assessment of the contribution of relative price changes. Some studies of that type are noted below.

reform program and to the events driving the flat growth in the other crops since the mid 1980s.²

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

3. The economic context

Growth and structural change

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 at over 9 per cent per year in real terms in the reform period up to 1984 and at nearly 6 per cent per year thereafter. Therefore 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. Also important was the reversion of land once used from grain to more suitable uses.

Other forces acting on agriculture are those from the 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. Depending on the pace of technological change in agriculture (discussed again below) the agriculture sector is under pressure to decline (relative to other sectors in a growing economy) (see Anderson, 1987).

These impacts of growth and industrialisation 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. As a consequence, especially in some regions of China, there is a rising opportunity cost of agricultural output. 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. 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 (1997a, 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 output of agricultural products, and of grain in particular. They use the CERU/MoA household survey data on grain specialist households to examine the effects of labour relocation on grain output.

² These data may even also understated 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 again in a later section.

Wu and Meng (1997a) 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 percent). 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 discussed again 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 (1997a) 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 labour. Wu and Meng (1997b) 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 eg Findlay and Watson, 1996a). Fan (1996) 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) reports that total government investment in agriculture reached a peak in 1978, then nearly halved by 1987 and increased in the following years. The 1994 level in real terms was however about a third lower than that in 1978. Fan also stresses the fluctuations in investment, the decline in investment in research and development and during the slump in investment after 1978, the run-down in the capacity of the irrigation and drainage systems.

We discuss below in more detail some current issues in the agricultural research system. 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 appear to be large in absolute terms. However the rate of which land is being transferred to other uses appears to be relatively low. Dong (1996) reports data which suggests that between 1958 and 1993, arable land area fell by 12%. Dong's data even suggests that the rate of which the arable area was falling has been less since 1978 (0.31% a year) compared to the prereform 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 his estimated rate, it would take 2 decades for Chinese agriculture to lose 10 percent 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 could respond to rising land values. Grain sown area in China can also follow a different trend to arable area, not only because of the composition of agricultural output, but also within the grain sector when there is scope to increase the rate of double cropping. Its growth has contributed to the increase in total output even though 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 also are 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.

The 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 gets 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.³

Regional variations

The extent of the change in the opportunity cost of agricultural output varies between regions. As a result, 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 illustrate the significance of the processes of the change in the structure of the rest of the economy for the agriculture sector, including grain.

Yang Hong (1996a, b) has identified the changes in the location of grain production in China. She finds significant variations between regions in the rate of output growth. 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 over 60% in Inner Mongolia, Jilin, Heilongjian, Ningxia and Xinjiang compared to the national average growth rate over the same period of just over 40%. 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 traditional pattern of trade within China was to move southern grain to the north. The new pattern is in the opposite direction (see Yang Hong, 1996a, for details). Forces for this relocation are those associated with shifts in comparative advantage in agricultural production. 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). Patterns of trade are therefore reversed. These trends may also have been reinforced by the withdrawal of policy support for grain production in southern provinces.

The composition of the national output of grain and of the grain traded within China is 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.

A third implication, stressed by Yang Hong (1996b), is the greater exposure of the production of grain to volatility on the supply side. The share of national maize output in

³ Another question is whether agricultural use itself is degrading soil quality. Lindert (1996) finds little supporting evidence for China, particularly for those soil characteristics which matter for agricultural production.

Heilongjiang, Jilin, Liaoning and Hebei has increased. Maize output is becoming more concentrated in those provinces which may expose maize supply to greater volatility, eg, as a consequence of some 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 quotes some 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 difficulty.

Finally it should be noted that the grain trade in China are also affected by trends in the composition of demand. Demand composition is changing but possibly more slowly than that composition of output.⁴ 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.

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 consequence of the trends in supply noted in the figures above compared to the growth in demand, in the context of restrictions on trade. The origins of and risks associated with this position are discussed by Garnaut, Cai and Huang (1996) and by Findlay and Watson (1996b). The implications of this gap, the resistances to change in domestic prices, the scope for a greater degree of openness to world trade in the grain market of China and the biases in the application of any pursuit of a greater degree of grain self sufficiency are important issues. There is concern in particular about the risk of China shifting by default to a path of protectionist policy, reversing the earlier position which was to tax rather than subsidise agriculture. This switch in agricultural policy has occurred in other East Asian economies but could only be pursued by China at a relatively much higher cost at this stage of Chinese development.

A more interesting 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, are discussed by Cheng, Findlay and Watson (1996).

4. Grain sector performance

There has been a debate over the effects of the agricultural reforms in China. Watson (1994) has reviewed the literature in general, and Carter (1995) focussed on the econometric work on the sources of agricultural output growth. Input growth is obviously

⁴ See Wu and Findlay (1996) for discussion of one scenario for China's international grain trade which stresses the likelihood of larger volumes of feed grain imports.

one contributor to output growth and the forces operating on agricultural input supply were discussed in the previous section. The 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 the 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”.⁵ 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 agricultural has put more weight on the contribution from technological change, especially after the first round effects of institutional change have been exhausted (see eg Huang, Rosegrant and Rozelle, 1996).

An issue in the assessment of the scope for research to play that role is the estimate of the current grain yield in China. Estimation of yields is however 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 land available may reduce these tax commitments imposed on any one community. The actual situation is likely to be a combination of overstated yields and understated output.

If grain output on the other hand is measured correctly then the estimated yield (output divided by area) will be overstated.⁶ 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 towards 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 the scope for its improvement. In that case, further technological change has therefore a bigger 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 per cent larger than the figure reported by the 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

⁵ There is also other work, including by Zhong and Carter (1995), who stress the importance of the weather in patterns of grain production over time, and by Huang and Rozelle (1995) who highlight the contribution of the increased inability to withstand the effects of natural disasters, rising salinity and soil erosion.

⁶ Crook and 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.

possibility which is that rather than yields being underreported, it is output, at least at the village level, which 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 understated the rate of growth of grain output.⁷

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 an assessment of actual versus potential yield in Chinese conditions at the 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 the 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 yield. 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 on how to reduce the factors which they identify as contributors to both gaps. Biotechnological research they suggest may offer the highest returns.

Other work has used a 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 the returns to agricultural research which lie in the range from 44% to 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 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 varieties. The number of new varieties has increased but the rate of increase is lower in the first half of the 1990s compared to the second half of the 1980s. These results raise some questions about the benefits of the reform process in the research sector. Rozelle and others also note that a remaining issue

⁷ 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 (1996).

in the reform process in the research sector is the strengthening of the property rights regime.

One issue in this work is the evaluation of the performance of the research sector. 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 rather than output. The new varieties may require fewer inputs, for example. This question is a topic for further work. If so, however, it could indicate a 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 seeds 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 determine 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 or/and 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 emergence rate is low.)

Preliminary survey findings using the CERU/MoA data to be reported by Wu include the following:

- Almost all grain farmers surveyed have changed varieties since the introduction of the household responsibility system (HRS), not only for the major crop, but also for other crops, eg. 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 3 times since HRS, 60% at least 4 times, and 37% at least 5 times, and 20% of households changed varieties from 6 to 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 43kg for wheat, 36kg for early Indica, 45kg for late Indica, 35kg for Japonica and 67kg 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 the farm level. On the other hand, there does appear to be significant variation within the sample in the rate of use of seeds. Maximum seed input for winter wheat was 1.7 times the average, for middle late Indica rice was 6.6 times the average and for maize was 7.5 times the average. This input, while it is subject to economising behaviour by farmers in general, appears likely 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 which apply to grain. Key elements in achieving an efficient outcome will be the institutional changes in the research sector and in the seed industry which were noted above. A more developed seed market may also contribute to an improvement performance in terms of seed use at the farm level. Choices of research effort in China will also be more efficient if they takes into account the cost of China's alternative sources of grain, such as purchases from the rest of the world. The scope for change in other institutions in rural China to contribute to productivity growth is discussed in the next section.

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.⁸ These estimates are considerably less than those of Lin and Shen 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
- the household head has longer agricultural experience
- the total land area being farmed is larger
- 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 the 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 was discussed in section 3 of this paper.

These results highlight both the role of the extent of use of markets and other institutional changes, for example, those affecting land area, in the performance of the grain sector. In the rest of this section we concentrate 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.

⁸ Potential output is derived from an estimate of the production frontier which is estimated by a including only factors of production in the regression equation. Other contributors to variations in output are considered in the second step of the analysis.

Plot consolidation

The 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 involved 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). The immediate gains are associated with economies in plot size rather than farm size.⁹

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 the 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, reduces the ease of access to credit and, in the absence of a market for land use rights, denies 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).

⁹ 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.

Farmer education

Another variable stressed in the Huang and Kalirajan results 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. Nguyen and Cheng report regression results using farm income as the dependent variable which suggest that

- the returns are statistically significant for the education of the 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 also 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.

There is however an econometric qualification to these results. Nguyen and Cheng refer to results from Wu, Richardson and Travers (1996) who report the analysis of survey of some very poor households in rural China. This survey suggests that low levels of literacy and low incomes are the joint effects of the same causes. Nguyen and Cheng suggest that further work is required to check that the significant economic effect of education in their own regression results, and in many other studies, was not achieved by misleadingly including in the sample a group of outliers (eg the group of poor households with illiterate heads in their own study) among which a low education level is not caused by poverty rather than the other way round.

Despite this qualification to the assessment of the size of the relationship between education and either income or grain output, the connection could still be significant. The problem is to measure accurately the size of the link. Even if that link is now small, the importance of education is likely to rise. Wu and Meng (1996a) also argue this case. Cheng (1996) observes that with the increased use of chemical fertilisers, new seeds and other modern inputs, grain production becomes more and more 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 the further education and training for those household-heads 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, the returns to education beyond a basic level may be small. That was the main result of

Nguyen and Cheng (1996) whose concern about the 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).¹⁰

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 the reduction of the total number of village officials (currently there are about three to five part-time village officials who are 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 (eg 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.¹¹

¹⁰ The difference in results could reflect the statistical methods used which treat the measurement errors likely to be associated with the input variables in different ways.

¹¹ There are qualifications to these results because of omitted variables problem (related to the exclusion of a soil quality variable and organic fertilisers, 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.

Field work by Cheng suggests that a contributor to allocative inefficiency of rice producers was the risks 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 by other factors as well. These factors range from

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

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 about 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

A theme of these results is the importance of the operation of markets for inputs, including land, labour, and purchased items such as fertiliser. Current restrictions on some agricultural input markets reflect the absence of other markets, for example, for dealing with risks in the agricultural production. The data suggest that institutional changes in these areas can have a significant effect on productivity. For the example, significant benefits would be available, according to this research, from institutional changes which led farmers themselves to consolidate their plots of land. It was stressed however change in markets other than just those for farm would be required in order to this outcome to occur by initiatives at the village level, that is, to occur in an efficient way. There may also be high returns to information about the effects of fertilisers in grain production and about methods of application. Longer run issues include decisions on the extent of 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 (1996a) and Watson (1996). Obviously, the changes in relative prices that emerge from market reforms have effects on the trends in grain output. Findlay and Watson (1996a) document examples of the supply response of grain output to relative price changes associated with marketing system reforms.¹² In this section, the focus is on the way that the development of markets affects the productivity with resources are used, rather than on the volumes of inputs which are 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 their 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 rice and maize.

Other researchers have found a positive relationship between the size of the quota and output, eg Sicular (1995) finds first that quotas do affect the allocation of resources at the farm level: quotas are not inframarginal. She also finds that quotas have a significant effect of taxing household income. But quotas in her results also appear to have a positive effect on productivity. One explanation is that the 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, provision of farm services at lower costs on a collective basis etc.¹³

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 between 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.

¹² 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 lower sown area next year.

¹³ One explanation for the difference between the results of Sicular and those of Huang and Kalirajan about the impact of the quota is that they use different data sets. Sicular uses data from one county in northern China.

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 of research reported here, higher grain output. The concerns about food supply security, which is one of the origins of the quota system, can be met through the development of a more market orientated 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 the grains with the 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 the 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 there is an inefficient volume of grain 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. The 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 so as to be able more carefully grain producer output and storage decision making.

5. Conclusion

The research reviewed here indicates that it is possible to raise the productivity of inputs used in grain production in China. The condition however 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
- the development of markets for other purchased agricultural inputs
- the deregulation of the seed market.

The greater degree of integration of domestic grain markets would also have significant effects on aggregate output, through the opportunities for specialisation and trade and through the effects on technical efficiency at the 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 that paper explains, 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 which apply to grain. Institutional changes in the research sector and in the seed industry, as noted above, are key objectives. In addition to the market reforms, therefore,

- 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

are important issues.

China can change the trend in grain output per head reported at the start of this paper. The question to be answered however is what will it 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 judgements about the costs and benefits. Using the

resources available in the rest of the world to supply grain to China is another option to be considered at that time. The integration of the domestic and international markets for grain will assist the assessment of all those options.

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Figure 1: Total grain output per capita, 1949-1995

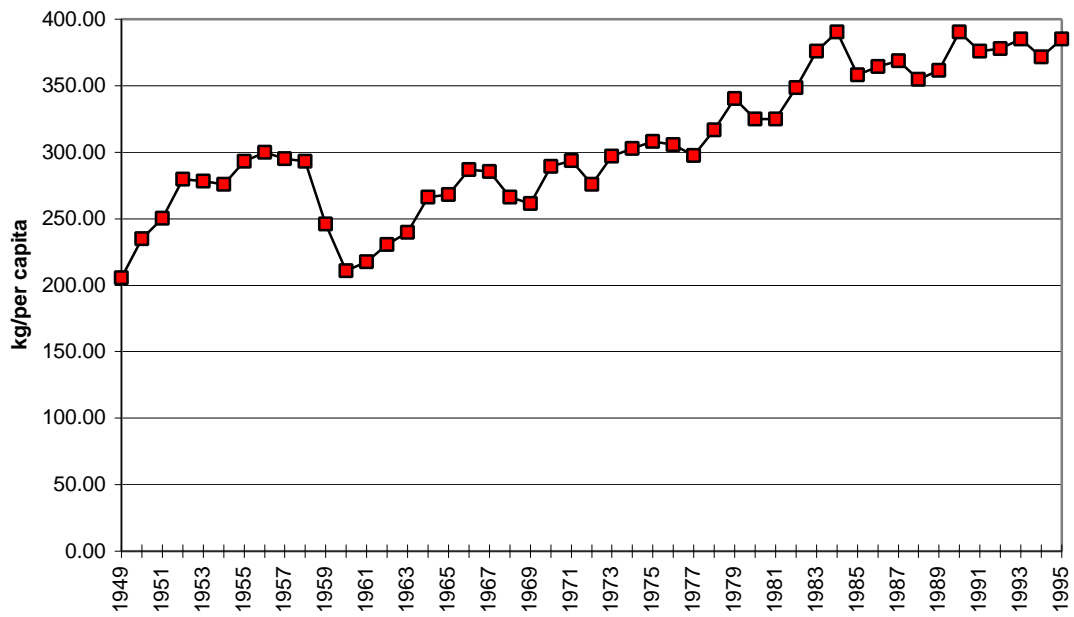


Figure 2: Wheat output per capita, 1949-1995

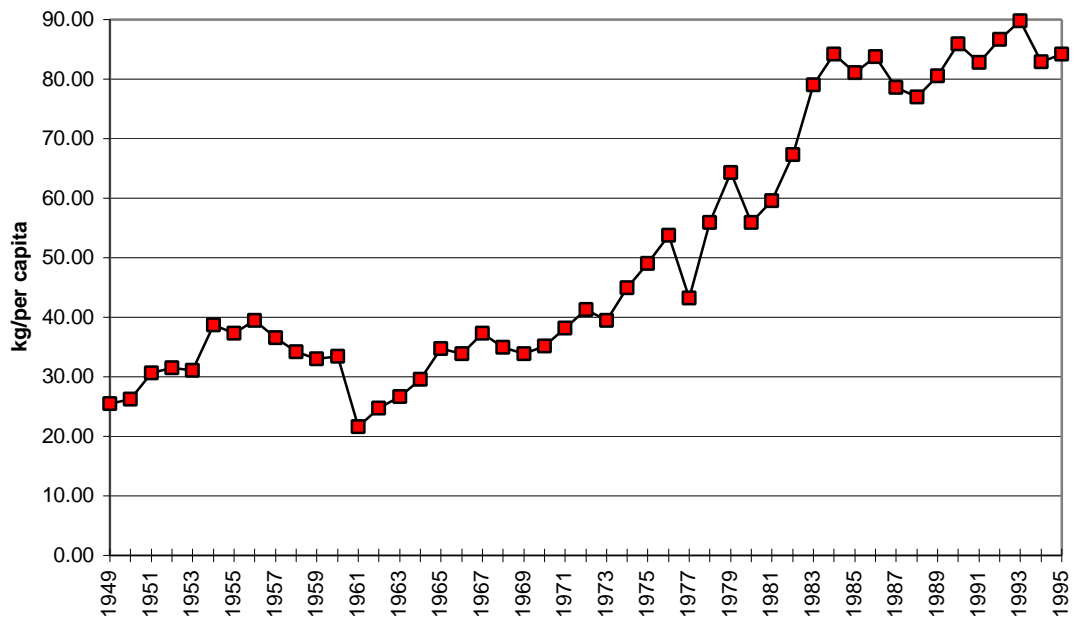


Figure 3: Rice output per capita, 1949-1995

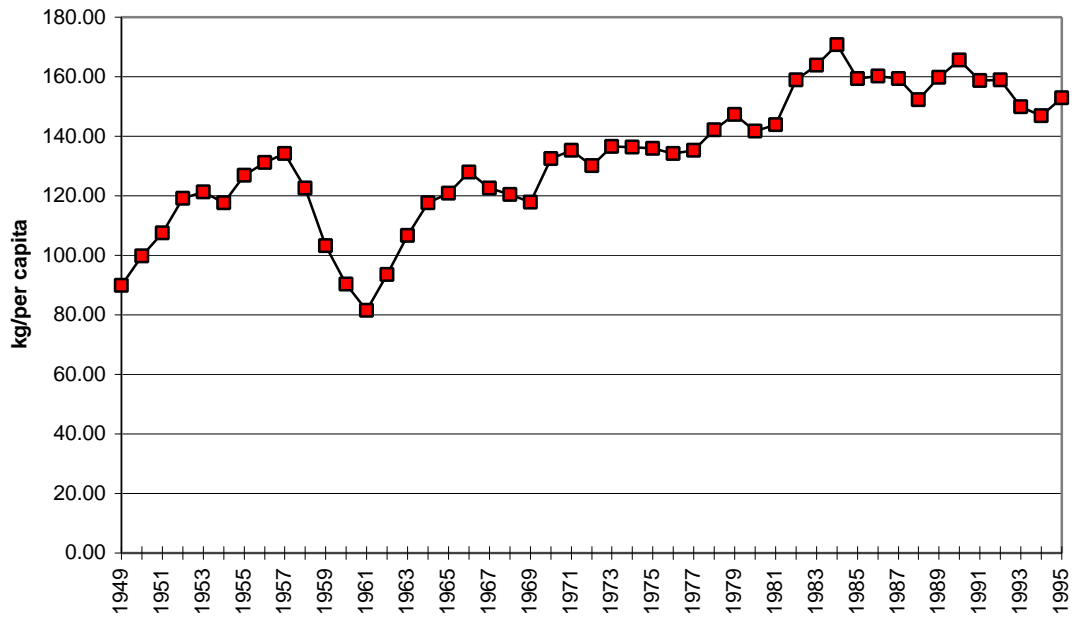
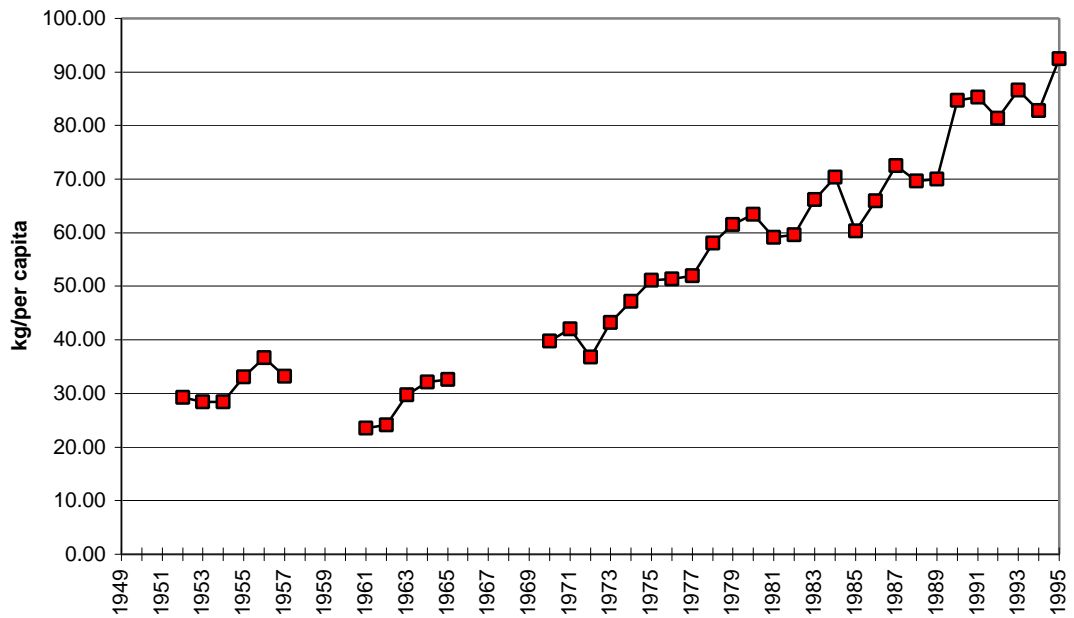


Figure 4: Maize output per capita, 1952-1995



Source: Yang Hong, 1996a

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