China’s Food Security:  
Challenges and Responses in a Global Context

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Exchange rate
1EUR = 1.296 US$
1CNY = 0.123 EUR
Abbreviations

ASEAN  Association of Southeast Asian Nations
CAADP  Comprehensive African Agriculture Development Programme
CCAP  Center for Chinese Agricultural Policy
DRC  Democratic Republic of the Congo
EU  European Union
FAO  Food and Agriculture Organization
FSU  Former Soviet Union
FUE  Fertilizer use efficiency
FYP  Five Year Plan
GDP  Gross domestic product
GHG  Greenhouse gases
GM  Genetically modified
GOC  Government of China
HRS  Household responsibility system
IFAD  International Fund for Agricultural Development
IFPRI  International Food Policy Research Institute
IIED  International Institute for Environment and Development
MEP  Ministry of Environmental Protection
MOA  Ministry of Agriculture
MOF  Ministry of Finance
MOST  Ministry of Science and Technology
NBSC  National Bureau of Statistics of China
NDRC  National Development and Reform Committee
N  Nitrogen
N-S  North-South
NBSC  National Bureau of Statistics of China
OECD  Organization for Economic Cooperation and Development
PDSF  EU-China Policy Dialogue Support Facility
R&D  Research and development
S-S  South-South
SSC  South-South Cooperation
USDA  United States Department of Agriculture
WTO  World Trade Organization
WUE  Water use efficiency
Executive Summary

1 China’s Food Security: Is it an issue?

The maintenance of high levels of Food Security (with the official target of over 95% self-sufficiency in grains for 2008-2020 continuing a policy that was first introduced in 1996) is a political imperative in China, but not a physical or economic issue now or in the period to 2030 and probably longer. FAO and CCAP projections suggest that on average China will continue to be close to self-sufficient for rice and wheat, and about 90% self-sufficient for maize and other coarse grains until 2025/2030. Only soybean imports will continue to rise and may increase to 100Mt per annum by 2030, that will require a major expansion in production by its traditional sources or new ones which this report considers is quite feasible.

This long-term average food security situation hides a number of local and global issues arising from (a) resource mismanagement (loss of good cropland to urban and industrial development; non-point pollution of land and water and high greenhouse gas (GHG) emissions) and (b) the knock-on effects of Chinese food purchases on world market prices if China is forced to make large imports during severe droughts or other extreme though this seems unlikely. This report concludes that all of these issues can be overcome.

1.2 Past and current food production and supply situation

China has undergone a series of reforms since 1978 that have sustained high rates of agricultural growth. Production growth occurred in all sub-sectors of food and agriculture with increased yields accounting for nearly all of the growth in grain production. Moreover, output of cotton, edible oils, vegetables, fruit, meats and fishery products grew even faster. Consequently, with the exception of soybeans since the late 1990s, food production has kept pace with or exceeded growth in demand for most of the past 30 years. China was a net exporter of food for most of the past 30 years and entry into the WTO in 2001 facilitated a shift in the pattern of trade in line with comparative advantage. This brought about greater imports of land intensive bulk commodities, notably soybean and greater exports of higher valued labour intensive fruit and vegetables. Nonetheless, the 95% grain self-sufficiency target has not been breached and food security has not been an issue to the present date.

However, although physical availability has not been an issue rising food prices have become a major concern. The Government of China (GOC) has acted quickly and comprehensively to ensure that the latter does not rise to levels that harm low income consumers or puts pressure on wages in the manufacturing and service sectors.

1.2.1 Major drivers of food demand

Population growth had declined to about 0.5 % per year by 2010 and by 2030 it will be close to zero. Consequently population growth no longer has significant implications for food security. Since 1978 income growth and urbanisation have become the main drivers of food demand with the substantial shifts in food consumption patterns. Demand for staple foods (rice, wheat, maize and root crops) has
fallen and that for vegetables, fruit, livestock products and feed grains has increased considerably. In addition, the proportion of food eaten away from home has become an increasingly important factor, and in the case of meat, for example, it can account for about 45% of consumption.

1.2.2 Major drivers of food production

Since 1978 the agricultural sector has responded well to qualitative and quantitative changes in food demand, leading to changes in the structure of production with declining importance of rice and wheat and the growing importance of cereals for livestock feed and fruit, vegetables and livestock products for direct consumption. The implementation of the household responsibility system (HRS) after its introduction in 1979 that gave individual farmers control over income rights of formerly collective owned land was a major policy driver for the rise in productivity based on improved crop varieties and high inputs of industrial fertilizers. The other major sources of growth were public agricultural research and development (R&D) and investment in irrigation. The former tripled between 1990 and 2010 and the irrigated area increased from 18 to c.50% between 1952 and 2010 with large benefits for food security.

However, most of these developments have involved a number of perverse or relatively ineffective subsidies that in the main go directly to farmers but are administered in such a way that they are income transfers to farmers rather than specific incentives to raise yields and production in a sustainable manner. The intensification of production has largely involved higher and inefficient applications of conventional synthetic fertilizers and caused serious environmental pollution. Consequently, a new agricultural development strategy is needed if the negative consequences of the present model are not to undermine future food security.

1.3 Future prospects

1.3.1 Introduction

Some early commentators in the 1990s and notably Lester Brown \(^1\) where unduly pessimistic about China’s ability to feed itself and suggested that its future grain import needs would distort world trade and prevent other developing countries meeting all of their food import needs. He also argued that there would be substantial environmental damage from attempts to expand production. The reality has been quite different and in the most years China has been a net food exporter since then, and could continue to be so through to 2030 with the exception of a few commodities such as maize, soybean and dairy. As this report will show he was too pessimistic about technological change in China, incorrectly identified the environmental risks, overestimated domestic demand for food and greatly underestimated the capacity of traditional and new exporters to meet China’s needs.

1.3.2 Projected demand to 2030 – food, feed & net exports

Population growth will have virtually no effect by 2030 and income driven changes in consumption preferences will have slowed down considerably. Direct demand for rice, wheat and other food grains will be declining and then virtually flat by 2030 and will require zero increases in production with positive implications for food security. The main uncertainties are about the indirect demand for cereals, the evolution of per caput demand for livestock products, and future gains in feed use efficiency.

It seems possible that the per caput demand for livestock products projected by some analysts may be too high, and consequently the total feed demand, imports of coarse grains and soybeans, and the risks to food security have been overestimated.

1.3.3 Projected production

China has the capacity to remain broadly self-sufficient for the next 10 to 20 years for most food commodities and achieve a high level of food security from domestic resources. The major exceptions are coarse grains (primarily maize), oilseeds (primarily soybean), beef, dairy products and possibly sugar. Production of these crops will be strongly influenced by GOC and farmer decisions about land and water allocation between crops, and prices on world markets which are likely to be lower than domestic prices.

Competition between cereals for food or feed and those for bioethanol production will not be an issue if current policies prevail and limit any further expansion of biofuel production to non-food crops grown on marginal land. The development and application of agricultural biotechnology is likely to play an increasingly important role. Increased R&D in GM maize, for example, could raise self-sufficiency in 2025 by several percentage points though not eliminate the need for imports.

1.3.4 Resource constraints and policy challenges

There are seven particular concerns:

(i) China has virtually no additional land to develop for crop production so the continuing loss of highly productive cropland to urban development and non-agricultural uses could undermine long-term food security. Part of the loss is unavoidable in that it is not feasible to restrict the expansion of urban and industrial development to marginal areas although the GOC has been trying to take some of the pressure off the fertile coastal areas by promoting development in Western China. Hence the past decline in average primary productivity seems inevitable.

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2 China’s Western Development Programme is a strategy adopted by the GOC to boost its less developed western regions. The programme covers 6 provinces (Gansu, Guizhou, Qinghai, Shaanxi, Sichuan, and Yunnan), 5 autonomous regions (Guangxi, Inner Mongolia, Ningxia, Tibet, and Xinjiang), and 1 municipality (Chongqing). The seven major development goals are of the programme: (i) Increasing economic growth; (ii) Expanding
Nonetheless some of the losses could be limited by tighter application of the existing legislation and the removal of the perverse economic incentives to local governments that encourage such transfers. Others gains could come from land consolidation and increases in cropping intensity which could have additional benefits by lowering the unit costs of production and reducing pollution. In contrast to the land loss issue, land degradation from desertification and soil erosion is not considered to be a major threat.

(ii) Labour resources. The loss of labour to non-agricultural activities without any or insufficient compensating increases in labour productivity. This problem is being intensified by the ageing of the farming population.

(iii) Irrigated land accounts for about 75% of grain production and much of it is dependent on falling groundwater tables. Improved water use efficiency is therefore a vital task for the GOC and farmers and full implementation of the available opportunities could minimise the impacts on food security.

(iv) Fertilization use efficiency (FUE) has declined by about one-third since 1978 with numerous negative environmental impacts on the local, national and global environment and particularly non-point pollution GOC actions since 2000 have failed to resolve the problem, and new initiatives are required to overcome the negative effects of low FUE on food security and the environment.

(v) Earlier assessments of the impact of climate change on Chinese agriculture suggested that China’s future food security was seriously at risk. More recent assessments using improved analytical tools conclude that although some areas may suffer others will benefit. Hence, at the national level climate change is not seen to be a serious threat to China’s staple cereal production and food security over the next 20-40 years unless the GOC and farmers fail to implement the available mitigation measures.

(vi) The report considers three emerging threats to crop production: soil acidification, heavy metal contamination of soils and low level ozone damage to crops. All of them are becoming increasingly serious and could affect food security and require responses that can be costly and need coordinated actions by several government ministries and departments that may not be easy to achieve.

(vii) Feed use efficiency will play a critical role in determining China’s demands on the world market for feed grains and the growth of pollution from the livestock sector. Average feed use efficiency for pork and dairy production is 25-50% lower than in other countries using the same breeds. The policy and technological responses required could be implemented in infrastructure construction; (iii) Improving the ecological environment; (iv) Providing better public services; (v) Developing and strengthening local industries; (vi) Elevating people’s living standards; and (vii) Reforming and opening up the region.
the next 5-10 years and have a substantial impact by 2020/30. These responses have important implications for lower maize and soy bean imports, reduced livestock pollution of surface waters and emissions of ammonia and GHGs.

2 Central and Local Government Context of Food Security Policies

2.1 State Council’s Food Security Strategy

2.1.1 Evolution of food security and food security polices since the 1950s

China suffered from acute food insecurity during the 1950s and 60s with average food consumption of only 2000 Kcal/person/day. The agricultural crisis in China in 1959-61 resulted in 30 million extra deaths. “Take grain as the key link” became a national policy thereafter. After 1979 the GOC started to introduce measures to ensure that poor agricultural growth did not endanger food security or hold back the development of the manufacturing and service sectors.

The major actions included introduction of the household responsibility system in 1979; replacement of mandatory quotas by voluntary contracts for grain in 1984; introduction of the “Provincial Governor’s Grain Bag Responsibility System” in 1994. Further reforms were introduced between 1995 and 2010 to provide a comprehensive policy framework and to improve the functioning of grain markets and the cost and efficiency of the grain reserve system.

Throughout the period 1950-2000 the focus of the national food production strategy was on maintaining 100% self-sufficiency in all staple grains defined as rice, wheat, coarse grains, soybeans, pulses, potatoes and sweet potatoes. However, towards the end of this period there was increasing discussion about the appropriateness of this definition because of (a) the decreasing importance of the potatoes and sweet potatoes in diets; (b) the increasing use of coarse grains and soybeans for livestock feed, (c) the impending entry of China into the WTO and (d) the shortage of arable land. These discussions led to the decision to revise the food security target to 95-100 % self-sufficiency for cereals under normal conditions and opened the way for the expansion of soybean imports.

2.1.2 Food security strategy in the 12th FYP period and beyond

The present and future objectives of China’s food security strategy are well presented in the national medium and long-term food security plan (2008-2020) as well the national 12th FYP. Maintaining 95% of grain self-sufficiency and 120 Mha of arable are the overarching targets, together with improved grain stock and logistic system.

The GOC has formulated the following policies and measures to safeguard food security:

(i) Strengthen government’s food security responsibility;
(ii) Strongly protect production resources, including arable land and grassland;

(iii) Strengthen scientific and technological support to agriculture;
(iv) Increase agriculture input for infrastructure, finance service and production subsidies;
(v) Perfect grain macro control mechanism;
(vi) Promote healthy food consumption and reduce food chain waste;
(vii) Push forward food legislation;
(viii) Implement specific programmes along whole food chain.

2.2 Institutional constraints to policy implementation

Formulation and implementation of food security policies involves different departments and sectors of central and local government. Consequently institutional barriers often become a constraint to the effective formulation and implementation of the policies.

Responsibilities of government departments
Overlapping responsibilities leads to inefficient management of resources. For example, the responsibilities of China’s water resource management are scattered between several ministries, which makes water pollution control more difficult, and particularly non-point pollution control against which little progress has been made. The complexity of management structures is also an issue for the grain production, distribution, and processing and consumption chain, with overlapping tasks being split between several ministries.

Perverse incentive to local government
Property sector development and infrastructure construction are major driving forces for China’s rapid economic development. Local government regard these as key components of their strategy to achieve their political target – GDP growth. Moreover, local governments have become to rely on land transfers for a substantial part of their revenues so there is a perverse economic incentive for them to allow them. Land transfer fees can account for 30-50% of total sub-provincial government revenue.

2.3 Future options for China’s food security policies

The GOC has formulated a comprehensive policy framework and policy instruments to ensure future food security. However, there are number of alternative policy options which may help for future food security.

Reduction of self-sufficiency rate
Maintaining 95% grain self-sufficiency remains the overarching target for future agricultural and food policy. However, with changes in domestic supply and demand, and China’s widening international cooperation for food and agriculture; there is a need to re-investigate the possibility of reduction of self-sufficiency rate. For example, China’s future challenge in food supply mainly comes from feed and edible oil demand. Some African countries are well placed to grow these crops with better potential and less cost than in China. This could be achieved through China’s increasing technology transfer and investment to African countries through various SSC programme.
Land Consolidation
Although there is consensus that land consolidation will increase land use efficiency, the progress has been slow. There is a need to develop policies to guide and regulate the process. A number of policy options are available to overcome the potentials risks of land use right transfer, include confirmation of household land use right contract, creation of off-farm employment, and improvement of the rural social security system.

Healthy food consumption
The overall nutrition improvement in China has been substantial. However, increase in meat consumption, particularly in the urban, has raised concerns of increased obesity and associated diseases. On the other hand, malnutrition is still common in many rural areas and vulnerable groups of people. Future policies need to tackle the challenge of over consumption as well as malnutrition.

Subsidies for environmental sustainability
The objective of current agricultural subsidies in China is to increase food production. However, maximising production has caused degradation of agri-environment, such as soil acidification caused by over use of nitrogen fertilizer, which now threatens the sustainability of China’s food supply. There is strong need to encourage farmers’ adoption of environmental friendly farming technologies by the introduction of appropriate subsidies and payments to farmers for ecosystem services.

3 Global Implications of China’s Future Food Security

3.1 Will China put pressure on global markets?

The question whether China’s food security needs will put pressure on global markets is multi-dimensional. Component questions include:

(a) Has the long-term food demand and supply situation been projected in a sound manner?
(b) Can China’s food security and food self-sufficiency policies continue to achieve the goal of 95% self-sufficiency in key commodities?
(c) Do other countries have the supply potential to meet China’s food and feed import needs without putting unsustainable pressures on their own natural resources and world market prices?.

Broadly speaking the answer to all three questions is yes.

There are only three commodities were China’s possible import needs account for more than 10% of the projected world trade: soybean (move from current 78% to about 80%), maize (>14%) and sugar (>12%). The only other notable import needs could be pork (up to 8%) and dairy products (up to 8%). All of these incremental needs are within the supply capacity of China’s traditional trading partners. In the case of maize and soybean, for example, they could be supplied by those in N. America, S. America and Eastern Europe. Moreover, a number of other countries have the capacity to expand production and become exporters once infrastructural and technological constraints are overcome, particularly some in Sub-Saharan Africa. Although pork imports could be substantial (possibly as much as 8% of world trade)
more recent estimates suggest the maintenance of near self-sufficiency and there need not be global food security risks associated with China’s long-term pork demand. The same is also true for wheat and rice needs.

3.2 China’s food security and the potential for new food exporters

There are many African countries that have substantial areas of land that are agro-climatically suitable for cereal and soybean production, but are constrained by poor crop distribution and marketing infrastructure, and by lack of access to fertilizer, improved seeds, other production inputs and technical advice. Average yields are generally low, and there has been serious under investment in agricultural R&D and advisory services for many years which China is now helping to strengthen. It is quite feasible to triple or quadruple maize and soybean yields over the next 10-20 years. Such opportunities could be important to China’s food security in terms of diversifying both politically and agro-climatically its sources of imports, and to global food security for similar reasons. China is playing an active part in exploiting this potential but is not a significant contributor to the so-called land grab.

3.3 North-South and South-South technology transfer and food security

Although attention tends to focus on China’s current support to R&D support programmes in Africa it started almost 50 years ago. However, its greatest contribution to global food security to date is in Asia, where it has shared the improved crop varieties and particularly hybrid rice developed by its scientists. This was a key part of the green revolution and has improved the food security of millions of people. Further contributions are likely in the future (a) from its large investment in agricultural R&D and (b) its bilateral aid programme for agricultural development. For example, China’s official aid to Africa has quadrupled since 2001 and about 50% of it goes to agriculture.

3.4 Implications of China’s food security for the EU

3.4.1 The EU as a supplier of China’s food and feeds

The EU could provide some of China’s wheat and barley imports although other low cost suppliers in the Russian Federation and the Ukraine may have greater comparative advantage. The situation for dairy products is different. The EU seems likely to continue to have surplus capacity and a cost-advantage so it could increase exports to China and particularly of processed higher-value added products.

3.4.2 EU support to raising agricultural productivity and increasing the efficiency and effectiveness of the food chain

This could be critically important. First, by sharing the EU’s well established public and private sector expertise in raising agricultural productivity, which will have secondary benefits for the EU’s food security. For example, joint action on crop and livestock diseases. Secondly, by helping to increase the efficiency and effectiveness of the food processing and marketing chain. The private sector is already making an important contribution to this.
3.4.3 China collaboration on raising global food security and particularly in Sub-Saharan Africa

EU-China collaboration on food and agriculture stretches back over 20 years most of the major initiatives have been bilateral ones. However, there are a number of food security challenges that are best tackled at the level of the EU 27, notably livestock and crop diseases, and food safety. The EU-China Dialogue, the EU-China Cooperation Plan on Agriculture and Rural Development, the EU-China Policy Dialogue Support Facility (PDSF) and the Task Force on Food, Agriculture and Biotechnologies could all help advance this collaboration. Finally, as regards food security in Sub-Saharan Africa some member countries have a long history of engagement with the region. The Commission could work with these countries to link their expertise with the large resources that China is allocating to supporting agriculture and food security in Sub-Saharan Africa.

3.5 Vulnerability to national and international disasters and the implications for global food security

GOC policies to address these shocks have been in place since the 1950s. They have become increasingly comprehensive and international over time. Most attention is devoted to natural droughts and floods; progressive climate change including the increasing frequency of extreme events; and livestock disease epidemics. The domestic and international mechanisms in place or being developed seem capable of preventing major disasters in China or overseas from becoming risks to national or global food security.

4.0 Conclusions

The report has four key conclusions:

- China’s food security to 2020/30 need not be at risk
- In the main China could feed itself. It has the capacity to maintain a high level of self-sufficiency except in soybean, maize and dairy products. However, this will require critical policy and technological changes to re-direct agriculture on to a sustainable growth path that minimizes GHG emissions and other negative impacts on the environment.
- China’s net food imports in 2020/30 need not place an unsustainable burden on world agriculture, and could provide agricultural export opportunities for some countries in Sub-Saharan Africa
- The implications for the EU are modest but some member countries could make some significant contributions to China’s food security as a source of commodities, management expertise or technology.

The longer-term situation is less clear. After 2030 food demand will be relatively stable, because of a declining and ageing population, and only modest income related changes in consumption patterns. Small gains in productivity should be able to meet much of the incremental demand and ensure food security. However, uncertainties regarding the impact of climate change on food production present a major challenge for China’s long-term food security. It seems quite possible that lack of national and international action in the next 10-20 years to slow down global GHG emissions could seriously disrupt food production and agricultural trade after 2050 and result in widespread food insecurity.
1 China’s Food Security: Is it an issue?

1.1 Introduction
The maintenance of high levels of Food Security (with over 95% self-sufficiency in grains is a policy that was officially made in 1996 and has been implemented thereafter) is a political imperative in China, but not a physical or economic issue now or in the period to 2030 and probably longer. FAO projections suggest that on average China will continue to be self-sufficient for rice, wheat, maize and sorghum until 2030. Only soybean imports will continue to rise and may increase from current nearly 60Mt to 100Mt per annum by 2030, which will require a major expansion in production in its traditional sources (USA, Brazil and Argentina) or new ones. But this will not be an economic issue. Such imports will require a minute fraction of China’s more than EUR2.3 trillion foreign exchange reserves (considerably less than 1%).

But the long-term average food security situation hides a number of local and global issues regarding the sustainability of agricultural production in China and particularly because of:
(a) resource mismanagement (loss of good cropland to urban and industrial development; non-point pollution of land and water and high greenhouse gas (GHG) emissions) that require substantial shifts in national policies and great improvements in the implementation of such policies by local governments. The latter may be aided by pressures from environmental and land reform lobby groups that are pushing for policies favourable to sustainable intensification rather than unsustainable high productivity, and
(b) the knock-on effects of Chinese food purchasers on world market prices if China is forced to make large imports during severe droughts or other extreme events. They could easily outbid less affluent and food insecure developing countries. To date this has not been an issue because of China’s policy of maintaining very large carry-over stocks of grain and of boosting irrigation – about 70% of the grain land is irrigated (and therefore less drought prone) and it accounts for an even greater share of production. However, both of these favourable factors need to be supported by policy changes if they are to continue their important food security roles.

Consequently this report undertakes three tasks. First, to provide an overview of the current and future food security situation in China, and the structure of food production. Second, to review the role of central and local government in the maintenance of food security. And finally, it assesses the Global and EU implications of China’s future food security

1.2 Past and current food production and supply situation
Growth of food and agricultural sector has been impressive in China since the late 1970s. Compared to 1970-1978 when agricultural GDP increased by 2.7 percent annually, the annual growth rate raised to 7.1 percent during the initial Reform period, 1978 to 1984 (Table 1). Although during the later reform periods, the annual growth rates had slowed (around 4 percent or so in real terms), these were still extraordinarily high rates of agricultural growth over such a sustained time period.
Production growth occurred in all sub-sectors of food and agriculture in both the early and late reform periods. Between 1978 and 1984, production of grain, including cereal, sweet potato, potato, soy and other beans, increased 4.7 percent annually (Table 1). While sown area did not change during this time (NSBC, 2011), yield growth accounted nearly all growth in grain production. More than the grain sector, cash crops and animal sector, in general, and specific commodities, such as cotton, edible oils, vegetables, fruit, meats and fishery, grew even faster in the early reform (Table 1). Unlike grain, the growth of non-grain sector continued throughout the reform era. Hence, in the case of many commodities the high growth rates, which have exceeded those of grains during almost the entire Reform era, are continuing to accelerate or at least maintain the high rate of growth.

High growth of food production has kept pace with or exceeded growth in demand for most of the last 30 years with the exception of soybeans since the late 1990s. China was a net exporter of food for most of the past 20 years (Figure 1) and for the deficit commodities other than soybeans the net trade has generally been c.1% or less. Thus, if we exclude soybean, the 95% grain self-sufficiency target has not been breached and food security has not been an issue.

Table 1 The annual growth rates (%) of China’s agricultural economy, 1970-2010

<table>
<thead>
<tr>
<th></th>
<th>Pre-reform</th>
<th>Reform period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural GDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain^a</td>
<td>2.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Cotton</td>
<td>-0.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Oil crops</td>
<td>2.1</td>
<td>14.9</td>
</tr>
<tr>
<td>Fruits</td>
<td>6.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Meats (pork/beef/poultry)</td>
<td>4.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Fishery</td>
<td>5.0</td>
<td>7.9</td>
</tr>
<tr>
<td>Planted area:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>2.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Orchards (fruits)</td>
<td>8.1</td>
<td>4.5</td>
</tr>
</tbody>
</table>

^a: Grain include cereal, sweet potato and potato, soy and other beans in China.
Sources: Author’s estimates based on data from National Bureau of Statistics of China (NBSC), 1985-2011.
While China’s accession to the World Trade Organisation (WTO) in 2001 has often been considered as a turning point in its relationship with the world, in fact China’s open door policy started much earlier. In the process, China has turned itself from an isolated and inward looking country into one of the world’s great trading nations, including in the area of agricultural trade. Since the 1978 reforms total agricultural exports have exceeded imports as shown in Figure 1 but this aggregate picture hides the important shift in the composition of trade that China has experienced over the past 2-3 decades. Accession to the WTO facilitated shifts in the pattern of China’s agricultural trade rather than directly changing it. Consequently, net exports of land-intensive bulk commodities, such as grains, oilseeds and sugar crops, have fallen faster and exports of higher-valued, more labour-intensive products, such as horticultural and animal products (including aquaculture) have risen faster. In other words, after China joined the WTO, it began to export more of those commodities in which it has a comparative advantage and import more of those for which it does less or advantage. This has improved farmers income and household food security.

However, although physical availability has not been an issue rising food prices have become a major concern and particularly food price inflation. The GOC acts quickly and comprehensively to ensure that the latter does not rise to levels that harm low income consumers or puts pressure on wages in the manufacturing and service sectors. Pork and vegetable prices are particularly sensitive because they account for a high proportion of food purchases and often vary significantly over seasons. This responsiveness of the GOC to food price inflation is well illustrated by the case of pork. Sixty per cent of China’s meat protein comes from pork and pork price is an important component of China’s food price.

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index\(^7\). Hence the GOC monitors pork prices very closely and intervenes quickly when they start to rise, which it has to do frequently because pork production is unstable for two reasons. First, because of the “normal” pig cycle as producers react to market prices. Secondly, because pig production is vulnerable to a number of serious diseases (foot and mouth, blue ear, and swine diarrhoea). Outbreaks of these diseases are common and widespread with whole herds being lost, and falls of 8% or more in national production. Up until 2009 GOC responses were effective but piecemeal – compensation for culled animals, subsidies for replacement sows, restriction of pig movements from infected areas and so on. Since 2009 seven government agencies have joined forces to operate a pork price alert system and subsidy programme to ensure that pig producers have a adequate incentives to expand pork production in line with demand\(^8\). Furthermore the GOC actions go further than the latter. Since soybean and other feed costs account for a large proportion of the costs of production (about 55\(^9\)) government agencies enter long-term purchase agreements for the importation of soybean and maintain large carry-over stocks in order to reduce the vulnerability of pig producers to unstable world markets\(^10\). And finally, imported pork is stored to be released onto the market to dampen price fluctuations. The point of this example is to illustrate to ability of the GOC to (a) introduce a number of integrated measures to maintain pork supplies albeit that supporting high pork consumption levels is not essential to national food security in nutritional terms, and (b) has the capacity to adopt similar approaches for staple foods.

1.2.1 Major drivers of food demand

The GOC started family planning policy to control population growth since middle of 1950s, and established the family planning commission under the State Council in 1964. In 1978, the family planning policy was included in the Constitutional Law approved at the 5\(^{th}\) National People’s Congress. The policy, known as “one child per family” by the western observers, encourages one couple to have one child only except ethnic minorities. This policy has progressively reduced the role of population growth as the major driver of food demand (Figure 2). By 2010 the growth rate had declined to about 0.5 % per year and by 2030 it will be close to zero. Consequently population growth no longer has significant implications for food security, although the ageing of the population will reduce average per capita food demand.


\(^9\) Feed Conversion Efficiency for Livestock Producers in China: Implications for Feed Ingredient Demand and the Production of Livestock Products. A report by the Center for Chinese Agricultural Policy, Chinese Academy of Sciences in conjunction with Bunge China Research

\(^10\) As footnote 7
Since 1978 income growth and urbanisation have increasingly become the main drivers of food demand. Per capita income growth in real term has averaged at 9.7% and 7.1% in urban and rural, respectively, in 2000-2010. Urban population share has increased from 19% in 1980 to more than 50% (51.3%) in 2011. These changes have brought about substantial shifts in food consumption patterns with decline in demand for staple foods (rice, wheat and coarse grain such as maize and root crops for food), increases in demand for vegetables, fruit, livestock products and feed grains (Figure 3), and substantial differences between higher income urban consumers and poor rural consumers (Figure 4). An increasingly important factor in this change in food consumption patterns is the proportion of food eaten away from home. In Beijing, for example, about 45% of meat consumption occurs away from home. In Beijing, for example, about 45% of meat consumption occurs away from home.

Figure 2 The long-term decline in population growth

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12 NBSC, 2011, Statistic Yearbook 2011, China Statistical Publishing House, Beijing
China’s agriculture has responded to these shifts in consumption patterns through both structural and technological change, and by large has met domestic needs without any serious threats to food self-sufficiency targets or food security (see next section). However, there are increasing concerns about China’s ability to meet long-term food demand (refs and see section 3), and that these demands may
endanger food security of other low-income developing countries or increasingly link China’s food security to global food security.\(^{15}\)

### 1.2.2 Major drivers of food production

Prior to the policy reforms of 1978 the expansion of food output was largely driven by the need to ensure national grain security for the growing population. “Take Grain as the Key Link” was a national primary agricultural policy. To ensure grain security, food production was expanded mainly through reclaiming new land for cultivation, substantial expansion of irrigation infrastructure, and adopting improved crop varieties.

The following three decades saw the increasing dominance of (a) income growth and urbanisation as drivers of both qualitative and quantitative changes in food demand as discussed above and (b) both productivity growth and increasing agricultural inputs. The former led to changes in agricultural production structure with declining importance of rice and wheat and the growing importance of cereals for livestock feed and fruit, vegetables and livestock products for direct consumption.\(^{16}\)

There have been several major driving forces of agricultural productivity. In the early reform period (1979-2004), agricultural productivity increased by about 50%.\(^{17}\) Previous studies have shown that the implementation of the household responsibility system (HRS), a policy that allocated the collective owned land equally to individual farmers and gave them control and income rights in agriculture, together with market liberalisation were the major sources of the rise in productivity in the early reform years.\(^{18}\) However, since these major policy shifts technological change has been the primary engine of agricultural productivity growth.\(^{19}\)

Public agricultural R&D was the major contributor to China’s growth in agricultural productivity and to food security. It tripled between 1990 and 2010, and in terms of staff numbers the public research

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system is the largest in the world with >65% of the staff working in the crops sector and particularly on rice, wheat and maize. Consequently, average cereal yields and total factor productivity in the crops sector grew by 2-3% between 1980 and 2010, though with important issues regarding the fall in partial factor productivity of nitrogen fertilizer (see Figure 6 and related discussions). Private investment started to grow in the 2000s\textsuperscript{20}, and is now about one-quarter of the size of public R&D though generally it is not in areas important to food security. This R&D played a critical role in development of high yielding crop varieties (particularly cereals) that have been responsible for about 30% of the incremental production over the past 20 – 30 years, and made an appreciable contribution to food security in other Asian countries through south-south technology transfer.

The full benefits of this R&D have not been realised because of continuing weaknesses in public extension systems, the provision of technical advice to farmers and in vocational training. Various reforms have been introduced but much more needs to be done including development of pluralistic extension systems and making full use of the private sector and farmer professional associations. The fundamental role of R&D in ensuring long term food security is recognised by the GOC’s No 1 Document for 2012 which focuses on innovation in agricultural science and technology. The key objectives for future R&D include raising agricultural output, resource use efficiency and labour productivity; strengthen agricultural extension services; and promote training and education in rural areas.

The investment in irrigation and transport infrastructure has also contributed to China’s agricultural productivity. Irrigation has played a critical role in establishing the highly productive agronomic systems in China\textsuperscript{21}. The proportion of cultivated area under irrigation increased from 18 percent in 1952 to a level at which about half of all cultivated land had been irrigated after the early 1990s\textsuperscript{22}. Irrigated land now accounts for about 70% grain area and 80% of grain production\textsuperscript{23}. With rising water scarcity, Wang et al. (2005)\textsuperscript{24} shows that the water management reform has been helping increase the efficiency of water use in north China. Transportation and market infrastructure have also improved remarkable since the early 1990s, which has not only improved market access for farmers, reduced transport costs for production inputs and commodities, and given China an efficient and well integrated food market\textsuperscript{25}, but also raised the return to farmers at the farm gate and facilitated agricultural structural changes.

\textsuperscript{23} NBSC 2001, Statistic Yearbook 2001, China Statistical Publishing House, Beijing
\textsuperscript{25} J Wang, Z Xu, J Huang, S Rozelle, 2005, Incentives in water management reform: assessing the effect on water use, production and poverty in the Yellow River Basin, Environment and Development Economics 10: 769–799
\textsuperscript{26} J Huang and S Rozelle, 2006. The Emergence of Agricultural Commodity Markets in China. China Economic Review 17 266-280
Last but not least, the use of off-farm production inputs has increased considerably, particularly synthetic nitrogen fertilizer and modern crop varieties, which were responsible for 50-60% of the incremental growth of agricultural production from the mid 1970s onwards.

But most of these developments have involved a number of perverse or relatively ineffective subsidies that have grown from c 100 million yuan in 2002 to over 100 billion yuan in 2010. The production of nitrogen fertilizers is heavily supported by perverse energy subsidies (EUR2.9 billion in 2007), and secondarily by storage and transport subsidies, which artificially lowers prices to farmers and encourages overuse. The largest subsidies go directly to farmers to encourage grain production but are administered in such a way that they are more an income transfer to farmers than specific incentives to raise yields and production.

However, these positive features carry with them some other unfavourable characteristics. First, it can be argued that the growth in crop output for much of reform period has also largely been from the intensification of production. Thus the intensification of production has involved higher and higher applications of conventional synthetic fertilizers (Figure 5) rather than more technologically advanced smart fertilizers such as slow-release formulations (that are >5% of the market). The situation for livestock production has some similarities to the crops sector, with part of the increased output stemming from the use of modern compound feeds and improvements in livestock breeds. However, much of the intensification has been associated with structural change involving backyard pig, poultry and dairy production being replaced by the much larger units employing substantially different management practices which could have significant positive implications for the environment because of better waste management.

Second, this pattern of intensification has had a number of negative consequences for food security. First, average partial factor productivity of fertilizer at the national level has declined though total factor productivity has increased. There has been substantial falls in fertilizer use efficiency (Figure 6.) partly related to the overuse (by 30-50%) and mismanagement of nitrogen fertilizer. Similarly, water use efficiency is also low, the national average WUE is only about 45%. In addition excessive irrigation, especially for covered intensive vegetable production, has accentuated the decline in N fertilizer

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29 D Norse, 2011, Greater food security and a better environment through improved nitrogen fertilizer management, SAIN Policy Brief No 2.
efficiency\textsuperscript{30}. These negative impacts will have affected food security in two main ways. First, they will have raised food production costs, contributed to food price inflation and reduced food purchasing power. Secondly, they will have reduced yields through soil degradation and increased pest attacks\textsuperscript{31}.

**Figure 5** Grain production, synthetic nitrogen fertilizer inputs and cropped area 1978-2007


\textsuperscript{31} J. Guo, X Liu, Y Zhang, J Shen, W Han, W Zhang, P Christie, K Goulding, P Vitousek and F Zhang 2010, Significant Acidification in Major Chinese Croplands, Science 327, 1008-1010

Also see footnote 22 and Section 1.3.4
It follows from the above that a new agricultural development strategy is needed if these negative consequences of the present model are not to undermine future food security. The GOC has already taken some steps to move on to a low carbon resource efficient pathway\textsuperscript{32} but more needs to be done to raise crop and livestock yields and achieve sustainable intensification. The policy and technological options for doing this are considered in section 3.

1.3 Future prospects

1.3.1 Introduction

Some early commentators where unduly pessimistic about China’s ability to feed itself. Lester Brown (1995)\textsuperscript{33}, for example, projected that China’s grain import needs would rise 155 Mt in 2010, 256 Mt in 2020 and 369 Mt 2030. He argued that these would distort world trade and prevent other developing countries meeting all of their food import needs. Alexandratos (1996)\textsuperscript{34} showed clearly that this pessimism was unfounded and based on weak data and inappropriate assumptions. More recently, representatives of international agencies and other observers were forecasting the need for major grain imports in 2011, because of widespread droughts earlier that year. The reality has been quite different. Net grain imports in 2010 were only c. 3 Mt, and this was largely maize for livestock feed, and grain production in 2011 was the highest ever. Much of the pessimism of the earlier projections stemmed from different assumptions about China’s supply potential (particularly land and water resources and

\footnotesize
\textsuperscript{32} R Ash et al 2012, China, the EU and China’s twelfth five-year programme, ECRAN Policy paper.  
\textsuperscript{33} As footnote 1.  
\textsuperscript{34} N Alexandratos. 1996. China’s projected cereals deficits in a world context. Agricultural Economics, 15: 1-16.
prospects for technological change) rather than growth in grain demand. Whilst the more recent pessimism regarding the impact of the 2011 drought on wheat production can be attributed to a lack of allowance for China’s agro-climate complexity and the GOC’s ability to quickly give farmers greater incentives to increase production. Lastly, the validity of some recent projections can be questioned because of their extreme assumptions about changes in consumptions patterns as discussed in the next section.

The following projections of food supply and demand in 2020 and 2030 are hopefully technically more reliable than the earlier projections. The drivers for food demand and production are better understood as discussed above. Databases and projection models have improved and modellers take greater account of parameter uncertainty. However, the future will continue to be shaped by policy choices that primarily affect production, for example, biofuel and GM crop policies and investment in R&D, but it may also be influenced by changes in demand if the GOC decides to discourage livestock consumption patterns that pose health risks to people and the environment.

1.3.2 Projected demand to 2030 – food, feed & net exports

Demand will continue to be driven by growth in population, incomes and urbanisation (as discussed earlier in section 1.2.1). Population growth will have virtually no effect by 2030 (Fig 1) although there will be impacts from the ageing of the population. Income driven changes in consumption preferences will also slow down.

Direct demand for cereals will follow the pattern of the past 30 years with per capita demand for rice, wheat and other food grains being virtually flat by 2030 following recent trends (Figure 7). It will require nearly zero increases in production (see next section) with no significant food security implications.

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The growth of indirect demand for cereals is less certain. The main uses are for livestock feed, food processing (particularly starch), and for alcoholic beverages which are all income driven. These projections assume that their use for biofuels will continue to be restricted (see next section). The largest use is for feed (about 40% of total demand), and its future demand is subject to two major uncertainties. First, that regarding the growth of per caput demand for livestock products. Second, about the growth in livestock productivity and especially about future gains in feed use efficiency, which will be discussed in the next section.

Results from the National Food Survey\textsuperscript{36} show that the growth in per caput adult meat consumption appears to have started to slow down from the early 1990s during a period of high urbanisation and income growth (Figure 8a), but the survey does not include food consumption away from home which has been growing considerably since 1990s as discussed in section 1.2.1. By 2009 consumption levels in rural areas were rising towards urban levels and those in cities, towns, and suburbs were converging (Figure 8b). Moreover, the impact of income growth on meat consumption was substantially reduced (Figure 8c). Similar shifts in consumption patterns were apparent for milk and eggs\textsuperscript{37}. Looking ahead to 2030 and beyond CCAP results suggest that urban meat consumption per capita will continue to rise until 2025-2030 but at a declining rate. Growth in rural meat consumption will continue for a further 5-


\textsuperscript{37} As footnote 36
10 years, but with population growth becoming negative after 2030 and ageing of the population total meat demand will level off by 2035 and then decline slowly.

It seems possible, therefore that the per caput demand for livestock products projected by some analysts may be too high (Figure 9). For example, IFPRI’s baseline projection gives per caput meat consumption levels in 2030 of about 70 kg per caput, and c.35 kg if people adopt a healthier low meat diet. These projections are in strong contrast to the food survey data (Fig.8c) that suggest that actual meat consumption levels of high income adults had levelled out in 2009 at about 37 kg, but this does not include consumption away from home so the total intake could be about 60 kg. Even if one allows for (a) the differences between the NFS data which is for actual meat consumption and the IFPRI data that uses dressed carcass weight divided by population, and (b) the NFS average consumption estimate is for adults as opposed to IFPRI’s average for the whole population, it still seems possible that meat demand in 2030 could be less than the 136 Mt projected by Masuda & (2010) and closer to the 93 Mt projected by CCAP for 2020/21 and the 104 Mt projected by FAO for 2030 (Table 2).

These uncertainties about the demand for meat, milk and eggs have substantial implications for total feed demand, imports of coarse grains and soybeans and food security. In addition, there are uncertainties about growth rates for technological and management improvements in livestock production to raise feed use efficiency. Past improvements in these two factors have been modest (Xiao et al, 2012) and have not achieved the large potential gains in feed use efficiency that are feasible by 2030. The MOA’s 12th FYP for livestock development and feed industry development both mention raising feed/grass/crop residue use efficiency, but do not set specific targets.

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Figure 8 National food survey of China

(a) Per caput adult meat consumption

(b) Consumption levels in rural and urban areas

(c) Impact of income growth on meat consumption
1.3.3 Projected production

The following projections assume the continuation of present policies and no appreciable impact of climate change on average national food production (Table 2). They suggest that China has the capacity to remain broadly self-sufficient for the next 10 to 20 years for most food commodities and achieve a high level of food security from domestic resources (Table 3). The major exceptions are coarse grains (primarily maize), oilseeds (primarily soybean), milk products and possibly sugar.


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39S Wiggins and S Keats, 2012, "China: are changes afoot for cereals?", Research reports and studies, May 2012, London: Overseas Development Institute
### Table 2 Current and Projected Production (Mt)

<table>
<thead>
<tr>
<th></th>
<th>CAPSiM - CCAP</th>
<th>OECD_FAO</th>
<th>FAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>195.8</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>115.2</td>
<td>103</td>
<td>114</td>
</tr>
<tr>
<td>Coarse grains</td>
<td>208.7</td>
<td>274</td>
<td>177</td>
</tr>
<tr>
<td>Maize</td>
<td>177.2</td>
<td>223</td>
<td></td>
</tr>
<tr>
<td>Oilseeds</td>
<td>47.4</td>
<td>53</td>
<td>56</td>
</tr>
<tr>
<td>Soybean</td>
<td>15.1</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>Sugar</td>
<td>14.4</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Beef &amp; mutton</td>
<td>8.0</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Beef</td>
<td>4.6</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Pork &amp; poultry</td>
<td>58.7</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Pork</td>
<td>45.8</td>
<td>57</td>
<td>49</td>
</tr>
<tr>
<td>Milk</td>
<td>37.5</td>
<td>79</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: Simulation results from CAPSiM 2012, CCAP, OECD-FAO (2012), and unpublished FAO data

### Table 3 Past and projected self-sufficiency levels (%)

<table>
<thead>
<tr>
<th></th>
<th>CAPSiM, CCAP</th>
<th>FAO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2020</td>
</tr>
<tr>
<td>Rice</td>
<td>100.1</td>
<td>100.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>99.2</td>
<td>99</td>
</tr>
<tr>
<td>Coarse grains</td>
<td>99.1</td>
<td>92.4</td>
</tr>
<tr>
<td>Oilseeds (vegetable oils for FAO)</td>
<td>49.0</td>
<td>41</td>
</tr>
<tr>
<td>Sugar</td>
<td>90.0</td>
<td>90.4</td>
</tr>
<tr>
<td>Beef &amp; mutton</td>
<td>99.5</td>
<td>97</td>
</tr>
<tr>
<td>Pork &amp; poultry</td>
<td>99.9</td>
<td>98.5</td>
</tr>
<tr>
<td>Milk</td>
<td>98.1</td>
<td>91.5</td>
</tr>
</tbody>
</table>

Source: As Table 2
There are differences in the estimates of Huang et al (2012)\textsuperscript{40} and FAO for the production and SSRs for sugar and beef which are part demand related (see next section) but also a reflection of the uncertainties about resource allocation. In the early 2000s the GOC decided that it was beneficial to allow more land, labour and other resources to be shifted from the production of cereals and soybean to vegetables and higher value crops and out of agriculture, because this shift need not endanger the production of staple foods and basic food security. This opened the way for greater imports of soybean and more recently of maize, and this is likely to continue (Figure 10).

\textbf{Figure 10 China’s net export of agriculture and food (billion EUR) under baseline in 2001-2020}

This allocation issue will continue to shape production throughout the projection period and beyond. Some recent policy decisions on this issue, for example, on biofuels, GM crops, and sugar, could shift the production pathway away from that suggested by Huang et al (2012) and FAO.

In 2007 the GOC prohibited the expansion of bioethanol production from cereals above the levels allocated at that time. Consequently, the potential competition between cereals for food or feed and those for bioethanol production will be prevented and any further expansion of biofuel production will

have to be based on non-food crops grown on marginal land\textsuperscript{41}. Thus earlier concerns that bioethanol production could threaten food security are no longer valid (Qiu et al., 2011)\textsuperscript{42}.

The 12 FYP sets a number of targets and investment decisions regarding the development and application of agricultural biotechnology, and the expansion of sugar production. Most of such targets set by the past two FYPs were achieved\textsuperscript{43} and so it is reasonable to assume that could continue to be the case and affect self-sufficiency levels. The increased R&D in GM maize could increase self-sufficiency in 2025 by several percentage points though not eliminated the need for imports\textsuperscript{44}. The Chinese Ministry of Agriculture has set a target of raising sugar production by 2 Mt over the plan period\textsuperscript{45}, and it is technologically feasible to continue this rate of expansion up to 2030, which would make China close to self-sufficient. However, (a) such a reallocation of cropland could take away land from food and feed production, (b) sugar beet and sugar cane may not be as profitable to farmers as other crops and (c) imported sugar could be cheaper.

A major factor affecting cereal production and imports will be progress or the lack thereof in raising feed use efficiency. This will be considered in next section.

1.3.4 Resource constraints and policy challenges

**Cropland** There are large uncertainties about the current area of cropland in part due to whether estimates are based on census data, which have been distorted in the past by local officials, or on remote sensing images. The main concern is the continuing loss of highly productive cropland to urban development and other non-agricultural uses given that less than 10% of the land mass is suitable for crops and some two-thirds of this area is not of high potential productivity. The 11\textsuperscript{th} and 12\textsuperscript{th} FYPs have addressed this issue by stipulating that the area should not fall below 120 Mha compared with 130 Mha in 1996 when there was a substantial upward revision in the official cropland area estimates. However, some analysts argue that the area is already below 120 Mha or soon will be\textsuperscript{46} but there are large uncertainties in the data. For example, recent unpublished estimates from CAS and the Ministry of Land and Resources show that the total area of cultivated land did not decline during 1990-2010 and is now about 140 Mha but average quality or primary productivity of land has been falling.

It is generally agreed that:


\textsuperscript{44} Huang, 2012. Views on China’s Food Security and Trade, unpublished, Center for Chinese Agricultural Policy.

\textsuperscript{45} Ministry of Agriculture, 2012, The 12th Five Year Plan for Agricultural and Rural Economy.

\textsuperscript{46} L Ye, 2011, Simulated Effects of Climate Change on Food Security in China toward 2050, presentation at International Conference on Climate Change and Food Security (ICCCFS) November 6-8, 2011, Beijing.
(a) urbanisation will continue to be the main cause of land loss and if this follows the pattern of the 1990s it could undermine food security. During the 1990s about 50% of the land loss was in the important grain producing provinces of Jiangsu, Guangdong and Hebei which can grow two crops per year because of their mild climate. In contrast, the main increases in cropland were in Heilongjiang and Inner Mongolia were cold winters prevent double cropping\textsuperscript{47}. This decline in average primary productivity will continue.

(b) some marginal cropland may be returned to pasture or forest through the grain for green or similar programmes but with limited implications for food security

(c) China has virtually no additional land to develop for crop production.

Although restrictions on land transfers from agriculture to other sectors have been placed on local governments these are not always applied. For example, any cropland which is transferred to non-agricultural uses is supposed to be balanced by an equal area of land reclamation elsewhere. This is seldom done in part because of perverse incentives, for example some local governments gain up to 50% of their total revenues from land transfer fees\textsuperscript{48}. In the short term at least the financial incentives for permitting land transfers seem likely to continue, and could pose a threat to food security unless productivity gains on the remaining land or food imports make up for the loss.

Some compensation for these losses could arise from land consolidation and an increase in cropping intensity\textsuperscript{49}. Land consolidation could:

(a) increase the effective cropped area because of the removal of narrow roads, footpaths, paddy levees and other non-cultivated land which can account for 20% of the gross cropland area\textsuperscript{50};

(b) allow greater mechanisation and other productivity enhancing changes that lower the unit costs of food production\textsuperscript{51}, and raise fertilizer use efficiency (FUE)\textsuperscript{52} with important environmental benefits as discussed below.

A number of analysts have concluded that the problem of land loss to non-agricultural uses will be compounded by land degradation from desertification\textsuperscript{53} and soil erosion\textsuperscript{54}. Though there is no doubt

\textsuperscript{49} As footnote 48
\textsuperscript{50} As footnote 48
that desertification and soil erosion are serious in some areas, their impact on staple cereal production is limited. For example, the bulk of rice and wheat production is irrigated and grown on naturally level river flood plains or on land which has been levelled by farmers over many centuries. Such land is not prone to serious erosion. The same is true for much of the maize, soybean and vegetable production.

Labour resources. They are and will continue to be an important constraint to agricultural growth but not a major or unmanageable challenge to food security. Two factors are of particular concern. First, the loss of labour to non-agricultural activities because of temporary or permanent out-migration without any or insufficient compensating increases in labour productivity through mechanisation and land consolidation (as discussed above). Second the progressive ageing of the active labour force such that a recent survey\(^{55}\) in five important food producing provinces found that >65% of those heavily engaged in farming were over 45 years of age and only 14% were in the under 35 group. This situation is likely to deteriorate further by 2030 if current policies prevail with growing difficulties in hiring labour and maintaining high multiple cropping rates, and continuing use of sub-optimal crop management practices that reduce output growth, contribute to low fertilizer use efficiency and are unsustainable in the long-run. However, as discussed above in the context of the land constraint and in section 2 regarding central and local government policies and practices this constraint can be overcome by a combination of land consolidation, appropriate mechanisation and improved provision of technical advice and skills and the GOC is re-shaping its policies to implement these measures. Thus, labour force change can be considered more as an opportunity than a challenge, although rising wages could have negative impacts on labour intensive products such as fruits and vegetables but not on commodities critical for food security commodities such as grains and edible oils.

Irrigation. Agriculture accounts for 65-70% of total water use. Income and urban/industrial development driven demand for water could pose similar challenges to those regarding land, because irrigation plays a critical role in staple food security, vegetable production and some feed grain production. Irrigated land produces about 80% of grain production\(^{56}\) and with around 37% of the maize and 80% of the wheat area being irrigated when required\(^{57}\). Much of this irrigation is dependent on falling groundwater tables (Wang et al, 2012; Xiong et al, 2009), but this is not the only challenge:

(a) continuing urbanisation and income growth will increase competition for water

(b) groundwater depletion means that the energy cost of pumping will rise and with it the GHG emissions from the production and use of that energy – these emissions already account for about 3% of agriculture’s total GHG emissions

\(^{57}\) USDA 2011, China Peoples Republic, Grain and Feed Annual. GAIN Report No CH1014 USDA Washington DC
Although water use efficiency (WUE) has risen in the past 10-20 years as a result of public investment in ditch and canal lining, sprinkler irrigation, etcetera average irrigation efficiency is still only about 45%\(^{(c)}\).

Climate change is likely to have a negative impact on cereal production in some parts of China unless there are sustained improvements in agricultural technology\(^{(d)}\).

Over irrigation adds to the low fertilizer use efficiency and non-point pollution challenges discussed below.

**Fertilization use efficiency (FUE).** This has declined by about one-third since 1978 (Figure 6) with numerous negative environmental impacts on the local, national and global environment and particularly non-point pollution\(^{(d)}\). A series of GOC actions since 2000 in successive FYPs have failed to resolve the problem\(^{(e)}\) which has complex origins that require integrated action by a number of ministries to improve advice to farmers and to help overcome the labour constraints of part-time farmers. For example, in 2007 four ministries – the Ministry of Science and Technology (MOST), the Ministry of Agriculture (MOA), the Ministry of Finance (MOF), and the State Administration of Grain signed collaboration agreements with major grain producing province to raise yields and lower negative environmental impacts through the application of improved science and technology. This appears to have had positive impacts on crop yields but not on FUE or on non-point pollution. Thus current staple food security is damaged by the reduction in yields caused by the overuse of nitrogen fertilizer\(^{(d)}\) and long-term food security is placed at risk by soil acidification (see below) and unnecessarily high GHG emissions.

**Climate change.** The impact of climate change on China’s food security must be assessed in an integrated manner that takes in to account of the:

- biophysical and physiological effects of climate change on crop distribution and yields;
- socio-economic drivers for GOC and farmer led responses and adaptations to climate change;
- evolution of the supply potential of countries that may be an important source of food imports and particularly of maize and soybeans.

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\(^{(d)}\) W Xiong, D Conway, E Lin, Y Xu, H Ju, J Jiang, I Holman, Y Li 2009, Future cereal production in China: The interaction of climate change, water availability and socio-economic scenarios, Global Environmental Change, Volume 19, Issue 1, February 2009, Pages 34–44.


\(^{(1)}\) MEP, 2010, Technical guideline on environmental safety application of chemical fertilizers, National Environmental Protection Standard, HJ555-2010.

\(^{(2)}\) D Norse, 2011, Greater food security and a better environment through improved nitrogen fertilizer management, SAIN Policy Brief No 2.
Earlier assessments of the impact of climate change on Chinese agriculture suggested that China’s food security was seriously at risk. However, they were based on analyses that either were not sufficiently integrated or not spatially disaggregated enough to arrive at reliable conclusions. Some recent studies do not have such limitations, and use scenario analysis to explore uncertainties in key parameters (Wei et al, 2009; Nelson et al, 2011; Ye et al, 2012, and are therefore a better starting point for determining the risks of climate change for food security. They all conclude that climate change is not a serious threat to China’s staple cereal production and food security over the next 20-40 years unless one adopts the unrealistic assumption that the GOC and farmers do not respond or adapt to climate change. In fact some scenarios suggest that climate change could have a small positive impact on food security but this would be much less than the positive impacts of measures to stop cropland loss or raise agricultural productivity. Although rice yields in the South of China might decline because of rising temperatures production could shift to cooler provinces further North – a trend that is already well established. Average wheat yields are projected to be favoured by climate change up to about 2030 but possible not thereafter. Maize yields may decrease but this could be counter balanced by yield increases from better crop management, conventional plant breeding and the introduction of GM maize. These increases should meet the direct demand for food grains and contribute to meeting feed grain demand.

Emerging threats. Soil acidification of much of China’s intensively cultivated land has doubled over the past 30 years and N fertilizer has contributed about 60% of this and is greatest under cash crops than cereals. Much of the acidification stems from the high inputs of N fertilizer rather than from acid rain, although ammonia emissions from fertilizer, manure and other livestock wastes may become of increasing importance. It can reduce crop yields, increase the availability of toxic metals and control is labour intensive and costly.

Soil pollution by heavy metals is receiving greater emphasis in GOC policies because of food safety issues but the implications for staple food production is probably limited.

Low level ozone damage to crops may already be serious because concentrations in parts of China down wind of cities and industrial areas are already exceed those known to cause yield loss in other countries. Wheat and soybean are particularly sensitive to ozone damage with losses of 4-15%.

63 Though none of the global circulation models they use can satisfactorily examine the impact of an increase in frequency of extreme events nor do the assessments give adequate consideration to the impact of climate change on livestock production.
Growing urbanisation and transport growth are likely to widen the area at risk but it remains an under researched issue that is not reflected in GOC priorities.

Feed use efficiency. In general it is low in China and although there have been significant improvements in the past 5-10 years that were largely associated with the shift from small to large scale production. This is particularly important as regards the large intensive dairy units that are expected to be the main source of increased milk output in the future, and in the pig industry which is the main user of feed grains. For example, the average feed use efficiency in dairy farms is 25-30% lower than in developed countries using the same breeds, and for pork production average feed conversion rates (kg feed/kg weight gain) are also much higher than in the EU although those for the best large operations are similar to the EU average. Consequently measures to raise feed use efficiency could have major benefits for food security, and the environment. The policy and technological responses required could be implemented in the next 5-10 years and have a substantial impact by 2020/30. They concern (a) the genetic improvement of livestock, which is currently partly constrained by GOC policies, for example, regarding the import of semen, and (b) the quality of the feed mix which is strongly influenced by the price of maize. These factors have important implications both for lower maize and soy bean imports and reduced livestock pollution of surface waters and emissions of ammonia and GHGs.

2 Central and Local Government Context of Food Security Policies

2.1 State Council’s Food Security Strategy

2.1.1 Evolution of food security and food security policies since the 1950s

China suffered from acute food insecurity during the 1950s and 60s with average food consumption of only 2000 Kcal/person/day and at times dropped substantially below this average because of droughts and pest outbreaks. Until the economic reforms of 1978 the GOC tended to focus on industrial development supported by cheap food and raw materials, and agriculture and food security were not given strong emphasis. The management of agricultural production was highly centralised under a command and control system with State imposed targets for local level production, unfavourable procurement prices, and tightly controlled marketing and trade. However, after 1979 the GOC started to introduce measures to ensure that poor agricultural growth did not endanger food security or hold back the development of the manufacturing and service sectors. As one of the Four modernisations (agriculture, industry, national defence, and science and technology), the rapid development of the agricultural sector in 1979-84 provided a fundamental base for the expansion of the industrial sector (Figure 11).

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68 Feed Conversion Efficiency for Livestock Producers in China: Implications for Feed Ingredient Demand and the Production of Livestock Products. A report by the Center for Chinese Agricultural Policy, Chinese Academy of Sciences in conjunction with Bunge China Research

The first major action in 1979 was the introduction of the household responsibility system to provide incentive for individual farmers to expand and diversify agricultural production. This system allowed farmers to sell surplus produce grown on land allocated to them by the collective once they had met their centrally imposed quota for staple food (rice, wheat, maize, soybean, edible oils) and livestock production. This led to the rapid increase in stable food productivity, which also enabled farmers to expand vegetables production (Figure 12) and backyard pig production (which doubled between 1980-90) and is a clear indication of how rapidly Chinese farmers respond to price and market incentives.
The next major reform was in 1984 when the mandatory quotas were replaced by voluntary contracts for grain following a fall in net grain imports. Grain production expanded throughout the next 10 years, but did not keep ahead of per capita demand and food security targets. This led to another set of reforms to boost staple food production (by re-imposing the state compulsory quota system in most parts of China, higher procurement prices and technological improvements) and to further decentralize the management of food security by the introduction in 1995 of the “Provincial Governor’s Grain Bag Responsibility System”. The latter made provincial governors responsible for ensuring that grain production and stocks in their province met local needs and grain prices were relatively stable and high enough to encourage farmers to raise their grain output without increasing food price inflation for urban consumers. It was effective but carried a number of negative features. Regional comparative advantage and inter-provincial trade was suppressed and both grain storage costs and losses from storage pests rose.

Further reforms were introduced between 1995 and 2010 to provide a comprehensive policy framework (Table 4) and to improve the functioning of grain markets and the cost and efficiency of the grain reserve system. Since 2002 this policy framework has received additional support China’s Agricultural which was strengthened to include articles that specifically address food security (Box 1). They have been effective in maintaining national food security, and contributing to global food security. Per capita grain production has exceeded demand together with substantial quantitative and qualitative improvements in dietary patterns. China was a net grain exporter for most of the past 20 years (see next section), has provided food aid to other countries, and has avoided de-stabilising international markets.

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by investing heavily in irrigation and using large carry-over stocks to offset the impact of droughts and other extreme events on domestic production (see Section 3).

Table 4 Food security policy framework and action points

<table>
<thead>
<tr>
<th>Policies</th>
<th>Action points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land Administration Law; Law on Land Contract in Rural Areas;</td>
<td>Protection arable land from other uses; Insist household responsibility system</td>
</tr>
<tr>
<td>Regulations on the Protection of Basic Farmland</td>
<td>and allow land use right transfer;</td>
</tr>
<tr>
<td>Farmer Professional Association Law</td>
<td></td>
</tr>
<tr>
<td>Scrap agricultural tax;</td>
<td>Farmer income protection</td>
</tr>
<tr>
<td>Agricultural subsidies (for farmers purchase high quality seeds, farm</td>
<td>Price stability</td>
</tr>
<tr>
<td>machinery, fertilisers, fuel and other input); Floor price for rice and</td>
<td></td>
</tr>
<tr>
<td>wheat purchase</td>
<td></td>
</tr>
<tr>
<td>Provincial governor “Rice Bag” responsibility; Establish major grain</td>
<td>Ensuring grain supply and demand is balanced within the province</td>
</tr>
<tr>
<td>production zones with preferable /specific financial support;</td>
<td></td>
</tr>
<tr>
<td>95% grain self-sufficiency; Multi-level food reserve system;</td>
<td>Ensure food supply and reduce volatility</td>
</tr>
<tr>
<td>R&amp;D: high yield varieties, water-saving technologies,</td>
<td>Increase per unit productivity</td>
</tr>
</tbody>
</table>

Throughout the period 1950-2000 the focus of the national food production strategy was on maintaining 100% self-sufficiency in all staple grains defined as rice, wheat, coarse grains, soybeans, pulses, potatoes and sweet potatoes. However, towards the end of this period there was increasing discussion about the appropriateness of this definition because of (a) the decreasing importance of the potatoes and sweet potatoes in diets; (b) the increasing use of coarse grains and soybeans for livestock feed, (c) the impending entry of China into the WTO and (d) the shortage of arable land. These discussions led to the decision to revise the food security target to 95-100 % self-sufficiency for cereals under normal conditions and opened the way for the expansion of soybean imports.

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2.1.2 Food security strategy in the 12th FYP period and beyond

Entering its 12th FYP period (2011-15), the GOC faces several challenges to maintain food security, including continued increase in food demand and decline in arable land. These were examined in Section 1 and the GOC has formulated responses to them on the basis of the following predictions for 202:

- Per capita grain demand 395 kg, total demand 572.5 billion kg;
Per capita food grain consumption 247.5 billion ton, account 43% of total consumption; feed grain consumption 235.5 billion ton, account 41% of total grain consumption;

Per capita edible oil consumption 20kg, total demand 29 million ton

A number of strategic plans have been prepared that address the food security problem and in particular respond to the continued increase in food demand (in both quantity and quality, mainly driven by increased wealth and consumption pattern), the constraints in natural resource base (land, water), and to global food price inflation. These include the Medium and Long-term Plan for National Food Security (2008-2020); National Plan for Expansion of Grain Production Capacity by 50 million Ton (2009-2020); The 12th Five-Year Plan for National Economic and Social Development (2011-2015); and 12th Five-Year Plan for Agricultural and Rural Economic Development.

The present and future objectives of China’s food security strategy are well presented in these documents. Maintaining 95% grain self-sufficiency and 120 Mha of arable are the overarching targets. This means future food security has to rely on increased productivity per unit of land, water, fertilizer, and livestock feed; therefore, sustainable intensification is the key objective. This situation is similar to that in other parts of the world, but the situation in China perhaps is more acute.


Prepared by the National Development and Reform Committee (NDRC), together with over more than 10 ministries, the Medium and Long-term Food Security Plan (2008-2020) (the Plan hereafter) outlines the objectives, tasks, and specific programmes for food security and provides the strategic framework for all actions and policy measures on food security leading to 2020.

Objectives

(i) Stabilize the grain-sown area and ensure that the arable land area is not less than 120 Mha in 2020
(ii) Ensure China remains basically self-sufficient in grain and other major food. Maintain grain self-sufficiency over 95%.
(iii) Maintain a reasonable level of grain stocks and the proportion of wheat and rice should not be less than 70% of the stock.
(iv) Establish a modern grain logistic system and reduce grain distribution costs.

The key actions

The Plan outlines a number of actions to safeguard China’s future food security. These include increasing grain production capability, utilization of non-grain food resources, international cooperation; further improve grain distribution system, strengthen grain storage, logistic and process system.

Increase grain production capability

The Plan calls for five main actions to increase grain production capacity. (i) Protect arable land. This includes protecting arable land from other uses, improving the quality of current arable land, and land reclamation. Increasing grain production capacity also needs strict control of non-point pollution and better advice to farmers on the sound use of fertilisers and other agri-chemicals to reduce...
contamination of land and water and safeguard the ecosystem for the grain production.  

(ii) Enhance infrastructure development, particularly water conservation, steadily increase irrigation water use efficiency from 0.5 in 2010 to over 0.55 by 2020. (iii) Increase per unit yield through technology progress. This includes technological innovation in crop and livestock breeding, land cultivation and resource use efficiency as well as technical extension.  

(iv) Comprehensive development of major grain production zones. (v) Improve agricultural services, including extension services, and pests, diseases and extreme weather early warning systems.

*Improve utilization of non-grain food resources*

The Plan calls active development of grain-saving livestock production systems and promotion of grass-fed livestock, as well for the expansion of large scale and intensive livestock production systems and increased feed use efficiency. Development of freshwater fishery as well as ocean fishing will be encouraged. Production of oilseed crops will be promoted when and where this can be done without undermining grain crop production.

*Extend international cooperation*

The government’s strategy is to use international market to adjust the domestic food supply and demand. It aims to establish long-term stable grain cooperation with certain major grain producing countries. “Going out” is also an important component of China’s international cooperation in agriculture. The government will continue to encourage enterprises to expand overseas to establish stable and reliable grain import systems, and strengthen domestic grain security. China’s “going out” strategy has strong global implications which are discussed further in section 3.

*Improve grain distribution system*

Grain distribution system improvement will focus on strengthening the capacity and effectiveness of state own enterprises in grain purchase, storage, and marketing system through establishing specialised regional wholesale markets, as well as township grain supply networks; development of information services platform, to facilitate e-business in grain trading, and strengthen the grain logistic system.

*Strengthen grain storage system*

The GOC aims to establish a grain stock adjustment system to strengthen the macro grain regulating capacity. The central strategic stock will be combined with adjustment turnover stock. The local government stock will be combined with commercial stock. Wheat and rice will be maintained at over 70% of the central and local government stock.

*Improve grain processing system*

Grain and oil, food processing industry will be developed by promoting large-scale grain processing and factory production of traditional food.

Actions in the feed industry include optimizing its structure, improving feed formulation, and establishing a safe, high quality and efficient feed industry system. Exploring the potential of non-grain feed sources, such as straw and grass to lower the need for feed grains will also be encouraged.

Policies and measures to safeguard food security

The Plan adopted the following policy measures to safeguard the goal of national food security:

(i) Strengthen the government’s food security responsibilities; provincial government is responsible for the region’s arable and water resource protection, grain production, distribution, storage and marketing regulation.

(ii) Strong protect of production resources, including arable land and grassland.

(iii) Enhance scientific and technological support to agriculture, establish the government-led multiple funding system and encourage business sectors and farmer associations to disseminate agricultural technologies.

(iv) Improve agricultural infrastructure and support services including pest and diseases control, rural finance service, the effectiveness of grain production subsidies and incentives, support to inter-regional grain supply and marketing

(v) Perfect the grain macro control mechanism; improve grain statistics system, emergency response system, grain distribution policies, and strengthen grain administration system.

(vi) Promote healthy food consumption and reduce waste along the whole food chain.

(vii) Speed up the development of food legislation.

(viii) Implement specific programmes and plans regarding grain production, distribution, storage, process and consumption.

Technological Pathways for Expansion of Grain Production

In 2009 the NDRC published the “National Plan for Expansion of Grain Production Capacity by 50 Million Ton (2009-2020)” to supplement the National Medium and Long-term Food Security Plan. It puts forward the following technological approaches for expanding grain output:

(i) Upgrade existing irrigation and drainage facilities and increase the irrigation area where conditions permit,

(ii) Spread the use of good crop varieties and high-yield cultivation technologies, and improve the integration of these two approaches

(iii) Change farming systems to fully exploit the potential of China’s limited land and water resources;

(iv) Promote the development and use of advanced and appropriate agricultural machinery and auxiliary technologies, accelerate mechanization of grain production;

(v) Prevent and control major diseases and pests to minimize loss from natural disasters.

The 12th Five-Year Plan for National Economic and Social Development (2011-2015)

This is China’s most comprehensive development plan which covers all the important sectors of social and economic development. The main tasks and targets related to agricultural development and food security are listed in Annex 1.

2.2 Institutional constraints to policy implementation

Formulation and implementation of food security policies involves different departments and sectors of central and local government. Consequently institutional barriers within government are often a constraint to the effective formulation and implementation of the policies.
Responsibilities of government departments

There are two aspects of government department responsibilities that are or may become barriers for the implementation of agricultural and food policies, namely overlapping and divided responsibilities.

Overlapping responsibilities leads to inefficient management of resources. “Nine dragons administer water” is a Chinese saying describing overlapping responsibilities of different parties that in the end can lead no one takes responsibilities; this situation is particularly true for China’s water resource management where the responsibilities are scattered between several ministries (Table 5). This makes water pollution control more difficult, and particularly non-point pollution control against which little progress has been made.

Table 5 Complexity of government structures responsible for resource management and the food system: the case of water

<table>
<thead>
<tr>
<th>Ministry</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Development and Reform Commission (NDRC)</td>
<td>Strategic planning</td>
</tr>
<tr>
<td>Ministry of Water Resources (MWR)</td>
<td>Water resource planning and development, flood control, drought relief, guidance on irrigation, drainage and rural water supply, watershed management and water-borne soil erosion</td>
</tr>
<tr>
<td>Ministry of Environmental Protection (MEP)</td>
<td>Environmental pollution prevention and control.</td>
</tr>
<tr>
<td>Ministry of Agriculture (MOA)</td>
<td>Irrigation and the use of water for agricultural purposes, wetland development, fisheries</td>
</tr>
<tr>
<td>Ministry of Housing and Urban–Rural Development (MHRUD)</td>
<td>Waste water treatment and use of urban groundwater</td>
</tr>
<tr>
<td>Ministry of Land and Resources (MLR)</td>
<td>Monitoring and prevention of over-extraction and contamination of groundwater</td>
</tr>
<tr>
<td>Ministry of Health (MOH)</td>
<td>Water quality standards</td>
</tr>
<tr>
<td>Ministry of Transport</td>
<td>Water pollution control relating to the transport sector</td>
</tr>
<tr>
<td>Ministry of Finance</td>
<td>Finance of water development and water pricing</td>
</tr>
<tr>
<td>Ministry of Science and Technology (MOST)</td>
<td>Funding of R&amp;D, e.g. on water use efficiency</td>
</tr>
</tbody>
</table>

The complexity of management structures is also an issue for the grain production, distribution, processing and consumption chain, with overlapping tasks being split between several ministries. For example, the NDRC is responsible for the regulating the price of fertiliser and other production input materials, MOA is responsible for grain production; State Administration of Grain (SAG) is responsible for grain purchase, storage, distribution and macro control, and MOFCOM is responsible for
international trade of agriculture products.\textsuperscript{75} Each sector has its own capacity to make and implement related policies, and sometimes this may have conflicting consequences. For example, changes in production input prices and grain prices have a strong impact on farmers’ incomes and therefore on the decisions about future grain production and farm input use.

The complicated and divided nature of departmental responsibilities is also apparent in the food safety governance system, see Annex 2. The chart shows how complicated the system is and the difficulties for inspection, and enforcement. Some departments are linked vertically under the direct auspices of a higher level authority, whilst others are linked latterly at the same level of government, and commonly with each department being responsible for certain parts of whole food safety chain which makes coordination more difficult.

\textit{Perverse incentives to local government}

The key objective of preventing the arable area declining below 120 million is clearly set out in the national medium and long term food security plan as well as in the 12\textsuperscript{th} FYP. However, the implementation of policies to achieve this objective face great difficulties at all levels. For example, property sector development and infrastructure construction are the major driving force for China’s rapid economic development. Local government regard these as key components of their strategy to achieve their political target – GDP growth. However, they are also the main reason for the loss of cropland. Table 6 show approved land for construction in the period of 2001-2008, two thirds of construction land was transferred from agricultural and half were from arable land. Research on agricultural land conversion in 1989 – 2006 and shows 67% of agricultural land converted to non-agricultural use were not justified or not necessary.\textsuperscript{76} Moreover, local governments have become to rely on land transfers for a substantial part of their revenues so there is a perverse economic incentive for them to allow them.\textsuperscript{77} Land transfer fees can account for 30-50% of total sub-provincial government revenue.

\textsuperscript{75} H Zhang, C Zhao, 2009, The basic framework of agricultural policies in China, Chinese Finance and Economic Press, Beijing
\textsuperscript{76} X Li, F Qu, W Yun, 2009, The temporal and special distribution of China’s construction land increment, China Rural Economy, No 4.
Table 6 Approval of Land for Construction Use (1000ha)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Transferred from agricultural land</th>
<th>Transferred from cultivated land</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>167</td>
<td>110</td>
<td>840</td>
</tr>
<tr>
<td>2002</td>
<td>184</td>
<td>138</td>
<td>102</td>
</tr>
<tr>
<td>2003</td>
<td>421</td>
<td>2758</td>
<td>192</td>
</tr>
<tr>
<td>2004</td>
<td>285</td>
<td>1678</td>
<td>116</td>
</tr>
<tr>
<td>2005</td>
<td>351</td>
<td>253</td>
<td>170</td>
</tr>
<tr>
<td>2006</td>
<td>406</td>
<td>288</td>
<td>189</td>
</tr>
<tr>
<td>2007</td>
<td>413</td>
<td>274</td>
<td>177</td>
</tr>
<tr>
<td>2008</td>
<td>399</td>
<td>270</td>
<td>173</td>
</tr>
<tr>
<td>2011</td>
<td>612</td>
<td>411</td>
<td>253</td>
</tr>
</tbody>
</table>


2.3 Future challenges for China’s food security policies

The Chinese government has formulated a comprehensive policy framework and policy instruments to ensure future food security as discussed above. However, there are number of alternative policy options which may help for future food security.

Reduction of self sufficiency rate

The grain White Paper published in 1996 was the first clear declaration by the GOC that grain self-sufficiency rate should not be less than 95%, and net imports should not be more than 5% of domestic consumption. Maintaining 95% grain self-sufficiency remains the overarching target for future agricultural and food policy. However, with changes in domestic supply and demand, and China’s widening international cooperation for food and agriculture, there is a need to re-investigate the possibility of a reduction in the self sufficiency rate.

Land Consolidation and the rural social security system

As briefly discussed in Section 1 there is a consensus that land consolidation will increase land use efficiency and it is an inevitable trend as more rural people move out to urban centres. Slow progress in land consolidation is mainly due to concerns about social security for those who transfer their land use rights but later lose their off-farm earnings. Land use right in rural China function as part of a social security safety-net. There are also concerns that agricultural land will be transferred to non-agricultural use. There is a need to develop policies to guide and regulate the process of land use transfer. A number of policy options are available to overcome the potentials risks of land use right.

79 L Sheng, X Guan and J Jiang, 2009, Impact of land use right transfer on food security in China, Modern Agricultural Science and Technology, No 9.
transfer, include confirmation of household land use right contract, subsidies and to grain production, and to improve the rural social security system.

Healthy food consumption

The overall nutrition improvement in China has been substantial (Figure 13). However, the increase in meat consumption, particularly in urban areas, has raised concerns about increased obesity and associated diseases. On the other hand, malnutrition is still common in many rural areas and vulnerable groups of people (Box 2). Future policies need to tackle the challenge of over consumption as well as malnutrition.

Figure 13 Comparison of height and weight of girls under 5 yr age in urban and rural areas in 1990 and 2010

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80 Y Huang, H Zhang, W Li and Q Liu, 2011, Investigation and Reflection on Rural Land Transfer, Issues in Agricultural Economy (Monthly) No 5.
In one sense China is better placed to meet this challenge than many developed countries because diets are still broadly rice, vegetable and white meat based with limited consumption of red meat and dairy products. However, a major public information campaign might be needed to limit a switch to high red meat diets and reduce obesity.

3 Global Implications of China’s Future Food Security

3.1 Will China put pressure on global markets?

Given the size of China’s population, its large total demand for cereals (540 Mt in 2010), and the relatively small size of the current world market, it is not surprising that some commentators have voiced concern that sudden large-scale grain purchases by China could destabilize global markets\footnote{R F Ash, 2011, Feeding Billions: Food Security in China, ISN Security Watch.}. It happened in the early 1970s when the USSR secretly made large grain purchases on the US market following a severe drought. China’s large purchase of wheat in 2003/04 had a similar impact but is
important to understand why these imports were needed. It was not because of the lack of production potential in China – it was mainly due to changes in the relative prices of grain and cash crops which favoured the latter. Wheat and rice production fell during 1998/99-2004 because of falling prices as a result of two major changes: 1) a decline in per capita consumption since about 2000 driven by rising incomes and urbanisation and 2) a decision by the GOC to lower the financial burden of maintaining large State grain stores. The GOC and local governments acted quickly to remove or lower these constraints and wheat expansion expanded during the rest of the decade keep close to 100% self-sufficiency.

It follows that this question must be considered comprehensively and dynamically. There are three main aspects to consider. First, will China’s food security needs put pressure on global food markets? Second, will China’s actions to protect its own food security help other developing countries to do the same? Third, and related to the previous question, will China’s trade with and aid to developing countries improve their agricultural productivity and food purchasing power? This section focuses largely on the first element, and sections 3.2 and 3.3 will address the other elements.

The question will China’s food security needs put pressure on global markets is multi-dimensional. Component questions include:

(a) Has the long-term food demand and supply situation been projected in a sound manner?

(b) Can the food security and food self-sufficiency policies examined in section 2 continue to achieve China’s goal of 95% self-sufficiency in key commodities?.

(c) Do other countries have the supply potential to meet China’s food and feed import needs without putting unsustainable pressures on their own natural resources and world market prices?.

Sections 1.2 and 1.3 addressed component (a) and concluded that the long-term demand for food and feed has probably been over-estimated and China’s production potential underestimated. With respect to component (b) Section 2 concluded that the current policy framework contains much of what is required to maintain 95% self-sufficiency for key commodities and that China’s past responses to domestic and foreign supply shortfalls show that the GOC and Chinese farmers have the capacity to react to positively to extreme events such as droughts and rising market prices.

Component question (c) may also be less of an issue than some analysts suggest. Taking maize and soybeans as potentially China’s largest import requirements it is illuminating to see how the current droughts in the USA have resulted in press comments about rocketing food prices and impending doom and more measured responses from farmers in the southern hemisphere who see a market opportunity. Brazil, Argentina and other South American countries have quickly expanded maize and soybean production to help overcome any reduction in US exports. Moreover, this supply potential is not just a short-term one. CCAP\textsuperscript{82}, USDA and OECD projections for 2020/2021 and FAO projections for 2030 all suggest that the traditional cereal and soybean exporters have significant capacity to expand their exports. The remainder of this section provides supporting evidence for this conclusion. The supply potential of non-traditional exporters will be examined in section 3.2.

\textit{China’s net food import needs in 2020/21 and 2030}. The above projections are relatively consistent with each other (Table 8). They suggest that there are only three commodities were China’s possible import

\textsuperscript{82} CCAP runs food projection based on it’s CAPSIM model and updates its projection every half year.
needs account for more than 10% of the projected world trade: soybean (>60), maize (14-16%) and sugar (> 12%). The only other notable import needs could be pork (up to 8%) and dairy products (up to 8%).

All of these incremental needs are within the supply capacity of China’s traditional trading partners. China’s soybean imports rose from 13.9 Mt in 2001 to 54.8 Mt in 2010. This four fold increase in imports was made possible by the rapid expansion of production in the USA and later in Brazil and Argentina without putting pressure on world market prices. China’s projected incremental import needs for 2020/2021 are21-35 Mt (Table 8) compared with nearly 41 Mt for the last decade, which the traditional exporters seem well able to supply. The USA has relatively limited potential to expand exports – possibly by only 2-3 Mt83, although in the longer-term climate change may increase the area suitable for soybeans. Brazil, in contrast could increase exports by 40Mt84 without the need for further deforestation85. A further 7 Mt could come from Argentina, and another 12 Mt from Uruguay, Paraguay and Bolivia86. Of course other countries will be increasing their import needs, notably India and SE Asian countries, but it is clear that traditional exporters have the capacity to meet these and those of China. In addition, a number of other countries have the capacity to expand production and become exporters once infrastructural and technological constraints are overcome (see next section).

The situation for China’s maize import needs is similar to the above. China’s 2020/2021 requirements could be around 18-20 Mt (Table 7). Maize exports from the USA have been slowing down but they could still expand by about 15 Mt by 2020/202187. The Ukraine and other Former Soviet Union (FSU) countries could export some 17 Mt per year by 2020/21, Argentina over 23 Mt and Brazil about 14Mt. Thus the global maize export capacity seems well able to meet China’s needs and those of other developing countries, and as with soybean there are countries in Africa which could become significant exporters in the long-term even though the overall picture might look bleak88 (see next section).

China’s long-term demand and supply for sugar raises more complex issues. First, it should be noted that some 65% of demand is by the food processing sector, and part of this demand could be met by synthetic sweeteners and other sugar substitutes unless the GOC continues to restrict their use. Second, there is no consensus regarding the evolution of supply and demand. FAO projects 93% self-sufficiency for 203089, and Luke Matthews90 projects near self-sufficiency in 2030 under a trend consumption growth scenario (2.2% p.a.). The latter is consistent with the 12th FYP target of 3.1% p.a. growth in production and near self-sufficiency. However, his high growth scenario (4.4% p.a.) projects a 4-5 Mt deficit for 2030 which is close to the CCAP’s CAPSiM estimates (Table 7) and those of the OECD91 (5Mt) which are based on the assumption that domestic production will be increasingly limited by water availability. The latter may be true but it is basically a question of GOC and farmer resource allocation. If

83 USDA, 2012 Agricultural projections to 2021 Report No OCE-2012-1. February USDA, Washington DC
84 USDA 2012 as footnote 80
85 E Contini, G Martha, 2011. Climate change and food security: Brazil, presentation at International Conference on Climate Change and Food Security, 6-8 Nov 2011, CAAS/IFPRI, Beijing, China
86 USDA 2012 as footnote 80
87 as note 80
89 unpublished supply utilisation accounts.
the GOC decides to allocate R&D and capital resources to raising irrigation efficiency and crop productivity, and domestic.

Table 7 China’s Current and Projected Net Exports (% of world trade in parenthesis) and Total World Trade(Mt)

<table>
<thead>
<tr>
<th></th>
<th>CAPSiM, CCAP</th>
<th>USDA</th>
<th>FAO</th>
<th>Projected world trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>0.23</td>
<td>0.6</td>
<td>&lt;0.1</td>
<td>0.55</td>
</tr>
<tr>
<td>Wheat</td>
<td>-0.95</td>
<td>-0.8 (&lt;1%)</td>
<td>0</td>
<td>-0.3 (&lt;1%)</td>
</tr>
<tr>
<td>Coarse grains</td>
<td>-2.96</td>
<td>-22.5</td>
<td>-2.5</td>
<td>-21</td>
</tr>
<tr>
<td>Maize</td>
<td>-1.44</td>
<td>-20.4 (16%)</td>
<td>-0.9</td>
<td>-18 (14%)</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>-55.09</td>
<td>-77.2</td>
<td>-12.9</td>
<td>-24</td>
</tr>
<tr>
<td>Soybean</td>
<td>-54.63</td>
<td>-75.9 (79%)</td>
<td>-52</td>
<td>-87 (62%)</td>
</tr>
<tr>
<td>Sugar</td>
<td>-1.68</td>
<td>-1.7 (3%)</td>
<td>-1.5</td>
<td>-0.85</td>
</tr>
<tr>
<td>Beef &amp; mutton</td>
<td>-0.04</td>
<td>-0.29</td>
<td>0.12</td>
<td>0</td>
</tr>
<tr>
<td>Beef</td>
<td>0</td>
<td>-0.08 (&lt;1%)</td>
<td></td>
<td>8.5</td>
</tr>
<tr>
<td>Pork &amp; poultry</td>
<td>-0.01</td>
<td>-1.25</td>
<td>0.32</td>
<td>0.6</td>
</tr>
<tr>
<td>Pork</td>
<td>-0.09</td>
<td>-0.30 (5-6%)</td>
<td>-0.2</td>
<td>-0.4 (7%)</td>
</tr>
<tr>
<td>Milk</td>
<td>-0.71</td>
<td>-7.3 (8.5%)</td>
<td>-0.52</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*All or just major exporters depending on the commodity

**110 countries

prices are favourable to farmers then near self-sufficiency is feasible. But from a strategic point of view the GOC may decide that it is more important to allocate these resources to soybean or maize production and accept higher sugar imports.

Pork is the remaining import requirement that could be substantial, that is, potentially as much as 8% of world trade (Table 7) although more recent estimates suggest the maintenance of near self-sufficiency. Given the close attention that the GOC gives to stable pork supply and prices (section 1.2) and the good pig production potential (section 1.3.3) it is assumed here that there are no global food

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92 as footnote40.

54
security risks associated with China’s long-term pork demand. The same is also true for wheat and rice needs.

3.2 China’s food security and the potential for new food exporters

The above discussion on the future supply potential of traditional food and feed exporters showed that many of those in Latin America have the land resources and opportunities for raising crop yields to meet China’s projected import needs. However, there are many African countries that have substantial areas of land that are agro-climatically suitable for cereal and soybean production but are constrained by poor crop distribution and marketing infrastructure, and by lack of access to fertilizer, improved seeds, other production inputs and technical advice. The potential land resources that are suitable for China’s main deficit crops are substantial (Table 8), and in total are more than double China’s arable area. Zambia alone has the supply potential to meet a substantial proportion of China’s 2010-2020 incremental maize import needs. Much of Zambia’s circa 13 Mha of land which could be available for expanded maize production is suitable for large-scale mechanisation, and the transport infrastructure is good partly thanks to China’s investment in the road and rail network since the 1960s. However, yields are generally low except on the larger commercial farms, and there has been underinvestment in agricultural R&D and advisory services for many years which China is now helping to strengthen. It is quite feasible to triple or quadruple maize yields over the next 10-20 years, and produce some 10 Mt for export. Mozambique has less land available, and maize yields are lower so the production potential is higher, but as with Zambia investment in agricultural R&D and advisory services has been low for many years. Moreover, land potential in northern Mozambique is constrained by the poor transport infrastructure.

<table>
<thead>
<tr>
<th></th>
<th>Current cropland * 2009</th>
<th>Additional potential cropland**</th>
<th>Current as % of potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>4.29</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Central African Republic</td>
<td>2.04</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Chad</td>
<td>4.33</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Congo</td>
<td>0.5</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Democratic Republic of the Congo</td>
<td>7.45</td>
<td>102</td>
<td>7</td>
</tr>
<tr>
<td>Madagascar</td>
<td>3.55</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Mozambique</td>
<td>5.3</td>
<td>29</td>
<td>16</td>
</tr>
<tr>
<td>Former Sudan</td>
<td>20.39</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>Tanzania</td>
<td>11.5</td>
<td>14</td>
<td>46</td>
</tr>
<tr>
<td>Zambia</td>
<td>3.9</td>
<td>26</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>52.8</td>
<td>282</td>
<td>19</td>
</tr>
</tbody>
</table>

*Arable land and permanent crops Source: FAOSTAT accessed October 2012
**Potentially available land outside nature reserves and other protected lands that are suitable or very suitable for at least one of following crops: wheat, maize, soybeans, sugar cane and oil palm. Source: based on data from Fischer and Shah, 2010

93 World Bank, 2011; FAO,2002 and 2012
95 Fischer, G. and Shad, M. Farmland investments and Food Security. International Institute for Applied Systems Analysis, Laxenburgh, Austria, August 2010 for the World Bank
Similar potentials exist for other food and feed crops: rice in Angola although soil management problems may have to be overcome; soybean in the Sudan, the DRC, Mozambique, Zambia and Angola but farmers have little experience; and sugarcane in the DRC and Madagascar. Such opportunities could be important to China’s food security in terms of diversifying both politically and agro-climatically its sources of imports, and to global food security for similar reasons. In addition they are important to the farmers in these countries, particularly where they are providing a new cash crop for them, and to workers in the support industries up and down stream of agriculture. These employment multipliers can have a substantial impact on food purchasing power and hence on food security. China is playing an active part in exploiting this potential but is not significant contributor to the so-called land grab.  

3.3 N-S and S-S technology transfer and food security

It is a strange twist of history that China’s current high dependence on soybeans from the USA is based on a very early example of technology transfer. The first crop of soybean in the USA in 1765 used seeds from China. Moreover, modern soybean varieties owe a lot to the 10,000 or so soybean varieties that William Morse collected in China during the late 1920s. They in turn have provided the foundation of soybean production in South America, so there are many farmers around the world whose wealth and food security stem from China’s first major contribution to technology transfer.

China more formal contributions to technology transfer date back to the 1960s, for example, with the establishment of rice demonstration farms in Malawi and Tanzania that were operated by Chinese farmers. In the main, they were not a success in part because most of them were operated in isolation from local farmers and there was little uptake of the improved Chinese farming practices. Nonetheless some that were operated more like commercial farms than demonstration centres made an important contribution to local food security, notably the Mbarali Farm in Tanzania that at times produced about 25% of national rice production. The next and much more significant contribution, which has improved the food security of millions of people in Asia, was China’s sharing of improved crop varieties and particularly hybrid rice through collaboration with the International Rice Research Institute. Hybrid rice varieties have higher yield potential than traditional ones, and from the early1980s China played a significant role in passing these benefits to other South & East Asian countries. This was a key part of the green revolution. A more indirect contribution to the food security of other countries through technology transfer has been China’s operation of biodigester construction and training programmes in over 12 countries in Asia, Africa and Central and South America.

The relatively ad hoc technology transfers of the 1960-2000 period made an important contribution to global food security. These are likely to continue with potentially very significant advances becoming available for North-South (N-S), South-North (S-N) and South-South (S-S) technology transfer from China’s highly successful rice and wheat breeding programmes and from its huge investment in

96 L Cotula, S Vermeulen, R Leonard and J Keeley, 2009, Land grab or development opportunity? Agricultural investment and land deals in Africa. Published by FAO, IFAD and IIED
98 In Asia: Philippines, Thailand, Vietnam, India, Bangladesh & Nepal; in Africa: Tunisia, Rwanda, Guinea Bissau, Ethiopia, & Tanzania; and in Central & South America: Cuba & Brazil.
biotechnology. However, since about 2004 these ad hoc transfers have been complemented by a more programmed approach to technology transfer through the FAO-China Strategic Alliance on South-South Cooperation, which is aimed particularly at raising agricultural productivity and food security. As part of this alliance, China has been supporting the African Union’s Comprehensive African Agriculture Development Programme (CAADP). The main milestones and future actions for this collaboration are given in Box 3.1. The main elements of an action plan were adopted at the 5th Ministerial Conference of the Forum on China-Africa Cooperation in Beijing in July 2012. It will be financed by the China-Africa Development Plan which is to be gradually increased to EUR 3.85 billion.

3.4 Implications of China’s food security for the EU

These implications can be assessed in terms of:

(a) the role of the EU as a supplier of China’s food and feed imports and technology needs

(b) EU support to China’s food security by helping to raise agricultural productivity and increase EU support to raising agricultural productivity and increasing the efficiency and effectiveness of the food chain

(c) EU-China collaboration on raising global food security and particularly in Sub-Saharan Africa.

3.4.1 The EU as a supplier of China’s food and feeds

The EU is already the fifth largest exporter of agricultural products to China though some of them are not essential to food security such as wines and spirits. In the longer term, however, the EU could provide some of China’s wheat and barley imports although other low cost suppliers in the Russian Federation and the Ukraine may have greater comparative advantage. The situation for dairy products is different. The EU seems likely to continue to have surplus capacity and a cost-advantage so it could increase exports to China and particularly of processed higher-value added products.

3.4.2 EU support to raising agricultural productivity and increasing the efficiency and effectiveness of the food chain

EU food and feed exports to China seems likely to play only a small role in China’s future food security. However, its support to the implementation of China’s food security policies could be critically important. First, by sharing the EU’s well established public and private sector expertise in raising agricultural productivity, which will have secondary benefits to the EU’s food security. For example, joint action on livestock and crop diseases could help to avoid the build up of epidemics and pandemics that in the past have caused serious reductions in cereal and meat supply, notably wheat rust and swine fever. EU support to raising fertilizer and feed use efficiency would benefit the EU and the world, because it will also help to reduce greenhouse gas emissions and mitigate climate change. Secondly, by increasing the efficiency and effectiveness of the food processing and marketing chain. The private sector is already making an important contribution to the latter. AB Agri, for example, is helping raise the efficiency of China’s livestock feed concentrates industry and of sugar production and processing.

Supermarkets such as Carrefour and Tesco are helping raise the efficiency of the marketing chain, reduce storage wastes and improve food quality and safety. The main issue here is perhaps what is the role, if any, of the Commission in widening these private sector contributions?

3.4.3 China collaboration on raising global food security and particularly in Sub-Saharan Africa

EU-China collaboration on food and agriculture stretches back over 20 years but there are few tangible outcomes of any magnitude. Most of the major initiatives have been bilateral ones such as those with Denmark, France, Germany, the Netherlands, the UK and others, yet there are a number of food security challenges that are best tackled at the level of the EU 27, notably livestock and crop diseases, and food safety. The EU-China Dialogue launched in 2005 has helped to promote mutual understanding on the dominant issues confronting global food security. And the EU-China Cooperation Plan on Agriculture and Rural Development signed in June 2012 provides an appropriate framework for extending collaboration. These are supported by more focused structures, for example, (a) the EU-China Policy Dialogue Support Facility (PDSF) which could do much to share EU experience on agri-environment problems and policies, and (b) the Task Force on Food, Agriculture and Biotechnologies, which could be very important given the vast investments that China is putting in to biotechnology R&D.

There remains the question of how China and the EU can work together to improve food security in Sub-Saharan Africa. A number of EU countries have a long history of engagement with Africa. Some of them still provide a great deal of support both multi-laterally through the CGIAR and bilaterally. Denmark, for example, contributed a great deal in the past through well focused programmes for seed quality improvement and the development veterinary services. China and the EU could work together on such programmes. Another possibility given the growing nitrogen fertilizer surplus in China and the difficulty that many African countries have in accessing sufficient fertilizer, is to revive the Freedom from Hunger Fertilizer programme which supported simple fertilizer trials and demonstrations throughout Sub-Saharan Africa in the 1960s and 70s.

3.5 Vulnerability to national and international disasters and the implications for global food security

Responses to such risks have been an important component of GOC policies for many years and have been addressed at various points in this report. The risks are both natural and man made, and can be internal and external in origin. The ones of greatest concern are: (a) natural droughts and floods within the range of past events; (b) man-made disasters, for example, increased flooding from deforestation and disruption of natural drainage systems, (c) climate change and increased frequency of extreme events notably droughts and floods; and pest and disease epidemics.

Risk (a) is a permanent feature of Chinese food production with weather induced losses in grain production occurring annually in one or more regions but normally offset by good production elsewhere. It has been the main driver during the past 50 years or more for China’s: (i) food self-sufficiency policies, (ii) high public investment in the expansion of the irrigated area and flood control and more recently in water conservation and improved water use efficiency, (iii) substantial public

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support for agricultural R&D since 1990 and (iv) heavy investment in food storage facilities, carry-over stocks and supply management mechanisms.

Risks (b) and (c) are addressed by one or more of the above measures but also through China’s ecosystem management programmes for reforestation, vulnerable slope lands and wetlands, and her large and world class climate change modelling, monitoring, adaptation and mitigation programmes. These programmes have already made important contributions to food security and will continue to do so. They are complimented by policy shifts to encourage the expansion of food production in the North-East of China which is considered to be favoured rather than endangered by climate change. In addition and well exemplified by the current situation, is China’s geographical diversification of its grain suppliers (as discussed in sections 3.1 and 3.2) so that it is less vulnerable to drought in the USA which in recent years has been its main source of maize and soybean imports.

Risk (d) is minimised by measures (iii) and (iv) for risk (a) but also by the comprehensive mechanisms discussed in section 1.2 to prevent pest and disease epidemics. They are particularly important for preventing livestock disease epidemics from becoming pandemic and causing major food supply disasters at the national and international level.

4 Conclusions

The report has four key conclusions:

- China’s food security to 2020/30 need not be at risk
- In the main China could feed itself. It has the capacity to maintain a high level of self-sufficiency except in soybean, maize and dairy products. However, this will require critical policy and technological changes to re-direct agriculture on to a sustainable growth path that minimizes GHG emissions and other negative impacts on the environment.
- China’s net food imports in 2020/30 need not place an unsustainable burden on world agriculture, and could provide agricultural export opportunities for some countries in Sub-Saharan Africa
- The implications for the EU are modest but some member countries could make some significant contributions to China’s food security as a source of commodities, management expertise or technology.

China’s net food imports in 2020/30 may be less than other assessments have proposed because (a) they over-estimated per caput demand for meat and (b) under-estimated the gains in feed use efficiency that are possible over the next 10-20 years and which would lower substantially the indirect demand for maize and soybeans.

The projected net imports of maize and soybean in 2020/21 are 16 and 54% respectively of projected world trade. Traditional exporters in N. and S. America can probably supply much of China’s needs, and there are potential exporters in Sub-Saharan Africa that could also make an important contribution.
Maintaining high levels of self-sufficiency though technically feasible, particularly given China’s substantial funding of agricultural R&D, will need major changes in GOC policies and farmers practices which are currently unsustainable. The Medium and Long Term Food Security Plan for 2008-2020 and the 12th FYP contain some of the measures required however more needs to done to re-direct subsidies and tighten the regulatory environment to promote greater fertilizer, water and feed use efficiency.

The main opportunities for the EU are as a supplier of dairy products, a research collaborator for the control of livestock and crop diseases, a source of management expertise for improving the performance of the food production, distribution and marketing chain, and as partner in support to Sub-Saharan African and other developing countries for the sustainable expansion of their agriculture and improvement of their food security.

The longer-term situation is less clear. After 2030 food demand will be relatively stable because of a declining and ageing population, and only modest income related changes in consumption patterns. Small gains in productivity should be able to meet much of the incremental demand and ensure food security. However, uncertainties regarding the impact of climate change on food production present a major challenge for China’s long-term food security. It seems quite possible that lack of national and international action in the next 10-20 years to slow down global GHG emissions could seriously disrupt food production and agricultural trade after 2050 and result in widespread food insecurity.

Notwithstanding the latter uncertainties the overall conclusion for 2012-2030 is that China can continue to meet most of its food security needs, and other countries could make up the balance without placing undue stress on their natural resources. Moreover, three GOC actions support the view that China’s food situation poses no risk to global food security and in fact improves it. First, it’s progressive response to changing comparative advantage by increasing imports of soybean and other land intensive commodities, and boosting exports of labour intensive crops, notably fruit and vegetables. Second, maintenance of large grain carry-over stocks to buffer against natural disasters. Finally, its strong support for both domestic and developing country agricultural R&D and for S-S technology transfer.
Annex 1. The 12th Five Year Plan for Agricultural and Rural Economic Development

Steadily Increase the Grain Production Capacity
- Stabilize grain planting area
- Optimize grain variety structure
- Strengthen the redevelopment of main grain production areas
- Increase per unit area yield

Substantially Improve the Level of Agricultural Material and Equipment
- Strengthen science and technology innovation and professional training
- Strengthen infrastructure development
- Accelerate agricultural mechanization and development of facility agriculture
- Build up the capacity for disaster prevention and reduction

Adjust and Optimize the Structure of Agricultural and Rural Economy
- Deepen agricultural structure adjustment
- Accelerate the development of the agricultural product processing industry
- Enhance township enterprise development
- Promote agricultural services
- Foster emerging rural industries

Increase Farmer Income
- Steadily increase incomes from household business operations
- Strive to increase wage incomes
- Effectively increase transfer income

Enhance Agricultural and Rural Public Services
- Strengthen the development of the agricultural public service system
- Enhance rural infrastructure construction
- Strengthen rural social services

Perfect and Innovate Rural and Agricultural Development Mechanism
- Perfect rural land administration system
- Develop multiple types of operations
- Further develop farmer technical associations
- Raise the quality of agricultural industry development
- Strengthen the establishment of modern agricultural demonstration zones

Protect Rural Ecological Environment
- Strictly protect arable land
- Strengthen grassland protection
- Strengthen water resource and agricultural biological resource protection
- Push forward agricultural energy saving and emission reduction and rural environmental management
<table>
<thead>
<tr>
<th>Item</th>
<th>2010</th>
<th>2015</th>
<th>Average annual increase (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agricultural products supply capacity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain crop sown area (100 million ha)</td>
<td>1.099</td>
<td>&gt;1.067</td>
<td></td>
</tr>
<tr>
<td>Grain production capacity (100 Mt)</td>
<td>&gt;5.0</td>
<td>&gt;5.4</td>
<td></td>
</tr>
<tr>
<td>Cotton, total production (10,000 t)</td>
<td>596</td>
<td>&gt;700</td>
<td>&gt;3.27</td>
</tr>
<tr>
<td>Yield of oil-bearing crops (10,000 t)</td>
<td>3230</td>
<td>3500</td>
<td>1.62</td>
</tr>
<tr>
<td>Yield of sugar crop (10,000 t)</td>
<td>12008</td>
<td>&gt;14000</td>
<td>&gt;3.12</td>
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<td>Total meat (10,000 t)</td>
<td>7925</td>
<td>8500</td>
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<td>Eggs (10,000 t)</td>
<td>2765</td>
<td>2900</td>
<td>0.96</td>
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<td>Milk (10,000 t)</td>
<td>3780</td>
<td>5000</td>
<td>5.75</td>
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<td>Total output of aquatic products (10,000 t)</td>
<td>5373</td>
<td>&gt;6000</td>
<td>&gt;2.23</td>
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<tr>
<td>Pass rate for regular quality test of agricultural products (%)</td>
<td>94.8</td>
<td>&gt;96</td>
<td>&gt;[1.2]</td>
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<tr>
<td><strong>Agricultural production structure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportion of livestock production value to total agricultural production value (%)</td>
<td>30</td>
<td>36</td>
<td>[6]</td>
</tr>
<tr>
<td>Proportion of fishery output value to total agricultural output value (%)</td>
<td>9.3</td>
<td>10</td>
<td>[0.7]</td>
</tr>
<tr>
<td>Ratio of the value of agricultural products processing industry to the total value of agricultural output</td>
<td>1.7</td>
<td>2.2</td>
<td>[0.5]</td>
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<tr>
<td>Average annual growth rate of added value of township enterprises (%)</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td><strong>Agricultural technology and equipment</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Contribution rate of technical progress (%)</td>
<td>52</td>
<td>&gt;55</td>
<td>&gt;[3]</td>
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<tr>
<td>Total mechanical power (100 million kW)</td>
<td>9.2</td>
<td>10</td>
<td>1.68</td>
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<td>Level of mechanization in ploughing, sowing and harvesting (%)</td>
<td>52</td>
<td>60</td>
<td>[8]</td>
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<tr>
<td>Increase in irrigated area (100 million ha)</td>
<td></td>
<td></td>
<td>[0.027]</td>
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<tr>
<td>Irrigation water use efficiency</td>
<td>0.5</td>
<td>0.53</td>
<td>[0.03]</td>
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<tr>
<td>Number of rural skilled population (10,000)</td>
<td>820</td>
<td>1300</td>
<td>6.8</td>
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<tr>
<td><strong>Agricultural production operation and management</strong></td>
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<tr>
<td>Number of households associated to production association (100 million)</td>
<td>1.07</td>
<td>1.3</td>
<td>3.97</td>
</tr>
<tr>
<td></td>
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<tr>
<td>--------------------------------</td>
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</tr>
<tr>
<td><strong>Proportion of large-scale dairy cattle farms (%) (annual in stock number over 100 heads)</strong></td>
<td>28</td>
<td>&gt;38</td>
<td>&gt;[10]</td>
</tr>
<tr>
<td><strong>Proportion of large-scale pig farms (%) (annual slaughter number over 500 heads)</strong></td>
<td>35</td>
<td>50</td>
<td>[15]</td>
</tr>
<tr>
<td><strong>Agricultural benefits and farmer income</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual growth rate in added value of agricultural, forestry and livestock output</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Rural labour transfer (10,000 people)</td>
<td></td>
<td></td>
<td>[4000]</td>
</tr>
<tr>
<td>Rural per person income (RMB yuan)</td>
<td>5919</td>
<td>&gt;8310</td>
<td>&gt;7</td>
</tr>
<tr>
<td><strong>Resource utilization and environmental protection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utilization rate of crop residues (%)</td>
<td>69</td>
<td>&gt;80</td>
<td>&gt;[11]</td>
</tr>
<tr>
<td>Percentage of biogas pits installed in suitable households (%)</td>
<td>33</td>
<td>&gt;50</td>
<td>&gt;[17]</td>
</tr>
<tr>
<td>Release various aquatic species for stock enhancement (100 million heads)</td>
<td>289</td>
<td></td>
<td>[1500]</td>
</tr>
</tbody>
</table>

[... ] 5-year cumulative number
Annex 2. The structure of the food safety governance system\textsuperscript{101}