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Driven by the Livestock Revolution?**

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# **CHINA'S AGRICULTURE, SMALLHOLDERS AND TRADE: DRIVEN BY THE LIVESTOCK REVOLUTION?**

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## **ABSTRACT**

China's sustained rapid economic growth and development has contributed to the surge in consumption and production of livestock in that country – termed the 'livestock revolution'. Consumption trends are first reviewed, and changes in food consumption patterns include a marked shift away from grains and towards meats and dairy products. A question is to what extent this rapid increase in demand for livestock products is reflected in China's agri-food trade statistics? While her agri-food imports have dramatically increased since China's accession to the WTO, livestock products have not made a noticeable contribution, although the import of certain animal feedstuffs has. This implies China's continuing self-sufficiency in most livestock products. The paper next considers developments in China's livestock farming sector and policies that have been contributing to these supply-side developments. The paper concludes with an examination of issues that may be important to the future development of China's, and the world's, livestock situation – this includes future demand developments, and the question of whether future demand growth in China might be met with local production, imports of final product, and /or imports of feedstuffs.

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## 1. INTRODUCTION

*“They labour at ploughing in the spring and hoeing in the summer, harvesting in the autumn and storing foodstuff in the winter...all the while exposed to the dust of spring, the heat of summer, the storms of autumn, and the chill of winter...No matter how hard they work they can be ruined by floods or droughts, or cruel and arbitrary officials who impose taxes at the wrong times or keep changing their orders....some as a consequence sell their lands.”*

Chao Cuo (200-154BC) in Ebrey 1996, p. 74.

The so-called livestock revolution (Delgado et al. 1999)<sup>2</sup> has occurred most obviously in China (Waldron et al. 2007; Zhang 1999; Fuglie et al. 2004). In recent times, both consumption and production of meat, milk and eggs have increased in China at rates well above those for the developing world in general, and even faster if compared with developed countries. What are the opportunities this revolution provides for agriculture, trade and smallholders in China and elsewhere in the developing world? While one view is that the global revolutionary growth has tended to occur in the poultry and dairy sectors, where large-scale integrated operations may be the major beneficiaries, there is hope that the revolution will provide income gains and a pathway out of poverty for millions of smallholders in the developing world (Upton 2000; Brown 2003). Others warn that the livestock revolution will not affect people equally – larger farmers in developing countries with access to credit and knowledge are likely to benefit, but smaller farmers may find it more difficult (Zhou 2003).

China’s rapid income growth has seen the country follow similar trends to other developing countries with increasing consumption of high value agri-food products<sup>3</sup> including those from livestock. Might such trends be expected to continue, and how might they impact on China’s and international markets? Some in the economics profession have had a propensity to project China’s imminent emergence as a major agri-food importer, to the point of ‘starving the world’, although such dire outcomes have not yet materialised. Within China’s rural society, remarkable developments have been occurring. Since 1978 households have increasingly been able to make their own production and marketing decisions; production has diversified in the face of strengthened incentives; farm productivity, total output and production per capita have all increased; land tenure has become more secure; local agricultural markets have emerged and in several cases have become more integrated and much of the surplus farm labour has been absorbed by rural and other industries, and the incidence of rural poverty has fallen. Such rural reforms have been a vital factor in China reducing the share of its population living in poverty from 53% to 8% over the course of 20 years.

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<sup>2</sup> Delgado et al. describe this as the massive global increase in demand for food of animal origin as a result of growth in population, urbanisation and incomes in developing countries.

<sup>3</sup> My definition of agri-food covers agricultural raw materials whether foods or not, plus food, raw or processed. Fish is excluded. HS commodities are 01, 02, 04-15, 1601, 1602, 17-23, 2401, 4001, 4101-4103, 5001, 5002, 5101 and 5201.

In this paper I first describe how food consumption patterns in both urban and rural China have been changing, with quite phenomenal growth in consumption of several products derived from livestock, driven amongst other things by urbanisation and income growth. I then present China's agri-food trade situation over the last couple of decades, for much of which China was a net food exporter. This situation changed in 2003 however, and imports in particular have grown rapidly over the past few years. To what extent was this growth in import demand driven by the increased consumption of animal products? I then proceed to look at developments in China's animal production sector, where production has also been increasing along with demand to allow China to remain largely self-sufficient in these products. This situation has been achieved through policy reforms and improved incentives to livestock producers, increased productivity, and structural change towards specialised production but within a sector that remains very largely based on smallholder production. I conclude the paper with discussion on China's possible future roles as an international trader in livestock products and feedstuffs.

## 2. CHANGING FOOD CONSUMPTION PATTERNS IN CHINA

*“Anything that walks, swims, crawls or flies with its back to heaven is edible.”* Cantonese saying.

It is well known from cross-sectional studies that as countries become wealthier, the share of food in total household expenditures eventually declines. Within the food expenditure bundle, the commonly-observed pattern is that shares of traditional foods such as grains or root crops eventually decline while those of animal products and other high-value foods will rise (Rae 1997; Cranfield et al. 1998). These features are also found in China’s evolving food consumption (Wang et al. 2004; Yang and McAulay 2004). Since the late 1970s, both urban and rural incomes have grown at average rates of 7% annually, but since 1995 urban incomes have grown at an annual rate of 8% compared with 4.5% for those of rural residents. The share of food in total urban household spending declined from 58% in 1978 to 36% in 2006. For rural households, the decline was from 68% to 43% (Tian 2007). While nominal urban and rural food expenditures per capita have not shown much growth since the mid-to-late 1990s, the changing patterns of Chinese diets include the increase in the share of animal products (meats, fish and dairy products) in total food expenditures from 38% to 44% over the 1991-2001 period for urban households, while for rural consumers the increase was from 33% to 37% over the same period (Ma et al. 2004).

Urban and rural residents differ not only in their average disposable incomes, but also in the types of food market environments within which they make their consumption choices. It is important to differentiate between urban and rural residents, since despite rapid migration, rural residents still comprise close to 60% of the total population. Urban residents increasingly purchase through supermarkets and department stores<sup>4</sup> and face a wide range of eating-out opportunities, while rural areas tend to be under-served by modern commercial marketing channels. This situation gives rise to substantial differences in food consumption levels and patterns between urban and rural residents. Between 1990 and 2006 in urban households, average in-home consumption per capita<sup>5</sup> of grains almost halved, while that of pork, beef, poultry, eggs, fish, milk and fruits all increased. The most rapid increases in urban per capita consumption between 1990 and 2006 have been for dairy products (296%) and poultry (144%). In rural households, these products also have shown the most rapid growth – 179% for poultry and 392% for dairy (from a very low base, and over the period 1995-2006). In rural households, where local culture and traditional habits shape diets and significant food consumption is from own-production, the decline in

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<sup>4</sup> But from a low base – wet markets are still the dominant source of purchases of urban residents. In fact much of the meat, fruits and vegetables sold in supermarkets has been purchased from wet markets as often are foods sold in urban restaurants (personal communication, Scott Waldron).

<sup>5</sup> These statistics do not accurately incorporate away-from-home consumption. Survey results are ‘discounted’ according to the number of meals eaten away from home by family members (personal communication, Funing Zhong). The quantities of food eaten away-from-home and their impacts on the quantities eaten at home are likely to be under-reported and/or under-estimated. Further, there is no consumption survey covering the over 100 million immigrants who might still be considered members of rural households.

the average per capita grain consumption was substantially less than for urban households, although consumption of all meats, fish and milk showed relatively large increases (Tian 2007). Absolute consumption levels per capita for grains are much higher in rural households than in urban, but for meats, fish and milk average per capita consumption is substantially higher in urban households. There has also been increasing demand for diversity, convenience, safety, healthy and for semi-processed and ready-to-eat food products especially among urban consumers.

Aggregate food consumption trends in China reflect not only per capita consumption levels in rural and urban regions, but also reflect the rapid migration of consumers from the countryside to urban locations. Total population growth from 1990 to 2005 averaged 0.9% per year, while that of the urban population was 3.5% per year. This is a result of migration since the birth rate among urban residents is lower than in the countryside. It is now well known that such urbanization of the population is a powerful explanator of changes in purchasing patterns. Rae (1998) showed that for a number of Asian countries, urbanization had a positive and significant effect on the demand for animal products after controlling for price and income effects. For China, he estimated expenditure and urbanization elasticities of 0.68 and 0.90 respectively, and also found that the consumption response to a marginal increase in expenditure was positively related to the level of urbanization. Continuing migration is therefore expected to contribute to further increases in consumption of animal products as the newly-urbanised lift their consumption levels, and change their expenditure patterns towards those of their urban neighbours.

How have the expenditure shares of the various livestock products changed in response to income growth? Marginal expenditure shares were estimated for a range of animal products within an animal products demand system by Ma et al. (2004).<sup>6</sup> For urban consumption, these exceeded average expenditure shares in 1999-2001 for fish, poultry, beef and milk, indicating that these products were taking rising shares of household spending on animal products, at the expense of pork (the traditional meat in Chinese diets), eggs and mutton. For rural consumption, the marginal shares exceed the average shares for fish, poultry and red meats (milk was not included in the rural model). Therefore there is a noticeable shift towards livestock products in the average Chinese diet, whether rural or urban based, and a strengthening of the share of poultry, beef, fish and milk within that increasing livestock consumption.

The data from the National Statistics Bureau (NSB) does not accurately incorporate food consumed away from home. Therefore (especially) the urban NSB consumption data are likely to be biased downwards, especially for livestock products. Among urban consumers, almost 9% of food expenditures were on food away from home in 1993, but this share rose to nearly 21% by 2005 (Tian 2007). While urban per capita food expenditure has been relatively stagnant since 2000 the share of food consumed at home has fallen as away-from-home eating opportunities have rapidly developed in China's urban areas. Income growth plays a central role in determining the level of

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<sup>6</sup> This study attempted to adjust consumption data to reflect away-from-home consumption.

away-from-home demand, but it has been shown by Ma et al (2006) to also affect the structure of those expenditures towards the consumption of meats and fish. They estimate an expenditure elasticity for away-from-home consumption of 1.74 which rises to 2.54 for household members in the top income quartile, and an expenditure elasticity of 0.98 for spending on meat away-from-home. These demonstrate how growth in away-from-home consumption has been driven by income growth in urban areas that increases the participation of this population in eating out.

### 3. CHINA'S AGRI-FOOD TRADE

*“Suppose there were people from another country who carried opium for sale in England and seduced your people into buying and smoking it; certainly your honourable ruler would deeply hate it and be bitterly aroused.”* Letter from official Lin Zexu to Queen Victoria prior to Opium War (Ebrey 1996, p. 239).

China has shown a positive trade balance in agri-food products for most years since 1949. This situation changed in 2003, and from that year on the trade balance has been negative. While the value of agri-food exports has recently increased along the longer-term trend, imports increased sharply from 2002, just after China's accession to the WTO. By 2006 agri-food imports totalled US\$31 billion compared with \$11.1 billion in 2002 - a threefold increase. China is now (2006) the world's 4<sup>th</sup> largest importer and 5<sup>th</sup> largest exporter of agri-food products.<sup>7</sup> State trading companies dominated China's trade in all major commodities during the 1980s and it was not until the following decade that a system of tariffs was developed and that private traders were permitted – at first with trade in animal and horticultural products along with some other minor products, and more recently in soybeans, maize, rice and wheat trade (Huang et al. 2007).

To what extent was China's recent agri-food import surge driven by increasing consumer demands from the urbanized and wealthier middle classes for livestock products and other items with relatively high income elasticities? The perhaps unexpected answer is that 60% of the increase in imports between 2002 and 2006 was accounted for by just three products: soybeans, cotton and natural rubber. Products demanded by industry (cotton, natural rubber, raw hides and skins and wool) contributed 41% of the growth in agri-food imports, reflecting the growth in the textiles, clothing and shoes, automobiles and construction industries in China. Imports of all animal products, food or otherwise, comprised just 7.9% of the overall growth in agri-food imports, of which hides and skins, and wool, contributed 6%. Dairy products made up 1.7% of that increase, and meats even less. This suggests that China has been largely able to supply increased demands for animal products from local supplies, albeit along with a rapid growth in soybean and other feedstuffs imports to supply its livestock feed sector. China has been a net importer of soybeans since 1996, and by 2006 was the world's leading importer, at 28.3 million tones (Gale 2007). On the export side horticultural products, either fresh or processed, dominate and accounted for 57% of the 2002-2006 increase in agri-food exports, and had a 42% share of China's total agri-food exports in 2006. Total livestock products made up 13.5% of that overall increase in agri-food exports, to which meats contributed 8% and animal guts, bladders and stomachs a further 3%.

While livestock products have not made a noticeable impact on China's recent agri-food trade development, what has been happening in terms of China's trade in these

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<sup>7</sup> Treating EU25 as a single region and excluding intra-EU trade.

products? Net exports of live animals, meats and dairy products combined fell from US\$1.7 to \$1.1 billion between 1996 and 2006. Over this period China remained a net exporter of meats with a trade balance of \$1.3 billion in each of those years, and with Hong Kong and Macao the major export destinations. By far the major meat category now exported is preserved and processed product, with net exports of \$1.26 billion in 2006, compared with \$0.33 billion in 1996. Through high temperature treatment, this category of product is able to overcome importer bans due to the presence of animal diseases, such as foot-and-mouth, in China. Between the mid-1990s and the early 2000s net exports of poultry, pigmeat and beef all declined, but since then beef and pig meat net exports have risen rapidly. China was a net importer of sheep/goat meat from 1998 until 2004, but since 2003 imports declined and China had an increasing export surplus of this meat from 2005. Net exports of ruminant meats (beef and sheep/goat meat) rose from \$9 million in 2000 to \$73 million in 2006 – beef imports fell in response to BSE outbreaks in North America; over the same period pigmeat net exports rose from \$10 million to \$380 million. The quantities traded are generally very small compared with total production: the net export quantities of pig meat and beef were 0.4% and 0.25% of domestic production, respectively, in 2005. China's net exports of poultry meat have been declining since 1996, and turned into a net deficit since 2002, although the net import volume was just 1.5% of domestic production in 2005. China has a trade deficit in dairy products, with net imports rising steadily from \$24 million in 1996 to \$464 million a decade later. As others have indicated (e.g. Huang et al. 2007) the commodity composition of China's agri-food trade reflects its comparative advantages – that is, exports tend to be the labour-intensive horticultural crops and non-ruminant animal products, while land-intensive crops such as grains, cotton and oilseeds tend to dominate imports.

The global agri-food trading environment has changed abruptly over the past year, due largely to droughts in major producing countries and rapidly increasing demands for cereals and oilseed crops for bioenergy production. It is rather early to whether this is a major structural change or a temporary phenomenon, but it has had a major impact on China's food markets, as elsewhere. For example in China feedstuff prices are at historically high levels and are rising ahead of prices of many livestock products, squeezing margins of livestock producers. This problem has been exacerbated by disease outbreaks among China's pig inventory – as a result the wholesale pork price rose 86% over the year from July 2006. Imports of pork have soared, reaching 21,000 tonnes in the first half of 2007 compared with 24,000 tonnes for the whole of 2006. Pork exports have sharply declined from the year earlier although the country remained a net exporter of this commodity in 2007 despite becoming a net importer over the last third of that year. Maize exports also raced ahead - up 85% over the first 11 months of 2007 compared with the same period of the previous year. In response the Chinese government has placed export taxes and quotas on maize and other crops in an effort to curb rising exports of these commodities and to reign in domestic food price inflation.

China's trade policies were reformed in preparation for eventual accession to the WTO (OECD 2005). Since 1992, China's MFN agricultural tariffs have been reduced

from a simple average of 45% to about 15% in 2005, and further reductions continue for some commodities as per China's WTO schedule. The dispersion of China's agricultural tariffs is also relatively low, with around 67% of tariff lines having tariffs of less than 20%. Tariff rate quotas (TRQs) were introduced for several commodities (but for no livestock products except wool) in 1996, although those on vegetable oils have since been phased out. State Trading Enterprises (STEs) have played an important role in China's agri-food trade. While some products have been deregulated from STE controls and under WTO accession the STEs have lost their monopoly controls over imports (except for tobacco trade), they remain important players (McCorrison and McLean 2007). TRQ allocations are reserved for STEs, for example 90% of the wheat quota and 60% for corn. On the export side, China's WTO accession agreement permits state trading to be retained for certain commodities. Prior to becoming a member of the WTO China had used export subsidies for rice and corn, and these ceased from 2002.<sup>8</sup>

The decline in China's agricultural tariffs had commenced well before the WTO accession date – in 1997, for example, the average agricultural tariff was around 33% having been 45% in 1992. For dairy products, pre-entry tariffs were 25% on powders and 50% on butter, cheese and yoghurt – these had been reduced to 10% for powders, yoghurt and butter and 12% for cheese by 2005. China's tariffs on beef products have been cut from 45% in 1997 to final rates of 12% to 20%. Rates for poultry and pig meats have also been reduced. Since substantial agricultural liberation took place in China between 1995 and 2001 in preparation for accession, the subsequent accession did not lead to a significant fall in protection on most agricultural commodities after that date (Anderson et al. 2007).

The surge in China's agri-food imports therefore has more likely been driven by the wider aspects of China's industrial growth, accession-related reforms and the abolition of the MFA textile and clothing quotas rather than agricultural reforms *per se*. Major factors include the substantial liberalisation of foreign investment into pillar manufacturing and services industries and the gradual withdrawal of the state from its dominant position in such industries that contributed significant productivity and income gains (Mai et al. 2003, Ianchovichina and Walmsley 2003), increased activity in China's textile and clothing sectors that contributed to increased demand for cotton imports (Zhai and Li 2000), and the surge in auto manufacturing (six million vehicles produced in 2005 versus 2 million before 2000) that increased the demand for rubber. China's livestock revolution, however, did contribute through the huge growth in protein feedstuffs.

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<sup>8</sup> However China exempted these sectors' rail and road taxes, which may be viewed as implicit export subsidies.

## 4. CHINA'S AGRICULTURAL AND LIVESTOCK POLICIES

*“What are the real conditions among Chinese farmers?...nine out of ten farmers do not own their fields...of the food produced in the fields...only 40% goes to the farmer...if the food raised in the fields all goes to the farmers, the farmers will be more eager to farm and production will increase..unless we can solve the agrarian problem there will be no solution to the livelihood problem...we must make the aim of food production not profit but the provision of sustenance for all the people....”*

Sun Yet-sen (1866-1925) in Hsu (1971, p.425).

### 4.1 Introduction

Following the founding of the People's Republic by Mao Zedong in 1949 land was confiscated from landlords and redistributed to poorer peasants during what was a period of social unrest. This was soon followed by peasant land owners pooling their land as their shares in cooperatives, and 90% of farmers were in cooperatives by 1956. Soon to follow was complete collectivization of land and the formation of the much larger communes with their production brigades and teams as part of the effort to reach the ambitious production targets of the Great Leap Forward. For various reasons agricultural production suffered during this period, and in combination with bad weather famine became widespread during 1959-62. The commune system was reorganized so as to give the brigades and teams more say in administrative and economic decision making, and policy emphasis on agriculture as a priority provided modern production methods and inputs to farming (Lardy 1983).

In the early years of the new Republic livestock production and marketing was characterised by households selling in loosely-controlled markets, as is the case now. But production could not keep pace with demand growth, and rising prices encouraged government to intervene in a number of ways. For example purchase contracts were introduced in the pig industry to secure supplies, leading to the State purchasing 92% of China's pigs in 1957 compared with 12% in 1953. The State established institutions to monopolise livestock marketing from 1953 through the establishment of the General Food Company (GFC) system to manage the supply and marketing of livestock and other non-staple foods. The State assigned sales targets to producers and set prices for products purchased by State organisations. In 1961 the egg industry was under State control, and all cattle purchases were confined to the State from that date (Waldron et al. 2003a).

## 4.2 The post-Cultural Revolution policy reforms

*“White cat, black cat – either will do as long as it catches mice.”*

Deng Xiaoping (Ebrey 1996, p. 313).

Of most relevance to today's Chinese agricultural economy are the reforms initiated in the late 1970s under the leadership of Deng Xiaoping. First and fundamentally, private incentives were introduced from the early 1980s through the gradual replacement of the commune system with the household responsibility system, within which farmers were allowed the freedom to allocate resources based on market signals and to sell their surplus produce (over and above government quotas and targets) in free markets thus increasing their income through production and market diversification (Tuan and Ke 1999). The role of free markets was to be encouraged and reliance on price controls would diminish. The policy objectives shifted from the pre-1978 focus on providing cheap food to support urban industrial development to foodgrain security and self-sufficiency.

By 1984 the GFC structure and its meat companies completely monopolised the pork, sheep/goat meat, beef and poultry production and distribution sectors. But from the mid-1980s government began to decentralise agricultural production and distribution by gradually liberalizing fruit and vegetable markets, followed by fisheries products, livestock products and oilseeds. Controls over the marketing of most commodities were eased considerably and urban and rural free markets were rapidly introduced and expanded (Lewis and Andrews 1989). Most non-grain products including livestock had been liberalized by the early 1990s (Gao et al. 1996). The pig purchase quota was replaced by free market trading, eggs were traded freely and all provinces abolished the beef quota system (Waldron et al. 2003a). The Government's Vegetable Basket Programme was introduced in 1988 to encourage infrastructural improvements in rural areas and development of a network of wholesale markets, and has contributed to the rapid development of the vegetable, livestock and fisheries sectors.

It would be a mistake to attribute the recent growth in the livestock sector in China to market forces alone, however. Government directives, policy pronouncements and other non-market incentives have played an important role in the growth of some livestock industries – recent promotion of the dairy industry is a case in point. But it should also be noted that once the industry in question fades from government attention, it tends to contract, and sometimes and especially in some areas it may contract sharply. The Chinese beef industry is a good example but so too is the Chinese fine wool industry (Waldron et al. 2007).

The State has also maintained control or influence over some aspects of the livestock industry. Exports of live farm animals and meats have been subject to quota (to Hong Kong and Macao) or export license, and State agencies control the production and distribution of breeding materials including importation of breeding stock. The State, through the activities of local officials, guide the activities of householders in a numbers of ways including the provision of support services, and the construction of

animal production facilities (Waldron et al. 2003a). Apart from poultry and dairy, foreign investment has not played a significant role in livestock development so State agencies have become major investors in production, slaughtering and processing.

Since the late 1990s, government policies have recognized the imperative of increasing farm and rural incomes, narrowing the rural-urban income gap, increasing the competitiveness of China's agriculture and reducing the tax burden on farmers. A series of "No. 1" documents since 2004 have set out the government's recent agricultural and rural policy objectives. Increasing farm incomes and enhancing foodgrain security have been addressed through grain marketing reforms introduced from 2004 that include minimum prices (rice and wheat), direct payments based on grain area sown, and subsidies for higher quality seeds and some machinery. Agricultural taxes in China had been in place for over 2000 years and had, amongst other things, contributed to peasant revolts and the downfall of dynasties (Levenson 1971) These taxes were equivalent to 8% of the value of farm output in 2003, and were phased out over the period 2004-2006. The 3<sup>rd</sup> No. 1 Document of 2006 aimed to create a new socialist countryside. In that pursuit, food security (especially grains) remains an important objective, as do increasing farmers' incomes and the harmonious development of rural society. To these ends, there is emphasis on rural infrastructure (e.g. roads, communications, schools, water), improving rural access to public services such as education, health and social security, enhancing rural-urban migration and encouragement of farmers' cooperatives and professional associations. The 4<sup>th</sup> document of 2007 has a focus on the promotion of modern agriculture. The 'multifunctions' of agriculture are to be developed, including agro-tourism, bio-energy, sustainability and rural environmental enhancement. Attention is also given to product safety and quality standards, including GIs, certification, labeling and traceability systems. Increases in direct state subsidies to agriculture were announced.

#### **4.3 Are China's livestock and feeds producers taxed or protected?**

*"Peasant families have long had no surplus of food. Even in a year of abundance they have to eat the chaff of the wheat. This evil is the result of surtax collections...If they abandon the land...they have no better way of making a living; if they keep it, the whole product yielded is not enough to pay the land tax."*

Memorial at the end of the reign of Tao Kuang (1821-1850)  
(Levenson 1971, p. 144).

Recent research has attempted to quantify the extent to which China's agricultural and trade policies have distorted production incentives over the post-1978 reform period (Huang et al. 2004, 2007; OECD 2007; Orden et al. 2007). During the early reform years, compulsory purchase of grains and livestock products at low prices resulted in returns to farmers well below world levels. In this period there was heavy implicit taxation on pig and poultry production, due also to China's policy emphasis on grains

and to Chinese<sup>9</sup> and foreign restrictions on trade in these products. The gap between domestic and world prices of these livestock products has narrowed considerably since the late 1990s and producers have been able to respond to these improved incentives to meet the growing domestic demand. Although China has, since 1994, had no policies that would hold pork and poultry prices below world levels, barriers imposed by importing countries ensure that nominal assistance rates (Huang et al. 2007) remain negative. Positive protection of milk remains, but at levels considerable less than those of a decade ago or earlier. Turning to feedstuffs, nominal rates of assistance for maize farmers have been positive since the mid-1990s. While soybean producers have received positive protection each year since the early 1990s, this protection has fallen sharply in recent years as trade protection was liberalized and China became integrated into the global soybean market. So for at least the past decade, poultry and pig producers faced the double disincentive of negative protection of outputs and positive protection of their major feed inputs.<sup>10</sup>

The OECD (2007) has recently estimated support to Chinese agriculture, taking account of other sources of assistance to farmers in addition to policies impacting directly on output prices. Their producer support estimate (PSEs) increased from 3% on average over the 1995-97 period to 10% by 2003, but have since declined to 8% in 2005. This level of support is low compared with the average for OECD member countries of around 30% and is exceeded by all OECD members with the exceptions of Australia and New Zealand. Changes in China's PSE are driven mainly by the evolution of support for grains: between 2000 and 2003 the crop PSE rose steadily while that for livestock declined somewhat (OECD 2005, Fig. 2.14). Anderson et al. (2007) show that WTO accession-related reduction of protection to China's manufacturing sectors also contributed to this relatively low level of protection, through lowering of indirect taxation of farmers. An implication is that further agricultural trade liberalization by China would not be expected to have much further impact on China's production and trade patterns, apart from a few exceptions such as dairy products. In today's relatively liberalized agricultural economy, Chinese producers can better respond to movements in international prices, as demonstrated by the rapid structural change from grains to livestock and horticultural production wherein lies the comparative advantage.

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<sup>9</sup> Voluntary quotas were in place in the 1990s, primarily to avoid supply shocks in the Hong Kong and Macao markets (Tian 2007).

<sup>10</sup> Rae (1992) found similar situations in many Southeast Asian livestock sectors in the late-1980s.

## 5. RECENT DEVELOPMENTS IN CHINA'S LIVESTOCK PRODUCTION SECTOR

*“A horse cannot gain weight if not fed with extra fodder during the night; a man cannot become wealthy without earnings apart from his regular salaries.” Chinese proverb.*

Despite rapid increases in the consumption of livestock products, these products do not dominate the growth in China's food imports in recent years. This suggests that domestic production has, by and large, been able to cater to the domestic demand expansion. China's agricultural output has expanded rapidly since the economic reforms of the late 1970s, reflecting both productivity growth and mobilization of inputs. Among livestock products over the period 1996-2006, output of beef and mutton has increased by 111% and 160% respectively, poultry meat production has increased by 81%, pork output by 65%, egg output by 68% and milk production by a massive 650% (Tian 2007).<sup>11</sup> Real gross agricultural output value (GAOV) has grown by 6.2% per year since 1990, but the output of the livestock sector grew even more rapidly, at 8.9% annually. Thus livestock's share of GAOV increased from almost 26% in 1990 to 32% by 2006 (NSB 2007). The livestock demand growth revolution was responsible for an even greater share of the agricultural output growth when crop feedstuffs are considered – while the increased livestock share occurred at the expense of the cropping sector, more land has been planted in corn (mainly substitution for wheat) at the same time as the total area sown in cereals has declined.

While the growth in animal numbers explains much of this output growth, productivity gains in China's livestock sector have also been striking. Rae et al (2006) used provincial enterprise-level livestock data for China, and estimated total factor productivity (TFP) annual growth rates of 3% to 5% for hogs and eggs, and 4% for beef over the 1990s. This study also decomposed growth in TFP into growth in technical change (TC: upward shifts in the production frontier) and technical efficiency (TE: the rate at which farmers are catching-up to the frontier). This revealed that growth in technical change occurred in all livestock sectors at rates between 3% and 6%. However, the rates of catch-up had been very slow or even negative, due in part to the deterioration of the extension system (CCICED 2004; Nyberg and Rozelle 1999). This suggests scope for future output growth if inefficient farmers can move closer to the technical frontier. TFP growth for milk was much slower than for the other enterprises at 0.5% to 1%, although growth in technical change was much faster at over 6%. This slow TFP growth was not unexpected given that the milk sector in China has recently been undergoing very rapid growth with many new entrants, producer experimentation and inevitable mistakes, and some slow adopters of new technologies. Nevertheless, a subsequent study (Ma et al 2007)

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<sup>11</sup> Concerns have been raised over the historical accuracy of China's livestock production statistics, and an increasing discrepancy over time between supply and consumption data and lack of consistency between output data and those on feed availability (Ma et al. 2004a). These problems are likely to have been more severe prior to 1996, at which time China's National Bureau of Statistics revised livestock data based on the first national agricultural census. It is believed that their livestock data are to be revised again in 2008, based on the second national census of agriculture.

estimated a milk TFP growth rate of just over 2% per year for specialist dairy farms in suburban locations – of interest since the location of milk production is moving nearer to major markets and as much as 50% of China's total milk production could now be occurring in such locations.

Backyard, part-time animal-raising is still the dominant form of livestock production in China. Livestock smallholders made up around 99% of all livestock operations, and produced 73% of hogs, 82% of cattle, over 60% of poultry, 73% of sheep and 65% of dairy cattle (MOA 2003a). But recent structural changes have seen a decline in the proportion of rural households that are raising livestock (Zhang 2006; Zhang and Somwaru 2004), and the emergence of specialist household producers as well as commercial, large scale enterprises especially in suburban regions of large cities. The specialist household systems<sup>12</sup> have a larger scale than the backyard systems and tend to be more market-oriented (Tian 2007). For example the output share of backyard (non-specialist) hog producers fell at the rate of around 2% per year from 1990 to 2001, while that of specialist hog households rose at the annual rate of 6.5% compared with a growth rate of just under 6% for commercial hog enterprises (Rae et al. 2006). But the household sector, whether specialised or not, remains dominant in China's livestock production and Chen and Rozelle (2003) suggest that financial difficulties experienced by some of the commercial operations may have been driven by competition from specialist household producers.

Since the late 1980s the Chinese government has taken measures to encourage development of intensive feedlots aiming at ensuring stable supply of quality products, and their numbers have been growing since the early 1990s. They tend to be located in either coastal regions with access to markets and ports, or in provinces with abundant feed supplies. Compared with backyard systems, feedlots are more capable of controlling quality and achieving scale economies. However their economic performance can be very susceptible to changes in input and output prices, as recently experienced with higher feed costs, and to problems regarding management and husbandry, disease control, inadequate technical and training services and risk-sharing and insurance (Wang 2007).

Structural change is also rapid in the milk sector (Ma et al. 2007). Urban demand growth has encouraged the development of milk production as well as the rapid expansion of processing facilities in China's suburban areas (Zhou, Tian and Zhou 2002). The government has implemented a wide range of measures to promote the development of suburban dairy farms, including the provision of concessional loans for investment, feed subsidies, the supply of improved breeds and the provision of technical assistance to producers (Wu, Huang and Rozelle, 2006). The injection of foreign capital and the introduction of advanced technologies has also helped promote suburban milk production (RTDDI, 1997; Tuo, 1999, MSTC, 2004). As has been the case in other livestock industries, 'concentration centres' in suburban areas are a

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<sup>12</sup> The Ministry of Agriculture officially defines households as specialised in an activity if it earns at least 60% of its income from that activity. In practice, specialisation is defined in terms of livestock heads or turnover.

recent phenomena in the dairy sector (Miao and Jiang, 2003; MOA, 2003; Yi, 2005). Small and scattered dairy farmers in the countryside are driving their cows into the concentration centres where they can rent space for their cows, and/or buy cows to start their business, and enjoy relatively modern production and marketing services such as access to concentrate feed, new owner training programs, animal disease control, milking facilities, milk collection and transportation (Zhang, 2005).

For most of China's livestock smallholders a significant proportion of household income comes from other sources. In the RCRE<sup>13</sup> survey the proportion of sample households that raised livestock fell from 76% in 1995 to 54% in 2005, with the average share of total household income derived from livestock rising from 11% in 1995 to 14% ten years later (Rae and Zhang 2007). The trend to specialization and increased scale, on average, among the remaining livestock-raising households from 1995 to 2005 is evident from the doubling in the average amount of grain used for feed and the often more-than-doubling of average household outputs of livestock products, and the increase in the average share of the labour force used in animal raising and in livestock's contribution to household income.

How strongly is such increased specialization, as may be encouraged by the livestock revolution, associated with rising household incomes among livestock-raising households? Rae and Zhang (2007) found, after controlling for several fixed effects such as household supplies of land, labour and capital, worker education, and household location, a U-shaped relationship between predicted household net income and the household's specialisation in livestock production (as measured by the share of the total labour force allocated to animal-raising) in 2005. This was especially obvious in China's eastern region.<sup>14</sup> For the majority of the national rural household sample, or those households that allocated less than half of their labour force to livestock raising, it was predicted that household incomes will rise as these diversified households further divert their labour from livestock to other income-earning activities. But highly-specialist livestock households in the East were predicted to earn similar (or higher), net household incomes than those earned by households in which animal-raising was a relatively minor activity and which had used their freed-up resources to perhaps specialize in other activities. Economies of scale and access to modern supply chains that scale engenders are likely to be part of the reason.

A structural change in hog production over the past two decades has been the growth of backyard hog production in the poorer inland regions and its contraction in the richer inland areas and coastal provinces. Chen and Rozelle (2003) put this down to the emergence of grain and feed markets in inland regions that facilitated hog production, and of improved labour markets in coastal areas that increased the opportunity cost of labour remaining in farm production. Using the RCRE data, Chen and Rozelle find support for the hypothesis of poorer households increasing livestock production in early stages of their development, but of decreasing livestock activity

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<sup>13</sup> The Research Centre for Rural Economy, Ministry of Agriculture, Beijing. This survey is conducted annually and includes over 20,000 rural households in 31 provinces.

<sup>14</sup> This analysis did not include households that raised no livestock.

once household incomes reach a certain level (Adams and He 1995, FAO 1999), which they term the 'rise and fall of backyard hog production' in China. In the beef sector, Longworth et. al (2001) found that cow/calf and breeding operations tend to be carried out only by poor semi-subsistence households. Such small scale production may not be profitable if the opportunity costs of labour are considered, so when labour markets develop that households can access, they may exit the cattle industry.

Between 1995 and 2005, many households in the RCRE sample exited livestock production. Of those rural households that were surveyed in both of these years, 21% did not raise any livestock in 1995. By 2005, this percentage had more than doubled to 48%. During the 1990s China's livestock markets experienced over-supply problems and price corrections, which would have influenced many households to move out of livestock production. These market problems occurred in the egg industry in 1996-97, the pork industry in 1999-2000, and the beef industry experienced a sharp market correction in 1996-97 following its rapid expansion in the first half of the 1990s. Such market developments encourage industry rationalisation, and in the beef industry hundreds of thousands of households left the industry in the late 1990s (Waldron, Brown and Longworth 2003). Specialised households responded more to the market corrections than did the more diversified households due in part to their 'hard' budget constraints (relative to more diversified households) that result from their greater dependence on commercial markets for inputs such as labour, capital and feedstuffs and greater exposure to risk (Longworth, Brown and Waldron 2001).

Rae and Zhang (2007) examined some of the factors that differentiated the exiting households from those that remained in livestock production. Their results support in some ways the finds of Chen and Rozelle. They find that households most likely to exit were in the coastal provinces, had higher household income prior to exit with a low contribution from livestock, had a well-educated workforce, were located near off-farm work opportunities, faced a higher opportunity cost of labour and participated in relevant social networks. Those most likely to remain in livestock production tended to be located in western regions, had a less-well-educated workforce and had access to higher endowments of land and labour. It was also found that the degree of household specialisation in livestock production impacted on the probability of exit. As specialisation increased so did the probability that the household would remain in livestock farming. But as higher levels of specialisation were approached (where more than about a half of the household labour is allocated to livestock) this probability declined with further specialisation. This applied to all regions, but was particularly noticeable in the West and Central regions. Given the downward price adjustments that occurred for several livestock products over this period (including for cattle, a major livestock enterprise in the Central and West regions), highly-specialised livestock households would appear to have suffered more than those with a more diversified business portfolio.

The growth in the livestock sector in China is being accompanied by the rapid development of modern supply chains. It has been found in other countries (Reardon

et al. 2004; Hu et al. 2004) that in such cases it is richer and larger farmers who benefit, rather than poorer, smaller farmers. Is this likely to be the case on China? Some evidence suggests that *large* commercial hog farms are emerging to service urban consumers (Fabiosa et al. 2005) and that an increasing volume of beef (from a very small base) is being sold through modern supply chains (Brown et al. 2002), but that *small* producers are increasing their participation in milk production (Wu et al. 2007). Based on surveys of livestock producers in Beijing and Hebei province, Bi (2007) concludes that there has been little penetration of modern supply chains by these producers, with the one exception of poultry production. While pig production in the survey was split evenly between poorer and richer households, the vast majority of poultry production occurred in the richer households. Given the role of supply chains in marketing poultry, it is concluded that the entry of these operators gives rise to increased scale of production and the exclusion of poorer households. In contrast, the poor were seen to benefit and increase market share (but not scale) when livestock are marketed primarily through traditional supply chains as is the case for pork. In the RCRE survey used by Rae and Zhang (2007), 74% of sample poultry meat production occurred in the East, the same region in which they found increasing household incomes as specialisation in livestock production reached very high levels. This appears to support Bi's finding (for Beijing and Hebei in the East region) that poultry production is concentrating among the wealthy households.

## 6. LOOKING AHEAD

*“Consider the past and you shall know the future.”*  
Chinese Proverb.

### 6.1 Will China’s demand for livestock products continue to grow?

Much of China’s rapid growth has been driven by investment and the export surplus, and hence less by increases in consumption (Lardy 2007). Since 2000, household consumption as a share of GDP has been steadily falling while the GDP share of investment and (especially since 2004) net exports of goods and services have been increasing. Household consumption as a share of GDP was 50% in 1990 but had declined to just 36% by 2006, by far the lowest share of any economy in the world.<sup>15</sup> This is due to reductions in both the share of household disposable income in GDP but also a decline in the share of consumption (and of course an increase in the savings share) in disposable income. Consequently, between 1995 and 2006, real GDP per capita increased at the rate of 7.9% per year, while that of per capita household consumption grew at the slower annual rate of 5.7%. This has occurred despite the government’s stated objective of strengthening domestic consumption as a major source of economic growth (Lardy 2007). There has also been a widening disparity between urban and rural incomes, and also between those in the coastal areas and elsewhere.<sup>16</sup> Looking ahead, how might growth in consumption’s share of GDP, and a narrowing of the rural-urban income gap, impact on food consumption in China and on its trade with the rest of the world? Should consumption become more important as a driver of China’s future growth, then a slow-down in GDP growth, as sometimes projected, need not lead to a slow down in the growth of household consumption. This, however, will require further Chinese government action in terms of macro, fiscal and other policy reforms (Lardy 2007). Food demand projections that are based on projected growth in GDP might then underestimate future demand growth.

Possible scope for further increases in consumption of livestock products as incomes continue to grow is indicated by comparing the progression of rural consumption relative to that by urban consumers. Real disposable incomes in China’s rural households were in 2005 at about the same level as in urban households in 1990 (Rozelle and Huang 2007). For milk and poultry meat the levels of per capita consumption by 2005 in rural households were also rather similar to those of their urban counterparts 15 years earlier. In both rural and urban regions, consumption of these products has been increasing linearly with real incomes, and consumption per person may well continue to grow, and not just in rural households. However, consumption of pork by urban consumers has levelled off, while that in rural

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<sup>15</sup> Lardy provides an interesting comparison with India: in 2004, China’s GDP per capita was two and a half times that of India, but its per capita consumption was only two-thirds higher than India’s.

<sup>16</sup> While the ratio of urban to rural incomes was 2.6:1 in 1978, it had risen to 3.3:1 in 2006. The Gini (%) coefficient has risen from 29 in 1978 to 37 in 2000 (Kanbur and Zhang 2005) and reached 47 in 2004 (WDI).

households reached by 2005 the level of urban consumers in 2000. Scope for further increases in pork consumption by either urban or rural consumers is therefore perhaps limited. In the case of red meats, urban consumption appears to be leveling off, but that of rural households remains well below that of urban consumers. While Tian (2007) concludes that China's future food demand growth will be largely determined by the rate of growth in rural incomes, urban income growth may remain an important driver for some livestock products and will also influence future growth in food consumption away from home. Future policy developments that affect migration, rural industrialisation, rural education and training, investments in new townships and cities in rural areas and the modernisation of food retailing in such regions can all be expected to play important roles in influencing the future growth of livestock product consumption in rural areas.<sup>17</sup> These will also help determine whether rural food consumption patterns will converge on those in urban areas as rural incomes approach those of the urban population.

## 6.2 Feeding China's Livestock

Rapidly growing domestic demand has driven the explosion of livestock production in China, which in turn has driven the rapid growth in demand for protein feedstuffs that was an important contributor to China becoming a net agri-food importer in recent years. Domestic production of feed crops, however, has also risen rapidly – and achieved against a backdrop of tight land constraints and a decline in the total area of sown cropland. The area sown in soybeans increased by 36% between 1991 and 2006, while total output rose by 69%. Under the 'soybean rehabilitation program' initiated in 1999 the government provided financial subsidies to farmers to adopt improved soybean varieties to raise yields and oil content, in response to the growth in imports. This supply expansion could not match the growth in demand as China became the world's leading importer of soybeans. Corn is a different trade story. The corn area grew from 21.6 million hectares in 1991 to 27.0 m. ha in 2006 – an increase of 25%, and total output increased over the same period by 47%. Despite the demand-side developments, China remained a net exporter of maize in most years since the mid-1980s, and was a net importer of maize only during 1995 and 1996 following lower domestic production. This is despite widespread concern over China's potential to switch to become a major net importer of maize and other grains. Indeed, various projections of China's grain trade have been made (as summarised in Fan and Agcaoili-Sombilla 1997) that projected imports of between 11 and 63 million tonnes in 2000, and between 14 and 108 million tonnes in 2005. China's actual grain imports in these two years were 3.1 mmt (2000) and 6.2 mmt (2005).

While China's exports of maize do fluctuate considerably from year to year, China has so far been able to meet its demands for livestock maize feed from domestic sources, assisted in part by increased use of soybean meals in animal feeds. For how

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<sup>17</sup> For example access to many social services including education and health care has favoured urban residents, property rights differ between rural and urban residents and the population registration system (*hukou*) creates disincentives to the migration of rural-borne residents (although recent relaxations have occurred in some metropolitan areas and villages (Lardy 2007; Cai 2007)).

long this will continue is not clear. But some factors suggest a slowing in the rate of growth of feed demand. Livestock feed efficiency has been increasing in China, which has resulted in savings of grain, and at the same time meat demand growth has switched from pork to poultry with its lower grain requirement per kg (the feed conversion ratio) of meat produced. Another factor influencing growth of demand for feedgrains is the slowing in the rate of production growth for both pork and poultry in recent years. Between 1996 and 2001 the annual production growth rates were 5.1% and 7.3% respectively for pork and poultry, but these had both fallen to 4.5% and 4.6% respectively for the 2001-2006 period. While the expansion of ethanol production in China was largely fed from maize stocks, the government has since 2006 prohibited further use of grain for this purpose. On the supply side, recent government measures to encourage grain production have had some success, and potential still exists for further increases in maize production perhaps at the cost of soybeans and some minor crops. More recently the government has imposed export taxes and quotas on exports of maize and some other crops as part of an effort to reign in galloping food price inflation. Recent increases in maize and ocean freight prices have resulted in domestic prices for maize being below the landed cost of imports,<sup>18</sup> and if this situation continues large-scale imports of maize do not seem to be on the horizon.

The development of bio-fuels could also impinge on China's (and others) demands for traditional livestock feedstuffs. Should grain and oilseed prices continue to strengthen, and as increased supplies of by-products suitable for livestock diets emerge from the bio-fuels industry, changes in feed formulation practices may occur, involving a shift away from maize and soybean towards locally available feedstuffs and bio-fuel by-products (ASA 2007). With the ban on grains as a bio-fuel feedstock, China has targeted sweet sorghum as one of several non-grain crops for bio-ethanol production. Simpson et al. (2007) suggest that the sweet sorghum bio-ethanol program will contribute significantly to China's total animal feedstuffs production. This is through two co-products: crushed stover (suitable for ruminants) which can be treated to increase its energy and protein content, and stillage from the grain distillation process which can be dried and to which micro-products can be added (and which can be fed to all animals and fish). Simpson et al. (2007) project that the sweet sorghum bio-ethanol program could allow China to reduce its imports of protein feed crops such as soybeans by about 21% by 2030.

### **6.3 Meeting growing demands: Imports of feed or final product?**

Some countries, such as those in Northeast Asia, have met increased demands for livestock products from their domestic animal stocks and from increasing imports of feedgrains until domestic supply constraints were reached, after which imports of livestock products grew. Others, such as China, have met that demand largely from domestic animal and grain resources. The question arises, especially in countries increasingly facing land, water, environmental or other constraints to livestock

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<sup>18</sup> Personal communication, Professor Tian Weiming, November 2007.

production, at what point might imports of feed grain be replaced by imports of meat products? I compare maize net imports with net imports of meats measured in grain equivalents<sup>19</sup> over the period 1975 to 2004 for Northeast Asia (Japan, South Korea and Taiwan Province) and China. In Northeast Asia, net imports of maize rose at an annual rate of 7.9% from 1975 until 1985, before slowing to an annual growth rate of 1.7% between 1986 and 2000 as domestic meat production met tightening constraints to further expansion. In comparison, net meat imports (in grain equivalents) rose at an annual rate of 8.1% from 1975 to 1985, before its growth rate increased to 10.9% per year between 1986 and 2000, no doubt also encouraged by the gradual opening of meat imports into this region. Since 2000, imports of both maize and meats have stabilised somewhat, in response to the slowdown of demand growth in this region.

The situation in China over the same period has been quite different. Since 1985, net exports of maize have fluctuated considerably, but around a rising trend. At the same time, China has also been a net exporter of meats (measured in grain equivalents). It is not at all clear whether, and if so when, China will emerge as a persistent importer of grains for livestock feeding, or whether further into the future China will eventually import more grains embodied in livestock products. But for the coming decade at least, China seems likely to continue producing livestock products at relatively low cost, given the labour-intensive nature of the production systems and the low opportunity cost of rural labour. The same can be said of the slaughtering and processing components of China's produced meats, resulting in labour shares of these activities in the final product being much lower than in developed countries. As a consequence further expansion of local production looks capable of supplying the continuing demand growth with the likely exception of dairy products (Ma et al. 2004), albeit in the face of continuing risks of rising feed costs, animal diseases and environmental concerns and regulations.<sup>20</sup>

As China's consumers of animal products become more sophisticated, market demand will become increasingly segmented as some consumers express demand for higher quality products. Given China's ongoing problems in reliably producing 'high quality' livestock products, much of this demand could be met from imports. Thus trade, as well as markets, could become increasingly segmented as specific types of product are imported to meet specific market niches. For example China is a net exporter of generic beef, but imports premium beef for the restaurant and hotel markets and also imports very low-value beef for processing. For China's trade in poultry meats, the unit value of exports has always exceeded that of imports since at least 1996, for example by 50% - 70% between 2004 and 2006. This would imply that China exports relatively high-value cuts of poultry meat and imports low value parts. Indeed, between 1999 and 2001, China was a net poultry meat exporter in value terms but a net importer in quantity terms.

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<sup>19</sup> Based on typical quantities of grain required to produce a kilogram of meat, the following coefficients are used to convert meat quantities to grain equivalents: beef (10), pork (4) and poultry (2). Beef cattle are fed considerably less grain in China than in the other countries, so a feed conversion rate of 6 is used, based on data in Longworth et al. (2001). The grain-equivalent of imported dairy products is omitted from this analysis.

<sup>20</sup> Personal communication, Tian Weiming.

A recent program of research has addressed how trade in meats may evolve, and in particular how rates of international convergence in livestock productivity growth might impact on meat trade (Rae and Hertel 2000; Nin et al. 2004; Hertel et al. 2007). China has been one of the focus countries in this program. In the most recent of these studies Hertel et al. (2007) decompose TFP growth rates into their technical change and catching-up components. They also use the methodology of Ludena et al. (2007) to derive TFP estimates for crops, ruminant and non-ruminant meat, as well as for total agriculture. As far as the productivity results are concerned, a common finding across all these studies was that China's productivity growth in non-ruminants was higher than that of all other countries or regions studied, and that she was rapidly catching up to the global technological frontier. Hertel et al. (2007), project an increase in China's trade balance in non-ruminant meats, but declining trade balances for ruminant meats and for land-intensive crops and agriculture overall, between 1997 and 2025. The meats projections are at variance with recent trends and rest upon, inter alia, a much faster annual rate of productivity growth in non-ruminants (6.5%) compared with rates of 3.4% for ruminants and 1.4% for crops. If indeed China is heading towards net importer status for non-ruminant products (this trade was almost in balance by 2006 with pigmeat net exports almost the same as net imports of poultry meat in value), it will be a challenge to reverse this trade status by 2025.

## 7. SUMMARY AND CONCLUSION

The question posed in the title of this address was whether the livestock revolution had been a driver of China's agriculture, smallholders and agri-food trade. My conclusion is that this phenomenon has indeed revolutionised the agricultural sector and the livestock industry in China, but that with the exception of protein feedstuffs, it has as yet had very little impact on China's international trade. China has successfully increased livestock production more or less in line with her consumption increases, and in the process has provided diversification and specialisation opportunities to millions of smallholder producers. But these developments have not been without periods of instability and declining prices, resulting in many producers exiting the industry. Specialist household and commercial operations are becoming more prevalent, encouraged in part, especially in the poultry sector and the richer coastal regions, by the growth of modern processing and retailing and the continuing exit of the traditional backyard producers, but face considerable financial and production risks.

I expect the livestock revolution to continue in China, although it may take different forms to those exhibited in the past as government and industry respond to existing and emerging problems and issues. Consumption of livestock products will no doubt continue to grow over the medium term but probably at a slower rate than in the past, encouraged by the continuation of trends in rural-to-urban migration, in rural income growth and in eating away from home. As higher-income consumers increasingly demand high-quality and safe livestock products, the industry will be required to respond through a variety of ways including continuing international cooperation in investment and technology development, and the improvement of backward linkages and integration involving the modern retail segment. This will also be crucial to future livestock product export growth. It remains to be seen how successful such vertically-integrated production systems will be in China. According to Rozelle (2007) the number of cooperatives and farmer associations – that primarily provide technology, inputs and marketing services – has grown tenfold between 1994 and 2003, yet only 8% of villages have cooperative or farmer associations and only 2% of households belong to such institutions, despite new farmer association legislation. On the other hand there are estimates that 25% of farmers are 'loosely' vertically integrated – for example large numbers of abattoirs have contracts with households and associations (personal communication, Scott Waldron).

A big unknown is to what extent the domestic industry can continue to supply this growth, and especially as sustainability becomes a more important issue in China. Environmental problems are already occurring, with some large-scale livestock operations having been relocated away from suburban locations, such as dairy farms shifting out from the Beijing area and medium/large scale hog farms having been forbidden in Shanghai. Also, over-grazing of grasslands is already a problem in the cattle and sheep sectors. Increasing pressures on cropland raise the question of where the industry will obtain its future feedstuff and forage supplies, and the extent to which these will be sourced internationally. Negating these pressures somewhat are

the prospects of new feedstuffs from emerging biofuels industries, and the likely slowdown in feedstuffs demand growth as the industry continues to improve efficiency of feed use. Should future high grain prices seriously disrupt white meat markets, will lean ruminant meats, fed on China's supplies of crop and biofuel residues, increase their market share at the expense of white meats? If recent growth in beef and sheepmeat exports is to continue into the future, further efforts will be required to address food safety, disease status, inspection systems and other concerns of importers, which in turn will require greater investments in processing and distribution systems and inspection services. If successful, might China become a significant competitor for the traditional exporters of these meats?

Wages are rising rapidly in China, across both regions and industries, not only in absolute terms but relative to other economies. While the country has for some time experienced a shortage of skilled labour, could it one day face shortages, and rising wages, of unskilled labour as well? These labour market developments might impact on China's future livestock industries in at least two ways. The study of Rae and Zhang (2007) found that the opportunity cost of farm labour had a positive but non-significant impact on the decision to exit livestock production. So as wages continue to rise it is possible that livestock farmers could be even more strongly encouraged to seek industrial employment, or that their children will increasingly choose off-farm employment over farm work. This could result in increased pressure on China's domestic supplies of livestock products. Finally, given the labour-intensive nature of non-ruminant production and meat processing in China, the industry could see its price advantage eroded which may offer increased opportunities for foreign suppliers in China's markets.

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