Journal of Integrative Agriculture 2015, 14(6): 989–994

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Editorial

Meat consumption in China and its impact on international food security: Status quo, trends, and policies

1. Background

China has seen drastic nutrition transition and food structure change with rapid economic growth in the past three decades. Specifically, the traditional fibre-dominated food system is being replaced by a western-style meat-dominated diet (Yu and Abler 2009; Tian and Yu 2013). In traditional China meat was regarded as a rarity and normally consumed during festivals, now it has become daily food for most Chinese consumers. Though many controversies have been uncovered in meat statistics in China (Yu and Abler 2014), an increasing trend of meat consumption has been observed. According to the Food Balance Sheet Statistics of the Food and Agriculture Organization (FAO), per capita meat supply in China increased from 10.3 kg in 1978 to 56.6 kg in 2011. However, the current level of per capita meat consumption in China is still relatively low in comparison to western developed countries, e.g., 87.9 kg for German and 117.6 kg for U.S. consumers.

In China the domestic meat industry is heavily hinged to consumer welfare, farmer welfare, nutritional status, agricultural trade, food security, and environmental issues. Chinese governments spend a lot of resources promoting animal husbandry in China. Given the sheer size of the population, Chinese consumers moving up the food chain inevitably shakes worldwide food security in an era of globalization. The whole world is keeping a close eye on meat consumption in China, and wants to see to what extent China could shift the world food market. Though China herself endeavors to maintain a high level of food self-sufficiency, large exporters, such as U.S. and Australia, are expecting China to further open its bulky meat and animal feed market, and are dreaming of great business opportunities there. However, low income countries, such as sub-Saharan African countries, worry that the increasing demand from China will push up world food prices and drive more of their people to fall into poverty.

Though some literature has shed light on meat consumption and its impact intentionally (e.g., Yu and Abler 2014), or unintentionally by food analysis in China (e.g., Yu and Abler 2009; Chen *et al.* 2015; Zhou *et al*. 2015), there is a call for updating and synthesizing research with a special focus on this topic. In response, we organized this special focus to look at status quo, trends, and policies of meat industries in China, and its impact on international food security.

2. Main findings

Though many related questions are important and interesting, this special focus consists of 14 research papers, providing frontier research on the following topics: (1) consumption; (2) production; (3) trade; (4) prices for meat products; and (5) food safety and the international experiences. In addition, two import policy-related issues, meat statistics and environmental sustainability of meat consumption, are intensively discussed as well.

The main findings of this special focus are summarized in the following section.

2.1. Consumption

The central question which concerns the whole world regarding meat economics in China is to what level Chinese consumers will increase meat consumption in the future. The prevalent parameters modeling consumer behavior are the consumption elasticities (including price elasticity and income elasticity). They are also used for projection. In the long run, income (expenditure) elasticities are particularly important, because they can well capture the consumption

doi: 10.1016/S2095-3119(14)60983-7

dynamics with income changes. Chen *et al.* (2015) provide a meta analysis for food demand elasticities in China. They find that income elasticities are very similar for red meat (pork, beef and mutton), all around 0.60, while poultry income elasticity is slightly higher at about 0.85.

In order to show the dynamic of expenditure elasticities, Burggraf *et al.* (2015) use the CHNS survey data to estimate meat elasticities in China between 1997 and 2009. They find that unconditional expenditure elasticity for meat stayed at around 1.0 and did not change much during this period (except for a slight decrease for pork products), which indicates that meat consumption in China will keep increasing in the near future with income growth. In 2009, the expenditure elasticities for pork, beef, mutton and poultry are 0.88, 1.04, 1.64 and 0.67, respectively. Burggraf *et al.* (2015) also compare meat consumption in China with that in Russia, and indicate that in 2008/2009 meat is still a luxury good in China, but a necessity good in Russia. Income growth in China and Russia tends to increase the demand for animal-based products much stronger than the demand for carbohydrates.

The current research did not provide much information about meat consumed from home, which often biases the estimation of meat consumption as well as elasticities. Min *et al*. (2015) use a unique household survey data and find that currently food away from home (FAFH) accounts for 30% of meat consumption for urban households in China. Similarly, Xiao *et al.* (2015) find that both consumption at home and FAFH are underestimated in the official statistics of NBSC. Particularly, they find that in 2010 FAFH accounts for 45% meat consumption in urban areas and for 20% in rural areas.

As income increases, consumers often pay more attention to quality attributes, in addition to quantity growth (Yu and Abler 2009). The share of FAFH meat consumption is expected to increase with further income growth, as rich consumers are more likely to purchase the service embedded in restaurant and ready-to-eat food. Ignoring this part of consumption in a demand analysis will bias down income (expenditure) elasticities (Min *et al.* 2015).

In addition, it is well known that China is experiencing a demographical change, stepping into an ageing society. Without considering the demographical change, the projection of meat consumption using the current elasticities will be biased. Min *et al.* (2015) find that meat consumption in households with old people is often lower due to health concerns. Considering the demographical change, meat consumption growth in the future will not be as large as the usual elasticities predicted. Rather, per capita meat consumption could shrink in about ten years.

Food safety is a major concern for Chinese consumers due to recent food safety scandals in China. To ensure food safety for consumers the government in China developed a unique certification system, which divides food safety into three levels. From the least to most stringent, they respectively are Safe Food, Green Food, and Organic Food Certifications (Yu *et al*. 2014a). Yu *et al*. (2014a, b) indicate that rich consumers are more likely to pay more for premium food, such as “Green Food” and “Organic Food”. For instance, Chinese consumers are willing to pay 40% more for Green Pork and 60% more for Organic Pork. However, the trust in certifications is still a major problem.

Over consumption of meat products could cause some diet-related diseases, such as obesity, type 2 diabetes, cardiovascular diseases, hypertension, and cancers (Shimokwa 2015). To a certain point, consumers then tend to change dietary habits towards a more healthy diet. In western society, such as in Germany, there is a recent movement to vegetarianism, calling for more vegetable consumption. From the 1980s, per capita meat consumption in Germany has dropped by more than 10%, from the peak of 96.7 kg in 1986 to 87.9 kg in 2011. Such a movement, I think, will come to China, and affect consumer behaviors in China in the near future.

In addition, Dong *et al*. (2015) using a partial equilibrium model, and Yu and Cao (2015) using a general equilibrium (GTAP) project meat consumption in the future. Their results are similar, and find that per capita consumption of meat products in China will continue to rise until 2030.

2.2. Production

Pork is the main meat consumed by the Chinese. Though the proportion of pork in total meat consumption has been steadily declining since the 1980s, it is still more than 60%. In this special focus, there are two papers which focus on pork production in China, contributed by Tian *et al.* (2015) and Zhou *et al.* (2015); and one paper on environmental issues related to production, contributed by Abler (2015).

Although the traditional backyard pig farms are shrinking and large scale pig farms are booming instead, around half of pork in China is still produced by small-scale backyard farms. According to the estimation by Yu and Abler (2014), the proportion of backyard pig production was 85% in 1991, and the number has dropped to 48% in 2009.

Tian *et al.* (2015) investigates the productivity and efficiency of hog production and the determinants of technical efficiency in China, using the fixed-point rural household survey data (2004–2010) from the Research Centre of Rural Economy (RCRE). They use a stochastic frontier translog production function with scaling property in inefficiency term, and find that the average technical efficiency of hog production in China is 0.59. More importantly, large and specialized farmers have higher technical efficiency than others, and

technical efficiency in the eastern region is higher than that in central and west China. A declining TFP of 20.6% is found during this period, mainly caused by the negative technology change. However, the scale and technical efficiency have not substantially changed. Tian *et al.* (2015) also point out that the technical efficiency of hog production in China can be improved by 40%, which can be realized by specialization and education, as well as technical spillover from eastern to western and central China.

In contrast, Zhou *et al.* (2015) use provincially aggregate data to study environmental and technical efficiency. They find that feed is the most efficient input, with an output elasticity of 0.55, which is higher than other inputs, such as capital and labor. The output elasticity with respect to the nitrogen is 0.29 on average. The scale elasticity in hog production is slightly higher than 1.

Animal husbandries create great environmental challenges, as it is difficult for governments to regulate the non-point source pollution, such as from the manure produced by animals. Zhou *et al.* (2015) specifically estimate the environmental efficiency of pork production in China. They find a great regional variation of environmental efficiency, ranging from 0.34 to 0.97, and the mean is 0.67. Southwest China is revealed as the most efficient region, while northwestern and northeastern China the least efficient regions. The environmental efficiency is observed to be declining over time.

Chinese governments have realized this environmental problem cause by the animal husbandry industry and have made many policies to promote control of manure runoff, liquid/solid separation of manure, biogas production, organic fertilizer from manure, and environmental audits of large livestock farms. Environmental protection in rural areas has been part of the Chinese central government's No. 1 Document since 2004. Many policy tools have been developed to rebate the non-point source pollutions. Abler (2015) presents an evaluation of agricultural non-point source pollution control options for China. He carefully reviews different policy options from different dimensions, including design standards (command & control), performance standards, and design and performance incentives. Evaluation criteria include economic efficiency and effectiveness, environmental impact and risk, and social criteria such as equity and food security. The evaluation indicates that the best options for China involve giving subsidies to farmers for changing production practices in order to reduce non-point emissions, combined with appropriate farmer education and technical assistance.

Feed is the main input for the meat industry. Accompanying the rapid growth of meat industries, in order to satisfy rising domestic meat demand, China started to increasingly import feed products, such as soybeans and corn, given the stringent domestic feed supply. Dong *et al*. (2015) project that increasing demand for meat in China's future will be reflected by increasingly importing feed grains. In other words, China will be confronted with feed security, rather than grain security.

2.3. Trade

As agricultural land resources are very limited in China, the nutrition transition and food structure change there is inevitably shifting world food security through the channel of international trade. In contrast to the earlier projection that China would import a large amount of meat products, net meat import is very small in comparison to total consumption in the past decade. Instead, China is importing a huge amount of feed products, mainly soybean, to feed domestic animal husbandry industries. For instance, China imported 63.4 million tons of soybeans in 2013, and more than 60% of the world export ends up in China[1].

Cheng *et al*. (2015) use the annual trade data from 1995 to 2012 to estimate the import demands for major meat products such as fresh/chilled beef, frozen pork, sheep & goat, offal and poultry in China. The results indicate that import demands for meat products are mostly determined by import price and real GDP. Other factors such as tariff and domestic meat in general do not have significant impacts on the meat imports of China. It also implies that nontariff measures do not have significant impact in the long run, as the demand is still there.

Dong *et al*. (2015) use a partial equilibrium model (CAPSim) to simulate future meat demand and production in China. In order to satisfy the increasing demand for meat, China will mainly increase its import of feed grains, rather than importing meat directly. The demand for commercial feed is projected to rise dramatically from 202.6 million tons in 2010, to 259.3 million tons in 2020 and 280 million tons in 2030. Although China's feed crop production (e.g., of maize and soybeans) will keep rising, the gaps between demand and supply will be further enlarged in the future. It is estimated that China's import of maize and soybeans will reach 19.0 and 76.4 million tons, respectively in 2020, and 39.8 and 84.6 million tons in 2030.

Yu and Cao (2015) use a computable general equilibrium model (GTAP) to project future meat consumption and trade in China, and obtain similar results to Dong *et al*. (2015). Until 2030, China still mainly imports feed grains (mainly soybean) rather than meat products. The self-sufficient rate

[1] http://uk.reuters.com/article/2014/01/10/china-trade-soy-idUKL3N0KJ2CD20140110

for soybeans will be even lower, decreasing from 39% in 2011 to 28% in 2030. As the labor cost in China rises, China will increase imports of meat products, but the self-sufficient rates for meat products still remain very high in the future. Specifically, the self-sufficient rates will be 88% for cattle meat and 93% for other meat products.

These projections generally agree that meat demand will increase in the future, but the increasing speed will slow down. Likewise, the growth rate for the import of feed products in China will slow down as well. Dong *et al*. (2013) project that feed demand will increase annually by about 6 million tons in 2011–2020, and 2 million tons in 2021–2030. The shock of China's import of feed grains on the international market will be very minor.

In addition, Zhou and Koemle (2015) test price transmission between the international soybean market and the domestic corn market, and find that there is long run equilibrium between them. Specifically, the international soybean price can predict (Granger cause) domestic corn price, but not vice versa. This implies that the feed market in China has been largely integrated into the international market.

2.4. Price

Meat carries a substantial weight in the Consumer Price Index (CPI) calculation in China. Even though the weights of various products in the CPI are not officially published by the National Bureau of Statistics of China (NBSC), it is believed that the weight of pork could be well above 6%, as the expenditure share of meat products was around 10% for urban households and more than 60% of meat consumed in China were pork products in 2010. Inaccurate pork statistics could lead to erroneous macroeconomic policies (Yu and Abler 2014). The Chinese government always keeps a close eye on meat prices in China. Understanding the dynamics of meat prices is also important for policy makings.

Even though China carried out monetary easing policies in the past decade and has the largest money supply measured by M2 in the world, meat prices do not go up proportionally. This is largely due to the over-supply effect, triggered by money supply and decreasing production costs caused by increasing production scales (Yu 2014).

Zhao and Wu (2015) specifically shed light on the evolution path of China's pork price by employing the threshold autoregression model (TAR). They find that the dynamic process of pork price has two regimes: the mild regime and the expansion regime. In particular, a change belongs to an expansion regime if it is larger than 0.588; otherwise, it falls in the mild regime. Economically, if a price change is larger than 0.588, market players will dramatically react. For instance, producers will increase or shrink production scale; or some enter into or exit from the industry. If a price change is smaller than 0.588, producers regard the price change as white noises and will stay in the current production scale, maintaining market equilibrium.

Feed is a major input of animal husbandry. It is important to know how price transmission occurs between feed and meat products. In addition, land scarcity limits China's ability to continue increasing its hog production without feed imports, particularly for soybean. The feed markets in China are therefore increasingly integrated into the global market. Zhou and Koemle (2015) conduct a study on price transmission between the hog price in China and feed prices, specifically domestic maize price and international soybean price, from January 2000 to April 2014. They identified a long-term stable equilibrium relationship between the three markets. However, no significant Granger causality between hog and feed market is identified. The long-run equilibrium partially results from the Granger causality between the international soybean market and domestic maize market. It evidences that the domestic hog market has been segregated by governmental policies, such as trade barriers, subsidies, direct market intervention, and monetary ease policies.

Due to increasing labor cost and other material costs, grain prices (such as wheat, maize and soybeans) in China are basically 20% higher than international prices. Meat prices in China are also not competitive. The price for poultry products in China is more than 40% higher than that in the international market; the prices for pork and beef are basically equal to those in the international market (Yu and Cao 2015). However, China takes no-tariff trade barriers, such animal diseases. The quantity of imported meat is still relatively small, and hence the price transmission from the international market to the domestic market is limited.

2.5. Food safety and international experiences

This special focus also includes two papers that shed light on other countries, and tries to provide some international experiences for Chinese meat industries from a comparative perspective.

It is well known that animal infectious diseases could have a significant impact on the welfare of both consumers and producers. However, studies looking at this topic are conducted in a very limited way in China, mainly due to data availability. Mu *et al.* (2015) examines the impact on the U.S. meat demand of the announced outbreaks of bovine spongiform encephalopathy (BSE) and avian influenza (AI). They indicate that beef and chicken demand was negatively affected by BSE and AI disease outbreaks. Specifically, in the short run, U.S. consumers shift demand due to both outbreaks but more so due to domestic disease outbreaks than for outbreaks occurring overseas. In the long run, in-

formation related to severe, persistently recurring overseas animal disease outbreaks changes U.S. consumers' meat consumption patterns, but the magnitudes are small.

Albania is a Balkan developing country with 59% of the population belonging to the Islamic religion. Mutton is the major meat consumed in Albania. Zhllima *et al*. (2015) provide a study on consumers' perception of food safety for small ruminant meat products, with the background of a weak food safety enforcement system. They classified surveyed consumers into four clusters according to their socio-demographic characteristics. Consumers in the cluster composed of females with university education and higher income are, on average, more concerned with current meat safety measures and tend to place more trust in the veterinarian stamp on meat carcasses rather than in local butchers. It shows that importance of certification and localities for food safety.

3. Policy extensions

In addition to the above 5 major topics, the special focus also extends the discussions to the following two important issues: meat statistics and consumption sustainability, because they have important policy implications.

3.1. Meat statistics

Accurate statistics are the foundation of good economic analyses. However, a large discrepancy between official meat production and consumption statistics in China has been long observed. The consumption data obtained from household survey data is only about half of the production reported by NBSC. Where has all the meat gone?

More than 60% of meat consumed in China is pork. Yu and Abler (2014) carefully scrutinized pork statistics in China and found that the discrepancy in pork statistics could be explained by: (1) production over-reporting, (2) loss and waste in the pork supply chain, (3) pork consumed away from home (FAFH), and (4) a mismatch in the Chinese rural household survey between food and mouths (i.e., migrant workers and boarding students who are counted as rural household members but live in urban areas for much of the year). Local officials have incentives to inflate production figures so as to improve their performance reviews and prospects for promotions, and this production over-reporting can contribute 50% of the discrepancy in the statistics.

Min *et al.* (2015) use a survey of 1 340 urban households in six cities and find that FAFH accounts for 30% of meat consumption in urban China. Similarly, Xiao *et al.* (2015) conducted a survey of meat consumption for 107 households in seven provinces and provide different outcomes for the meat statistics in China in 2010. They find that FAFH accounts for 45% of meat consumption in urban areas, and for 20% in rural areas. In comparison, the consumption statistics is underestimated by 50% in NBSC. Hence, they conclude that the discrepancy between consumption and production in NBSC is mainly attributable to underreporting of consumption, while production over-reporting, loss and waste, and other statistical errors, are very marginal. This provides a different view on the controversies about meat statistics in China.

In recent times, traditional pig production, characterized by a large number of small backyard farms, is gradually being replaced by large scale farms with modern technologies (Yu and Abler 2014; Tian *et al*. 2015). Due to this change, it has become difficult for the tradition governmental statistic system to capture the full picture of pig production in China. In addition to traditional over-reporting incentives for local officials, the subsidy policies of governments for large farms give incentives for farms to inflate their reported production. Due to animal infectious diseases, substantial production loss is observed every year in China. However, so far, there is no credible statistics for these figures at the national level.

3.2. Consumption sustainability

Because meat products are among the most energy-intensive, ecologically burdensome, and ethically concerned foods, sustainable meat consumption is critical for achieving a sustainable food system. Such a concept is especially important for China given a very strict constraint of land resources in China. Shimokawa (2015) comprehensively reviewed the major questions related to sustainable meat consumption in China from the following four perspectives: (1) food security, (2) health, (3) environment, (4) ethical issues.

First, meat production requires more resources than grain production. In China, the feed conversion ratio is 5.0–7.0 to 1 for cattle, 2.8–4.5 to 1 for pigs, and 1.7–2.0 to 1 for chicken. Moving-up the food chain in China poses challenges for food security across the whole world.

Second, over consumption of meat products also leads to negative health consequences, such as diabetes, cardiovascular diseases and hypertension. Thus, promoting a healthy dietary is important for ensuring sustainable meat consumption.

Third, animal husbandries create great environmental challenges, as it is difficult for governments to regulate the non-point source pollution, such as from the manure produced by animals. Abler (2015) contributed to the regulation of non-point pollution in China.

Finally, the animal husbandry industry induces unique ethical concerns. The treatment of animals, their raising, how they are transported and the form of slaughter, are

important characteristics of a civilization and require of ethical justification (Shimokawa 2015). In Europe, animal welfare has been raised as an important standard for meat industries. On the one hand this helps create a more ethical and friendly world, while on the other hand it also forms trade barriers.

How to achieve the sustainability of meat consumption poses a great challenge to China's government. Certifications are considered as good tools for promoting consumption sustainability. However, the lack of trust in certifications is a major problem in China, and it may undermine the effectiveness of certification.

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