doi:10.1017/S0043933918000429

Reviews

Egg production in China

Z. YANG[1, 2, †], S.P. ROSE[2]*, H.M. YANG[1], V. PIRGOZLIEV[2] and Z.Y. WANG[1]

[1]College of Animal Science and Technology, Yangzhou University, Yangzhou, Jiangsu Province, P.R. China 225000; [2]The National Institute of Poultry Husbandry, Harper Adams University, Edgmond, Newport, UK TF10 8NB, United Kingdom
***Corresponding author: sprose@harper-adams.ac.uk**
†Z. Yang was a visiting researcher in Harper Adams University funded by the China Scholarship Council (CSC).

China has been the world's largest producer of eggs for the last 30 years. There have been considerable recent changes in the structure of the egg industry due to rapid economic growth, improved supply chains and favourable prices. Since 2012, revenue from poultry has increased by 8.7% on average. Annual growth rate of egg production has been approximately 0.6 million tonnes per year from 2000 to 2016 (FAO, 2017), and 2016 saw the total eggs produced reaching a peak of 31 million tonnes. Egg production in China continues to provide the population with a significant proportion of their intake of high quality dietary protein. Egg consumption is expected to continue to increase with the rise in the urban population. It is probable that the highest increase in demand for eggs will be for 'out of home' consumption and in processed food products. These levels of production are associated with the spread of intensive systems. The poultry sector is no longer dominated by hundreds of millions of smallholders keeping birds as a side-line activity and many small farmers have ceased production. Chinese consumers are becoming more focused on the quality and safety of eggs. Future developments in the egg production are expected to concentrate on quality, safety and traceability of eggs.

Keywords: egg production; laying hen; China

Introduction

China produces more than 40% of all the eggs in the world, making it the largest producer, and its annual production keeps increasing (Aho, 2002; Magdelaine, 2011). Rapid economic growth, improved supply chains and favourable prices have led to a constant rise in egg consumption. Improving national food security is a major long-term strategy of the Government and this has encouraged the development of the laying hen

© World's Poultry Science Association 2018

Received for publication January 23, 2018
Accepted for publication April 24, 2018

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

industry within the country (Iddamalgoda *et al.*, 2001; Windhorst, 2006). China has a 5000-year history of egg production but, for almost all of this time, this has been achieved by small-scale backyard family units. However, since the 1980s there has been a rapid expansion of the egg production within the country. Early expansion of the egg industry was led by state-run farms, but the private farming sector now dominates production (Yang, 2000). The numbers of large-scale, vertically-integrated, intensive egg production units have increased significantly at the start of the 21st century. However, smaller husbandry systems that are owned and operated by individual farmers continue to represent a significant part of the overall egg output in the country and still play a key role in a large number of people's livelihoods (Yang, 2011).

China is self-sufficient in egg production, although a significant proportion of feed ingredients needed for this production is imported. Outbreaks of high pathogenic H5N1 avian influenza virus in China since 2004 have caused serious concerns in the industry and for the Chinese Government (Martin *et al.*, 2011). The Government has taken measures to improve biosecurity by, when necessary, prohibiting all live bird markets in the cities and closing many small egg production farms (Tan *et al.*, 2013). These regulations have hastened change in the Chinese egg industry in the early years of the 21st century.

The objective of this review is to examine the recent changes in the egg industry in China. A further objective is to understand how the industry manages to supply their eggs to the areas of demand and to explain the methods used by poultry farmers for egg production within China.

Production and demand for eggs in China

Egg production in China has continued to increase in each of the years since 2000. The average annual growth rate of egg production was approximately 0.6 million tonnes per year from 2000 to 2016 (FAO, 2017). In 2016, the total eggs produced in China reached a peak of 31 million tonnes. The increase in egg consumption has been achieved by increasing the amount of domestic production. China is self-sufficient in shell egg production and has a very small number of imported eggs that is offset by a larger, but still relatively small, net export of eggs (FAO, 2017). In 2013, the quantities of imported and exported eggs were 175,000 and 100,000 tonnes, respectively. More than 70% of imported eggs were hatching eggs destined for breeding stock. The majority of exported shell eggs were sent to Hong Kong (90%) and Macau (10%). Exported eggs accounted for only 0.5% of the annual domestic production (USDA, 2014).

The egg consumption of the Chinese people has continued to increase in recent years. Eggs contribute approximately 6% of the protein in the diets of Chinese citizens. This proportion has increased slowly in recent years, although not at the same rate of increase that has occurred for pig and poultry meat (*Figure 1*).

Meanwhile, the contribution of protein from cereals has markedly decreased. Urban residents eat approximately 70% more eggs than rural residents but this difference is rapidly changing; The greatest increases in egg consumption have been seen in the population living in rural areas, whereas egg consumption in the urban population has remained approximately stable (*Figure 2*).

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

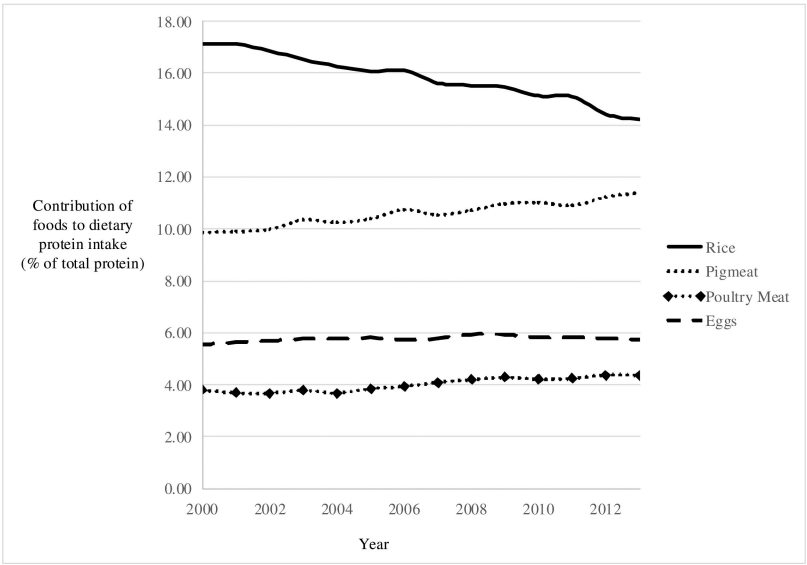


Figure 1 The contribution of different human foods to the total protein supply in China (Adapted from FAO, 2017).

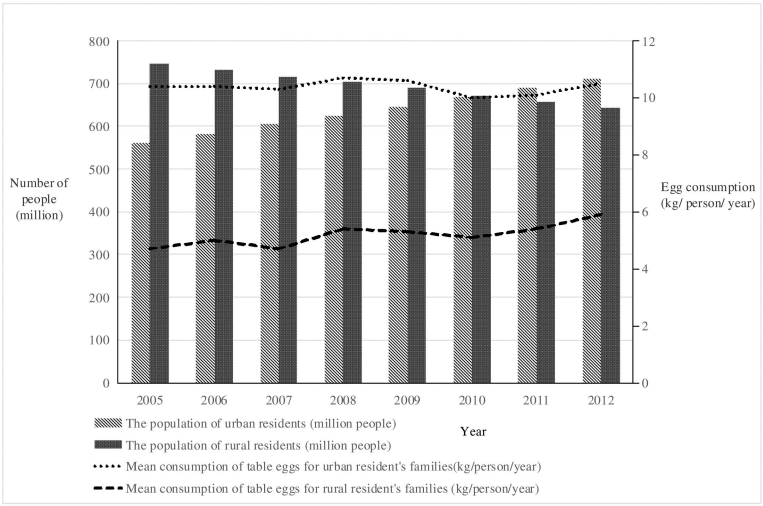


Figure 2 Egg consumption of urban and rural people in China (Adapted from National Bureau of Statistics of China, 2017).

Egg consumption in rural families is still much lower than that in urban families (5.9 kg eggs per capita *vs*. 10.5 kg eggs per capita in 2012), but with the rapid increase in urbanisation it is expected that the future demand for eggs will increase (Wang *et al.*, 2015). In 2010, home consumption of eggs accounted for 53% of egg sales with 'dining out' consumption accounting for 28% and 19% for further processed egg (*Figure 3*). Home consumption of shell eggs increased slowly whereas further processed egg

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

consumption more than doubled (144% increase) between 2000 and 2010, and dining out consumption rose by approximately 40% during this time.

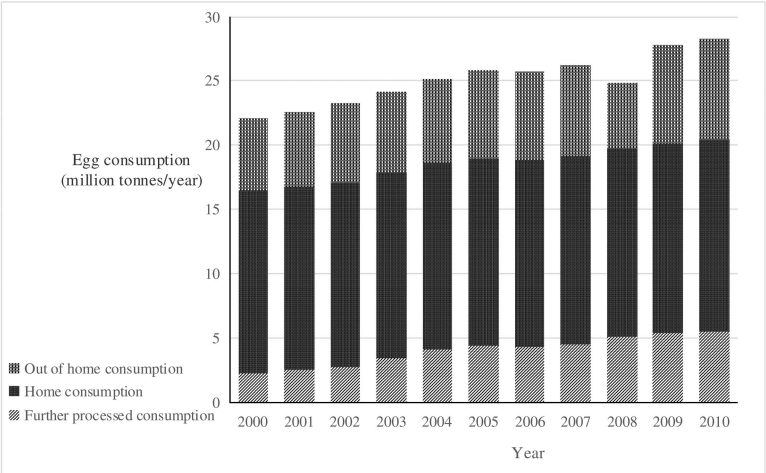


Figure 3 Egg consumption in China from 2000 to 2010 (Adapted from National Bureau of Statistics of China, 2017).

In the five years since 2012, the annual revenue for the poultry industry has grown at an average rate of 8.7% per annum (NBSC, 2017). Eggs are mostly sold by the farmers to wholesalers. The proportion of eggs sold through supermarkets is increasing, although not at the same rate of the wholesale market for eggs. There is an increasing number of small shops or street stalls that sell poultry products and this remains the dominant route for egg sales.

The retail egg price is approximately 30-40% greater than the price received by egg producers. Urban families with high incomes are becoming increasingly concerned about their long-term health and the state of the environment and some are now prepared to buy organic or free-range eggs. Speciality eggs are emerging in response to the demand from these affluent urban consumers (Zhang *et al.*, 2016; Godfray *et al.*, 2010). Approximately 5% of eggs are branded and this yields a two to five-fold premium in margin over the generic product (Ke and Han, 2007).

Egg price has relatively little effect on consumer demand for eggs: The egg market in China is relatively inflexible for price and this is particularly the case in urban residents and most profound in those in high income brackets (*Table 1*) (Ke and Han, 2007). Demand for eggs is more elastic in price in rural communities but this is less evident in high income households who favour high protein intakes. Low income households have relatively low protein intakes (Popkin and Du, 2003), and at times of high animal protein prices, they would change to buy cheaper foods, such as pulses and a higher proportion of grains. The farm price of eggs is therefore highly sensitive to changes in production levels and the supply of eggs. There are seasonal fluctuations in egg price, with lowest prices in late spring and highest in the autumn (Li *et al.*, 2010; CAAA, 2017).

There is a significant proportion of egg production systems that do not use fully environment-controlled buildings. These systems can have large seasonal changes in production from spring to autumn and hence have a significant effect on the numbers of eggs that enter the wholesale market at these times. A three-year cycle in egg prices is evident in the Chinese market (*Figure 4*). Smaller egg producers tend to have low-cost

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

poultry houses and so have low fixed capital costs in their business. These producers may delay restocking their houses at times of low egg prices and this results in this cycle of changing egg prices (Gueye, 2009; Zhou and Li, 2012).

Table 1 Income elasticity estimates for eggs for urban and rural households in China, 2005 (Ke and Han, 2007).

Urban households

Income group	**lowest**	**low**	**Lower middle**	**Middle**	**Upper middle**	**High**	**Highest**
	10%	**10%**	**20%**	**20%**	**20%**	**10%**	**10%**
Egg consumption(kg)	8.3	10.2	11	11.6	11.9	12.5	11.5
Elasticity for eggs	-	0.469	0.158	0.167	0.081	0.213	-2.027

Rural households

Income group	**low**	**Lower Middle**	**Middle**	**Upper Middle**	**High**
	20%	**20%**	**20%**	**20%**	**20%**
Egg consumption (kg)	2.6	3.7	4.6	5.6	7.3
Elasticity for eggs	-	0.852	0.389	0.372	0.609

The decision to restock may be affected by changes in the costs of production. In the last decade, costs at farm level have generally changed in line with layer feed prices, which reached a peak in 2013. Average cost of egg production was 8.7 Yuan/kg (US $1.31 /kg) and feed was 2350 Yuan/ tonne (US$352 /tonne) (IEC, 2017). Variation in feed costs remain the major, but not the only, influence on production costs.

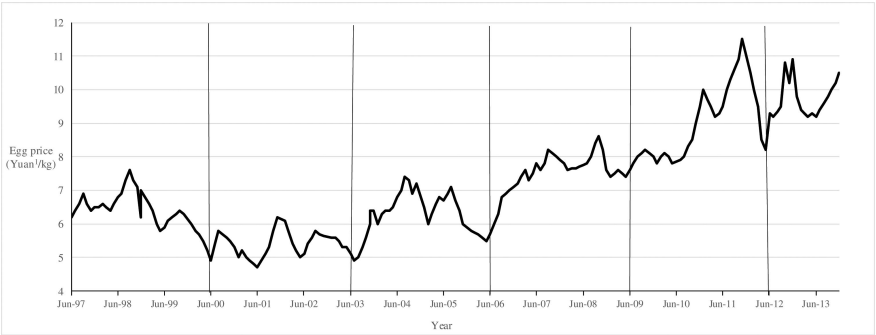


Figure 4 Annual trend of egg price in China from 1997 to 2013 (Yuan[1]/kg) (Adapted from China Animal Agriculture Association, 2017).
[1]Currency conversion used: One Chinese Yuan =0.15 US$
[2]Vertical lines indicate the duration of egg price cycle.

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

Structure of industry

Egg production in China has grown steadily over recent years, with a 24% increase in production from 2006 to 2015. Eggs are produced in all provinces of China but now production is concentrating in a relatively few provinces (*Figure 5*), whereby 10 Chinese provinces produce 80% of the national eggs.

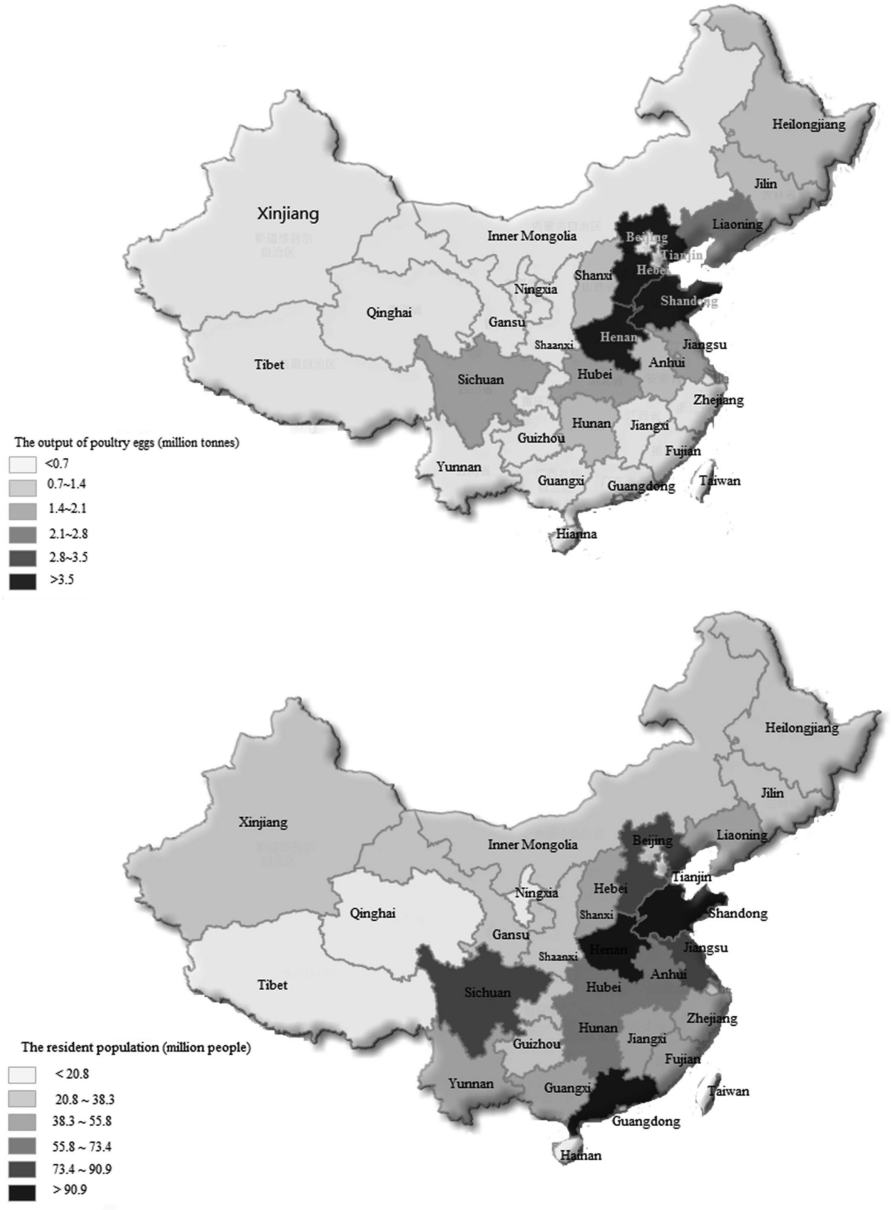


Figure 5 The output of poultry eggs (million tonnes per year) and the resident population (year-end) of China in 2015 (Adapted from National Bureau of Statistics of China, 2017).

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

In order to meet the demands throughout the whole nation there is a substantial movement of eggs around the country. Eggs are transported from North and Northeast China to Southeast and Southern regions as well as into big cities like Beijing, Tianjin and Shanghai. The province of Guangdong, in the south of China, has the largest gap between supply and demand with an inflow of two million tonnes of eggs each year, followed by Shanghai (0.75 million tonnes), Zhejiang (0.7 million tonnes) and Beijing (0.6 million tonnes) (*Table 2*). The concentration of egg production in the North and North-East of China is likely due to the availability of locally produced cereals as well as good access to ports for imported feedstuffs. Recent major improvements in the transport infrastructure by the Chinese Government have facilitated this centralisation in the egg production industry (Démurger, 2001).

Table 2 Net egg flows (million tonnes/year) and resident population (year-end) (10 000 residents) of each province in China in 2015 (Adapted from China Animal Agriculture Association, 2017 and National Bureau of Statistics of China, 2017).

Province	Egg flows (million tonnes/ year)	The population (million)
Hebei	1.8	74.3
Henan	1.7	94.8
Liaoning	1.5	43.8
Shandong	1.0	98.5
Jilin	0.5	27.5
Hubei	0.4	58.5
Heilongjiang	0.4	38.1
Sichuan	0.3	82.0
Inner Mongolia	0.3	25.1
Shaanxi	0.1	37.9
Ningxia	0.1	6.7
Xinjiang	0.1	23.6
Tibet	0.1	3.2
Hunan	0.1	67.8
Qinghai	0.1	5.9
Hainan	0.1	9.1
Shanxi	0.1	45.7
Jiangsu	0.1	79.8
Gansu	-0.08	26.0
Guizhou	-0.1	35.3
Anhui	-0.15	61.4
Yunnan	-0.2	47.4
Chongqing	-0.23	30.2
Guangxi	-0.25	48.0
Jiangxi	-0.3	45.7
Tianjin	-0.4	15.5
Fujian	-0.55	38.4
Beijing	-0.6	21.7
Zhejiang	-0.7	55.4
Shanghai	-0.75	24.2
Guangdong	-2.0	108.5

*Positive number represents the quantity of the exported eggs to other provinces; Negative number represents the quantity of the imported eggs to the province.

Henan, Shangdong, Hebei, Liaoning, Sichuan and Jiangsu, the six largest egg-producing provinces, accounted for nearly 61% of the total production of the country (NBSC, 2017). Most of these provinces have increased their egg production in recent years, except for Hebei. The reduction in egg production in Hebei may be due to the relatively large number of small egg producers in this province that may be ceasing

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

production due to Government legislation, the poorer viability of relatively small-scale production methods and the availability to them of other employment opportunities in the nearby, rapidly developing, urban areas (Li *et al.*, 2010).

Intensification of egg production has occurred throughout the country. In 2008, 43% of all eggs produced were from flocks with sizes less than 2,000 hens, but in 2014 this size of egg producer only supplied 4% of all eggs produced in China (*Table 3*). Large numbers of relatively small independent egg producers still exist and, in 2014, over 50% of all eggs produced were from flock sizes of less than 10,000 hens. However, large integrated companies have been established which manage large operations.

The top six largest egg producers (Beijing Huadu Yukou Poultry Company, Beijing Pinggu Charoen Pokphand, Beijing Deqingyuan Poultry Company, Anhui Rong Da and Shanxi Dajiang Nongke) have flock sizes of more than five million laying hens. Such companies are mostly vertically integrated and manage the bird husbandry, feed milling, transport and distribution of the eggs. Recent increases in the average size of Chinese egg production units are similar to the way which the egg production industries in developed countries, such as European Union and United States, developed (Mench *et al.*, 2011).

Table 3 Size of laying hen units and their contribution to the proportion of total eggs produced in China in 2008 and 2014 (Adapted from China Animal Agriculture Association, 2017).

Size of production unit (Number of hens)	Contribution to total egg production in 2008 (%)	Contribution to total egg production in 2014 (%)
<2 000	43.6	3.5
2 000~4 999	16.0	27.5
5 000~9 000	18.0	25.9
10 000~50 000	17.0	34.9
50 000~100 000	2.9	5.7
100 000~500 000	2.5	2.5

Management methods

Eggs are primarily produced in cage systems, regardless of the size of the enterprise. Around 90% of eggs are produced from cage systems with 9% from free-range systems and 1% from barn systems (IEC, 2017). Large, modern egg production farms increasingly use environment-controlled buildings in which cages incorporate automatic feed delivery and automatic egg collection equipment (*Table 4*). Recently-built egg production farms are typically on sites housing up to half a million hens. There are only a few sites that have more than a million birds.

Small egg production farms (less than 10,000 hens) typically use polythene tunnels, old greenhouses, or other farm buildings for hen housing that have none or poor environmental control. The tiered cages that are installed in these buildings often have little automation and feed is delivered and eggs are collected manually (*Table 4*). This type of production requires a high labour input, which is provided by farmers who are keeping birds as a side-line activity. However less people are now willing to work in the countryside as there are better employment opportunities in urban areas. Hence, many small farmers have given up egg production.

There has been growth in the free-range and organic chicken production over the past five years, but these account for a small number of chickens farmed. However, this is slowly shifting as Chinese consumers are now increasingly willing to buy cage-free eggs (Wang *et al.*, 2017; Rakonjac *et al.*, 2014; Zhang *et al.*, 2016). Laying hen strains that

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

produce brown shelled eggs are the predominant stock used in the Chinese industry. Approximately 70% of eggs sold are brown shelled (IEC, 2017). Hyline supplies 77% of all the laying stock (brown and tinted brown shelled eggs) whereas a local breeding company, Jinghong and Jingfen, supply 12% of the birds (tinted brown shells) (NBSC, 2017). The remaining 11% of laying stock are supplied by Lohmann (brown shelled eggs), Nongda (white shelled eggs) and there are some traditional breeding companies that produce stock that lay green shelled eggs.

Table 4 Management methods in different scale farms (Yang *et al.*, 2014).

		Drinker type		Feeding type		Egg collection	
Number of hens/ farm	Percent in tiered cages	Water trough	Nipple or cup drinker	Manual feeding	Automated feeding	Manual egg collection	Automated egg collection
<2 000	92.5	22.2	77.8	98.5	1.5	99.5	0.5
2 000~4 999	87.2	15.1	84.9	96.9	3.1	99.7	0.3
5 000~9 000	87.7	11.1	88.9	88.9	11.1	99.4	0.6
10 000~50 000	92.9	8.6	91.4	61.6	38.4	96.1	3.9
50 000~100 000	91.4	2.3	97.7	31.8	68.2	88.1	11.9
100 000~500 000	95.2	10.0	90.0	15.1	84.9	77.8	22.2

There are no formal regulations for animal densities in laying hen units, so farmers tend to stock to the economic optimum. Most large integrated companies keep flocks for a 60 to 70 week laying period, whereas small independent producers may use extended laying periods depending on the market conditions that prevail.

Conclusions

Egg production continues to provide the Chinese population with a high proportion of their intake of high quality dietary protein. Egg consumption is expected to continue to increase with the rise in the human urban population. It is probable that the major increase in demand for eggs will be for 'dining out' consumption and their use in further-processed food products. The poultry sector is no longer dominated by hundreds of millions of smallholders keeping birds as a side-line activity. Many small farmers have given up production, especially in the economically more developed Eastern provinces of the country. In the future, it is expected that intensification will continue. Small-scale and non-commercial farmers will continue their exit from the industry. It is possible that the number of poultry farmers in China could halve by 2020. Egg production is concentrated in certain regions of China and the logistical network continues to evolve that distributes the eggs to the consumer. Chinese consumers are becoming more focused on the quality. traceability and safety of eggs, and future developments in the egg production market may concentrate on these aspects.

Acknowledgments

This review was produced as part of the Project of Jiangsu Province Policy Leading Program of the People's Republic of China (SZ-HA2017010) and the Scientific Research Foundation of PhD Student of Yangzhou University.

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press

References

AHO, P.W. (2002) The World's commercial chicken meat and egg industries, in: BELL, D.D. & WEAVER, W. D. (Eds) *Commercial Chicken Meat and Egg Production*, pp. 3-17 (US, Springer).

CAAA (2017) China Animal Agriculture Association. http://www.caaa.cn/ (Accessed 15/11/2017).

DÉMURGER, S. (2001) Infrastructure development and economic growth: an explanation for regional disparities in China. *Journal of Comparative Economics* **29**: 95-117.

FAO (2017) FAO Country star. http://www.fao.org/faostat/en/#data/TP (Accessed 15/11/2017).

IDDAMALGODA, A., HAYASHI, S., GOTO, E., SUGIYAMA, M. and OGURI, K. (2001) Current Asian trends in egg production and consumption: a demand analysis of selected countries. *World's Poultry Science Journal* **57**: 49-54.

IEC (2017) International Egg commission https://www.internationalegg.com/ (Accessed 15/11/2017).

GODFRAY, H.C.J., BEDDINGTON, J.R., CRUTE, I.R., HADDAD, L., LAWRENCE, D., MUIR, J.F., PRETTY, J., ROBINSON, S., THOMAS, S.M. and TOULMIN, C. (2010) Food security: the challenge of feeding 9 billion people. *Science* **327**: 812-818.

GUEYE, E.F. (2009) The role of networks in information dissemination to family poultry farmers. *World's Poultry Science Journal* **65**: 115-124.

KE, B. and HAN, Y. (2007) Poultry sector in China: structural changes during the past decade and future trends. In poultry in the 21st century: avian influenza and beyond. *Proceedings of the International Poultry Conference*, Bangkok. pp. 1-33.

LI, Z.M., XU, S.W., DONG, X.X., LI, G.Q., LIU, H. and WANG, Y.T. (2010) The short-term market price transmission mechanism of egg industry chain in China. *Scientia Agricultura Sinica* **43**: 4951-4962.

MAGDELAINE, P. (2011) Egg and egg product production and consumption in Europe and the rest of the world, in: *Improving the safety and quality of eggs and egg products: Egg chemistry, production and consumption*, Vol. 1, pp. 3-16 (UK, Woodhead Publishing).

MARTIN, V., PFEIFFER, D.U., ZHOU, X., XIAO, X., PROSSER, D.J., GUO, F. and GILBERT, M. (2011) Spatial distribution and risk factors of highly pathogenic avian influenza (HPAI) H5N1 in China. *PLoS pathogens* **7**: 1-11.

MENCH, J.A., SUMNER, D.A. and ROSEN-MOLINA, J.T. (2011) Sustainability of egg production in the United States - The policy and market context. *Poultry Science* **90**: 229-240.

NBSC (2017) National Bureau of Statistics of China. http://data.stats.gov.cn/index.htm (Accessed 16/11/ 17).

POPKIN, B.M. and DU, S. (2003) Dynamics of the nutrition transition toward the animal foods sector in China and its implications: a worried perspective. *The Journal of Nutrition* **133**: 3898S-3906S.

RAKONJAC, S., BOGOSAVLJEVIĆ-BOŠKOVIĆ, S., PAVLOVSKI, Z., ŠKRBIĆ, Z., DOSKOVIĆ, V., PETROVIĆ, M.D. and PETRIČEVIĆ, V. (2014) Laying hen rearing systems: A review of major production results and egg quality traits. *World's Poultry Science Journal* **70**: 93-104.

TAN, Z., SHEN, Y. and YANG, D. (2013) The effect and influence of closing live poultry markets to control and prevent human avian influenza infection. *Chinese Journal of Health Policy* **6**: 67-85.

USDA (2014) International egg and poultry review. United State Department of Agriculture. https://www.usda.gov/ (Accessed 16/11/ 17).

WANG, J., CHEN, J. and LIU, H. (2015) China's egg consumption and its influencing factors. *Agricultural Outlook* **1**: 75-80.

WANG, J., YUE, H., WU, S., ZHANG, H. and QI, G. (2017) Nutritional modulation of health, egg quality and environmental pollution of the layers. *Animal Nutrition* **3**: 91-96.

WINDHORST, H.W. (2006) Changes in poultry production and trade worldwide. *World's Poultry Science Journal* **62**: 585-602.

YANG, N. (2000) Review and prospect of Chinese egg industry on the eve of the new century. *China Poultry* **22**: 1-3.

YANG, N., QIN, F., XU, G., ZHAO, Y., XUE, L. and ZHOU, X. (2014) Analysis of current status of Chinese egg industry in 2013. *China Poultry* **36**: 2-9.

YANG, N. (2011) Social economic aspects of egg production in China, in: *Improving the safety and quality of eggs and egg products: Egg chemistry, production and consumption*, Vol. 2, pp. 17-26 (UK, Woodhead Publishing).

ZHANG, G., CHEN, A., ZHAO, Y., XU, Z., CHEN, G. and YANG, S. (2016) Egg safety standards in China need to be improved. *Journal of Food Protection* **79**: 512-515.

ZHOU, H. and LI, H. (2012) Fluctuation analysis of the price of eggs in the 21st century. *Journal of Beijing University of Agriculture* **27**: 49-52.

https://doi.org/10.1017/S0043933918000429 Published online by Cambridge University Press