Chapter 2. Overview of the food and agriculture situation in China

This chapter describes the overall economic, social and environmental context in which the food and agriculture sector in China operates, and the natural resource base upon which it relies. It provides an overview of the general geographical and economic characteristics of China; outlines the share of the agri-food complex in the economy; identifies the main structural characteristics of the food and agriculture sector; provides an overview of the main food and agriculture outputs and markets; and analyses the main trends in agricultural productivity, competitiveness and sustainability. It finally raises a number of issues the agri-food complex is likely to face in the future.

2.1. General natural and economic context

The People's Republic of China (hereafter "China") has the world's largest population (1.4 billion) and the largest area of agricultural land (515 million hectares). Since 2009, it has become the largest economy in the world, measured by the size of GDP, adjusted by PPP. However, China is a resource-scarce country: arable land per capita is only 0.08 hectare, which is less than one-third of the OECD average. Similarly, freshwater resources per capita of 2 061 m^3 are less than one-tenth of the OECD average, resulting in severe competition between agriculture and other users of water resources.

Table 2.1. Contextual indicators, 2015*

	GDP	GDP per capita	Population	Total land area	Agricultural land	Arable land per capita	Freshwater resources	Freshwater resources per capita
	billion USD in PPP**	USD in PPP**	million	thousand km^2	thousand ha	hectares	billion m^3	m^3
	(2015*)	(2015*)	(2015*)	(2015*)	(2015*)	(2015*)	(2014)	(2014)
China	19 778	14 388	1 376	9 425	515 358	0.08	2 813	2 061
(world ranking)	(1)	(81)	(1)	(2)	(1)	(133)	(5)	(104)
Australia	1 132	47 028	24	7 682	396 615	2.002	492	20 971
Brazil	3 199	15 391	204	8 358	278 808	0.39	5 661	27 721
India	8 019	6 126	1 309	2 973	180 280	0.12	1 446	1 118
Indonesia	2 842	11 058	258	1 812	57 000	0.09	2 019	7 914
Japan	4 871	38 419	127	365	4 537	0.03	430	3 378
Korea	1 754	34 647	51	97	1 769	0.03	65	1 278
Russia	3 580	24 469	146	16 377	220 200	0.86	4 312	29 982
South Africa	726	13 209	54	1 213	96 841	0.23	45	827
United States	18 037	56 066	321	9 147	405 437	0.49	2 818	8 846
OECD	52 403	40 895	1 281	34 341	1 211 805	0.31	10 483	28 117

Note: * or latest available year; ** PPP: Purchasing Power Parity.
Source: FAO (2015a), *FAOSTAT* (database), Food and Agriculture Organization of the United Nations, http://faostat3.fao.org/home/E; OECD (2015a), *OECD.Stat* (database), http://stats.oecd.org/; World Bank (2015), *World Development Indicators* (database), http://data.worldbank.org/indicator.

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China achieved three decades of remarkable economic growth after the market-oriented economic reform in the late 1970s. Growth accelerated in the first 15 years of reform, starting from 1978.[1] In this early reform period, annual GDP growth rates increased from 4.9% in 1970–78 to 8.8% in 1979–84. Rising income in the initial years of reform stimulated domestic demand, and the high savings rate was transferred into capital investments in the non-agricultural sectors in particular. The growing demand in both domestic and international markets and rising investment accelerated growth of the Chinese economy, which achieved an annual GDP growth rate of 9.7% in 1985–95.

The Asian financial crisis of the late 1990s slowed China's economic growth, leading to an 8.2% annual GDP growth in 1996–2000. However, the GDP growth rate recovered to over 10% for most years of the 2000s. As a result, per capita GDP at purchasing power parity increased from less than 10% in 1995 to 35% of the OECD average in 2015. Poverty rates, measured at USD 1.90 a day (2011 PPP), declined from 57% to 11% between 1993 and 2010 (World Bank, 2015). As real GDP growth rate has fallen below 10% in recent years, China has entered into a lower but likely more sustainable "New Normal" growth path, with an official target of doubling GDP per capita between 2010 and 2020 (OECD, 2015b).

The high investment rate has been a major driver of China's high economic growth. Capital accumulation contributed to the majority of GDP growth since the 2000s, followed by Total Factor Productivity (TFP) growth. The contribution of TFP growth to GDP growth has recently declined: according to estimates by the Asian Productivity Organization, the average annual TFP growth rate fell from 5% in 2003-07 to less than 3% in 2008-12 (APO, 2015). As the rapid aging of the population is expected to reduce the national saving rate (which has been supporting the high investment rate), boosting productivity growth will be crucial for long-term sustainable economic growth in China.

Table 2.2. Real GDP growth rate

Annual percentage growth rate

	1981-85	1986-90	1991-95	1996-2000	2001-05	2006-10	2011-15
China	12.1	7.7	13.1	8.3	10.1	10.9	7.6
Japan	4.3	5.5	0.9	0.4	1.4	0.0	1.1
Brazil	2.5	0.9	3.5	2.1	3.3	4.6	1.7
Indonesia	5.0	7.4	7.6	-1.0	5.0	5.8	5.5
India	4.9	6.2	6.1	5.7	7.2	8.1	6.4
Russia	n.a.	n.a.	-10.1	3.0	6.4	2.4	1.8
South Africa	0.4	2.1	1.3	2.4	4.1	2.5	2.0
United States	3.5	3.3	3.3	4.4	2.9	0.3	2.3
EU28	2.0	3.5	1.7	3.2	1.8	0.3	0.4
OECD	2.9	3.8	2.3	3.5	2.5	0.6	1.7

Source: World Bank (2016), *World Development Indicators* (database), http://data.worldbank.org/indicator.

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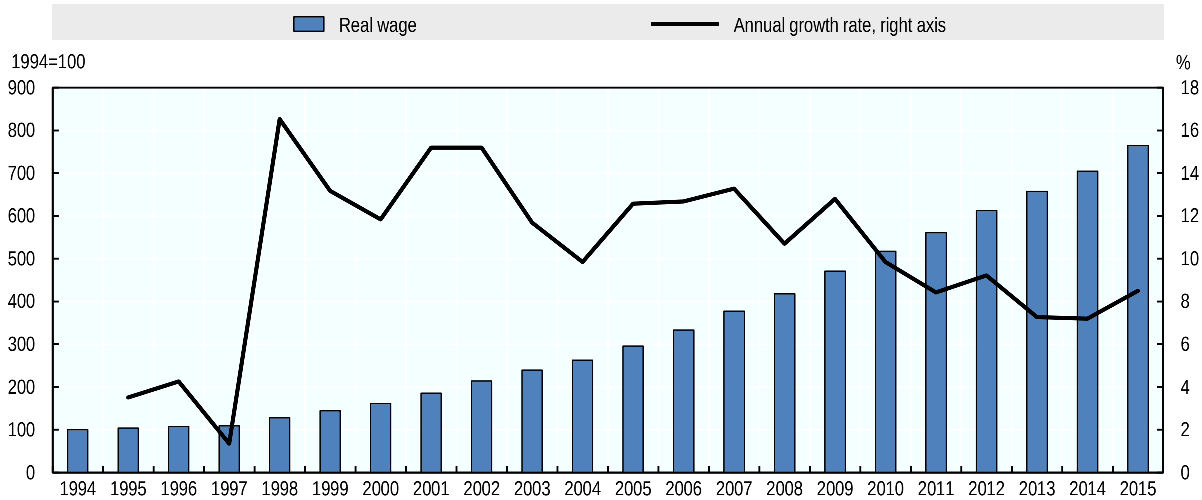
China's strong economic growth has also been supported by an influx of surplus labour from rural provinces to large cities mostly located in coastal areas. Much of the debate has been about whether China is either close to, or has already reached, the Lewis turning point that unlimited supply of rural labour at constant price exhausts (Cai and Wang, 2010; Yang, Chen and Monarch, 2010; Golley and Meng, 2011; Li et al., 2012). According to Li et al. (2012), the wage rate of China's unskilled labour remained low and fairly constant until the late 1990s, but the cost of labour started to increase from 1997. The average real wage increased by 11% p.a. between 1997 and 2015 (Figure 2.1).

The increase in the real wage rate has strong implications for the structure of the Chinese economy, including the agricultural sector. It requires the economy to produce higher value-added goods and services rather than importing intermediate inputs and assembling them by making use of cheap labour inputs. With a decline in comparative advantage of labour-intensive sectors, the economic structure needs to evolve to more knowledge- and capital-intensive sectors. Higher wages also require that the agricultural sector reduce labour input and offer higher returns on family labour input. This economic pressure on agriculture to offer higher farm income increases the size of family farms which is required to generate an income that is comparable with other sectors.

Figure 2.1. Evolution of average real wage rate in China, 1994 to 2015



Source: NBSC (2016), China Statistical Yearbook 2016.

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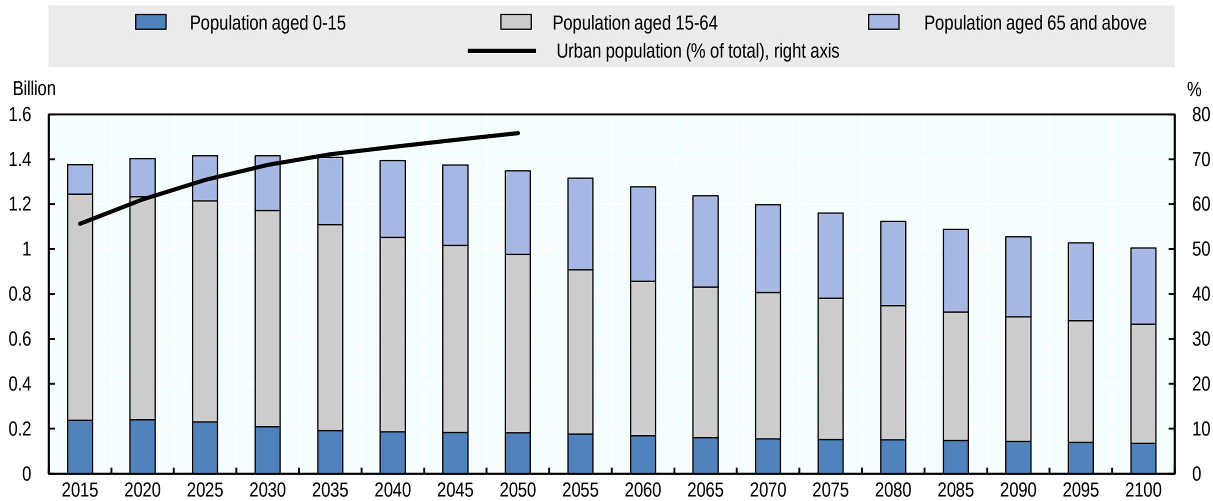
Demographic change

Demographic change is another important driving factor of the Chinese economy in the long-term. Although the population of China is currently the largest in the world, the working age population already started to decline in 2015 and the overall population is projected to peak in 2030 (United Nations, 2015). The slowing down of China's population growth is partly driven by the family planning policy in place from 1980 that has limited the majority of family units in the country to one child each.[2]

China is aging more rapidly than practically any other country. In 1982, only 4.9% of the population was over the age of 65, but by the end of 2015 this share had increased to 10.5% (NBSC, 2016). Aging of the population is faster in rural areas, where more than half of the elderly population lives. Due to a decline in the birth rate and an increase in average life expectancy (from 75.7 to 80.2 years by 2050), the share of the population over the age of 65 is expected to increase to more than 20% by 2035 and to almost 30% by 2050 (United Nations, 2015).

In addition, the share of urban population increased from less than 20% in 1980 to 50% in 2010 and is expected to reach 75% by 2050 (United Nations, 2015). Consequently, the rural population is expected to nearly halve by 2050. The expected change in demographic structure and urbanisation are crucial factors to develop a long-term strategy for the food and agriculture sector in China. The working population in agriculture will decline, with an increasing share of aged farmers. While per capita consumption of meat, dairy and fish products is expected to increase with income growth, the domestic demand for food grain is likely to decline, requiring agricultural policies to focus more on producing high value-added products. The export of agri-food products will be more important to sustain growth in domestic agriculture.

Figure 2.2. Projection of China's demographic structure, 2015 to 2100



Source: United Nations (2015), Population Division: World Population Prospects, the 2015 Revision, Department of Economics and Social Affairs.

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Natural resource use

Land and water are scarce resources in China, and both are crucial factors of production in agriculture. Due to increasing competition with urban land use, arable land area decreased by 15.3% (19.2 million hectares) between 1991 and 2014 (FAO, 2016). Agricultural land use and urban or industrial land use respectively accounted for 40% and 4% of total land use in 2015 (NBSC, 2016).

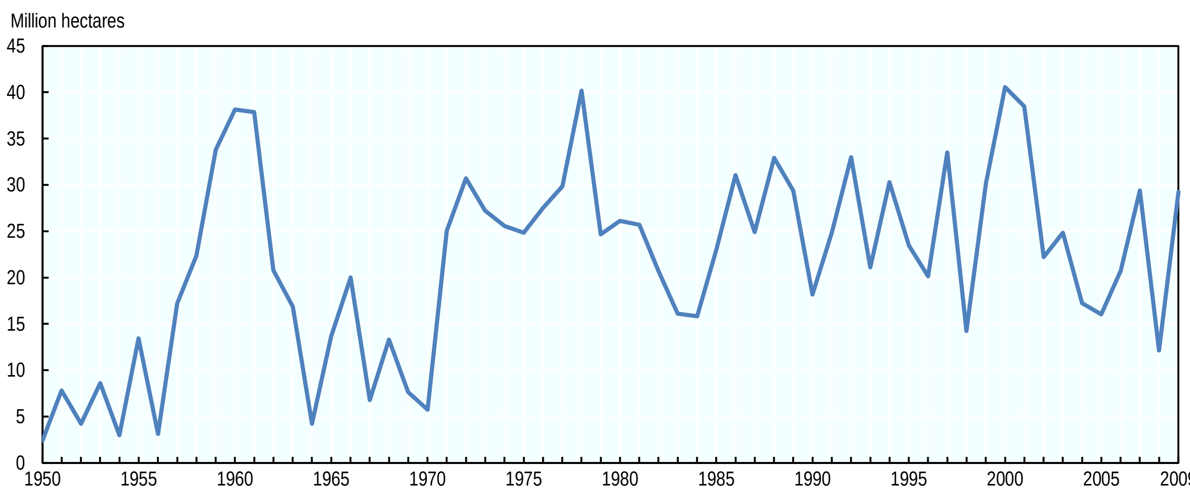
Overall, agriculture remains the biggest user of China's water resources. Water use in agriculture gradually increased from 378.4 to 385.1 billion m^3 between 2000 and 2015, but the share of agriculture water use declined from 69% to 63% in the same period due to an increase in other use of water (NBSC, 2016). China's irrigated land area has increased by 36% between 1990 and 2015, representing 48.8% of total cultivated land in 2015.[3] While irrigation consumed 55% of China's total water use, only half of the irrigated water was effectively utilised.[4] More efficient water use is critical to the sustainable growth of China's agricultural sector.

While China's freshwater resource endowment is concentrated in the southern part of China, the northern part of the country, rich in land resources and a major grain production area, suffers from water scarcity.[5] High and increasing demand from agriculture, industry, and residential development coupled with low precipitation levels has resulted in the drying of major rivers and significant surface and groundwater stress, particularly in Northeast China (Cai, 2008; Jiang, 2009; Fang et al., 2010; Giordano, 2009, Huang et al., 2010; OECD, 2007). China ranked first in a global assessment of water risks for global agriculture production, with Northeast China identified as a hotspot for future water risks for agriculture (OECD, 2017).[6] Brown and Halweil (1998) projected that yields will decline one-half to two-thirds as farmers revert to rain-fed agriculture if access to irrigated water declines. The water stress has also increased concern on water quality and ecosystems. Moreover, groundwater overdraft has generated flow cut-offs of the Yellow River and its tributaries, coastal seawater intrusion and localised land subsidence (Wang and Jin, 2006; Wang et al., 2007; Jiang, 2009; Sun et al., 2010).

Climate change

Changes in precipitation patterns across China have been observed for the past century, with northern China receiving less rainfall and southern and southwestern China receiving significantly more. China is ranked as one of the top two countries in terms of population at risk and economic damages of flood, mostly because of river flooding (Sadoff et al., 2015). Recurrent floods affect millions of people yearly, especially in southern China (Gleick, 2009; Zheng et al., 2010). Severe droughts have become a frequent occurrence – particularly in northeastern China (Paio et al., 2010). Drought-affected area shows an increasing trend over time (Figure 2.3). In recent years, southern regions have also been affected by drought; for instance, the 2010 drought in the Southwest region caused water shortages for millions of people and animals.

Figure 2.3. Drought-affected area in China, 1950 to 2009



Source: Wang, X. J. et al. (2012).

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Projections suggest that a number of climatic changes will occur in the coming decades, with implications for the agriculture sector. Temperatures are projected to continue to rise 2-4°C in Asia in the medium-term (2046-65) and 4-6°C in the long-term (2081-2100). Such trends may enable the spread of pest and diseases, increasing the vulnerability of crop production. Average precipitation in China is also projected to increase 30% in the medium-term (Hijoka et al., 2014). The retraction and seasonal melting of the Himalayan glaciers will also impact freshwater levels, contributing to a surge in annual runoff from major rivers, but also severely reducing water storage in the long term. Meanwhile, a number of studies report a drying of the northeast and more frequent flooding in the south (e.g. Piao et al., 2010). Sea level rises could also accelerate, with the East China Sea off Shanghai increasing 7.5 to 14.5 cm (Buckley, 2015). This may increase water salinity in rivers and aquifers, and land losses.

An increase in temperatures and more frequent and severe natural disasters are expected to affect the productivity of certain crops. For example, rising temperatures are already affecting planting times of rice. Some research shows that rice production is nearing heat stress limits in certain areas – particularly in eastern China – and that yields will decline as temperatures rise further (Hijoka et al., 2014). On the other hand, some studies and scenarios project that rice yields will increase in eastern China and wheat production could increase in the Huang-Hai Plain due to rising temperatures and precipitation (Hijoka et al., 2014; Xiong et al., 2010). Long-term policy strategies to improve agricultural productivity and sustainability need to take into consideration the uncertainty in the production environment imposed by climate change.

2.2. Importance of agriculture in the economy

Along with its rapid growth, the Chinese economy has experienced a significant structural change. While the annual growth of agriculture value-added averaged 4–5% throughout the post-reform period, the growth of the manufacturing and service sectors has been from two to over three times faster than that of agriculture since 1985. As a result, the share of agriculture in GDP declined from 28% in 1978 to 9% in 2015. Similarly, its share of employment fell from 71% to 28% over the same period. A larger employment share than value-added share in agriculture indicates a lower level of labour productivity than in the manufacturing and service sectors. The value added per worker in agriculture was 22% and 27 % of that in the manufacturing and service sectors in 2015, respectively.

Nonetheless, agriculture in China still accounts for a much higher share in the economy than in OECD countries (Table 2.3). The share of agri-food products in total export declined from 12% to 2% between 1992 and 2015. This is the lowest in BRIICS countries, but still higher than in Korea and Japan. Despite a declining economic share, agriculture accounts for a majority of natural resource use in China, such as land and water withdrawals. The share of agriculture in value-added and employment is expected to decline further as per capita income increases, following the experience of other countries in East Asia such as Korea and Japan (Figure 2.4).

Table 2.3. Importance of agriculture in the economy, 2015*

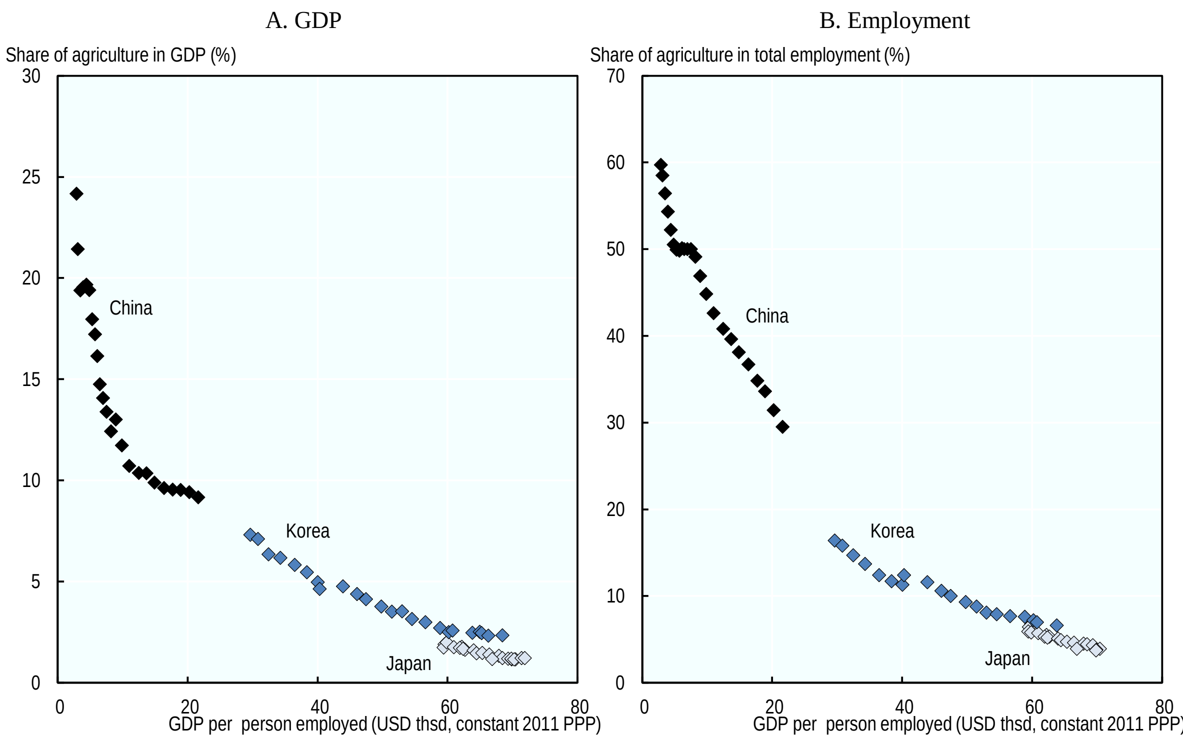
	Gross value added	Employment	Exports	Imports	Total land area	Total water withdrawals
	Per cent					
China	8.8	28.3	2.8	6.6	54.8	64.3
Japan	1.1	3.6	0.8	10.1	12.4	66.8
Australia	2.6	2.6	17.2	6.7	52.9	65.7
Brazil	5.0	10.29	37.6	5.1	33.8	60.0
Korea	2.3	5.2	1.2	5.9	18.0	54.7
India	17.5	47.1	11.5	5.7	60.4	90.4
Indonesia	13.5	32.9	21.6	10.0	31.5	81.9
Russia	4.6	6.7	4.7	13.9	13.3	19.9
South Africa	2.3	5.6	11.8	6.1	79.8	62.5
OECD	1.5	4.8	8.3	8.0	35.6	43.9

Note: * or latest available year.
Source: OECD System of National Accounts, OECD Annual Labour Force Statistics; UN Comtrade (2015), *United Nations Commodity Trade Statistics* (database) http://comtrade.un.org/; World Bank (2016), *World Development Indicators* (database), http://data.worldbank.org/indicator; FAO (2015a), *FAOSTAT* (database), http://faostat3.fao.org/home/E; FAO (2015b), AQUASTAT Main Database.

StatLink http://dx.doi.org/10.1787/888933829835

The slow decline in the total number of workers in Chinese agriculture is a major constraint to improvement in labour productivity in the sector. While the average annual growth rate of agricultural value-added in 2000-15 was higher than in most OECD countries and emerging economies, China's labour productivity growth in agriculture is slower than in such countries as the United States, the Russian Federation, Brazil, South Africa, Korea and Japan. While agricultural value-added grew at 4.0%, agricultural value-added per worker in China grew on average 4.2% p.a. in 2000-15 (Figure 2.5). This means that the improvement in labour productivity growth is almost entirely accounted for by the growth in output; this contrasts with most OECD countries, where a decline in workers in agriculture is a major contributor to labour productivity growth in the sector.

Figure 2.4. Economic development and share of agriculture in the economy



Source: World Bank (2015), World Development Indicators (database) and NBSC (2015), China Statistical Yearbook 2015.

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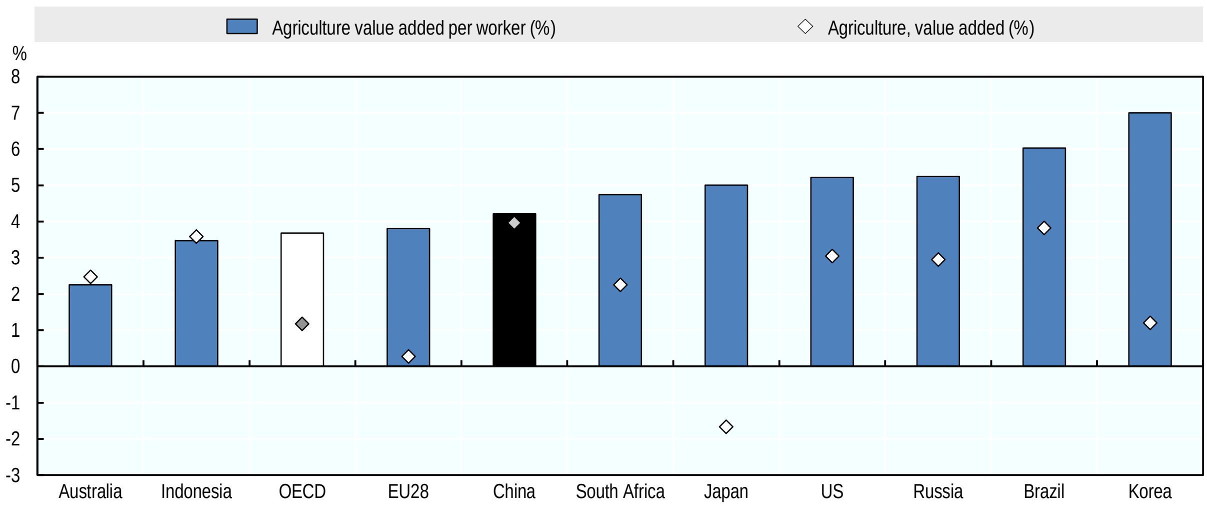
Figure 2.5. Labour productivity growth, 2000-15

Average annual growth rate



Note: The OECD aggregates do not include Lithuania.
Source: World Bank (2017), World Development Indicators (database), http://data.worldbank.org/indicator (accessed November 2017).

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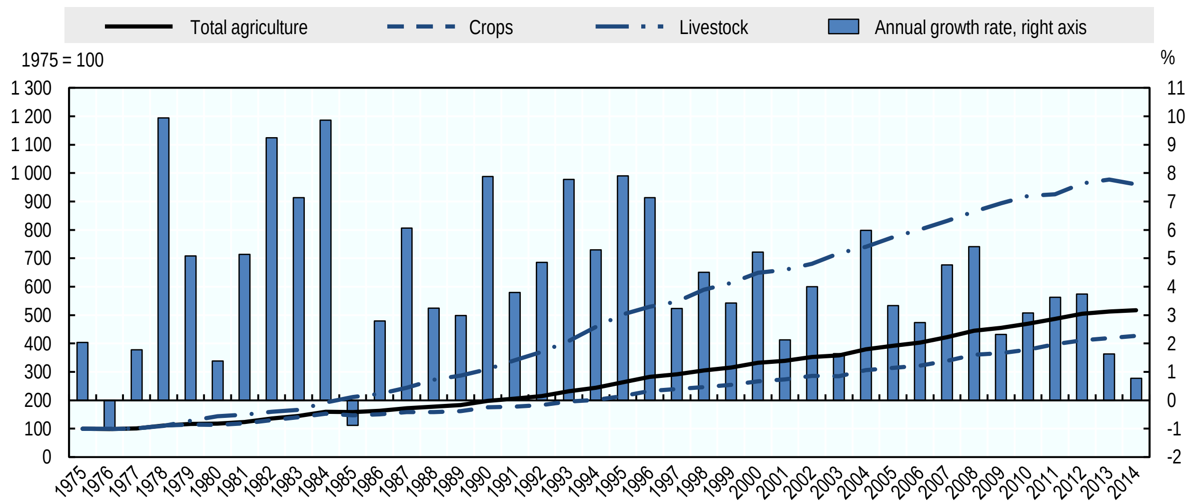
2.3. Characteristics of the food and agriculture sector

Production

China's agricultural sector expanded strongly since the implementation of economic reform in the late 1970s. Total agricultural production grew at 4.5% p.a. between 1977 and 2014, leading to an expansion of agricultural output by more than 5 times in real terms in three decades (Figure 2.6). Existing studies find that the institutional reform which shifted from collective agricultural production systems to individual household production was the main cause of agricultural growth in the early reform period (Lin, 1992; Huang and Rozelle, 1996).

The composition of agricultural output in China has changed significantly over the last decades, driven by the shift in consumption towards livestock products and more value-added agricultural products such as fruits and vegetables. In particular, the rapid expansion of the livestock and fisheries sectors reduced the dominance of the crop sector in the early reform period. The share of meat in agricultural production increased from 29% to 39% in 1980-2010 (Figure 2.7). Within the crop sector, production shifted to cash-crops, reducing the share of rice in agricultural production value from 30% to 9% in the same period. The value of vegetable and fruit production grew by 10 and 18 times in three decades, respectively, and these two sectors already accounted for one-third of agricultural production in 2010.

Figure 2.6. China's agricultural output indices, 1975 to 2014



Source: FAO (2017), FAOSTAT (database), http://www.fao.org/faostat/en/#home.

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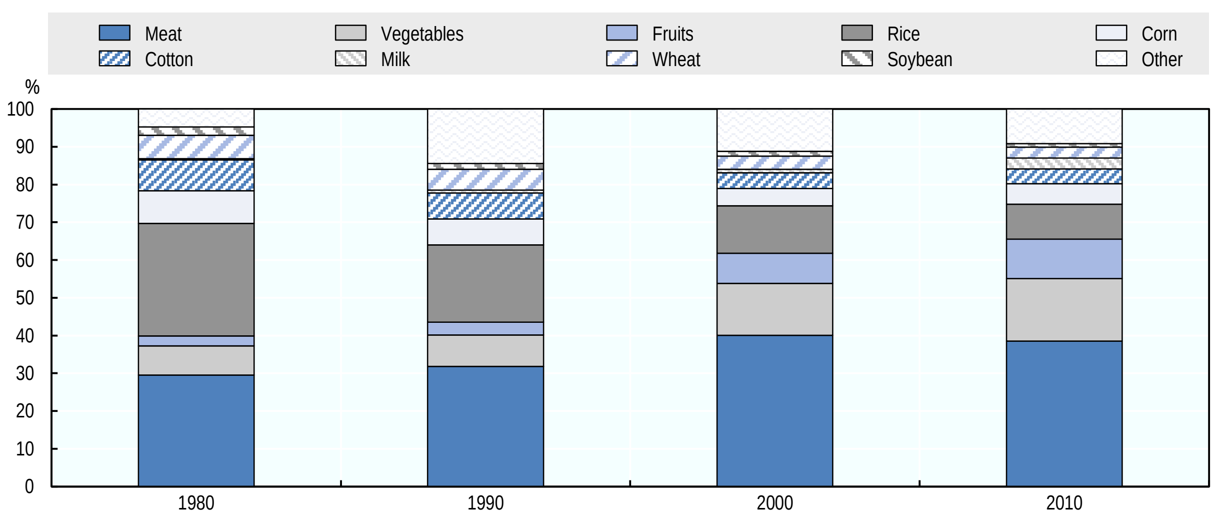
Figure 2.7. Composition of China's agricultural production value, selected years



Source: FAO (2017), FAOSTAT (database), http://www.fao.org/faostat/en/#home.

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Agricultural production in China also experienced a geographical relocation and a spatial concentration in the past three decades (Cho et al., 2007; You, 2013). For example, rice production has been concentrating in northern China, mainly in northeast China, driven by the increased costs of land and wages in the comparatively developed provinces in coastal regions (Li et al., 2013).[7] Wheat production increased only in the Huang–Huai-Hai plain, but declined significantly in the rest of China.

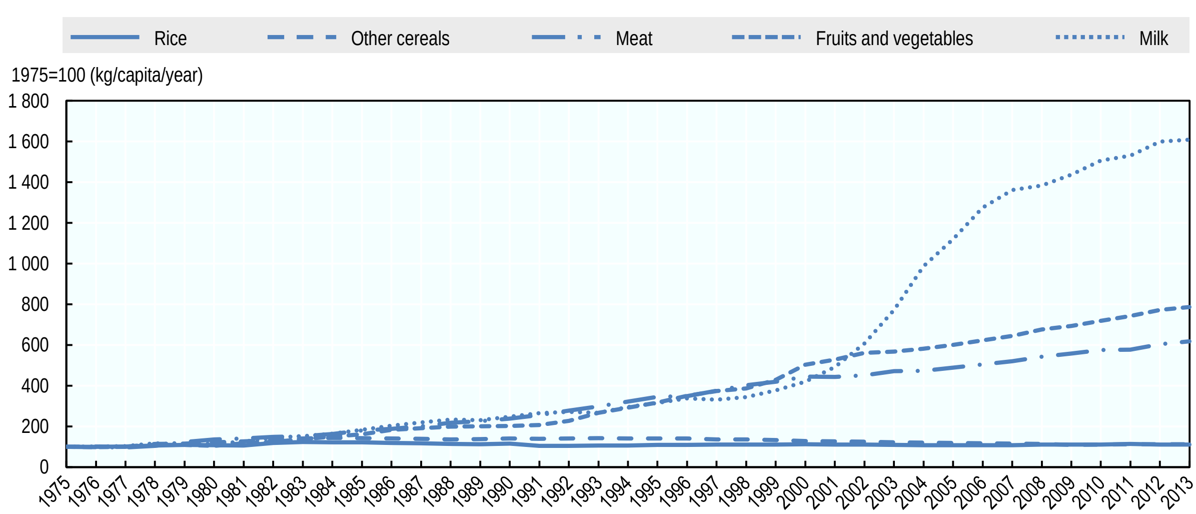
In livestock sectors, dairy production has been clustered in north China, but it is spreading to other regions, whereas the production of pork and poultry meat moved gradually to south China. These spatial variations are mainly driven by the evolution of livestock production towards specialised industries. The increased demand for livestock production concentrated in comparatively developed and populated regions like Southeast China. Dairy production is still widely distributed throughout north China, with the trend of regional concentration in three areas: Northeast China, Inner Mongolia and Xinjiang. The pattern of feed supply has important impacts on spatial distribution of livestock production. The rapid increase in soybean import relocated soybean processing enterprises to the coastal areas in the southeast, which also contributed to the relocation of pork and poultry production to this region.

Consumption and trade

The nutritional situation in China improved significantly as the per capita income level increased. The prevalence of undernourishment declined from 24% to 9% between 1990-92 and 2014-16, which represents of reduction of approximately 100 million in the total number of undernourished. Similarly, the poverty headcount ratio at USD 1.9 per day (2011 PPP) fell from 88% in the early 1980s to 1.9% in 2013 (World Bank, 2015).

The diet of the Chinese population has shifted significantly in the last decades, and this is a major driver of structural change in agricultural production. Cereal consumption started to decline on a per capita basis in the mid-1980s. Per capita supply of rice and other cereals declined from peak levels by 10% and 20%, respectively (Figure 2.8). By contrast, per capita meat supply grew at more than 6% p.a. between 1980 and 2000. Annual per capita supply of meat reached 60 kg in 2010 and exceeded that in Japan as from 2003. Considering higher annual per capita meat supply in Hong Kong, China (180 kg) and in Chinese Taipei (81 kg), per capita meat consumption in China may still increase in the future. Similarly, per capita milk supply increased more than 10 times in the last 30 years, with particularly high growth rates during the 2000s. Per capita milk consumption in China is also below that in Hong Kong, China and Chinese Taipei, implying a further increase in the future.

Figure 2.8. Food supply per capita in China, 1975 to 2013

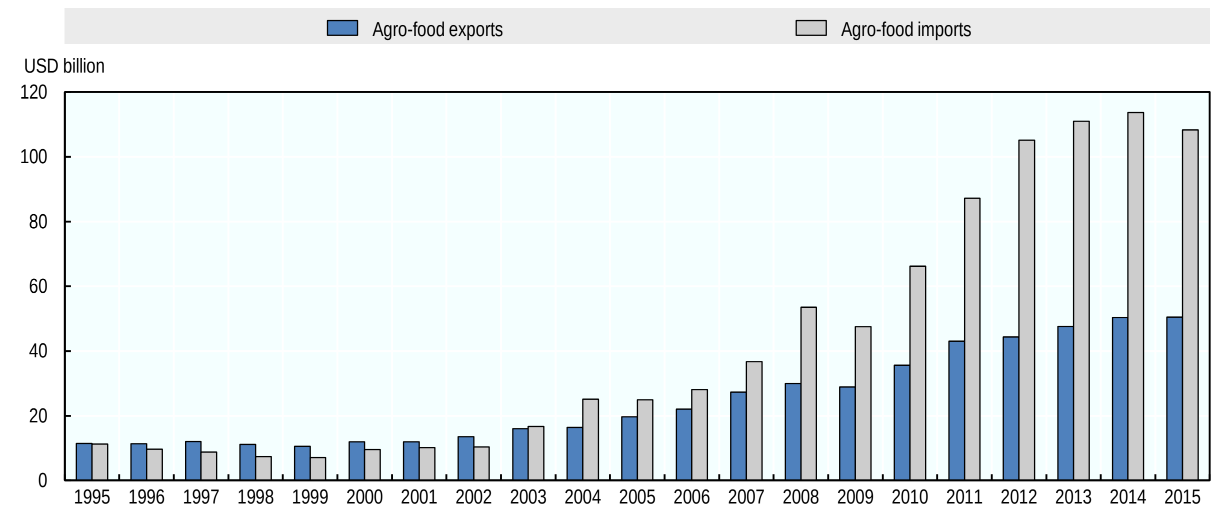


Source: FAO (2017), FAOSTAT (database), http://www.fao.org/faostat/en/#home.

StatLink http://dx.doi.org/10.1787/888933828695

Agro-food imports have been increasing, particularly since the mid-2000s, which has turned China into a net importer of agro-food products since 2003 (Figure 2.9). Agro-food imports increased by 6.9% per annum between 2004 and 2014, while agro-food exports grew by 2.3% per annum. The trade deficit in agro-food products has widened in recent years. The composition of agro-food trade has also evolved in the last decades. The share of processed agricultural products in agro-food exports increased from 34% to 43% between 1995-99 and 2010-14 (Figure 2.10). While the share of cereal, vegetable oilseed and vegetable oils in total agro-food exports has been marginalised, these products account for more than half of total agro-food imports in recent years. These changes in trade patterns reflect the comparative advantage of China in labour intensive agro-food products rather than land-intensive crop production.

Figure 2.9. Value of China's agro-food export and import, 1995 to 2015



Source: UN Comtrade (2015), United Nations Commodity Trade Statistics (database), http://comtrade.un.org/.

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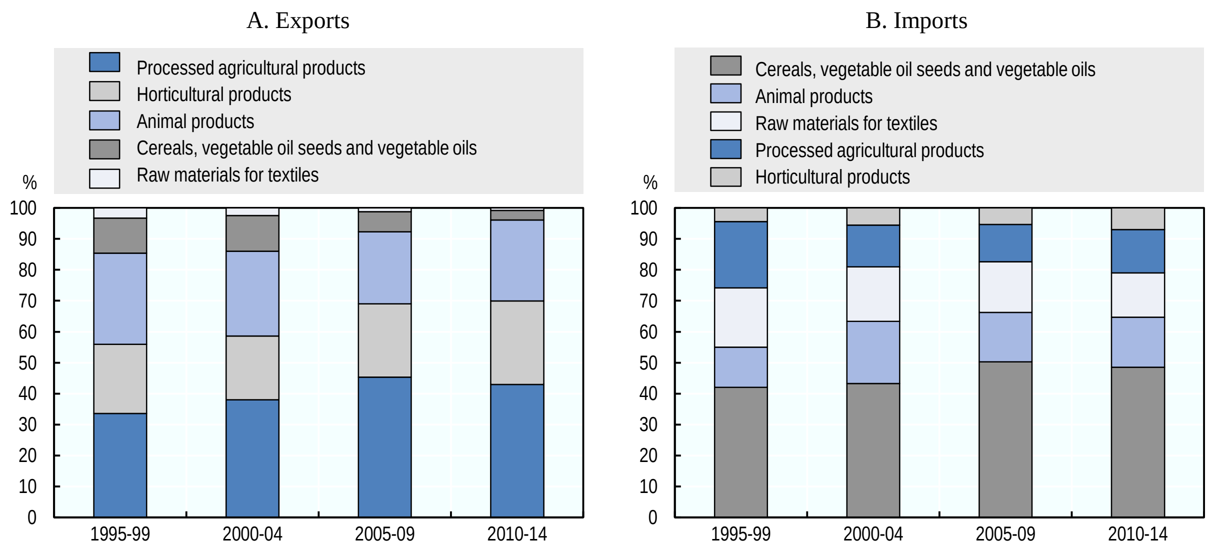
China is almost self-sufficient in bovine, pig and poultry meats, as well as rice, wheat and maize. However, decreases in self-sufficiency rates in soybean and barley production (to 16% and 47% in 2013, respectively) have increased its dependency on imports of soybean and barley (Figure 2.11). Indeed, China is currently the world’s largest importer of oilseeds, absorbing more than half of world oilseed exports.

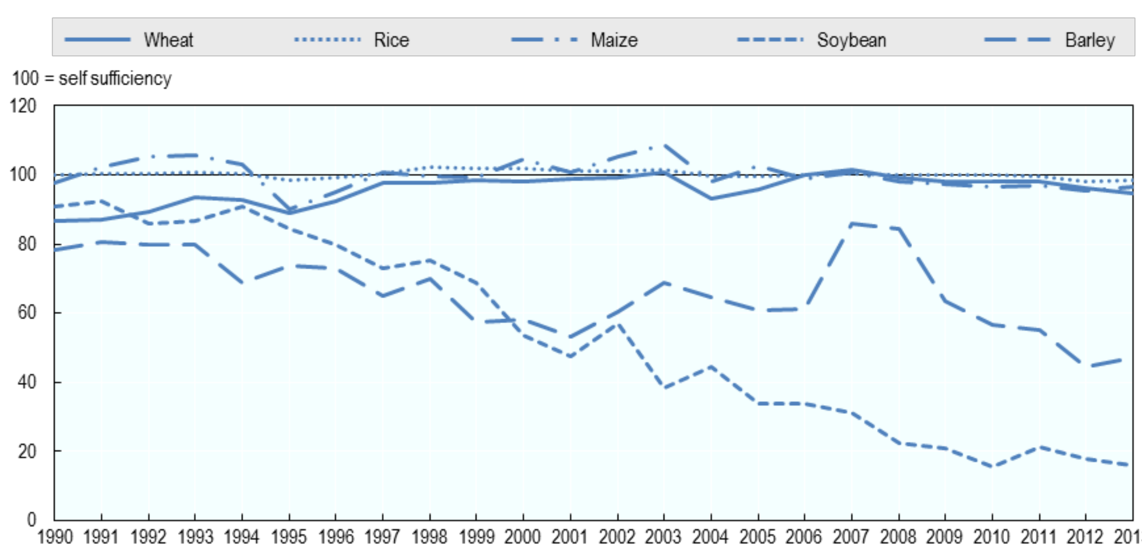
Figure 2.10. Composition of China's agro-food trade, 1995-2014



Source: UN Comtrade (2015), United Nations Commodity Trade Statistics (database), http://comtrade.un.org/.

StatLink http://dx.doi.org/10.1787/888933828733

Figure 2.11. China's self-sufficiency of grains, 1990 to 2013



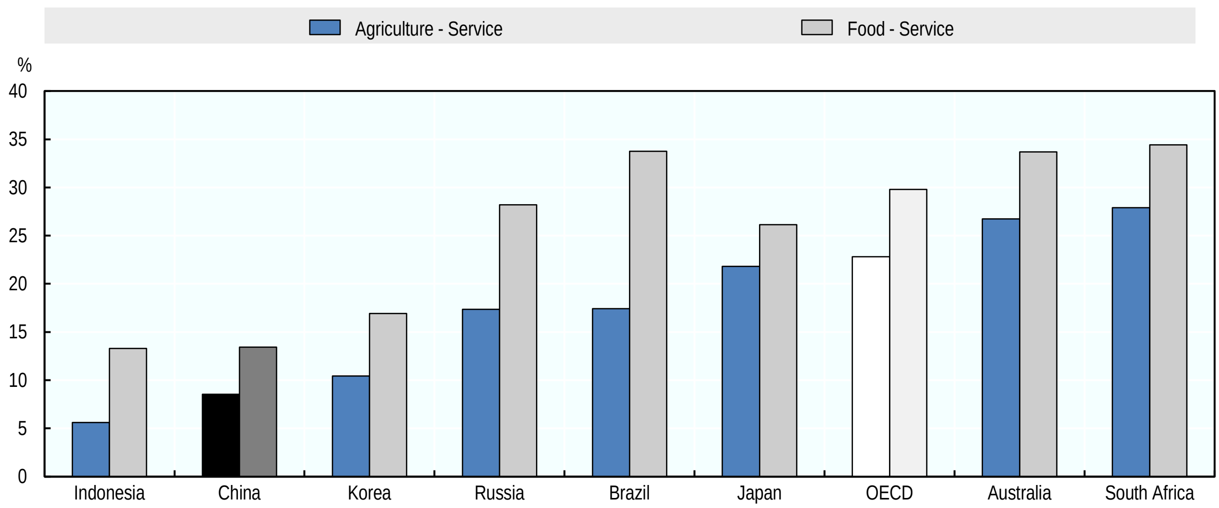
Note: Computed as net exports/domestic supply, 100 indicates full self-sufficiency, -100 indicates net imports fill all domestic consumption.
Source: FAO (2017), FAOSTAT (database), Food and Agriculture Organization of the United Nations, http://www.fao.org/faostat/en/#home.

StatLink http://dx.doi.org/10.1787/888933828752

The OECD-WTO Trade in Value Added Database, which measures trade flows in value-added terms (instead of gross value), showed that in 2011 China's domestic value-added components of gross exports for agricultural and manufactured food products were 90%

and 75%, respectively. This means that a quarter of the export value of manufactured food products is sourced from foreign industries, in particular service sectors. On the other hand, the value-added share of the domestic service sector in China increased from 6% to 9% in agriculture exports and 5% to 13% in manufactured food exports between 1995 and 2011, but remains low compared to OECD countries and some BRIICS counties (Figure 2.12). This implies that the "servicification" of agro-food industries could be enhanced to promote more value-added in the agriculture sectors in China.

Figure 2.12. Share of value added by domestic service industry in exports, 2011



Note: The OECD aggregates do not include Latvia and Lithuania.
Source: OECD/WTO (2015), OECD-WTO: Statistics on Trade in Value Added (database).

StatLink http://dx.doi.org/10.1787/888933828771

Farm structure

Farm consolidation

As a result of the Household Responsibility System (HRS) reform of the late 1970s to reallocate village land to all rural households, China's agriculture has been dominated by small family farms. The average size of operated land per household was only 0.7 hectares in 1985, when the HRS reform was completed (Table 2.4). Each household is normally allocated, on average, 3 to 4 plots to ensure equity of land distribution in consideration of different land quality. Around 60% of the plots are less than 0.1 ha, and close to a quarter of them are larger than 0.15 ha. Average farm size fell gradually to 0.55 hectares in 2000 (Huang and Ding, 2016), but was estimated to increase to 0.78 ha in 2013, driven by an increase in the number of rural households which stopped farming.

While average farm size is still small, operational rights of land have been concentrating more on large-scale farms, particularly in Northeast and North China. These regions have seen more rapid farm consolidation recently, with an increase of average farm size from 1.03 to 1.73 ha between 2008 and 2013. Increased labour mobility and transfer of land among farmers over the past three decades have gradually adjusted the existing farm structure (Huang, Gao and Rozelle, 2012). While an expansion of average farm size is modest due to the slow reduction of farm households, agricultural production has increasingly been dominated by large-scale farm operations, including co-operative and corporate farms. Ji et al. (2016) find that 20% of China's land is cultivated by farms larger than 2 hectares and 4% of land is operated by a new class of corporate farms.

Table 2.4. Average farm size in China overall, and in Northeast and North China combined, 1985-2013

	Average farm size in China			Average farm size in Northeast and North China regions
	Including all households living in rural, based on RIES dataset	Percentage of households living in rural without farming, based on RLLS dataset	Estimated farm size in China based on (a) and (b)	
	(a)	(b)	(c)	(d)
1985	0.73			
1990	0.67			
1995	0.65			
2000	0.55	4.6	0.58	
2001	0.55	4.6	0.58	
2002	0.55	5.2	0.58	
2003	0.53	6.4	0.57	0.92
2004	0.55	7.8	0.59	0.97
2005	0.57	8.4	0.62	1.00
2006	0.58	9.1	0.63	1.02
2007	0.57	10.3	0.64	1.03
2008	0.58	11.8	0.66	1.03
2009	0.61	15.2	0.72	1.17
2010	0.61	17.1	0.73	1.41
2011	0.60	18.6	0.73	1.61
2012	0.61	19.8	0.76	1.72
2013	0.61	20.7	0.78	1.73

Note: Farm size in column (c) is adjusted by excluding rural households which fully rented out, gave up or sold their land. The formula used is: c = a /(1- b/100). Data in column (d) are based on surveys in 6 provinces in Northeast and North China.
Source: Huang and Ding (2016).

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Government policy has increasingly been focused on establishing large farm operations. Document No. 1 of 2016 aims to exploit the leading role of diverse forms of large-scale operations, promoting the consolidation of land resources to new agricultural operation entities including family farms, farming service providers and co-operatives. As of June 2015, there were more than 870 000 family farms with an average scale of 200 mu (13.3 hectares), over 1.4 million farmers' co-operatives, and 120 000 leading enterprises of agricultural industrialisation, all of which have gradually become major management units of agriculture in China. Farming is becoming a professional choice instead of a matter of family succession, as more and more migrant workers, college graduates, veteran soldiers and even urban residents begin to return to rural areas to start agricultural businesses, injecting new vitality into China's agriculture.

The co-operative organisation of small family farms is increasing its role in establishing large-scale farm operations, connecting to markets and adopting new technologies. In contrast to the former state-led co-operative established under the collective farming system, the new co-operative organisation emerged in the late 1980s as a voluntary organisation of farmers to disseminate agricultural technology and carry out marketing activity (Ji et al., 2012). Farmer Professional Co-operatives (FPC) and other types of voluntary co-operatives are expected to constitute a new farm management system in China, playing key roles for small-scale family farms to adopt technology, integrate with supply chains and benefit from economy of scale in farm operation (Box 2.1).

Box 2.1. Development of voluntary co-operatives in China

The institutional framework to provide a legal status to Farmer Professional Co-operatives (FPC) was promulgated in 2007. The governance of FPC is based on the principles of "voluntary participation, free withdrawal, democratic control and return of surplus to co-operative members". Farmers are required to constitute at least 80% of the co-operative members, each having a single vote. The central policy and local governments have been trying to promote and foster FPCs since the late 1990s and increased the role of FPCs as a recipient of government financial support (Chen 2016). With the development of a clear legal environment, the number of FPCs increased by 8.8 times between 2008 and 2013, reaching a membership of 28.5% of all farm households in China (Hoken, 2016).

FPC services typically include technical training, processing, marketing and purchasing inputs. The co-operatives often function as a broker of technologies through sharing information and providing advisory and training services. In other cases, the co-operatives allow smallholder farms to obtain more competitive prices in input and output markets through their bargaining power. While retailers and food processors often face high transaction costs when contracting directly with small-scale farms, the co-operatives facilitate contract farming and the integration of smallholder farms to value chains.

On the other hand, other types of voluntary co-operatives to consolidate land operational rights have been developed in China. Farmers established Land Shareholding Co-operatives (LSC) in which they trust their land operational rights and receive dividends every year according to their share (Ren, et. al, 2017). These voluntary co-operatives are increasingly playing an important role in rationalising the structure of agricultural production through integrating the farming operation and land use rights. By the end of 2013, 4.6 million hectares of land had been transferred to co-operatives, accounting for 20.4% of total land transfer (Zhong, 2016). These co-operatives also provide mechanisation service and consolidate the farm operation without transaction of land rights. Co-operatives now account for 13% of total mechanically ploughed area (Zhong, 2016). The consolidation of farm operation through co-operatives is becoming a core unit of large farm operation in China.

The government supports the development of co-operatives as a new type of farm management unit. In addition to providing a legal status and standard operational rules for the farmers' co-operatives, the government is increasing direct support to them. For example, it provides them with financial and technical support through preferential treatment for value-added tax and stamp duties, credit guarantees and personnel training (Zhong, 2016). The co-operatives have also become a major recipient of producer subsidies, receiving 30% of the national subsidy for purchase of agricultural machinery in 2012.

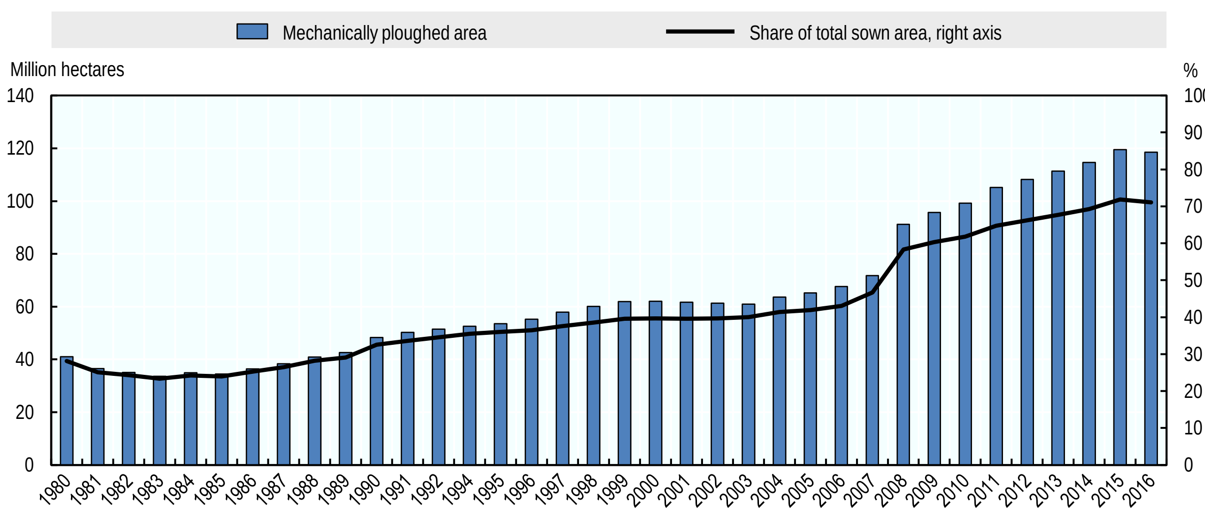
Farm mechanisation

Under the collective farm system, agricultural machinery stations were established at different administrative levels to provide machine operation services at a fixed price. The use of mechanical ploughing declined in the early 1980s after the introduction of Household Responsibility System, but in the late 1980s farmers were again induced to adopt labour-saving technology by a rapid increase in off-farm employment opportunities. An increase in the real wage rate since the 2000s further accelerated the incentive to mechanise farm operations.

In the past decade, the number of rural residents who have off-farm employment as well as the number of permanent migrants to urban and sub-urban areas has increased significantly. Farm mechanisation allowed some farmers to expand farm size, but also helped others to spend more time on off-farm activities to increase their income. As the opportunity costs of farming increase, the number of days that China's farmers devote to on-farm work has fallen significantly. By 2014, the average number of labour days spent on farm had fallen to less than 100 per hectare, which is half of the level in the 1990s.

Mechanically ploughed area more than doubled between 1980 and 2013, with an annual growth rate of more than 3% between 1983 and 2006 (Figure 2.13), accelerating to over 5% between 2008 and 2016. More than 70% of cultivated area was mechanically ploughed in 2016. By contrast, mechanically harvested area increased only around 1.5 times in the 1990s. Mechanical sowing and reaping have started to accelerate since 2003, with annual growth rates of 4.9% and 9.5% in 2003-16, respectively. By 2016, more than half of sown area was mechanically sown or reaped.

Figure 2.13. Evolution of mechanically ploughed area in China, 1980 to 2016



Source: NBSC (2017), China Rural Statistical Yearbook 2017, China Statistics Press.

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An important feature of farm mechanisation in China is the large contribution of farm machine service providers to the rapid expansion of mechanical operations in ploughing, sowing and harvesting and the use of large-size farm machines (Box 2.2). In 2013, service providers accounted for two-thirds of the total area benefiting from farm machines (Zhang, Yang and Reardon, 2015). The use of farm machine service providers allows small scale farmers to save their labour input and to avoid a large capital investment and maintenance cost associated with farm-owned machines. The development of farm mechanisation services in China is a remarkable organisational innovation to enhance productivity growth in a country dominated by small-scale family farms. However, fragmented farmland is a constraint to the efficient use of large-size farm machines. Complementary investment in infrastructure such as land adjustment and developing farm roads would further reduce the production cost through more efficient use of farm mechanisation.

Box 2.2. Evolution of mechanisation service providers

Generally, two types of mechanisation services exist in China. One is mechanical services provided by Specialized Custom Plowers, Planters and Harvesters (SCPPH) teams, who own large machines. The other is machine rental markets, where households operate rented machines. There has been a rapid rise in SCPPH teams' activities. Most typically, SCPPH teams provide mechanical operation services from ploughing to harvesting to smallholders. The smallholders supervise the process of mechanical operations and pay a fee to the machine service provider.

Mechanical operation teams have extended their activities beyond simply providing mechanical operation services. For example, in northeast China, these teams have started to rent land and consolidate land use rights. They use large machines on the consolidated land and upgrade their machines with subsidies provided from the government. However, they also face some constraints on keeping or expanding land consolidation. First, the land rental contracts are mainly short-term, often subject to annual renewal. The farmers who rent out their land tend to hesitate to sign long-term contracts. The tenure insecurity discourages the operators from investing in the land. Secondly, the operators may not be able to obtain the quota to buy the subsidised large machines, even though they would like to upgrade their current ones.

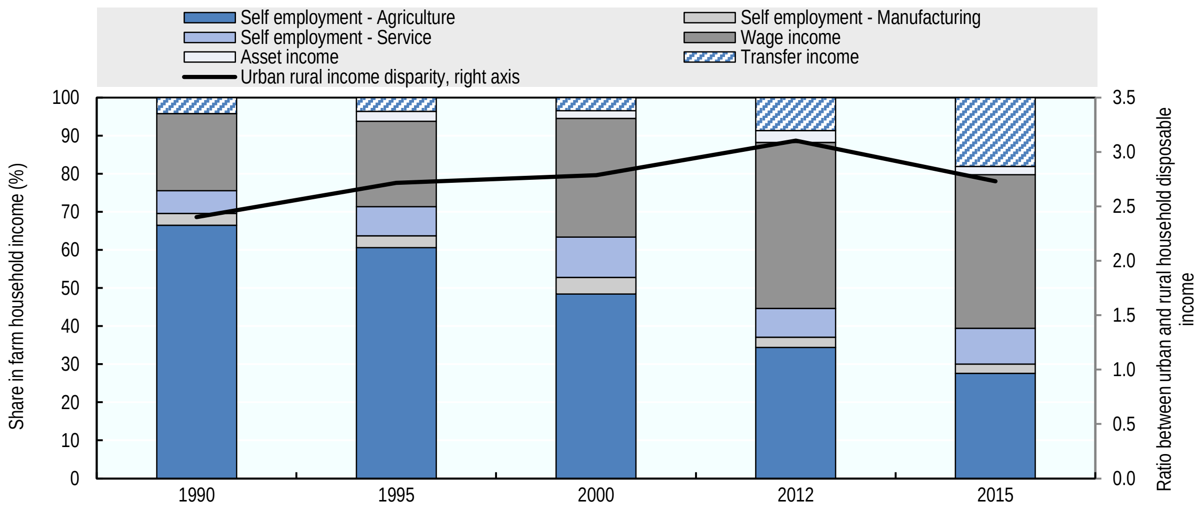
Farm income structure

Although the average income of rural households grew at 12% p.a. in 1990-2012, average urban household income grew at 13.7% p.a. in the same period. As a result, income disparity between rural and urban households, measured by the ratio of average urban and rural household disposable income, increased from 2.4 to 3.3 between 1990 and 2005, but declined to 2.7 in 2015 (Figure 2.14). Income disparities are also significant among regions, between urban and rural households, and among households within the same location (Cai et al., 2002; NSBC, 2015). Nonetheless, increasing rural household incomes reduced the poverty rate in rural areas from 30.7% to 5.7% between 1978 and 2015.[8]

Rural households are increasingly sourcing their income from off-farm activities. The share of income from family farming declined from two-thirds in 1990 to less than one-third in 2015. In contrast, the share of wage income increased from 20% to 40% over the same period. The increasing share of off-farm income indicates increasing employment opportunities in local non-farm sectors. The mechanisation of farming also allowed farm households to spend more time in off-farm activities. The recent increase in the importance of transfer income shows that rural households are more dependent on remittance and social security payments.

China's Rural Public Investment Survey shows that the share of the rural labour force working off the farm increased from 45% to 60% in 2000-11. Li et al. (2013) find that more than 90% of young male workers in rural areas were participating in off-farm employment, compared to more than 80% of young female workers.[9] In the 1980s and 1990s, most migrants moved to the large cities on the east coast. Some research showed that over 50% of migrants moved to China's eastern regions during the first two decades of reform (Cai and Wang, 2003; Fan, 2005. Li et al. (2013) show the shifts in the destination of migrants. In 2011, about two-thirds of migrants worked within their own province. This is mainly because investment in the manufacturing sector is moving from the eastern coastal regions to interior provinces and because the government implemented a number of economic policies to promote regional industrialisation in the central and western parts of China.

Figure 2.14. Income structure of rural household in China, selected years



Source: NBSC (2016), China Rural Statistical Yearbook 2016, China Statistics Press.

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2.4. Productivity, competitiveness and sustainability performance

According to US Department of Agriculture estimates, TFP growth in primary agriculture in China is much higher than in most OECD countries. However, the TFP growth rate slowed from 4.3% p.a. in 1991-2000 to 3.3% in 2001-14 (Figure 2.15). China achieved the highest TFP growth among BRIICS countries in primary agriculture both in 1991-2000 and 2001-14, but from this group only China and South Africa saw productivity growth slow in the more recent period.

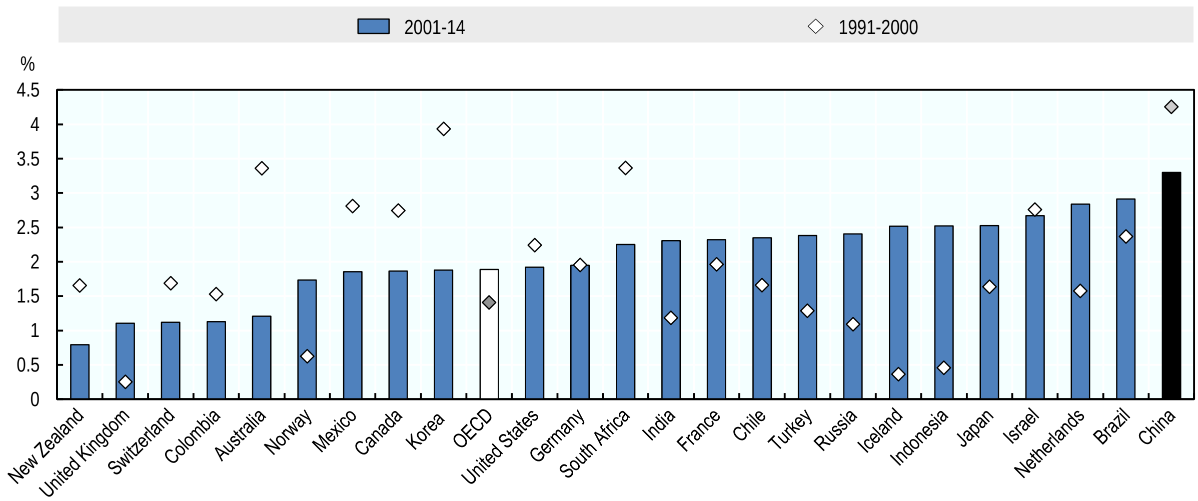
China's agriculture TFP had stagnated until the early 1980s, following the transformation of its collective farming system to the household responsibility system (HRS) in the late 1970s. Under the collective farming system, a group of farmers formed a production team and shared the residual profit depending on the work points they earned. However, this system lacked an individual work incentive: farmers tended to receive fixed work points for a day's work regardless of the quality and quantity of their work (Lin, 1988).

To provide individual work incentives in agricultural production, the Chinese government decided to de-collectivise production and granted land use rights and residual income rights to individual farmers from 1978. The positive effect on productivity of implementing the HRS, which was mostly completed between 1979 and 1983, was immense: the average annual TFP growth rate of primary agriculture went up to 4.8% in 1978-1984, compared to -0.1% in 1971-77 (Figure 2.16). By using growth-accounting techniques, McMillan, Whalley and Zhu (1989) identify that 78% of the increase in agricultural productivity in China between 1978 and 1984 can be attributed to the incentive effects of HRS.

Despite the initial success of HRS, the high growth rate of grain production did not last long. In fact, the growth rate of grain production was negative between 1984 and 1987. Average TFP also slowed to 0.3% in 1985-91. Of the many possible reasons for the stagnant agricultural production growth, one of the main causes suggested by researchers and policy makers was weak tenure security (Prosterman, Hanstad and Ping, 1996). TFP growth has been driven more by a low (sometime negative) growth rate in overall input since the 2000s

(Figure 2.17). Farm consolidation, mechanisation and reduced labour input in farming have become important drivers of productivity growth. The growth in agricultural output is now mainly driven by the improvement in productivity rather than an increase in input.

Figure 2.15. Annual agricultural Total Factor Productivity (TFP) growth rates, 1991-2000 and 2001-2014



Note: The OECD aggregates do not include Lithuania and Slovenia.
Source: United States Department of Agriculture (2017), USDA Economic Research Service, International Agricultural Productivity (database), https://www.ers.usda.gov/data-products/international-agricultural-productivity (accessed November 2017).

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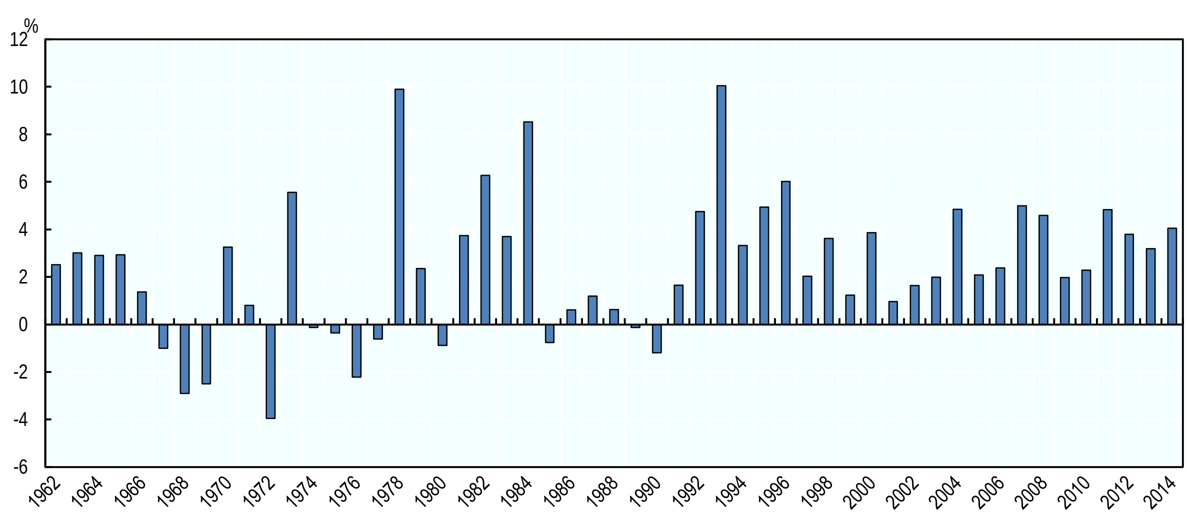
Figure 2.16. China's annual agricultural Total Factor Productivity growth rates, 1961 to 2014



Source: United States Department of Agriculture (2017), USDA Economic Research Service, International Agricultural Productivity (database), https://www.ers.usda.gov/data-products/international-agricultural-productivity (accessed November 2017).

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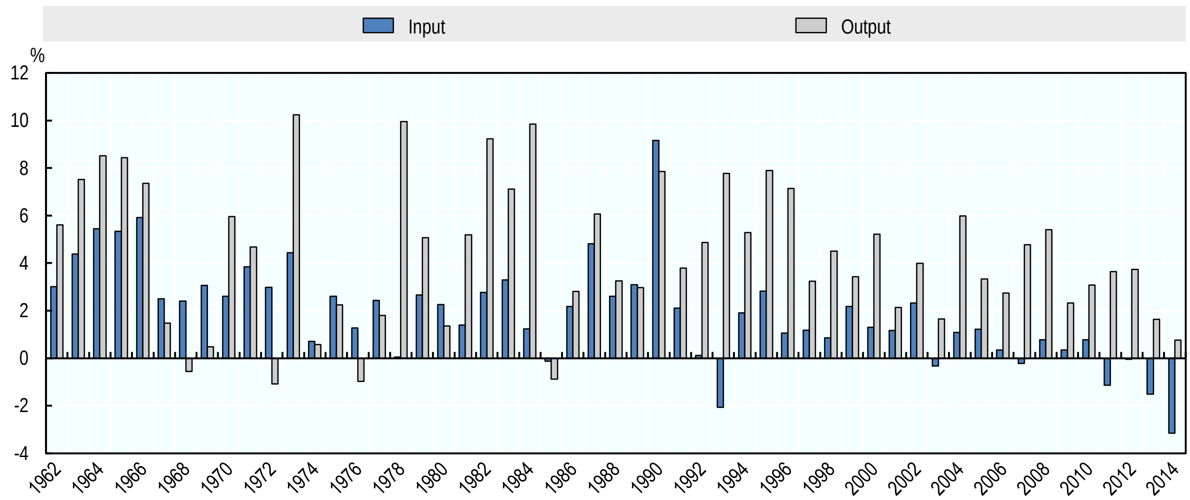
Figure 2.17. China's annual growth rates in agricultural inputs and outputs, 1961 to 2014



Source: United States Department of Agriculture (2017), USDA Economic Research Service, International Agricultural Productivity (database), https://www.ers.usda.gov/data-products/international-agricultural-productivity (accessed November 2017).

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Competitiveness of agro-food industries

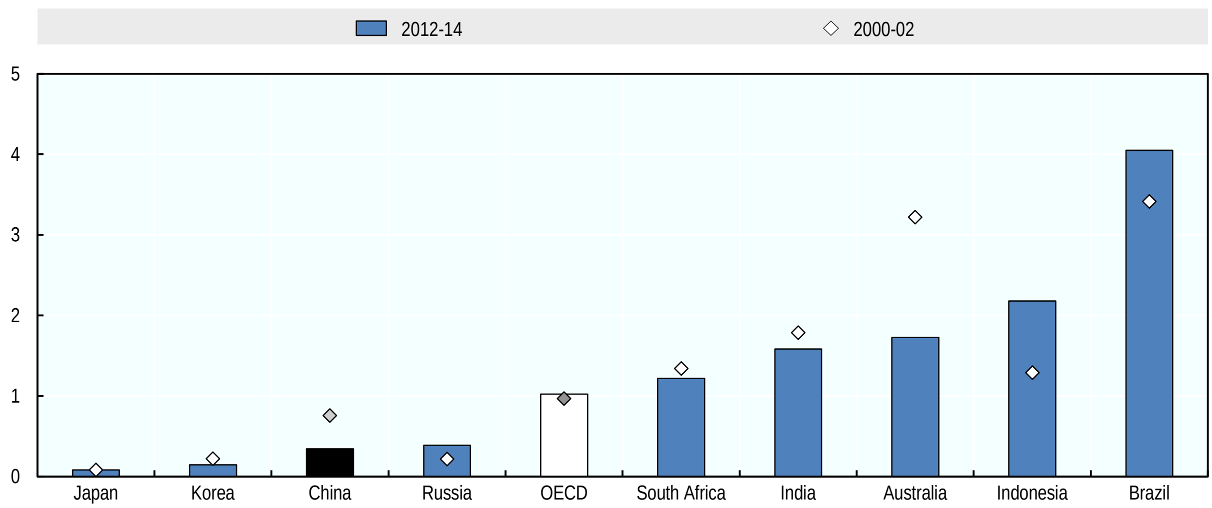
In contrast to the concept of productivity, competitiveness is a relative concept, in which the competitiveness of firms or nations can be measured only relative to other firms or nations (Latruffe, 2010). Among a number of competitiveness indicators, the Revealed Comparative Advantage (RCA) index (Balassa index) is a trade measure of competitiveness that calculates the ratio of a country's export share of a commodity in the international market to the country's export share of all other commodities.[10]

China's RCA index of the agro-food sector was less than one in 2012-14, indicating that China does not have a comparative advantage in this sector. Along with a declining share of agro-food products in total export in China, the RCA index of the agro-food sector declined from 0.75 to 0.34 between 2000-02 and 2012-14, leading to the lowest score among the BRIICS countries (Figure 2.18). The evolution of its RCA index implies that China's comparative disadvantage in the agro-food sector deepened in the last decade.

Following the classification of the agro-food sector based on land and labour input intensity by Chen (2006), RCA indices of land-intensive and labour-intensive agro-food sectors are calculated separately (Figure 2.19). The indices show that China has a comparative advantage in labour-intensive agro-food products such as processed agricultural products and horticulture, but does not have a comparative advantage in land-intensive agro-food products such as cereals. Indeed, the RCA index of the land-intensive sector has declined significantly in the last decade.

Figure 2.18. Revealed comparative advantage in agro-food products, 2000-02 and 2012-14

RCA index



Notes: Agro-food products include food, beverage and raw materials for textiles.
The OECD aggregates do not include Latvia and Lithuania.
Source: UN Comtrade (2015), United Nations Commodity Trade Statistics (database), http://comtrade.un.org/.

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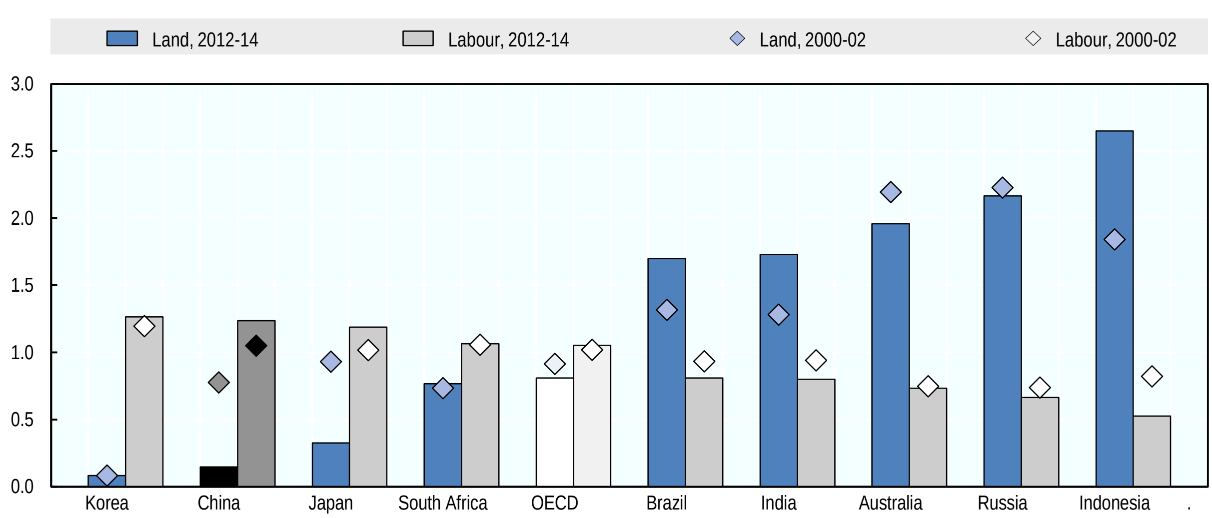
Figure 2.19. Revealed comparative advantage in agriculture sector by land and labour intensity, 2000-02 and 2012-14

RCA index



Notes: Land-intensive agriculture products include cereals, vegetable oil seeds, vegetables and raw materials (excluding silk) for textiles. Labour-intensive agriculture products include processed agricultural products, animal products, horticultural products and silk.
The OECD aggregates do not include Latvia and Lithuania.
Source: UN Comtrade (2015), United Nations Commodity Trade Statistics (database), http://comtrade.un.org/.

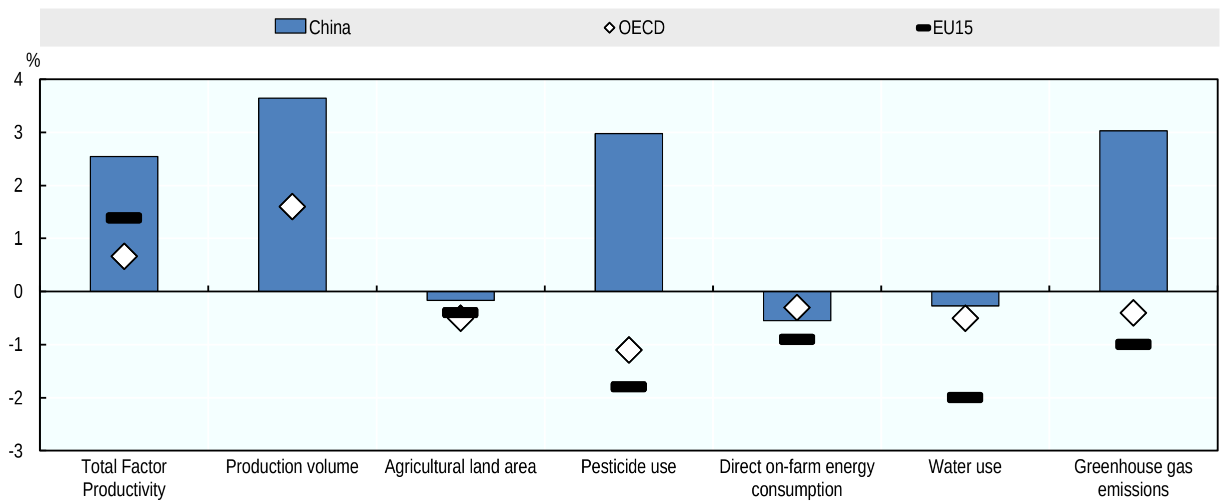
StatLink http://dx.doi.org/10.1787/888933828904

Sustainability performance of agriculture

As the previous section highlighted, China's agricultural production volume has steadily increased over the last decades – rising by 21% from 1993 to 2013 (13% for crops and 39% for livestock). Although the increase in agricultural production helped China to meet the growing food demand and to increase farm income, it also led to an intensive use of natural resources and purchased inputs, increasing the environmental pressure from agriculture. Figure 2.20highlights the contrast between rising environmental pressures in China and average declines in the EU15 and OECD countries.[11] Sustainable agricultural productivity growth in the coming decades increasingly depends on sustainable use of natural resources.

Figure 2.20. Trends in selected agriculture and environmental indicators

Average annual percent change between 2000-02 and 2010-12*



Notes: * or nearest available period.
The OECD aggregates do not include Lithuania.
Source: OECD (2017), Agri-environmental Indicators (database); OECD (2017), Environmental Database for water use; International Energy Agency (2016), IEA World Energy Statistics and Balances (database) for energy consumption; USDA, Economic Research Service, International Agricultural Productivity (database) for Total Factor Productivity.

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Soil quality

China faces serious soil contamination due to both industrial and agriculture pollutants. Waste water, waste gas and solid waste residues from industries are contributing to heavy metal pollution. Within agriculture, the main pollution sources are chemical fertilisers and pesticides, plastic mulch, animal manure and wastes, and crop residues. Contamination is particularly high in areas bordering factories, mines and intensive farming. According to the first National Soil Pollution Situation Survey for the April 2005 – February 2013 period, 16% of the surveyed sites suffered from soil pollution; this rate is even higher for cultivated land, at 20%. Pollutants are mainly inorganic, in particular heavy metals such as cadmium, mercury, arsenic, copper, lead, zinc, and nickel.

Several studies have demonstrated the linkage between soil contamination and the safety and quality of agricultural products. For instance, Williams et al. (2010) find significant heavy metal pollution in rice produced from many of the principal rice production provinces based on surveys conducted during the period 1999-2009. Li, Wu and Liang (2008) also report the impacts of soil pollution on food quality and safety, especially the impacts of pollution from heavy metals, fertilisers and pesticides on vegetables and grains.

Water quality

The sustainability of agriculture productivity growth is also threatened by water quantity and quality issues across China. Water quality problems trigger different types of water shortages, threaten drinking water supplies, and increase risks for humans, agriculture and the environment (Jiang, 2009). In particular, increases in water usage and pollution have raised a concern on the future capacity to irrigate agricultural production. Water pollution has forced cutbacks in irrigation and resulted in increasing food safety hazards (Jiang, 2009; Khan, Hanjra and Mu, 2009; HSBC, 2014).

Agricultural, industrial and residential pollution of surface and groundwater continues to be significant in many regions (Liu and Speed, 2009; Shen, 2015). According to MEP (2014), groundwater pollution has worsened since 2011. A 2016 study by MWR found that 80% of groundwater wells tested were improper for drinking or for agricultural use (Buckley and Piao, 2016).[12] The rapid increase in livestock production is a key source of pollution; waterways are increasingly polluted by the 4 billion tonnes of manure produced annually. Pesticides and fertilisers are a second prominent source of pollution, due to inefficient usage and intensive production of mono-crops such as soybeans, corn and other feed crops (Schneider, 2011).

Eutrophication (the excessive richness of nutrients in a body of water, often caused by run-off from the land) is a serious challenge to Chinese agriculture due to the pollution of China's water resources. A number of key lakes and reservoirs are under national-level monitoring and testing. According to China Environmental Bulletins, between 25% and 56% of key lakes and reservoirs were in some state of eutrophication in 2006-14 (Table 2.5).

Table 2.5. Eutrophication in key lakes and reservoirs in China, 2006 to 2014

	Number of key lakes and reservoirs with eutrophication				Share of total number under national monitoring (%)	Total number under national monitoring
	Severe	Medium	Mild	Sum		
2006	2	4	9	15	55.6	27
2007	2	3	9	14	50.0	28
2008	1	5	6	12	42.9	28
2009	1	2	8	11	42.3	26
2010	1	2	11	14	53.8	26
2011	0	2	12	14	53.8	26
2012	0	4	11	15	25.0	60
2013	0	1	16	17	27.9	61
2014	0	2	13	15	24.6	61

Source: MEP (2015).

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Nutrients

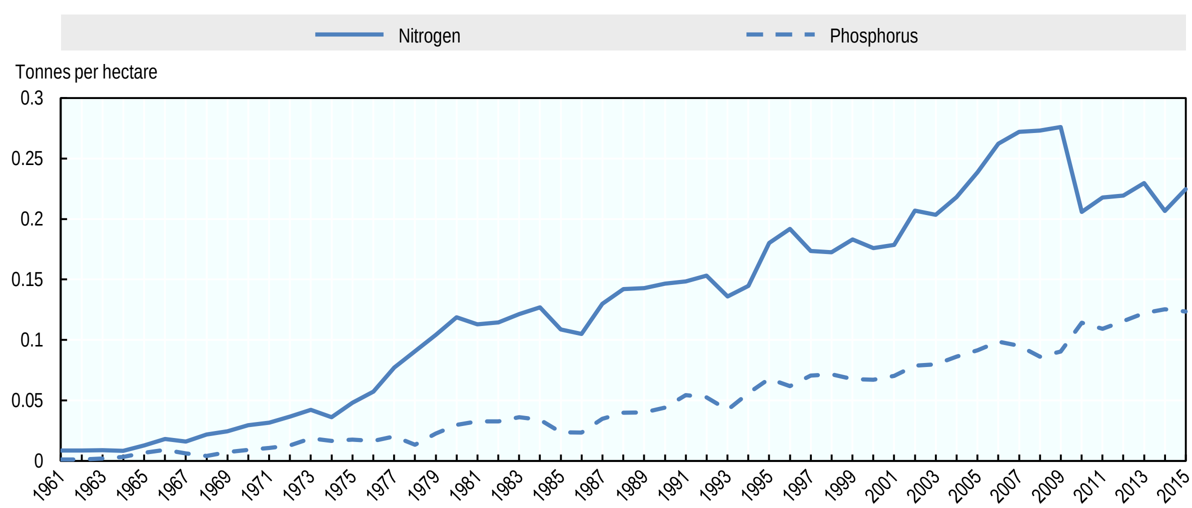
Nutrient inputs in China have steadily increased over the last three decades, promoting production levels but also raising a concern about the risk of soil pollution and water eutrophication. Nitrogen use increased by 174% from 105 kg to 288 kg per hectare between 1986 and 2013. Phosphate inputs increased by 294% from 23 kg to 92 kg per hectare over the same period (Figure 2.21). With government initiatives to curb the growth of fertiliser use, increases in the nitrogen and phosphorus inputs have levelled off to some extent since 2007.

The average fertiliser use in China of 400 kg per hectare is one of the highest in the world. More specifically, the intensity of nitrogenous and phosphate fertiliser consumption on cultivated land in China is 2.5 and 1.9 times the world average, respectively (Zhao et al., 2008). This trend contrasts with that in OECD countries, where nitrogen and particularly phosphorus use have declined sharply in recent decades. The trend in China shows that increases in nutrient input use have exceeded yield growth, suggesting diminishing marginal contributions of nutrient input to yield growth.

Although data on nutrient balances is more limited, Wang et al. (2014) find that China recorded nitrogen and phosphate surpluses of 6.95 million tonnes and 6.75 million tonnes in 2010, respectively. However, significant variation exists across China, ranging from −259 kg to 896 kg per hectare for nitrogen and −97 kg to 774 kg per hectare for phosphates at county level. The highest nitrogen surpluses were recorded primarily in eastern and north-eastern China. Wang et al. (2014) also find that fertiliser use is an important source of non-point source pollution, and that reducing fertiliser levels and improving the efficiency of nutrient use is key to improving the environmental performance of the agriculture sector. Indeed, only 40% of nitrogen fertilisers are applied efficiently; the remainder evaporates or runs off before being absorbed by crops (China Org, 2006). Small and fragmented holdings as well as transfer of farm labour to non-farm employment have been associated in some areas with higher rates of nutrient application (Tan et al., 2008).

Figure 2.21. Nitrogen and phosphorus inputs in China, 1961 to 2015

Tonnes per hectare of arable land and permanent crops



Source: International Fertilizer Association (2017).

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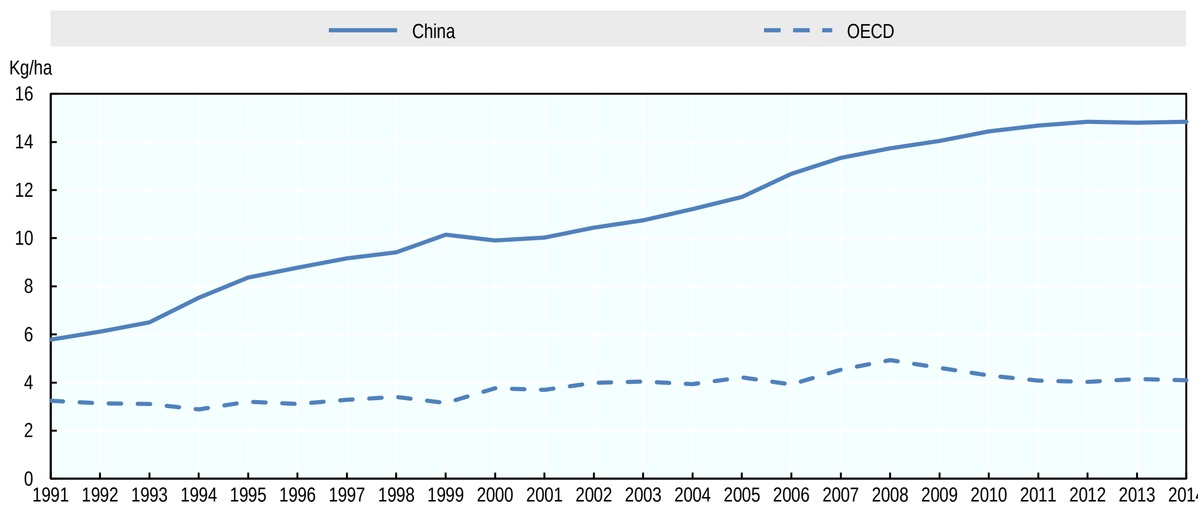
Pesticides

Increases in pesticide use boosted agricultural production by reducing pest damage, but also polluted water systems and affected human health and ecosystems. The use of chemical pesticides in China has steadily increased since the early 1990s, paralleling the upward trend in crop production (Figure 2.22). Pesticide use per hectare in China rose by 135% from 5.8 kg to 14.6 kg in 1991-2012. By contrast, the intensity of pesticide use in OECD countries increased by 18% in the same period and has shown a declining trend since 2008. While the gradual elimination and ban of high-toxicity and high-residue improved the safety of pesticides in China, per hectare use of pesticides there remains twice the world average.

Figure 2.22. Pesticide use per hectare, 1991 to 2014



Source: FAO (2017), FAOSTAT (database), http://www.fao.org/faostat/en/#home.

StatLink http://dx.doi.org/10.1787/888933828961

Agricultural ammonia emissions

Ammonia emissions have increased significantly in China in the past decades, contributing to China's atmospheric pollution. Increases in fertiliser application and livestock manure are the main contributors to rising ammonia emissions. In particular, rising livestock production has increased the share of manure in total ammonia emissions, from 37% to 46% in 1978-2008. At the same time, the contribution from synthetic fertilisers decreased from 43% to 39% in the same period. Without proper treatment and management of animal manure, ammonia emission from livestock production are projected to increase with rising demand for livestock-based products (Xu et al., 2015).

While official statistics of agricultural ammonia emissions are not available, a number of studies suggest that China is the largest emitter of ammonia emissions globally. In a recent study, Xu et al. (2015) estimate that total agricultural ammonia emissions in China were 8.4 million tonnes in 2008. Other studies estimate emissions between 4.3 to 13.7 million tonnes. For example, Liu et al. (2013) estimate that total ammonia emissions in China more than doubled in the 1980-2010 period, from 6 million to around 14 million tonnes per year.

Biodiversity

Maintaining biodiversity is another key to achieving sustainable growth in agriculture in China. In addition to providing genetic resources, biodiversity supports agricultural production through pollination and soil and water conservation. China is one of the most biodiverse countries in the world, home to 17 300 animal and plant species. However, the benefits of biodiversity for crop production may start to wane as large number of species are nearing extinction. Urbanisation, industrialisation, logging, mining, hunting and climate change are altering ecosystems and degrading the habitats of many species (OECD, 2007).

Air quality

Air quality is also an issue for sustainable productivity growth in the agriculture sector. In particular, ground-level ozone can trigger widespread losses in sensitive crops, while other pollutants – such as sulphur dioxide and nitrogen dioxide – can have significant effects on production in localised areas. A number of studies highlight the negative effect of air pollution on crop yields in China. For instance, Marshall, Ashmore and Hinchcliffe (1997) assert that air pollution may reduce yields of certain crops by more than 15% in a significant number of cultivated areas. Wang and Mauzerall (2004) estimated yield losses of up to 9% for wheat, rice and maize and 23% to 27% for soybeans. Carter et al. (2017) find a statistical significant nonlinear relationship between ozone concentration and rice yields in Southeast China; they estimate that an additional *day* with a maximum ozone concentration greater than 120 ppb is associated with a yield loss of $1.12\% \pm 0.83\%$ relative to a day with maximum ozone concentration less than 60 pp. Assuming the ozone level continues to increase, Tai, Val Martin and Heald (2014) project further declines in production of wheat, rice, maize and soybeans by 2050.

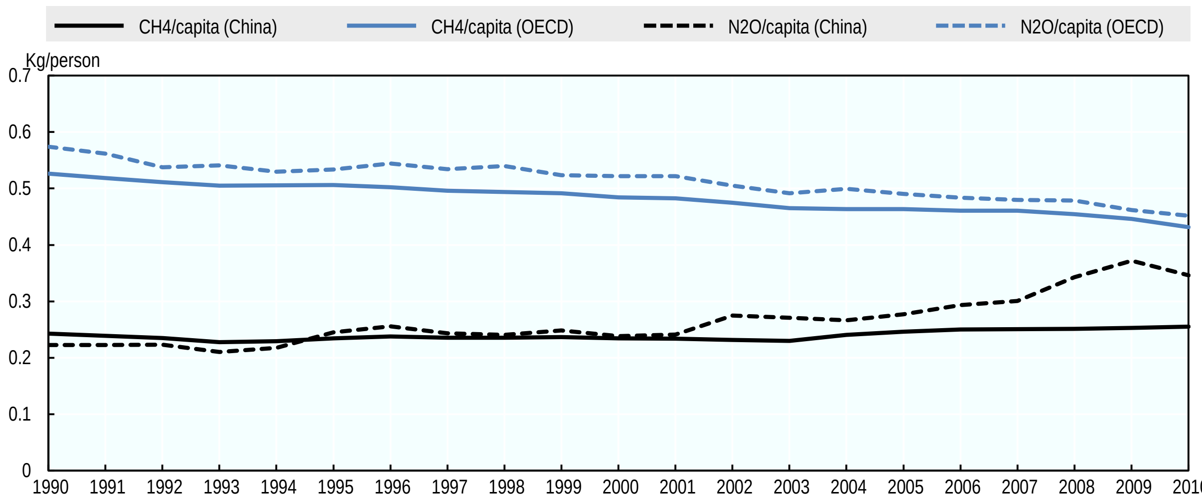
GHG emissions

Sustainable agricultural productivity growth in China is exposed to challenges from a changing climate – from rising temperatures to increasingly severe and frequent shocks. Total annual greenhouse gas (GHG) emissions from agriculture increased 51% from 543 to 818 thousand tonnes (CO_2 equivalent) in 1990-2010. China's agriculture GHG emissions are nearing the total emissions for all OECD countries (1.092 million tonnes in 2010), but remain below the OECD total on a per capita basis (0.60 versus 0.88 kg/person in 2010). GHG emissions from agriculture are projected to rise further, partly due to increased livestock production.

Methane was formerly the largest source of agriculture emissions, accounting for 52% of the total emission in 1990, but nitrous oxide emissions increased at a faster rate, exceeding methane emissions in 1995. By 2010, the share of nitrous oxide emissions in total agricultural emissions reached 58%. As shown in Figure 2.23, emissions per capita of both gases have been converging with those of the OECD. From 2000, the GHG emissions from agriculture increased at about 2.6% annually, with methane and nitrous oxide emissions rising at 1% and 3.9% per year respectively.

Figure 2.23. GHG emissions (methane and nitrous oxide), 1990 to 2010

CO_2 equivalent in kg/person



Note: The OECD aggregates do not include Latvia and Lithuania.
Source: FAO (2015a), FAOSTAT (database), http://www.fao.org/faostat/en/#home and OECD (2015a) OECD.Stat (database), for population, http://stats.oecd.org.

StatLink http://dx.doi.org/10.1787/888933828980

2.5. Policy challenges for innovation, agricultural productivity growth and sustainability in China

The Chinese economy has shifted into a “new normal” situation in which lower but more sustainable economic growth rates are expected. The economy is experiencing a number of important structural changes. The working age population in China started to decline in 2015 and the aging of the population as a whole is expected to advance rapidly over the next decades. The rapid increase in the real wage rate since the early 2000s required a change in the growth model, which had relied on an ample supply of low wage workers from rural areas. China’s remarkable economic growth in the last few decades has been sustained largely by an accumulation of capital, supported by large saving rates. These structural changes in the economy suggest that China’s economic growth will increasingly depend on productivity growth through innovation, including in the food and agricultural sector.

In China, agriculture still accounts for nearly 30% of employment, but generates less than 10% of GDP, indicating that labour productivity is significantly lower than in the rest of the economy. A slow decline in the total number of workers in agriculture is a major constraint to improvement in labour productivity, which grew at a slower pace than in the United States, the Russian Federation, Brazil, South Africa, Korea and Japan in 2000-15. The growth rate of total factor productivity in primary agriculture for the period 2001-14 slowed down compared to the 1990s, while other BRIICS countries (except for South Africa) experienced an accelerated growth rate in recent years compared to the 1990s. Productivity growth has become a key driver to achieving sustainable growth in the agricultural sector in China.

The rising cost of labour and a rapid aging of the rural population require agricultural production to concentrate on a smaller number of farms and on less labour-intensive ones. Although the sector is largely dominated by small family farms, “new-style” farms, such as large family farms, co-operative farms, and farms run by agribusiness companies, have emerged and are increasingly significant. Higher labour costs drove rapid farm mechanisation, allowing farmers to save labour input and expand farm size or engage in off-farm activities.

The development of farm mechanisation service providers across China has enabled small-scale farms to save labour input and improve productivity. Farmer Professional Cooperatives have become a key institution through which small-scale farmers can have access to technology, finance and farm mechanisation services and can integrate with agri-food value chains. Considering the structural characteristics of Chinese agriculture, which is dominated by small-scale family farms, the development of diverse farm management units is a key organisational innovation to enhance agricultural productivity and profitability in China.

Rural households are increasingly obtaining their income from off-farm activities, which have already become the major source of income. Reducing the existing large income disparity between urban and rural households depends largely on the development of non-farm sectors in rural areas and migration of the rural population to urban areas.

The diet shift in China associated with income growth has been a major driver of shifting domestic agricultural production towards livestock and fruit and vegetable production. These areas are already dominating the agricultural sector in terms of the production value. Future growth in the food and agricultural sector in China comes largely from such high value-added agricultural products. Low value added from China’s domestic service sector in its food and agricultural export also implies that more linkage between agriculture and service sectors would add value to agriculture and food products. While China maintained near self-sufficiency in grain production, the country lost comparative advantage in land-intensive products. Policies to maintain the near self-sufficiency of grain production constrains the structural evolution of Chinese agriculture towards more value-added production.

China’s agriculture development has been achieved at the expense of sustainable use of natural resources. Agriculture uses most of the land and water resources in China. The expansion of the sector, especially for products with high self-sufficiency targets, has been aided partly by the intensive use of chemical inputs such as mineral fertilisers and pesticides. Intensive use of chemical inputs in the crop sectors have led to soil degradation, water pollution, and damaged bio-diversity. The availability of water resources has reached its limit of sustainable use, particularly in areas where irrigation is intensive or water resources are scarce. Small-scale farming and engagement in non-farm employment activities also led to inefficient use of chemical inputs. The development of the livestock sector has created serious stress on China’s grassland areas. The release of animal manure and waste water from intensive livestock and aquaculture farms further pollutes the environment, especially water resources.

Growing environmental challenges have also become significant constraints to sustainable productivity growth of agriculture in China. Contamination and pollution of soil and water resources raises uncertainty about future productivity trends. Climate change is expected to impact agricultural production through rising temperatures, the spread of pests and disease, and more frequent and more severe droughts and floods. The sustainable productivity growth of agriculture requires a policy strategy to curb and eventually reverse the current practice in chemical inputs use and to mitigate these environmental constraints where natural resources are currently exploited.

Notes

[1] The "reform period" refers to the years since 1978, when the Government of China instituted its policy of "reform and opening up". The years 1979 to 1984 are considered as the "early reform period".

[2] China announced a change in family planning policy to allow family units to have two children from 2016. This policy is expected to mitigate the projected decline in population.

[3] Irrigated land increased from 48 390 ha in 1990 to 65 973 ha in 2015 (NBSC, 2016). Total cultivated land progressed from 95 656 ha to 135 067 ha in the same period (MLR, 2016).

[4] The effective utilisation ratio of water improved from 44% in 2002 to 52% in 2013, but remains approximately 20 percentage points below the ratio in developed countries. China's open-channel irrigation system is particularly susceptible to leakages and other losses, and only a fraction of irrigation land is equipped with modern water-saving irrigation technologies. Approximately 140 billion m3 of water is lost every year, which means that producing 1 kg of grain requires 0.96 m3 of water in China (twice the water needed in developed countries) (Zhao et al., 2008).

[5] Large differences in climate translate into a gradient of precipitation from the dry northwest plateaux to the humid southeast coastal areas (Jiang, 2009). On the other hand, China's population, agriculture and economic activities are concentrated in the relatively dry northeast regions, closer to coasts, and far from the glaciers, and therefore depend on key river systems and aquifers (Liu and Speed, 2009). The rapid development of the Chinese economy has led to significant surface and groundwater quantity and quality issues in this region (e.g. OECD, 2007; Jiang, 2009; Jiao, 2010; Sadoff et al., 2015).

[6] Simulated impacts of surface- and ground-water risks in Northeast China by 2050 show in particular that without further efforts national maize and wheat production could decline by 8-12% (OECD, 2017).

[7] Other potential drivers include more intensive investment in infrastructure, such as water conservation facilities, and the demand shift towards higher quality japonica rice produced in this region.

[8] In 2010, the Chinese government raised the rural poverty standard, to equal or even exceed the global standard.

[9] In spite of the emergence of a migrant wage-earning subsector, many individuals found off-farm jobs as self-employment (Rozelle et al., 1999; Zhang et al., 2006). According to de Brauw et al. (2002), between the early 1980s and 2000 the number of rural labourers that found an off-farm job in the city or another rural area rose from 9.3 million to 56 million. During the same period, the number of rural individuals that began small, non-farm self-employed enterprises rose from 26.1 million to 79.5 million.

[10] The trade measure of competitiveness is based on the concept that trade flows reflect differences in production costs among countries and that a country will specialise in the production of a good in which it has a cost advantage. For the i-th country and j-th commodity, the RCA is defined as follows:

$$\mathrm{RCA}_{ij} = \mathrm{RXA}_{ij} = \left(X_{ij} / X_{ik} \right) / \left(X_{nj} / X_{nk} \right)$$

where X are exports; k denotes all commodities other than j; n denotes all countries other than i. An RCA index greater than 1 indicates that the country has a comparative advantage in the commodity under consideration, since it has a strong export sector. This reveals higher competitiveness.

[11] Annex Table 2.A.1 summarises selected agri-environmental indicators in China.

[12] 32.9% of wells tested had Grade 4 quality water – only fit for industrial uses but not for agriculture or drinking uses; an additional 47.3% of wells were at the lower Grade 5 – not even usable for industries.

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Annex 2.A. Background table

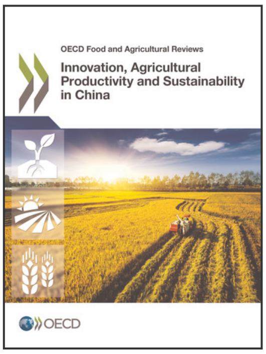
Annex Table 2.A.1. Selected agri-environmental indicators in China, 1990 to 2011*

	1990	1995	2000	2005	2010	2011
Land						
Forest area (% of land area)	16.7	17.8	18.9	20.6	22.0	22.3
Agricultural land (% of land area)	54.2	56.3	56.3	56.2	55.6	55.7
Agricultural land use (in %):						
Arable land	24.5	23.2	23.0	22.6	21.5	21.5
Permanent crops	1.5	2.0	2.1	2.4	2.8	2.8
Permanent meadows and pastures	74.0	74.8	74.8	75.0	75.7	75.7
Conservation area over 30% ground cover	..	..	..	0.02	..	0.6
Water						
Share of irrigated land (% of cultivated land)	50.6	53.1	42.0	45.1	44.6	45.6
Annual freshwater withdrawals:						
Total (billion cubic meters)	..	500	525.4	..	554.1	554.1
Agriculture withdrawals (% of total)	..	83	77.6	..	64.6	64.6
Air and climate change						
Agricultural methane emissions:						
(thousand metric tons of CO2 equivalent)	523 333	..	485 703	516 884	589 862	..
(% of totalmethane emissions)	51.5	..	46.5	38.9	35.9	..
Agricultural nitrous oxide emissions:						
(thousand metric tons of CO2 equivalent)	253 402	..	303 561	347 092	415 149	..
(% of total)	79.6	..	77.4	74.9	75.4	..
Livestock						
Livestock[1] number per ha of agricultural area	0.71	0.81	0.84	0.82	0.92	0.91
Fertiliser and pesticide use						
Fertiliser[2] use on arable and permanent crop area (tonnes per thousand ha)	..	..	..	314.67	412.90	..
Pesticide[3] use on arable and permanent crop area (tonnes per thousand ha)	0	0	9.75	8.84	17.81	..
Energy						
Energy use in agriculture and forestry (% of total energy use)	3.83	3.56	3.08	3.15	2.08	..
Bioenergy production (% of total renewable energy production)	94.83	92.29	90.7	84.11	76.02	..

* or latest available year.
1. Cattle, buffaloes, pigs, sheep, goats, and poultry.
2. Nitrogen and phosphate nutrients.
3. An active ingredient.

Source: FAOSTAT (2015); AQUASTAT (2015); World Bank (2015), *World Development Indicators* (database), http://data.worldbank.org/indicator, *China Statistical Yearbook* and *Land Resources Bulletin.*

StatLink http://dx.doi.org/10.1787/888933829892



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OECD