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Understanding recent challenges and new food policy in China☆

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ABSTRACT

Despite of remarkable achievements in the past, China is also facing several major challenges, in particular on ensuring sustainable growth of agriculture, improving food security, increasing farmers' income. The paper reviews China's agricultural and food policy with specific focus on recent challenges, initial policy responses and their consequences, and re-adjusting in policies. The results show that the policy responses to the challenges of sustainable agriculture are strong and encouraging. Adjusting the national food security target in response to sustainable agriculture and major efforts to improve food security are significant. To increase farmer's income, China has shifted its policy regime from taxing to subsidizing and protecting agriculture in the past decade. However, the results of these efforts are mixture. Price interventions increased farmers' income, they also resulted in several serious problems. Good news is that some new efforts to solve these problems may bring China's market reform back to the right track though they still needs to be evaluated. The paper concludes that the previous experiences on agricultural development through institutional reform, technology change, market reform, and investment in agriculture should still be the keys for successfully ensuring food security and sustainable agriculture for China in the future.

1. Introduction

China's agriculture has changed dramatically since the late 1970s. Agriculture grew at an average rate of 4.6% annually in more than three decades (NBSC, 2015). Although per capita water availability is only 1/4 of the global average and arable land accounts for only 8% of the world total, China provided about 95% of total food for about 20% of the world's population in 2015. The growth has been accompanied with significant structural change in production and food consumption. Growth in agriculture and off-farm employment raised farmers' income and massively reduced rural poverty. China was the first developing country to meet the Millennium Development Goals on reducing poverty population by half ahead of the 2015 deadline.

While the past accomplishments are impressive, China has reached a stage of agricultural development when the previous challenges have intensified and new challenges have emerged. Increased food production has been at the expense of environment and sustainable development (Zhang et al., 2013; Lu et al., 2015). Furthermore, recent rising wages have significantly increased the cost of food production and lowered agricultural competitiveness in the global market, which further raises food security concern in China (Huang, 2013; Han, 2015). In addition, despite steady growth of farmers' income, their average income is still low, and the rural-urban income gap remains high. How to ensure national food security, higher growth of farmers' income, and sustainable agricultural development are central goals of China's recent agricultural and food policy.

Recognizing the challenges, the Chinese government has taken a series of strong policy measures. The most notable ones are the political commitments to *San Nong* issues (three rural issues: agriculture, rural areas, and farmers). For example, in the past 13 years (2004–2016), the Number One Document, the first and most important national policy document each year released by the Central Committee of the Communist Party of China, has exclusively focused on these three issues. In the literature, while several papers discuss some major policy changes in the recent decade, such as eliminating agricultural tax (Tao and Qin, 2007; Liu et al., 2012), increasing agricultural subsidies (Huang et al., 2011, 2013; Yi et al., 2015), enhancing agricultural research and development expenditure (Huang and Rozelle, 2014; Babu et al., 2016), and raising agricultural price and income support for farmers (OECD, 2013), none of them systematically

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examines the evolution of recent policies and motivations for policy changes.

Understanding the evolution of recent policy changes is interesting not only for China's own development in the coming years, but also for the rest of world. Regarding China, there are both experiences and lessons to be learned from the past and recent policy changes. With the sheer size of its population, any change in China is likely to have profound impact on the international food trade and global food system.

The overall goals of this paper are to review China's agricultural and food policy with specific focus on recent challenges, policy responses and their consequences, and provide policy implications for the way forward. The rest of the paper is organized as follows. Section 2 describes China's agricultural development and past experience. Section 3 presents the major challenges in terms of farmers' income, food security, and sustainable agricultural development that have addressed great attentions by Chinese leaders. Section 4 discusses the recent government policy responses and outcomes. The last section concludes this paper with several policy implications.

2. China's food security and agriculture: past success and experience

2.1. Food security

For more than 20 years, while there were several pessimistic predictions about China's food security and its impact on global agricultural markets, they have failed to materialize. First, there were concerns in the early 1990s that China might struggle to feed itself and massive food imports would eventually starve the world (Brown, 1995). Second, when China entered the WTO in 2001, there were concerns that China's agriculture sector might face enormous challenges and be flooded with cheap food imports. However, the reality was quite different. Food security was largely ensured, and total food exports exceeded imports by the mid-2000s (NBSC, 2015). Rice, wheat and many other commodities are nearly self-sufficient (Fig. 1). Large net import (import-export) occurs only in oilseeds, mainly soybean. Household food security has also improved significantly. For example, the prevalence of undernourishment among the population fell from 24% in 1992 to less than 10% in 2015 in China (FAO, 2015). Despite of the micronutrient problem remains a challenge in the less developed regions (Luo et al., 2014), overall micronutrient has been significantly improved (MOH, 2012).

2.2. Agricultural growth and structural change

Achieving high level of food security in China is mainly due to its rapid agricultural growth. Compared to the pre-reform period of 1970–78, when agricultural gross domestic product (GDP) rose by 2.7% annually, the growth rate more than tripled to 7.1% during the initial reform period of 1979–1984 (Table 1). Although during the later reform period (1985–2014), the annual growth rate reduced to approximately 4%, this growth is still extraordinarily high over such a sustained period.

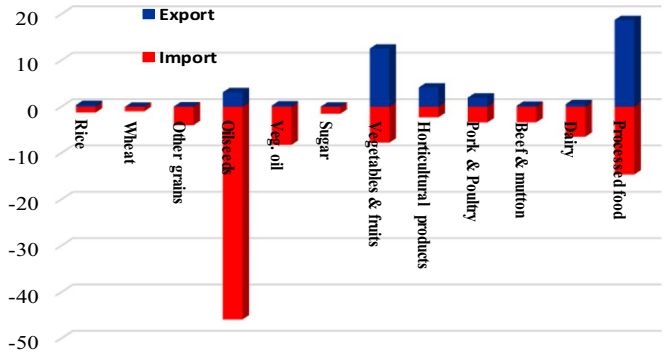

Fig. 1. China's food import and export in 2014 (billion US$). Numbers are calculated based on UNCOMTRADE database.

The growth in crop production has occurred in all commodities. Between 1978 and 2014, grain production increased by 1.9%, nearly double the population growth (1.0%, Table 1). Moreover, the average annual growth rate for cotton, edible oils, and fruits reached 3.2%, 8.8%, and 12.6%, respectively, in 1978–2014. Livestock (6.6%) and aquaculture products (8%) have been growing even faster than the output growth in the crop sector over the same period (Table 1).

Accompanied with agricultural growth is significant production structural change and improvement of food consumption patterns in China. Within the agriculture sector, the area share of cash crops (or non-grain crops) increased from 20% in 1978 to 32% in 2014. Over the same period, the share of animal products (livestock and fishery) in total agricultural output raised from 17–38% (NBSC, 2015).

2.3. Major policies and experience before the mid-2000s

Many factors have simultaneously contributed to China's agricultural growth in the past, of which, rural institutional innovation, technology change, market reform, and investment in agriculture are the four major driving factors (Huang et al., 2011).

2.3.1. Institutional reforms

Rural economic reforms were initiated in 1978 through implementation of the household responsibility system (HRS) that contracted cultivated land to individual households in each village for 15 years based on the number of people and/or labor in the household (equity). As the HRS is an institutional innovation to incentive problems inherent in the previous collective production system under People's communes, it significantly raised agriculutural productivity in the early reform period. For example, previous studies show that the HRS accounted for about 40–50% of the total rise in ariuclutural output during 1978–1984 (Lin, 1992; Huang and Rozelle, 1996; Fan, 1997). Both McMillan et al. (1989) and Jin et al. (2002) also show that HRS contributed significantly to total factor productivity (TFP) growth in major commodities. The significant rise of agricultural production with the equitable distribution of land is a major reason for massive reduction of rural poverty in the early reform period. After the mid-1980s, to facilitate agricultural investment, China's land reforms have focused on stabilizing land tenure (or ensuring the land contract rights). The land contract was also extended to additional 30 years starting in the late 1990s.

2.3.2. Technology changes

Given its large population but with limit of land resource, China's agricultural growth has to largely depend on technological changes. China has developed its strong agricultural science & technology (S & T) innovation system. Huang et al. (2012) estimate that China had at least 68,000 research staff working in the public agricultural R & D system by the late 2000s. China has also developed the largest public agricultural extension system in the world with approximately 700,000 staff members in recent years (Huang and Rozelle, 2015). Previous studies show that technology change has been a primary source of agricultural productivity growth. Hybrid rice was developed by China's scientists in the late 1970s. Technological innovations in wheat, maize, cash crops, and animal products have also been signficiant. Empirical studies show that the average annual growth rates of TFP in the grain sector increased from 1.5% in 1985 to 2.4% in 1995–2004; annual growth rates of TFP in cash crops and livestock also exceeded 3.5% over the same period (Jin et al., 2010). They also show that nearly all growth in TFP were from technological changes in the 1990s and early 2000s. Since the mid-1990s, China has also relied on innovation from plant biotechnology. For example, Bt cotton has benefited millions of

Table 1
Average annual growth rate (%) of agriculture in China, 1980–2014. Figure for GDP (in real terms) in 1970–78 is the growth rate of national income in real terms. Data are from NBSC, various issues.

	Pre-reform period 1970–78	Reform period						
		1979–84	1985–95	1996–00	2001–05	2006–10	2011–14	1978–2014Average
Agri. GDP	2.7	7.1	4.0	3.4	4.3	4.5	4.1	4.6
Grain	2.8	4.7	1.7	−0.7	1.1	2.5	2.0	1.9
Cotton	−0.4	19.3	−0.3	−1.9	5.3	−0.9	−2.1	3.2
Edible oils	2.1	8.9	17.2	8.0	2.0	−2.7	9.8	8.8
Fruits	6.6	8.0	12.5	8.2	29.2	6.0	12.8	12.6
Meat	4.4	8.5	10.0	7.3	5.1	−3.1	7.7	6.6
Fishery	5	7.4	12.6	6.8	3.9	3.6	11.0	8.3
Population	1.80	1.40	1.37	0.91	0.63	0.51	0.50	1.0
Per capita GDP	3.1	7.4	8.3	7.2	9.0	10.6	7.5	8.3

farmers since 1997 (Huang et al., 2002).

2.3.3. Gradual market reform and trade liberalization

China's market reform is unique. The reform was gradually implemented from non-strategic products to strategically important products, which has facilitated China's smooth transformation from a previous planned economy to the market oriented economy (Park et al., 2002; Huang and Rozelle, 2006). By the late 1990s, the government almost phased out its direct market intervention program in almost all agricultural commodities. Trade liberalization began with relaxing trade restrictions and market access in the early 1990s, followed by tariff reduction. Simple average import tariff for all agricultural products was reduced from 42.2% in 1992 to 23.6% in 1998, 21% in 2001 when China joined WTO, and 17% in 2004. Previous studies show that the above reforms have been successful. For example, regional agricultural market prices have increasingly transmitted across space and over time (Huang et al., 2004; Huang and Rozelle, 2006). Farmers have been gaining from increased allocative efficiency based on market prices (deBrauw et al., 2004). By the mid-2000s, most of agricultural commodity prices in China almost equaled the international prices (Huang et al., 2009). Following the comparative advantage of China's agriculture, both the export of labor-intensive products (e.g., horticulture) and the import of land-intensive commodities (e.g., soybeans, cotton, edible oil, and sugar) have been rising, which contributed to agricultural structural change and farmers' income growth.

2.3.4. Investment in agriculture

Increasing investment in agriculture has also contributed to steady growth of China's agriculture in the past. The most significant investment has occurred in water control (e.g., irrigation and flood control), land improvement, agricultural technology, rural roads, and market infrastructure. Today, more than half of the cultivated land is irrigated. Massive investment into rural roads and agricultural wholesale markets fosters integrated markets that link hundreds of million small farms to processors, retailers, and consumers (Wang et al., 2009). Investment in the low- and medium-yield crop land to improve soil quality and irrigation has also raised land production capacity. Investment in agricultural R & D, as we mentioned earlier, is one of the most successful stories of public investment in agriculture.

3. Grand challenges: farmers' income, food security, and sustainable agriculture

Although China's agricultural development has recorded remarkable achievements in the past, it faces huge challenges today. While there are a number of other challenges (e.g., food safety; malnutrition and micronutrient deficiency in the less developed regions, and rural poverty, etc.), the biggest challenges that have driven China's recent policy changes are related to how to maintain higher growth of farmers' income and reduce rural-urban income gap, ensure national food security, and achieve sustainable agricultural growth. On food security, it is worth to note that while the definition of food security by FAO covers several dimensions, China's food security has mainly focused on grain self-sufficiency.

3.1. Challenges in maintaining higher growth of farmers' income and reducing urban-rural income gap

Although average real income per capita in both rural and urban areas has increased significantly since the reform was initiated in 1978, the urban-rural income gap (or ratio) increased from 2.54 in 1997 to 3.23 in 2003 (Fig. 2), a situation that could threaten the social stability and has attracted much attention from China's policymakers. Despite significant efforts to raise farmers' income in both agriculture and off-

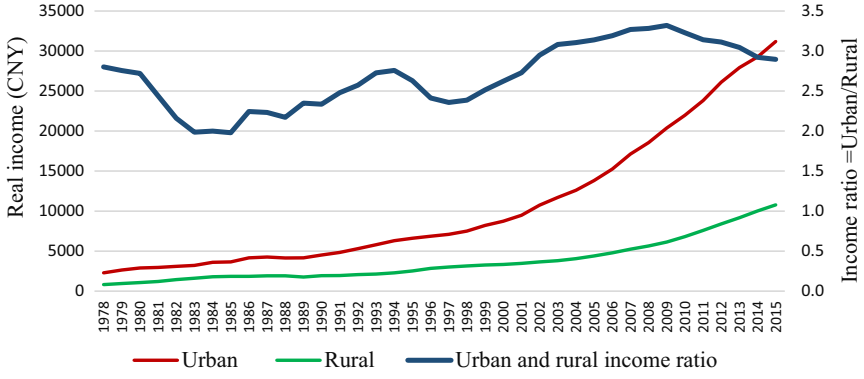

Fig. 2. Per capital real income in rural and urban areas in 1978–2015. Urban income is measured as per capita disposable income, while rural income is measured as per capita net income because data on disposable income for rural areas are available only after 2013. During 2013–2015, rural disposal income was about 6% higher than rural net income. Rural and urban income are deflated by rural CPI and urban CPI, respectively, to obtain the real income at 2015 price (CPI_{2015}=100). All data are from NBSC, various years.

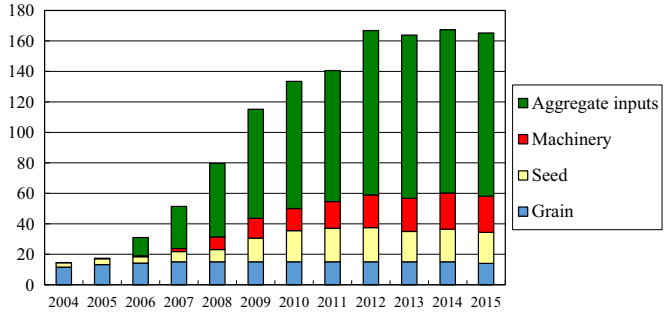

Fig. 3. Four major agricultural subsidies in 2004–2015 (billion CNY in current price). Data are from various official documents.

farming employment, the urban-rural income gap further increased, though at a much lower speed during 2003–2009 (Fig. 2). The faster income growth in rural areas than in urban ones did lower the income gap from its peak value of 3.33 in 2009 to 2.73 in 2015; however, the absolute urban-rural income difference reached about 20,000 CNY (or USD 3200). In rural area, despite of significant rise of income from off-farm employment, agriculture still contributed to about 42% of average rural households in 2014. Meantime, there were still nearly 60 million (5.3%) rural population under poverty in 2015 (NBSC, 2016).

3.2. Challenges in ensuring national food security

Despite remarkable achievements in ensuring national food security, recent emerging issues have raised the Chinese government's concerns on food security, particularly grain security. After grain production reached a historical high in 1998 (512 million tons), it fell to 431 million tons in 2003 (NBSC, various issues). Government grain stock had also successively decreased from its peak level in 1999 to the lowest level in 2004. On the other hand, with rising income, the demand for food, especially meats, has continued to rise. Although average farm size had increased from 0.57 ha in 2003 to 0.78 ha in 2013 (Huang and Ding, 2016), farm size is still small. On the cost of production, rural labor wages (or opportunity cost for agriculture) have increased at more than 8% annually after the mid-2000s (Li et al., 2012; Wang et al., 2011). Despite of rising agricultural mechanization largely in response to rising rural wage, increasing labor cost still contributed most of the increase in production cost in recent years (Wang et al., 2014). One of the major impacts of rising production cost is the fall of China's agricultural competitiveness in the international market. China shifted from a net food exporter to a net food importer in 2004, and food imports have gradually increased thereafter. Food security is likely to be further challenged by deterioration of already very scarce land and water resources (Lu et al., 2015).

3.3. Challenges in achieving sustainable agricultural development

Intensified agriculture with high input and output in the past has resulted in huge stress on the limited natural resources and rural environment, which may threaten the sustainable development of agriculture in the future. China's agricultural production highly depends on irrigation. Currently about half of cultivated land is irrigated. Rising demand for irrigation water has resulted in overdraft of groundwater and therefore falling groundwater table and land degradation in most of northern China (MWR, 2016). The sustainability of irrigated agriculture is also challenged by the rising water demand from urbanization and ecological civilization construction and water pollution. Climate change is expected to further exacerbate the water shortage (Ding et al., 2006; Wang et al., 2013). Meantime, although the declining trend of cultivated land has slowed down due to strict regulations on alternative uses of cultivated land (e.g., 1.8 billion mu or 120 million ha red line for cultivated land by 2020), soil quality degradation has been occurring in many regions (Zhang et al., 2013; Liu et al., 2013b). It is estimated that more than half of the cultivated land has experienced different levels of degradation (Li et al., 2011). Excessive use of modern inputs (e.g., fertilizers and pesticides) has caused serious non-point pollution and soil degradation (Liu et al., 2013a) and will become one of major factors threaten sustainable agricultural development in the future (Lu et al., 2015).

4. Evolution of recent policies

Given the challenges discussed above, China's policymakers have made several major policy responses. Here we present evolution and consequences of these policy responses.

4.1. Shift from taxing to subsidizing agriculture

4.1.1. Direct subsidy program

The concerns on food security and farmers' income have led the Chinese government to take a series of strong policy measures since the early 2000s. The first set of policy measures comprised the abolition of taxes and fees and in the meantime introduction of the agricultural subsidy program in 2004. Subsidies to farmers started with “Direct grain subsidy,” “Quality seed subsidy,” and “Machinery subsidy” (Fig. 3). The agricultural subsidy program was extended to “Aggregate input subsidy” in 2006 when domestic chemical fertilizer and fuel prices began to rise with international prices. Almost all farmers receive subsidies. The total amount of four major subsidies reached the peak of 164.3 billion yuan (or 26.1 billion US$) in 2012, about 3.13% of agricultural GDP. Beside these four major subsidies, other recent subsidies to farmers include subsidies for agricultural insurance, credit, land consolidation, and soil conservation and improvement (Fig. 3).

However, given the size of farming households, the impact of subsidy program on farmers' income is moderate. China has more than 200 million farm households (or rural households with land contracts), and an average household receives only about 850 CNY (or about USD 130). In this regard, using agricultural subsidy to raise farmers' income is meaningful only in terms of politics that shows government's commitment to help farmers.

The impact of agricultural subsidies on grain production is negligible. Using household data from a national representative survey, Huang et. al. (2011) show that subsidies are mostly being given to the land contractor, not the tiller due to the difficulty in identifying actual crop production and input use by household, and that the subsidies do not distort production no matter if they look at descriptive statistics or regression analyses.

4.1.2. Price intervention program

Meantime, to increase farmers' income and promote grain and other major crop production, China has also sought price policy support. The most important policy measures are the minimum procurement price, which has been implemented for rice since 2004 and wheat since 2006, and the temporary storage program (TSP), which was initiated in 2008 for maize, soybean, and rapeseeds (Table 2).

While the above price support efforts increased crop production and price and therefore farmers' total income from agriculture, the urban-rural income gap still remained high and even increased from 3.21 in 2004 to 3.33 in 2009 due to higher income growth in urban (Fig. 2). To further raise farmers' income, both minimum prices for rice and wheat and procurement prices for maize, soybean, and rapeseed under the TSP were gradually increased until 2014 (Table 2). Concerning farmers' income in cotton and sugarcane production regions, the TSP was further extended to cotton in 2011 and sugar in 2012. During 2009–2014, the ratio of urban to rural per capita income fell from 3.33 to 2.92 (Fig. 2); part of this change obviously came from

Table 2
Domestic intervention prices, rural CPI, and exchange rates, 2004–2015. Data on prices are extracted from various policy documents. Rural consumer price index (CPI) and exchange rates are from NBSC (2015).

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Minimal procurement prices (CNY/ton)												
Early indica paddy	1400	1400	1400	1400	1540	1800	1860	2040	2400	2640	2700	2700
Japonica paddy	1500	1500	1500	1500	1640	1900	2100	2560	2800	3000	3100	3100
Middle indica paddy		1440	1440	1440	1580	1840	1940	2140	2500	2700	2760	2760
Late indica paddy		1440	1440	1440	1580	1840	1940	2140	2500	2700	2760	2760
White wheat			1440	1440	1540	1740	1800	1900	2040	2240	2360	2360
Red and mixed wheat			1380	1380	1440	1660	1720	1860	2040	2240	2360	2360
Procurement price under Temporary Storage Program (CNY/ton)												
Maize					1500	1500	1700	1980	2120	2240	2240	2000
Soybean					3700	3740	3800	4000	4600	4600	–	–
Rapeseed					4400	3700	3900	4600	5000	5100	5100	–
Target price (CNY/ton)												
Soybean in Inner Mongolia and Northeast China											4800	4800
Cotton in Xinjiang											19,800	19,100
Rural CPI (2010=100)	83.2	85.0	86.3	90.9	96.8	96.5	100.0	105.8	108.4	111.5	113.5	115.0
Exchange rate (CNY/USD)	8.28	8.19	7.97	7.61	6.95	6.83	6.77	6.46	6.31	6.2	6.14	6.23

the results of government price intervention policy, though this impact has not been evaluated in the literature.

While the price intervention policy has increased farmers' income, it also generated a large price gap between the domestic and international markets. Indeed, right before the global food crisis in 2007–2008, domestic prices were very close to the international prices. The average rate of assistance to agriculture for import-competing commodities (or policy distortion) was only 7.5% in the early 2000s (Huang et al., 2009). During the global food crisis, China was able to prevent the significant rise of grain prices by drawing down stocks and trade control (Yang et al., 2008). However, while the global food prices fell sharply in late 2008, and has since then experienced upward and downward trends after 2009, China continued to raise its domestic price in 2009–2014 (Table 2). The price gaps between the domestic and international markets have increased significantly since 2012. By late 2015, the wholesale price of maize was about 40% higher than the imported price; the number reached 50% in early 2016. The domestic wholesale prices of rice, wheat, and cotton were also higher than international prices by a range from 30–50% in 2015.

As we would expect, the increasing domestic prices and large price gaps between the domestic and international markets have resulted in huge policy-induced challenges. Rising prices stimulated domestic production. The large price gap has caused an increase in China's imports. To avoid the price from falling due to the increased supply from both domestic production and imports, the government has had to continue buying products from farmers and built up massive storage. Meantime, the high and rising domestic maize and sugar prices have seriously hurt downstream industries such as the feed & livestock sector and food processing industry. Rising domestic cotton prices have also had a severe impact on production, export, and employment of textile and garment industries. Regarding soybean and rapeseeds, because these products are largely liberalized, their international prices are fully transmitted into the domestic market, the TSP has had little impact on domestic price and production but has increased government storage and financial burden.

4.2. Efforts to adjust and reform the current policy support system

4.2.1. Efforts to cap the direct subsidy program

Recognizing only a moderate effect on farmers' income and the failure to raise grain production, and significant financial burden, there was debate on expanding the existing subsidy program among the policymakers in 2011–2012. With a fall of government's fiscal income growth rate from 25% in 2011 to only 10% in 2013 due to slowdown of economic growth (NBSC, 2014), a decision was made to cap the total subsidy budget for 2013 in 2012 (Fig.3).

4.2.2. Efforts to lower intervention prices after 2013

With rising grain stock, particularly maize, and falling international grain prices in recent years, China has also begun to adjust its intervention policies in rice, wheat, and maize. The government lowered the maize price in 2013 and 2015 and rice and wheat prices in 2014 and 2016 (Table 2).

4.2.3. Efforts to phase out some price intervention programs since 2014

Despite lowering procurement prices, the price intervention program was still difficult to be maintained because the international food and cotton prices have continued to fall after 2013. Given the policy-induced challenges discussed above, TSP was discontinued for soybean and cotton in 2014 (and replaced by the target price policy), for rapeseed in 2014, and for sugar in 2015.

4.2.4. Efforts to pilot the target price policy since 2014

Recognizing the difficulty of sustaining the existing price intervention program, China introduced a target price pilot reform program in 2014. This pilot program was implemented for soybean in Inner Mongolia and Northeast China and for cotton in Xingjiang in 2014, and has continued since then. Farmers receive payment from the government if the market price is lower than the target price. The amount of payment depends on the total production and the difference between the target and market prices. Huang et al. (2015) show that the target price pilot program for cotton achieved its major policy goals: market price for cotton significantly fell and the price gap between domestic and imported cotton decreased from more than 40% in 2013 to about 20% in 2015. Considering tariff rate (5%) and value-added tax (13%) for imported cotton, the price difference between the domestic and international markets disappeared. Meantime, cotton farmers received the payment as planned, and textile and garment industries recovered their production due to lower cotton market prices. However, using the target price policy to raise farmers' income as one of the policy goals is also a challenge because of the huge financial burden and costs of policy implementation for millions of small farmers in China (Huang et al., 2015).

4.2.5. Efforts to separate income support from maize pricing policy in 2016

Among the remaining crops under the price intervention program (rice, wheat, and maize), maize policy intervention faces the biggest challenge. The high prices of rice and wheat have promoted domestic production only moderately because of falling demand for or little growth of rice and wheat in recent years (Huang et al., 2015). However, high maize price has resulted in strong growth in maize production

partially due to the rising feed demand. Maize production reached historical high (225 million tons) in 2015. This production expansion together with rising maize imports generate a huge increase in government's maize stock. While there is no official data available, the estimated numbers of the government main stock range from 110 million tons (USDA, 2016) to more than 240 million tons from industrial sources at the end of 2015. How to dispose of this massive stock has became one of the biggest problems in agriculture in the recent two years.

Reforming the maize price intervention is becoming imperative after considering the substitutional impact of restricting maize import through the tariff rate quota (TRQ) system. Import quotas for maize was 7.2 million tons in 2015. Tariff rate is 1% for import within quota and 65% about quota. Higher domestic maize price with restrictions on maize imports under TRQ has resulted in huge imports of other feeds without TRQ to substitute maize. For example, barley import increased from 2 million tons in 2011 to nearly 12 million tons in 2015. Over the same period, distillers dried grains with soluble (DDGS) imports also increased from less than 2 million tons to nearly 7 million tons, and sorghum imports from nearly zero to 11.8 million tons.

In June 2016, the Chinese government announced a new pilot reform on maize. This reform is called *Jiabu fenli* in Chinese, that is, separating income support from pricing policy and allowing maize price to be determined by the market. Under this pilot reform, farmers are provided with a fixed amount of subsidy (or income support) in four major maize production provinces, including all three provinces in Northeast China and Inner Mongolia, which together accounted for 44% of total maize production in 2014 (NBSC, 2015). While this reform has not been fully implemented, it is expected to have significant implications not only to farmers' income and government budget allocation, but also all sectors related to maize in China and rest of the world.

4.3. Adjusting food security target and improving agricultural competitiveness

4.3.1. Adjusting targets of national food security

Besides the primary focus on farmers' income in recent years, the foundation of agricultural policies has been government's strong focus on achieving food, particularly grain, self-sufficiency in the past several decades. But the food self-sufficiency policy has also gradually changed over time in response to changes in food supply and demand. Before the mid-1990s, a nearly complete self-sufficiency in grain was a national goal. With rising food demand and given the land and water constraints, the grain self-sufficiency level has been targeted at 95% or higher since 1996.

However, with rapid growth of demand for feed grain over time, it is widely accepted that 95% grain self-sufficiency is impossible. Import of soybean for feed and edible oils has increased from a few million tons in the mid-1990s to 55 million tons in 2010. Meantime, China also shifted from a net exporter to net importer for maize in 2010, and total grain self-sufficiency fell to 92% in the same year. By 2014, China imported 106 million tons grain, of which soybean accounted for two-third of the total grain import. For all the Number One policy documents since 2004, China first time used cereal and food grain (*kouliang*, rice, and wheat) rather than grain in general in 2014. "Ensure largely self-sufficiency in cereal and absolute security in *kouliang*" has become the new and main national food security goals. Given that China had achieved nearly full self-sufficiency in rice and wheat in the past decade and their demand will fall with the rise of income in the future, *largely* (not fully) self-sufficiency in cereal is often interpreted as a more liberalized maize market in the future.

4.3.2. Fostering land consolidation and small-farm transformation

With rising wage, to improve agricultural productivity/competitiveness and farmers' income, the recent major policy efforts have focused on land consolidation. These include stabilizing the land contract rights by issuing official land contract certification (Deininger et al., 2014), fostering land rental market, and providing policy support for land transfer (Huang and Ding, 2016).

According to official data, about one-third of the households' contracted land was transferred among farmers by 2015 (MOA, 2016). Institutional innovation through establishing land transfer service centers to reduce land transaction costs, policy support for land transfer and larger farms to expedite land consolidation, and farm mechanization services all contributed to the recent evolution of China's farm operations and small-farm transformation (Huang and Ding, 2016).

To further facilitate small-farm transformation and improve agricultural productivity, the government has planned to implement a new land institutional reform—*San-quant-fen-shy*—that is, separating three rights of cultivated land: village collective land owner rights, individual household land contract rights, and land operational rights. While land transfer has been occurring, the relationship between contract rights and operational rights have not been clarified. Legally separating the land operational rights from the contract rights has important implication not only on expanding the land rental market and land consolidation (efficient goal), but also on achieving the goal of equal land distribution. In the future, China will become a country with all current rural registered households (about 260 million) holding contract rights (or "landlords"), and much less number of more efficient farmers operating about 1.2 billion ha of cultivated land and earning profit after paying for the rental costs.

4.4. Moving toward enhancing production capacity and sustainable agriculture

Recognizing the resource constraints and challenges in sustainable development, the Chinese government has made a stronger political commitment toward investment in agriculture since the mid-2000s, which has generated substantial public investment in land, water, and technology. The growth of investment in agriculture has been targeted to exceed that of government's overall fiscal expenditure. During 2004–2014, while the share of agriculture in GDP fell from 13–9%, its share in government expenditure rose from 8–10% (NBSC, 2015). Growth in agricultural R & D expenditure is exceptional. Annual growth rate of public agricultural R & D expenditure in real terms increased from an average of 16% in 2000–2009 to more than 20% in the early 2000s (Hu et al., 2011). In the water sector, China made a decision in 2011 to invest about 630 billion US$ in water conservation during 2012–2020. Meantime, China is planning to establish a pricing mechanism that appropriately reflects the cost of water to encourages water saving within a decade. On cultivated land, priority is to improve land productivity through developing "high-standard farmland" with highly drought- and flood-resistant.

A more significant and strategical change is China's attempt to mainstream sustainable agriculture into the national development goals. For example, in recent years, China has been seeking a new development thought, called "*Cang-liang-yu-di*" ("storage food in land,") and "*Cang-liang-yu-ji*" ("storage food in technology"). "*Cang-liang-yu-di*" primarily considers the production capacity in the long run rather than the current actual production, implementation of this development strategy will have important implications for future agricultural trade and production in both China and the rest of the world. "*Cang-liang-yu-ji*" reemphasizes the role of technology on food security. In 2015, China also announced a number of significant policy initiatives and plans, including several policy initiatives to scale back use of chemical fertilizer (rather than previous policy to promote fertilizer use for raising crop yields), a plan to cap total fertilizer use by or before 2020 and fall thereafter, and a plan to achieve "zero discharge" of agricultural waste by 2030. In May 2016, China also issued "Soil Pollution Control Plan of Action," whose goals are as

follows: to preliminarily curb worsening soil pollution by 2020; to stabilize and improve soil environment and quality by 2030; and to comprehensively improve soil environment and quality by 2050.

5. Concluding remarks

Nearly 40 years have passed after China started its reform in 1978, which witnessed the reform achievements and policy impacts in the first 30 years and the evolution and impacts of the new food policies in responses to the recent challenges in food security, farmers' income and sustainable agriculture. During the first 30 years, institutional reform, technology change, market reform, and investment in agriculture were the four major agricultural and food policies that led to successful agricultural development.

Despite of remarkable achievements in the past, China's agriculture is currently facing unprecedented challenges. The previous challenges, especially resource and environmental degradation, have intensified. Concerns on sustainable agricultural development are rising. In the past decade, rising cost of agricultural production has lowered China's agricultural competitiveness. Imports of many agricultural products are increasing. Meanwhile, despite the steady growth of farmers' income, the urban-rural income gap remains high. The government has decided to double farmers' income during 2010–2020 and eliminate rural poverty by 2020. While recent efforts have raised farmers' income and narrowed the urban-rural income gap, the progress is slow and absolute income gap continues to increase.

Recognizing the challenges of sustainable agriculture, strong policy measures are being undertaken by the Chinese government. Sustainable development has become one of major national development strategic goals for agriculture. Several large national plans and actions for sustainable agriculture and enhancing long-run agricultural productivity are underway. While the evaluation of their impacts would take many years, they must have significant implications not only for China's agriculture and food security in the short and long run, but also for international trade and global agriculture.

The recent adjustments of the national food security target and several efforts to improve agricultural productivity are appropriate. While overall grain security is still a priority of the national policy, currently, the Chinese government has made it clear that complete self-sufficiency target is mainly applied to food grain, rather than all grains. The recent Number One documents also often indicate that China must fully utilize the domestic and international resources and markets to ensure its food security. Therefore, China's role is expected to increase in international trade. To improve agricultural productivity, in addition to investing more in agricultural technology and resources, China has also made considerable efforts to foster land consolidation. Small-farm transformation has been undergoing smoothly. A plan to separate the land operational rights from contract rights is innovative, as it achieves both equity and efficiency goals.

Concerning farmer's income growth and rural poverty, China has shifted its policy regime from taxing to subsidizing agriculture since the mid-2000s. In terms of the total budget, today, China is running the largest agricultural subsidy program in the world. However, given the size of rural farming households, the program's contribution to farmers' income is very moderate. Financial burden has emerged. Therefore, capping agricultural subsidies since 2012 is not surprising. China has decided to eliminate rural poverty by 2020. While this is an ambitious goal, as a political commitment, the goal is very likely to be realized. However, at the same time, China should pay much more attention to the micronutrient deficit of many people in the less developed regions.

There is big lesson from using price and market interventions to raise farmers' income. Price interventions increased domestic production and farmers' income. However, they also resulted in several serious problems. The interventions together with the falling international prices in recent years have increased the price gaps of major agricultural commodities between China and international markets. Imports of many agricultural products have been rising. Increase in production and imports have resulted in massive rise of government grain stocks. In the past three years, China was at the crossroads of making a decision on how to manage its price intervention policies and meantime ensure national food security and increase farmers' income.

The recent efforts to resolve the dilemma of price and market intervention are encouraging but also challenging. The target price policy seems a feasible solution to the current dilemma, as it lets the market to determine agricultural prices and farmers' income is ensured with the target prices. However, if the goal of target price policy is set to raise farmers' income rather than mitigating market risks, a huge financial burden will become the next policy dilemma. Moreover, actual implementation of target price policy to millions of small farms is also challenging. The most recent maize market reform initiated in 2016 seems to have taken some considerations of the defects of the target price policy. Maize price will be determined by the market. A separate income support will be provided to farmers if maize farmers operate at a loss. However, the amount of income support is not pre-determined, which helps the government to mitigate financial risk and burden. With more than half of income from non-farm activities for average rural households, to significant raise rural household's income, more efforts should be made to increase off-farm employment for rural labor in the future.

China's experiences in agricultural development and food policies in the first 30 years of reform and the recent decade are useful lessons not only for China's way forward to its agricultural and food policy, but also to many developing countries. As we discussed above, institutional reform, technological change, market reform, and investment in agriculture are major driving forces for the miraculous success of China's agricultural development in the past. The policy challenges resulted from the unsuccessful price and market interventions in the past decade and the recent efforts to eliminate these interventions are vivid policy experiments that show the appropriate roles of government and market. Therefore, we believe that the previous experiences on agricultural development based on the four major policy driving forces will still be the keys for successful agricultural development and ensuring food security for China in the future.

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