THE POLITICAL ECONOMY OF SEEDS:

PARADIGMATIC SHIFTS OF SEED GOVERNANCE AND SEED MARKETIZATION IN CHINA

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CERTIFICATE OF ORIGINALITY

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Abstract

Seed is the most important means of production for agricultural producers, and also one of the defining elements of agricultural production. Drawing on the theoretical frameworks of Marxist political economy and Marxist political ecology, the research focuses on three themes: seed commodification, the role of seed in agrarian change, and seed governance.

First, the research explores the transition of the seed provision system and the development of seed marketization. It reviews China's collective seed provision system in the Mao era (1950s-1970s) that combined grassroots self-reliance with state's support and subsidies. When the neoliberal project was globally launched in the 1970s, seed marketization was also initiated with the unfolding of China's Reform and Opening up (1978). Since then, China's seed marketization went through three stages: the monopoly of state-owned seed companies, free competition, and industry concentration and centralization. This research depicts and interprets the developmental stages and features of the commodification of seed in China.

Second, seed is crucial in shaping the agricultural modes of production. This research uses the case of introducing hybrid maize seed to Northeast China to explain how seed helped establish and maintain capitalist agriculture. In another case, this research explores how seed enables agricultural upstream agents to undertake agricultural production and accumulate capital along the agricultural industry chain. Contrary to the belief in technology neutrality, these two cases show the significance of technology in the formation of capitalist agriculture, class differentiation and the increasing profit concentration in the agricultural industry chain.

Third, this research concentrates on the paradigmatic changes of seed governance in China that is characterized by a dramatic transition since the end of the Mao era and the enactment of China's first seed law in 2000. In the Mao era when seed was not a commodity, seed governance was not necessary in the collective seed provision system. However, since seed

marketization began in China, seed governance was to facilitate the liberalization of China's domestic seed market. Between 2000 and 2010, China's seed market had seen the participation of foreign seed companies, the withdrawal of research institution-associated seed enterprises, and the increase in domestic private seed enterprises. The overproduction crisis in China's domestic seed market that continued from 2010 contributed to a new seed governance regime that encouraged concentration and centralization in China's domestic seed industry.

By focusing on the three themes, this research explains the unfolding of the neoliberalization project in China's context and examines China's agrarian change by looking into the role of seed. The research finds that the neoliberalization and agricultural capitalization in China dramatically transformed the provision system of means of production and agricultural mode of production, which both point to the concentration of profit and power in the big players. The state plays a crucial role in the creation of agricultural capitalists and large domestic seed companies that can participate in the global seed market.

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Table of contents

List of figures

List of tables

List of abbreviations

ABS	Access and Benefit-Sharing agreements
ATE	Agricultural technology extension
CITIC Group	China International Trust & Investment Corporation
CNADC	China National Agricultural Development Group Co., Ltd, zhongguo nongye fazhan jituan youxian gongsi, or zhongnongfa
COFCO	China National Cereals, Oils and Foodstuffs Corporation
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
HRS	Household Responsibility System
HYVs	High-Yielding Seeds
IRRI	International Rice Research Institute
MOA	Ministry of Agriculture of the People's Republic of China
MOST	Ministry of Science and Technology of the People's Republic of China
NEEQ	National Equities Exchange and Quotations, The New Third Board
PPB	Participatory Plant Breeding
PVP	Regulations of the People's Republic of China on the Protection of New Varieties of Plants
PVPA	Plant Variety Protection Act
R&D	Research and Development
si zi yi fu	Four Self-Reliance and One Supplement
si hua yi gong	Four–izations and One Supply
TRIPS	Trade-Related Intellectual Property Rights Agreements
UPOV	Union for the Protection of New Varieties Plant Breeders' Rights of Plants
WTO	World Trade Organization
WB	World Bank
BRI	One and Road Initiative

Chapter 1 From the grassroots to the market: The transformation of China's seed provision systems

Since China's market reform from the 1980s, especially since 2000, the development of the seed market and the efficiency of seed governance are often measured by the market economy standards, which mainly highlight where the market and the governance structure falls out of the market economy orthodoxy, without first questioning whether the standards are justified or not. However, the narrative of the seed market and the approaches of seed governance from Wang Jinhai[1], a retired government official who used to be the head of the municipal Seed Station (种子管理处, zhongzi guanli chu) in Heilongjiang, Northeast China, may strike some as strange:

> In the period of "four–izations and one supply," only the seed companies were allowed to sell seed. To begin with, there was not a seed market to govern, and there were few problems with the seed quality. Nobody would sell fake seed because there was no need to. Seed was cheap, on the one hand; on the other, overproduced seed could be sold as grain and the state would subsidize the prices. They would not be sold as seed for the next season.
>
> Every year, we would inspect the seed production sites for the entire summer. Some production teams might not dare to report on the low purity seed. But if the seed plots were noticeably impure, the leaders from the Bureau of Agriculture (nongye ju) would scold the manager of the seed company on site, and the problem would be addressed immediately, as people's faces were very thin back then.

As someone who worked in the seed system for over 30 years since the 1970s and witnessed first-handed the changes in China's domestic seed market and the seed governance regimes, Wang's narrative expressed a certain degree of nostalgia, which is shared by my other research participants in the project. Among 150 or so people I interviewed during my fieldwork, 15 are retired from or are currently working in China's seed governance authorities. Noticeably, their opinions towards the seed market and seed governance pre- and post-marketization are related to their education backgrounds and work experiences.

1 Interview with Wang Jinhai, May 19, 2017. All the names of the research participants are pseudonyms.

Wang was born in 1952. He returned to his production team after graduating from senior high school. Before 1949, the literacy rate in China was below 20% (people.com.cn, 2009). When new China was founded, the state dedicated to providing education opportunities to more people, especially the peasants and workers. Wang was amongst them. Upon returning, he successively became the propagandist of Mao's thoughts, the political instructor of the militia, the cashier and technician of the *production team* (生产队, shengchan dui, explanation on the term later in this chapter). In 1974, Wang was selected as the *peasant-worker-soldier student* (工农兵学员, gong nong bing xueyuan) to study at the Northeast Academy of Agriculture (dongbei nongxueyuan). It was a Maoist initiative to help young people with peasant, worker and soldier family backgrounds to learn agricultural knowledge and skills. Three years later, he was assigned to work at the Nenjiang branch (分校, fen xiao) of the academy. Within one year, he was relocated to the seed station (种子站, zhongzi zhan) in the Nenjiang district and remained in the seed governance system for nearly 30 years.

In the Mao era (1956-1976), many people with a rural background, like Wang, were educated in the agricultural academies and worked at their own production teams, brigades or communes within the collective farming system. Some of them served at various seed governance authorities, based on the levels and length of their training. Memories and narratives of the seed provision system in the Mao era were valuable in terms that it is under-documented in the literature, on the one hand, and they can serve as an alternative model to seed commodification, on the other. Non-commodified seed provision systems could be an inspiration for the social movements that are protecting farmer's seed rights.

A glimpse at the seed provision system in the Mao era

Around the time when Wang was born (1950s), a collective farming system also was formed in China. The three-tiered system consisted of production teams, *brigades* (生产大队, shengchan dadui) and *communes* (公社, gongshe) from the bottom to the top, which later became the institutional base for a collective seed provision system. In April 1958, the Ministry of Agriculture and the Ministry of Grains jointly organized the First National Seed Conference (全国种子工作会议, quanguo zhongzi gongzuo huiyi) and produced a policy that emphasized seed self-reliance at all grassroots levels. Production teams were expected to carry out their own seed selection and breeding, and to save and use their own seed. These grassroots self-reliant practices would be supplemented by some adjustments (the policy was referred to as "*four self-reliance and one supplement*", 四自一辅, si zi yi fu).

Auntie Gao, born in 1949, was the mother-in-law of my hostess in Fencha village, Heilongjiang Province. One afternoon after lunch, she took the time to enlighten me about the collective farming practices at her production team and how the seed was grown, selected, saved and used. As a 69-year-old senior woman, she might not clearly remember or fully comprehend the organizational changes in farming over the years, but her fond memory of her youth time credits the lively collective period.

Auntie Gao's production team mainly grew wheat, soy and millet for government procurement[2], together with maize, potato and several bean varieties. Wheat productivity was low which made eating food made with wheat flour a rare pleasure. Millet, instead, became their staple food. Soy was central for local people's everyday life, for it could be made into cooking sauce, tofu, oil and the soy cake for animal feed. Maize was a long way from being the main crop in this northeastern province, as it has been since 2012. Back then, it was only consumed to make porridge and steamed cake, as a supplementary food.

Seed breeding was not commonly practiced at the production team level until around 1975. The production team, as Auntie Gao recalled, was responsible for its own selection, saving and re-using of all the crop seed during the Mao era, which she remembered in great detail:

> After maize is harvested, the women members select the biggest and best-shaped cobs and tie every pair of them together before hanging them in the team storage for wind-drying and storage. When the next spring comes and the cobs are well dried, the team members use a special machine to thresh them and try to keep the particles intact. Wheat seed selection requires the most experienced members who possess the skills and physical strength to do winnowing. The heavier and better particles will be left at the upwind for the able men members to further sieve. Soil, stone pieces and other unwanted small matter will be sieved off. If it is well done, the seed will be left at the center of the sifter and they will be kept in separated cubes of the team storage. Millet and soy seeds are selected in the similar way. But for soy seed, in the following spring, the women members will be gathered at the team storage[3]and asked to pick out the

2 In 1953, the planned purchase and distribution policy (tong gou tong xiao) was launched in China. It was designed by Chen Yun, the then Vice Premier of China's State Council, to stabilize the domestic market and to guarantee that the planned demands for grains would be met through the government procurement (Wang, 2005). Soon afterwards, oil plants (November 1953), cotton cloth and cotton (September 1954) and other main agricultural products were also included in the policy.

3 In another interview, the production team technician, Su Tianwen (May 18, 2017, Heilongjiang) spoke of the reasons why soy seed selection needed to be done at the storage, instead of being carried out at each individual house. This arrangement was made to supervise the selection process and make sure all the seeds would remain in the production team, rather than being hidden and consumed by the members. In some cases, the soy could be distributed to each household, but the amount would be recorded and compared with when the seeds were returned. A loss of 1.5-2kg out of 100kg soy was permitted.

premature ones or those with worm holes. For potato, the bigger ones will be selected and kept in the underground cellars, waiting for the women members to cut out the sprouted parts as seed in the next growing season. The seeds are selected, saved and re-used year after year, and the productivity doesn't change much.

Auntie Gao's memory reflects several features of seed provision at the production team level. Firstly, seed saving is an annual collective activity which is instructed by the production team and carried out by its members. In case of losses that occur during storage or selection, additional 10%-15% of grains are saved to the annual use. Secondly, a clear division of labor between genders exists. Men are responsible for physically demanding procedures such as winnowing and sieving, while women are particularly needed in selecting and screening, where care is essential. Thirdly, seed saving requires communal facilities (sun fields and storages), which personnel are assigned by the production team to attend to. Fourthly, additional material gains are not given to those who have the experience and skills in seed selection, but their fellow members' admiration can be felt back then and even now. Auntie Gao spoke with great respect of the senior members who led them in saving seed.

The production teams' seed self-sufficiency was facilitated by the brigades and communes. Each brigade and each commune had a seed base specializing in seed production and seed supply, which was referred to as *liangzhongchang* (良种场). The seed base could be one production team, or a site allocated by the brigade or commune where a group of people were selected from different production teams to work on. In addition to seed production, these seed bases often carried out seed breeding experiments or help the agricultural academies with new seed variety tests.

When the production team is short of seed, either it is due to a bad harvest or it simply is in need of better varieties, the need can be met through two channels. One is to exchange seeds with other production teams. The other is to purchase from the seed bases established at the brigade or commune level. Seed exchanges and purchases are both regulated by the state, but they do not strictly follow the market law of demand and supply. Seed is the most important agricultural input, especially in conventional agriculture where there were few if not none chemical inputs were applied. However, under the collective farming system, the state consciously avoided the commodification of seed, and set according regulations to safeguard production teams' easy access to improved varieties at a low cost. Seed is exchanged with grains in equal amount or only requires a small addition. Cash is needed when the production teams purchase from the seed bases. Even so, seed prices are only about 2.5 times of the grain

prices. In addition, seed exchanges and seed purchases exist not only inside one commune, they are also practiced between communes and between provinces.

Seed commodification and institutional changes of seed governance

In 1978, China joined the rest of the world in embracing the market economy by initiating the *Reform and* Opening up (改革开放, gaige kaifang). The seed provision system also transformed differently from the Mao era.

Dissolving the collective seed provision system

In the previous period, the collective farming system was self-sufficient in seed provision with the supplementary help from the state. As seed was not treated as a commodity in the Mao era, the focus of seed governance then was to instruct and organize seed breeding, to supervise seed production, to coordinate inter-provincial seed exchange, to popularize improved varieties, and to carry out variety certification and seed tests (CNSA, 2007). However, since 1978, the collective seed provision system was replaced by regional seed provision directly organized by county seed companies. In June 1978, China's State Council approved the report from the Ministry of Agriculture and Forestry (农林部, nonglin bu), which proposed to establish seed companies at provincial, municipal, and county levels. In practice, the newly established seed companies and the existing seed governance authorities, seed stations, were staffed by the same personnel. The new arrangement was to realize regionalization of seed distribution, specialization of seed production, standardization of seed quality, mechanization of seed processing and centralization of seed supply at the county level, often referred to as *four–izations and one supply* (四自一辅), or 'si hua yi gong'.

These newly established county seed companies relied on the seed bases and production teams for seed production. The former was the cornerstone of the new seed provision system (Shu, 1982). In 1982, there were 2,290 state-owned seed bases, basically each in every county. The total farmland of the seed bases reached 2.25 million mu[4], with 300,000 people working on them. Apart from the state-owned seed bases, the county seed companies also relied on special seed bases, those at the brigade and commune level or collective-owned, and individual rural households to supply seed. In total, the supply scale of the new seed provision system was about 30 million mu, which annually produced over 5 billion kg of seed, nearly half of the national seed demand (ibid.).

4 1 mu=666.67 m2

Wang Jinhai's account, cited at the beginning of this chapter, also made three crucial points about seed quality supervision in the "*four-izations and one supply*" period, at least in the beginning years. Firstly, the low profits in seed discouraged the sale of inferior seed or fake seed. And, the state's subsidies reduced the risks of overproduction and prevented dated seed from being sold. Secondly, the administrative coordination played an important role in securing the seed quality. Since seed bases and the seed companies were both within the agricultural system, seed production was administratively coordinated, and the production process was more regularly and closely inspected. Contrary to post supervision that is popular applied today in business contracts, the agricultural administrative departments used process supervision on seed production. Thirdly, the seed company managers did not just sell seed, but also held pride in their work. "A thin face" was a term used to describe the moral responsibility that one felt for one's work and the shame that one would consequently face if one failed to do so.

The seed bases enjoyed the state support in funds, material supplies and in many other ways until the public institution reform (事业单位改革，shiye danwei gaige) in the 1990s (Xie & Liao, 2007; Wang L. , 2010). The reform is aimed at reducing the personnel financed by the government and transforming the public institutions which involved in production and business activities, into independent enterprises. This reform put some seed bases into such a difficult situation that they were forced to distribute part of their land among the employees as their salary, and to contract out the other part in order to support the retirees[5]. Seed bases remained only in name. On the other hand, with the liberalization of China's domestic seed market, newly emerged private companies preferred making production contracts with private seed producers other than the seed bases, for the contract terms were more flexible with the former.

The seed companies' production base at the village level was also changed with the deepening of China's domestic reform. In rural China, the reform dismantled the collective farming system and replaced it with the *Household Responsibility System* (家庭联产承包责任制, HRS, jiating lianchan chengbao zeren zhi), under which, each household contracted a share of land from the collective according to their family sizes and thereafter they were supposed to make their own economic decisions and be responsible for the subsequent gains and losses. Without the coordination of the production team leaders, the seed companies then had to make contracts with individual rural households. With the increasing gap between seed and grain

5 Interview with Wang Jinhai, May 19, 2017

prices, and the insufficient inspection that individual seed production received, some producers were tempted to mix grains in the seed.

Competition and profit-making introduced to the public institutions

> Graduated from the agricultural academy in 1996, the following year Wu Caimin[6] was assigned to work at the agricultural technology station (农技站，nong ji zhan), a county-level extension institution in Hunan Province. Among the 17 staff who were funded by the government budget, 9 were technicians and 5 of them were college graduates. Agricultural extension work was contracted to these technicians and each of them was responsible for 3 or 4 villages. As a fresh graduate, Wu learnt agricultural technology from both the books and the local peasants. In his spare time, he would go to villages and talk to peasants. Wu paid special attention to the folk terms for technical words in order to better communicate with the peasants when they sought for his help.
>
> Agricultural technology was introduced to the peasants in both collective and individual ways. Before the spring sowing, village leaders would be assembled by the government, and the technicians would lecture them on seed choices and pest hazard prevention. Afterwards, they would also bring learning materials back and disseminate them to the villagers. In other times, the technicians would go to villages to introduce the latest agricultural technologies. When an individual peasant needed help, for instance, with the temperature and time for seed soaking, technicians like Wu would give them one on one instructions.

Wang Jinhai's fellow technicians learnt agricultural knowledge and technology from the state-initiated training programs, while the latter technicians, like Wu, benefited from the education system established in the Mao era and had the chance to receive a college education. Different in education though, technicians shared the similar dedication to work and contributed significantly to the increase in agricultural productivity, especially in the planned economy (Zhang, Luo, Huang, & Pan, 2010). Technicians like Wu continued to transfer the latest technology to the peasants in the 1990s. However, the marketization of seed changed the agricultural institutions and their staff, and not long before the structural adjustment program in China put some of the technicians out of a job.

6 Interview with Wu Caimin, Hunan, May 1, 2017

The seed companies were established inside the government, but not all the staff were civil servants and paid by the government. Instead, the seed companies, like the rural households, were expected to be responsible for their own gains and losses (Tong, 2002). The imperative of profit-making gradually shifted the seed companies' focus from seed provision to seed sales. In 1987, the former Ministry of Agriculture officially separated the China National Seed Corporation from the National Seed Station, signifying the creation of independent seed enterprises in China and a liberalizing domestic seed market. Besides the former state-owned seed companies, new actors also entered the seed market. In the 1990s, the state further cut financial allocation for the public institutions. In 1989, the State Council (State Council, 1989) introduced paid services and competition into the public institutions. It encouraged the agricultural research and extension institutions to sell agricultural inputs to match the technology that they promote (技物结合，ji wu jiehe). The 1993 Law on Agricultural Technology Extension upheld the decision. Thereafter, the pressure of profit-making transferred these institutions to be more enterprise-like. Take one agricultural academy in Hunan Province for instance[7]:

> Seed breeder Xu Gushan started working in this institute from 1976 and retired in 2010. When he first started, the institute consisted of ten offices (科室，ke shi), including seed variety, cultivation, crop protection, soil and fertilizer. Since 1987, the academy went through a dramatic adjustment and introduced pig farming to increase its incomes. Later on, the crop protection office started selling agro-chemicals, and the variety office set up a seed enterprise. In the 1990s, these business activities became very profitable. Pig farming created a bonus of RMB 20,000 for the person in charge and the crop protection office's income reached over RMB 100,000. The seed variety office also profited, but the success was not generally shared. Seed breeding was under-funded and those who continued this work sometimes could not even get paid. Others' incomes were not impacted by the low financial support for research since they were compensated from seed sales. In the end, only Xu chose seed breeding over seed sales.

The agricultural technology extension (农技推广，nong ji tui guang, ATE) system went through an even greater transformation. Under the newly established HRS, ATE largely depended on the public institutions, the ATE system. Between 1978 and 1988, the ATE system rapidly expanded. In 1989, there were 1003 county-level ATE centers, 198 animal husbandry technology centers and 198 aqua-cultural technology centers (Chen, Chen, & Xue, 1989). All

7 Interview with Xu Gushan, Hunan, April 27, 2017

the ATE institutions established their own agricultural input sales departments. Although the commercial business compensated the low funds that ATE received from the local governments, unfortunately, it gave the local governments an excuse to further cut their financial support (Huang, Hu, & Zhi, 2009). In 1992, 44% of county-level ATE stations and 41% of township-level ATE stations were faced with funding reduction or termination, and one third of the technicians left their positions (Song, 2008). Table 1 illustrates the personnel loss of China's ATE system from 1996 to 2006[8].

Table 1.1 Personnel of China's ATE (10,000)

Year	Total	Above the county level*	County level	Township level
1996	102.5	6.9	37.5	58.1
1997	101.4	6.6	37.8	57.0
1998	105.8	6.0	35.8	64.0
1999	103.5	6.5	35.6	61.4
2000	101.3	7.1	35.3	58.9
2001	98.2	7.2	35.0	56.0
2002	93.4	6.8	34.3	52.3
2003	88.0	6.8	33.0	48.2
2004	83.2	6.6	32.0	44.6
2005	84.2	7.3	33.2	43.7
2006	78.8	7.3	31.8	39.7

Note: ATEs above the county level include the prefectural (municipal), provincial and national ATEs. Source: The Ministry of Agriculture. (Huang, Hu, & Zhi, 2009)

The Center for Chinese Agricultural Policy conducted a rapid rural appraisal in 28 counties of seven provinces across China. The survey revealed that, among the total 363 ATE stations, 77% had no funds for technology extension and 25% could not pay technicians' salaries on time (Zhang, Luo, Huang, & Pan, 2010). Faced with the increasing funding issues, the ATE system concentrated more on the profit-making commercial activities, selling seed, agro-chemicals and fertilizers. Besides the seed companies, ATE stations became the other main seed market actors. In the meantime, ATE work was seriously undermined:

8 The State Council took measures to increase the ATE technicians, but without fiscal support, ATE stations continued to lose their personnel.

> In the 1990s, the whole system nearly collapsed: no real service delivery took place; few or no innovations reached farmers; connections with other rural development agencies were non-existent or ineffective. The system itself had not been updated and most staff dedicated time and energy to activities other than serving farmers or contributions to sustainable rural development. (Zhang, Luo, Huang, & Pan, 2010)

Inside the seed companies and ATE stations, the profit-making opportunity was witnessed by those working there. In the 1990s, when the state regulations on market entry loosened, these company staff and technicians (even Wu) were the first to start their private business as seed salesmen. Some of them left their jobs or lost them in the government streamlining; others kept seed selling as a side job. Their former work experience equipped them with three crucial advantages: the technical expertise that enabled them to examine the seed qualities; the marketing channels, previously exclusive to the seed companies and ATE stations, were now captured by them; the colleague relationship they had in seed companies or ATE stations would advance their access to government policies in the future.

The 2000 Seed Law and the rapid transformation of China's domestic seed market

"The reform in the 1990s was a notable 'breaking-off' from the path of the 1980s" (Yue, 2016) in China. Th observation made by Yue still stands regarding the development of China's domestic seed market. China's seed governance and seed marketization went through several defining changes in the 1990s. The separation of seed companies from seed stations not only created the first group of independent seed enterprises[9], but also resulted in independent market inspection and management for the first time. The introduction of competition mechanism and profit-making activities to the agricultural extension and research institutions contributed to the undermining of seed breeding and the decrease of technology transfer to the peasants. These changes, in turn, paved the way for even greater transformation in seed governance and seed marketization after the Millennium.

Besides the institutional changes in the seed companies and ATE stations, the 1990s also saw China's integration with the world economy. Since the Reform and Opening up, China had been seeking development inspirations from the ex-socialist countries (Hungry, Poland and Yugoslavia), the neighbouring Japan, and East Asian newly industrializing economies (South

9 The seed companies were not fully independent. They still enjoyed government fiscal support to some extent and also shouldered social welfares for their staff.

Korea andTaiwan) in the 1980s (Yue, 2016). However, from the early 1990s onwards, China turned her head to the US and reached out to international institutions, such as the International Monetary Fund (IMF) and the World Bank (WB).

Since the 1950s, IMF and WB initiated the Structural Adjustment Programs (SAPs), a loan attached project that required receiving countries to implement market-oriented reforms. From 1996 to 2002, the WB provided a loan of USD 57.1 million to China to promote seed commercialization, to encourage privatization of China's state-owned seed companies, and to advocate technology application in agriculture. It was also aimed at streamlining China's domestic seed sector, especially through the promotion of breeders' rights and international cooperation in seed breeding (WB, 2003). Consistent with the loan requirements, in 1995, the Fifth Plenary Session of the Fourteenth Central Committee launched the Seed Project (种子工程， zhongzi gongcheng) in China. It intended to realize four fundamental changes in China's seed sector, including the improvement of seed production, the socialization and internationalization of market competition, the establishment of large-scale specialized seed enterprises or enterprise groups, and the integration of seed research, production, extension and marketing (Li, Jiggins, Van Bueren, & Leeuwis, 2013).

The Seed Project provides a blueprint for seed governance and seed marketization in China throughout the Ninth Five-Year Plan and extended to 2010 (Comprehensive Plan for the Seed Project , 1996). Nevertheless, the significance of the Seed Project was overshadowed by the rolling out of China's first Seed Law (2000). The latter signifies the liberalization of China's domestic seed market to domestic and foreign private enterprises. It also means a deeper transformation of China's seed governance regime and the seed market structure.

> The threshold for market entry was set very low in 2000. The Seed Law stipulates in Article 26, Chapter 5 that, business certificates (经营许可证, jingying xukezheng) must first be obtained before applications for business licenses（营业执照， yingye zhizhao） are made. To obtain the production certificates (生产许可证, shengchan xukezheng), according to Article 6, Chapter 2, Regulations on Crop Seeds Production and Business Certificate (the Regulations), the applicants must provide registered asset of RMB 1 million for conventional seed (stock seed included) and hybrid parent seed, while hybrid seed production requires registered asset of RMB 5 million. Additionally, applicants also need to meet requirements for sunning grounds, drying facilities, warehouses and technical personnel. For business certificates (经营许可

证, jingying xukezheng), the Regulations states that, the applicant must provide the registered asset of RMB 5 million for main hybrid crop seed and of RMB 1 million for other seeds. Fixed capitals and technicians are also required. However, business certificates are not required if applicants only sell packaged seed and promise not to sub-package them, or if they can obtain written commission from those who possess business certificates.

In practice, at times, the Seed Law and the Regulations were only followed in name. Registered assets could be borrowed upon application and be returned when the certificate and licence were obtained. As to fix capitals, the sunning grounds, drying facilities and warehouses were not always inspected on site by the related administrative authorities. Similarly, technicians' qualifications could also be fake. For seed salesmen, the Seed Law's emphasis on the commodity form of seed (packages) in fact gives permission to anyone to sell packaged seed. Easy access to the seed market contributed to the rapid increase of seed enterprises and seed salesmen in China. By the end of 2000, there were more than 2,300 registered seed enterprises in China (Jiang, Guo, & Li, 2015). Within 6 years, the number increased to over 9,000 (Yang, Wang, Gong, & Wang , 2006). The number of seed salesmen was beyond counting.

In addition to the rapid increase of private seed enterprises and seed salesmen, the 2000 Seed Law also set off the structural adjustment of state-owned seed companies (Article 56, Chapter 9). But before that, the separation of seed governance and seed management must first be completed. According to the 2000 Seed Law, the agricultural administrative authorities were no longer allowed to participate in seed production and management. Nor were seed production and management institutions part of the seed administrative body. Local agricultural public institutions should also strip off their business activities, and divert their focus to technology extension and seed-related services. They could also merge with seed governance institutions and ATE institutions. The full separation of seed governance and seed management was to be completed before July 2007[10], set by the State Council (State Council, 2006).

When the separation was achieved, the state-owned seed companies would be structurally adjusted into independent joint-stock companies. The accounts of the previous companies would be cleared. The properties and the land assigned to them would be sold or dealt with

10 In practice, the separation was not fully completed by this date, partly due to inner resistances from the seed companies, in fear of losing government supports for the newly established seed companies. (Wang & Zhao, 2008)

otherwise. These incomes would first be used to compensate the previous employees who were fired or decided to seek job opportunities elsewhere (State Council, 2006). Tried as the seed companies may, during the structural adjustment, these company employees were to bear the reform costs. They lost the stable jobs and related social welfare. In return, some of them became contract workers at the new companies, others were given seed money to start their own business or received compensation to find other jobs. However, the compensation was too little to make up to their losses. Till today, those who were laid off during the structural adjustment of the state-owned companies are still looking for ways to express their frustrations[11], and to make the market reform costs known (Wang H. , 2006). In 2006, people.com.cn (2006), an online news platform established by People's Daily (the official newspaper of the Communist Party of China), reported the following news:

> Nehe[12] Seed Company once was one of the biggest county seed companies in China. It owned 15 subsidiaries and its marketing network spread along 5 exclusive railway lines and reached out to the entire country. Staffed by a stunning number of 500 employees, the company was well equipped with complete office and inspection & testing facilities. It also had plenty of sites for storage and other uses. Either measured by employee number, production scale, technical level or inspection & testing capacity, Nehe Seed Company was top of the seed industry. It was especially famous for potato seed.
>
> Like other seed companies, Nehe Seed Company also went through structural adjustment in early 2001. When it first started, a workgroup was sent by the county government to see through the reform. They explained to the company employees that the company had to be structurally adjusted because it was unable to pay its debts. There was not any policy to follow, no government instruction to listen to and no model to replicate. But the reform had to be done. The word got out and on the same day, over 100 employees rushed to the warehouses and plundered the company properties. Some employees received crop seed according to their working years. Others refused, because they did not think this was legal. Besides seed, in a few days, everything that was movable, including office supplies, inspection & testing equipment and processing facilities, was taken away by those in charge.

11 Interview with Wu Caimin, Hunan, May 1, 2017

12 Nehe is a county-level city in Qiqihar City, Heilongjiang Province, Northeast China.

> At the beginning of the structural adjustment, the company neither checked its assets or held employee representative meetings. Employees were utterly at loss about how they lost their jobs, while the company lost much of its properties before any reform could take place.
>
> 5 years later, when the people.cn released the news, the former seed company employees told the reporter that they never received the same compensation as others previously working at the public institutions. On top of that, they themselves were expected to pay for the unemployment insurance in full. Also, if they were to have their pensions upon retirement, they first needed to submit RMB 30,000.

The structural adjustment of Nehe Seed Company was sudden and unexpected. The state-owned assets were lost to the companies employees who did not know where their future lay and wanted to take as many advantages as they could in the unknown reform. During my work fieldwork in Nehe, I came across the one who eventually privatized the county seed company. Reluctant to reveal the actual process of privatization, Manager Zhang[13] only provided me with a vague description of how structural adjustment happened.

According to the State Council (State Council, 2006), the structural adjustment could be achieved through the transfer of property rights, through the establishment of the share-holding system, and through mergers, bankruptcy as well as selling. Before the reform, Manager Zhang was in charge of two subsidiaries of the seed company, including the famous potato seed company. According to him, 14 out of the 16 companies were losing money before the structural adjustment, and only 2 were qualified to establish share-holding systems. The companies first stripped off non-performing assets and then distributed the shares among several people. The state retained shares as well. Eventually, the state withdrew from the new companies and Manager Zhang bought out the rest shareholders. And now, the seed company, renamed Xifei, was officially privatized.

Privatization was encouraged in the reform of state-owned seed companies. Share purchase enjoyed favorable policies (Yang Z. , 2005). The newly structured and organized company could continue using the previous company name, and inherit the invisible capital of a good reputation that took the state-owned company years to build (Wang G. , 2000). Others, like Manager Zhang's Xifei, were permitted to keep the previous company facilities and seed strains. The reform might mean chaos and loss for others, but Manager Zhang came out of it

13 Interview with Manager Zhang, May 15, 2017

stronger. His company was the only one that had registered asset of RMB 5 million in 2001 and still is the biggest seed company today in Nehe.

Manager Zhang's old colleague, Yan[14], also started his seed business when the seed market was liberalized for competition. He worked in Nehe Seed Company for 18 years and left his job in 1998, before the reform started. During our interview, he envied Manager Zhang for the favorable conditions he got from taking over the state-owned company. Besides the facilities and seed strains, Xifei company also received various government subsidies that other companies could not dream of. Every year, the State Council would subsidize one company at each county to store seed in case of natural disasters. Xifei was the only receiver of this subsidy over the years. When the disaster does not happen, Xifei is allowed to sell the subsidized seed on the market. In that case, it will rely on other local seed companies to deal with the seed, but subsidies are exclusive to Xifei itself.

China's entry to WTO and the re-configuration of the seed market

The 2000 Seed Law was China's attempt to conform to international conventions on seed governance and seed marketization, and it also paved the way for China's entry to WTO. China's negation of the WTO membership lasted for almost 15 years. When criticized that China made concession to America in order to obtain the WTO membership (Brahm, 2002), Long Yongtu, then vice minister of Ministry of Foreign Trade and Economic Cooperation (MOFTEC), explained "The result of the negotiation (with America) is that China has decided to insist on reform and opening with integration into the world economic trends. China will now follow international rules in doing things, which is not a concession either. " Upon accession, China agreed to "Open and liberalize its regime in order to better integrate in the world economy and offer a more predictable environment for trade and foreign investment in accordance with WTO rules" (WTO, 2001).

Before the entry, China's seed market had already been liberalized for foreign seed, with Monsanto being the leading figure. China's accession to WTO created more favorable legal and market environment for transitional corporations to invest in China's seed sector.

China once produced the world most cotton for 20 years, but in 1992/1993, an outbreak of pest resistance to insecticides put China's cotton production to test (Fok & Xu, 2008). To overcome this problem, China introduced Bt cotton seed to cotton producers. In 1997, Bt

14 Interview with Yan, May 13, 2017

cotton seed from two joint adventures, Ji Dai Company and Biocentury, was commercially released in China, shortly after China's own Bt seed debut on the domestic market (Wang & Fok, 2014). Ji Dai Company was a subsidiary of Delta and Pine Land Company (D&PL), once the world's leading cotton seed company, which later was taken over by Monsanto (ETC, 2006). The Bt cotton technology that D&PL used was also licensed by Monsanto (Monsanto, 2019).

China's main crop seed market was liberalized after that of vegetable and cotton seed. Back to 1998, Monsanto reached out to Guangxi Province, Southwest China. The next year, it brought hybrid corn seed, Dika, to the Maize Research Institute, Guangxi Academy of Agricultural Sciences. However, the institute was not interested in any cooperation with Monsanto. Before long, Monsanto stroke a deal with the provincial seed company and signed a contract for exclusive agency. The unsuccessful attempt with the Maize Research Institute turned out to be a blessing in disguise, for Monsanto benefitted more with the sales contract with the seed company. The company soon appointed a sales team, and with the help of its connection with the government, seed promotion meetings were held inside the agricultural system, attended by heads of agricultural departments.

Although China National Seed Group Co., Ltd (CHINA SEED) formed a joint venture, China Seed International Seed Co., Ltd, with Monsanto in 2001, my research participant Li Wu[15] recalled that when Monsanto started selling seeds in Guangxi, CHINA SEED was already there to help. It pulled human resources elsewhere to Guangxi and held carpet-bombing demonstrations for Dika 007. Beforehand, employees had to receive intensive training, learning the publicity words and rehearsing the speeches. They would then be distributed to every township and each village to promote the seed. Massive wall and vehicle advertising was also in place. In a span of two years, Monsanto spent RMB 2-3 million alone in advertising, a massive marketing investment that even today is still rarely seen in China's domestic seed companies. Monsanto's seed was not well received in the first two years, but soon it took one-third of the Guangxi hybrid corn seed market, with an annual profit of RMB 20-30 million.

Before China's entry to WTO, the transnational seed corporations presented in China's seed market primarily in Monsanto's way: seeking for seed sales agents. Their partnership with China's leading seed companies not only provided them with human resources and an

15 Interview with Li Wu, April 5, 2017. Li Wu worked at the provincial seed company, Guangxi, from 2000 to 2007, and now is the manager of the CHINA SEED's Nanning Office.

established marketing network, but also made access to the government possible. The transnational seed corporations, in turn, furthered their advantages over the domestic seed companies with the help of their financial capacities and marketing tactics. Nonetheless, the tensions between the transnational seed corporations and their Chinese partners did exist. Seeing Dika 007's popularity on the market, Monsanto proposed to increase seed prices and profit more from the market opportunity. But the provincial seed company refused. As a counter-measure, Monsanto paid a penalty of RMB 500,000 to end the exclusive agency contract and instead, distributed the agency to several newly established seed companies in Guangxi. Upon leaving, Monsanto also took away the best salesmen of the provincial company.

To comply with WTO rules and its related regulations, for instance, the General Agreement on Trade-Related Aspects of Intellectual Property Rights and the Agreement on Trade-Related Investment Measures, China changed its domestic laws to reduce the barriers to foreign direct investment (FDI). Foreign investors can establish three kinds of enterprises in China, namely, equity joint ventures, contractual joint ventures, and wholly foreign-owned enterprises. Laws regarding these legal entities were issues since 1979, and for two decades, FDI in China was restricted. However, in 2001, the latter two laws were substantially altered. FDI firms no longer are required to balance their own exchange income and expenses; they are free to source raw materials and equipment inside or outside China; mandatory export requirement is removed and FDI firms are free to sell their products on China's domestic market or elsewhere; FDI firms no longer need to file their production and business plan to the Chinese government. In general, China promises to provide non-discriminatory treatment to FDI firms.

With more favourable entry conditions, many transnational seed corporations sought partnership with Chinese seed companies (Cheng, 2011; Yang Y. , 2014). Table 2 lists the main joint ventures in China's hybrid corn seed industry since China's entry to WTO. By 2010, more than 70 foreign seed companies entered China's seed market (Ma, 2010; Zhao & Lin, 2009).

Table 1.2 Joint Ventures in Hybrid Corn Seeds

Year	Transnational Seed Giants	Chinese Partners	Joint Ventures	Seed Products	Market Areas

2001	Monsanto Company	China National Seed Group Co., Ltd. (CHINA SEED)	CNSGC-DEKALB Seed Company Ltd. (CNDK) since 2001. China Seed International Co., Ltd. since 2013.	DK 007, DK 008, M751, M753, DK 519, DK 516, etc.	North, Northeast, Northwest, Southwest China and Huang-Huai-Hai Region (the Yellow River region)
2002	DuPont Pioneer	Shandong Denghai Seeds Co., Ltd.	Shandong Denghai Pioneer Seeds Co., Ltd.	Xianyu 335, Xianyu 508, Xianyu696, Xianyu688, etc.	Huang-Huai-Hai Region
2002	Limagrain	Shanxi Tengda Seed Co., Ltd	Shanxi Limagrain Special Crops R&D Co., Ltd.	Field crop seeds (wheat & corn), notably LIC016, and vegetable seeds.	Northeast China and Inner Mongolia
2006	DuPont Pioneer	Gansu Dunhuang Seed Co., Ltd.	Dunhuang Seed Pioneer Hi-Bred Co., Ltd.	Xianyu 335, Xianyu 508, Xianyu696, 32D22, etc.	Northeast and Northwest China
2008	Syngenta	Sanbei Seed Co., Ltd.	Sanbei Seed Co., Ltd.	Syngenta 408, Syngenta 203, Syngenta 205, Syngenta101, Sanbei 2, Sanbei 89, etc	Northeast, Northwest, Southwest China and Huang-Huai-Hai Region
2014	KWS SAAT AG	Beidahuang Kenfeng Seed Co., Ltd.	Kenfeng-KWS Seed Co., Ltd.	Kenwo No.1, Kenwo No. 2, Kenwo No. 1, Demeiya No. 3, Demeiya No. 2	Northeast China

Note: Comfiled by the author from official websites of the above seed companies.

Competition from the transnational seed corporations changed the landscape of China's domestic seed market. One of the most crucial changes was the increase in seed prices. Upon the accession to WTO, China enacted price-fixing laws (for instance, Price Law of People's Republic of China) and regulations on commodities that are were important to China's domestic social and economic development. In August 2001, the State Development and Planning Commission published the first price-fixing catalogue which included 13 categories of commodities that were regulated by the central government. Seed prices were regulated by provincial governments and each year the Price Bureaus (later the Development and Reform Commissions) will publish their own catalogues. Eventually, in 2014, the State Development and Reform Commission notified the local governments to liberalize the seed prices, among other commodities.

From 2001 to 2006, China's domestic seed enterprises rapidly increased while the FDI in China's seed market was still at the initial stage. Seed sales still depended on the marketing networks that existed before China's domestic seed market was entirely liberalized. With the government's price-fixing regulations, the increase of seed prices was still under control. In 2006, the selling prices of ordinary hybrid rice varieties increase by 250% above the production costs, while those of special varieties increased by 566.7% (Zhang Y. , 2006). In the next 5 years, China's seed market witnessed soaring seed prices and fierce competition brought by the foreign seed. The accession to WTO did not leave China's domestic seed enterprise enough time and space to develop or strengthen their breeding capacities. Foreign hybrid rice and corn seed demonstrated better traits, which earned them great popularity on China's domestic seed market. In turn, these seeds also enjoyed unprecedentedly high prices. In my project, the research participants often referred to hybrid corn seed, Xianyu 335, and the marketing miracle it created to explain the changes brought by foreign seed.

As shown in Table 2, in 2002, DuPont Pioneer jointly founded Shandong Denghai Pioneer Seeds Co., Ltd (Denghai Pioneer) with Shandong Denghai Seeds Co., Ltd. Two years later, its signature product Xianyu 335 appeared on the Huang-Huai-Hai region market (a major grain production area) and within two years, its sales rapidly increased. On the same year, DuPont Pioneer founded Dunhuang Seed Pioneer Hi-Bred Co., Ltd with Gansu Dunhuang Seed Co., Ltd to further expand its seed sales in the Northeast and Northwest China. In merely three years, Xianyu 335 took 40% of the Northeast China's hybrid corn seed market (Chen Y. , 2012). Xianyu 335's success first attributed to its exceptional productivity trait. The high germination rate saved peasants' thinning time and reduced the amount of seed used on average farmland plots. Besides, Xianyu 335 dehydrates fast and is suitable for mechanical harvest. Came along with its market popularity was Xianyu 335's high selling price. Denghai Pioneer set the price at RMB 40/kg when Xianyu 335 first appeared on Northeast China's seed market. At that time, the average seed price was only around RMB 15/kg.

High profits attracted waves of seed enterprises and sales agents to enter the hybrid corn seed market. Some stole the parent plants of Xianyu 335 and created hybrid seed of their own.The breeding goal was to create varieties that resembled Xianyu 335's main traits. Others did not possess the breeding capacity, and instead, sought to purchase seed from Xianyu 335's production base in Gansu[16]. Such seed would be sold on the market under other names. As a result, the prices of hybrid corn seed were generally lifted by Xianyu 335.

16 Interview with Wang Jinhai, May 19, 2017

Since 2006, China's seed market not only featured the flooding in of foreign seed and the subsequent increase in seed prices, it also saw the growing importance of marketing strategies. Luda 8, signature product of Zufeng Seed Company, was the leading hybrid corn seed in Yunnan Province, Southwest China, for several years. In the past 10 years, the average cultivated area of hybrid corn in Yunnan was 21.45 million mu[17] (National Bureau of Statistics of China, 2019), and theoretically seed demand is annually 2kg/mu (in practice, 3kg). Yunnan is one of the most geographically complex regions in China, encompassing mountains, valleys and deep gorges. The adaptation of seed is therefore constrained by the rapid altitude changes. Even so, during the years when Luda 8 was popularly received by peasants, its annual sales took up 7.8% to 9% of the total seed supply.

However, some held reservation about Luda 8's market success. Recognizing that Luda 8 was well received on the market, Gao Xueguo[18], researcher at the Research Institute of Grain Crops, Yunnan Academy of Agricultural Sciences, and also the founder/manager of Zhenshi Seed Company, insisted that the disease resistance capacity and the yielding ability of Luda 8 were not as exceptional as its shape trait. Zufeng also realized this, and therefore it made the shape trait the focus of its marketing campaign. Gao held that the marketing strategy was misleading, for the shape trait is only one of the many traits that make a good variety, others including the disease and drought resistance capacity as well as the yielding ability and stability. Zufeng's marketing campaign did not provide the full information of its product, while peasants lack of the access to it, without the help from the agricultural extension institutions. Unfortunately, asymmetric information has become a feature of the seed market since the seed market took form.

Since the accession to WTO, China's seed market experienced an unprecedented development. Merely a decade later, overproduction broke out in the seed industry. In the past, occasional imbalance between seed supply and demand also existed, but the gaps between the two were never over 50%. From 2010 to 2016, however, 'overproduction and oversupply' commonly appeared in the annual reports of listed seed companies (Sohu, 2017), and now the gap was beyond 100% (Yu, 2014).

On the other hand, the re-configuration of China's domestic seed market also intensified the transformation of the seed governance regime, especially the power relation between the agro-industrial capitals (large seed companies) and the state. Firstly, after ATE institutions

17 Luo Yongfeng is the manager of Shihe Seed Company, a leading hybrid corn seed company in Dali, Yunnan. He claimed that the cultivated area of hybrid corn in Yunnan should be 16 million mu. Interview with Luo Yongfeng, March 12, 2017

18 Interview with Gao Xueguo, March 10, 2017

withdrew from the seed market, the institution employees' access to the latest and true information about the seed varieties is constrained. They find it difficult to introduce seed to peasants and fear the responsibility if the introduced seed do not perform well. Instead, seed companies' own commercial advertisements and marketing campaigns become peasants' main channels to learn about seeds. Again, the problem of asymmetric information appears. Secondly, under-staffed seed governance authorities cannot fulfil the according responsibilities. Li Guozhen[19], deputy chief of Nehe Seed Station, helplessly admitted:

> In Nehe County, there are over 400 seed sales sites spreading at every village and each township; while our station is staffed by 9 employees and only 5 of us can do the real work. Before 2016, when we were expected to do a full inspection of the seed market in every spring, we could barely manage. Since 2016, the full market inspection was replaced by the "*two random and one public*" (双随机、一公开, shuang suiji, yi gongkai) policy. Both the inspected sales stores and the inspectors will be randomly chosen, and the inspection arrangements and results will be made public. However, the prefectural- and municipal-level seed authorities are equipped with independent inspection departments, we county Seed Station staff are supposed to take up the additional responsibility.

Thirdly, with the increasing market influences, the power of major agro-capitals has also grown over the years. In turn, the power is sometimes used to expand the market share of the major agro-capitals, in the meantime, violating seed laws and regulations. This behavior not only disturbs the local seed market and hurts the interests of other seed enterprises, but also challenges the authority of the seed governance departments. In 2016, Longping High-tech, China's leading hybrid rice seed company, antagonized many seed enterprises and the local seed authorities in Guangxi Province, Southwest China[20].

> Before the late rice was sowed, Longping High-tech released several uncertified hybrid rice varieties on the seed market of Guangxi Province, which directly threatened the survival of the local seed enterprises. These seed enterprises jointly wrote a complaint letter to the Administration Bureau of Seed in Guangxi. Guangxi Seed Association also sent a letter to back up the local seed industry's complaint. However, neither the seed enterprises nor the Seed Association dared to directly mention Longping High-tech's name. Instead, they vaguely used "certain major seed

19 Interview with Li Guozhen, May 22, 2017

20 Interview with Tang Denglian, March 29, 2017

company" to refer to Longping. Of course, you can tell from the mentioned seed varieties that they were pointing fingers at Longping High-tech. In the letter, they also wrote "This company felt free to disturb our local market just because it has the finances, human resources and brand influences to do so." This incident put the Seed Bureau in a dilemma: The Seed Bureau's responsibility is to uphold the seed laws and regulations as well as maintain the market order, but Longping High-tech possesses such financial power and influences that it might not respect the local authority. In the end, the Seed Bureau only asked Longping High-tech to withdraw the released seed but did not charge any penalty.

The neoliberal turn of China's seed provision

This chapter examines the transformation of China's seed provision systems from 1956 to today. In the first two decades (1956-1978), seed was not considered as a commodity. Instead, seed's use value, rather than exchange value, was its central character. Seed was the most important means of production for agricultural development, whereby industrialization could be supported and the stability of socialist China could be maintained. To safeguard producers' control of means of production, the Mao era regime established the collective farming system, and peasants' seed rights also took the collective form. Under this system, peasants were organized in seed production, selection, saving and re-using. The production team built their own facilities for seed processing, while the combination of local experienced peasants and state-trained agricultural technicians guaranteed seed quality. Outside the production team, the commune-coordinated seed exchanges and seed purchases provided peasants easy and low-cost access to improved seed varieties. In addition, peasants' seed rights were also facilitated by seed bases and research institutions through the state's supplementary help.

The Reform and Opening up in 1978 signifies a new seed provision system. At this stage, seed started taking the commodity form and realized its exchange value. In the beginning, seed marketization was controlled and the marketized seed provision was mainly carried out by county seed companies. But the market monopoly was not enjoyed long by these companies. The public institution reform gave rise to new seed sales agents while the breaking down of the collective farming system further dissolved the institutional foundation of the county seed companies. Even prior to the fully liberalized seed market, profit-making imperative already set in motion market competition which, in turn, urged the cutting of government regulation and the increase of market freedom.

The transition of the seed provision system was part of the rapid transformation of the Chinese society, which happened against the backdrop of the globally turn to neoliberalism. Harvey (Harvey, 2007) argued:

> There has everywhere been an emphatic turn towards neoliberalism in political-economic practices and thinking since the 1970s. Deregulation, privatization, and withdrawal of the state from many areas of social provision have been all too common.

Since the late 1990s, China's seed market reform and seed governance transition followed the "common" route. The separation of the seed companies and seed stations paved the way for the privatization of state-owned seed companies, which put an end to the state's seed provision (except for disaster-relief seed). The enactment of the 2000 Seed Law introduced market competition into the seed sector. The law set a low threshold for entering China's seed market and led to a rapid increase of seed enterprises and seed sales agents. In the meantime, government's regulation of the seed industry greatly decreased. China's entry to WTO further conforms the domestic market reform and regulation regime to the international convention. Thereafter, China's unprepared domestic seed companies were faced with intense competition from the transnational seed corporations. Market chaos and the unprecedented overproduction in the seed industry occurred after the liberalization and deregulation of China's seed market.

In the past 60 years, the institutional foundation of China's seed provision systems transited from the grassroots to state-owned county seed companies, and eventually became private seed companies. In this process, peasants have lost control of the crucial means of production. Their knowledge of seed is also increasingly limited due to asymmetric information on the market and the withdrawal of agricultural technology extension services, which are provided by the diminishing public institutions. On the other hand, China's neoliberalization created powerful agro-industrial capitals, whose increasing control of seed has not only changed China's seed industry, but also profoundly influenced China's agrarian transformation.

Organization of the thesis

Drawing on the theoretical framework of Marxist political, the research focuses on three themes: seed commodification, the role of seed in agrarian change, and seed governance. It answers the following questions: How has the neoliberal project unfolded in China's domestic seed market and transformed China's seed governance? How has seed enabled the development of capitalist agriculture in China? What are the implications of seed

commodification for peasants, agrarian change and the development of agro-capital in China? How to re-establish peasant's control over seed?

In the introductory chapter 1, the research reviews the historical transformation of seed marketization and seed governance in China. The structural adjustment that was introduced to China following the Reform and Opening up in 1978 utterly altered the collective seed provision system in the Mao era (1950s-1970s) that combined grassroots self-reliance with state's support and subsidies. Since then, China's seed marketization went through three stages: the monopoly of state-owned seed companies, free competition, and industry concentration and centralization. In a story-telling fashion, Chapter 1 examines the changes in seed marketization and seed governance against the background of China's neoliberalization project.

Chapter 2 and Chapter 3 explore the role of technology in agrarian change. Chapter 2 uses the case of introducing hybrid maize seed to Northeast China to explain how seed helped establish and maintain capitalist agriculture. In the cropping pattern transition, maize replaced soya and became the dominant crop. More importantly, maize production transformed the agricultural mode of production: the intensification of mechanization, the increase of farming scales, the increasing demand for capital investment and the marketization of agricultural produce. In turn, peasant differentiation was also accelerated. Chapter 3 explores the new dynamics in China's agrarian change featuring the supply-side reform in both agricultural production and the re-configuration of China's domestic seed market. This new transformation signifies the increasing penetration of capitalism in agriculture and capital accumulation along the entire agricultural production chain. Contrary to the belief in technology neutrality, these two chapters show the significance of technology in the formation of capitalist agriculture, class differentiation and the increasing profit concentration in the agricultural industry chain.

In addition to Chapter 1's brief depiction of the transition trajectory underlying China's domestic seed industry and seed governance, Chapter 4 attempts to specifically discuss the structural changes of China's seed governance policies and Chinese agribusiness's capital accumulation strategies. It further probes the state's role in China's seed industry transition with particular reference to policy making and the state's interactions with agro-capital interests. In the Mao era when seed was not a commodity, seed governance was not necessary in the collective seed provision system. However, since seed marketization began in China, seed governance was to facilitate the liberalization of China's domestic seed market. Between 2000 and 2010, China's seed market had seen the participation of foreign seed companies, the withdrawal of research institution-associated seed enterprises, and the increasing of domestic

private seed enterprises. The overproduction crisis in China's domestic seed market that continued from 2010 contributed to a new seed governance regime that encouraged concentration and centralization in China's domestic seed industry.

China's domestic seed market was liberalized around 2000 and over the past two decades, it has experienced dramatic changes, which the seed markets in developed countries witnessed over a period of 80 years. In about 10 years, overproduction already occurred on China's domestic seed industry. To solve such problems, China's domestic seed industry went through capital centralization at home and deeper participation on the global seed market abroad. Underlying all of these changes is the role that the state plays in the intensification of financialization, which are the two main issues in Chapter 5. Since 2010. capital is of growing importance in shaping the competition rules in the seed market. The new changes in the seed market with overproduction problems confirms Marxist theory of a crisis in an economic system driven by profit maximization. However, instead of calling it a crisis, it is portrayed as an opportunity to transform China's domestic market and strengthen the presence of Chinese seed enterprises in the global market—It is the necessary next step to catch up to transnational agribusiness companies. Following Chapter 4, Chapter 5 further explores the state's direct participation in the transformation of China's domestic seed industry. It also links the reorganization of China's domestic seed industry with the state's globalization initiative and points out promising research directions deriving from this project that the researcher didn't have the time and resources to look into.

Chapter 6 evolves around two contradictory tendencies, the alienation of the peasant from seed and seed breeding, and the endeavors to recover peasant control over seed. The first tendency was formed since China's market reform and strengthened through the adoption of the mainstream intellectual property right regime. While the second tendency is discussed using China's historical experience of the grassroots breeding movement, and the current social initiatives that encourage peasant's participation in seed breeding. The former not only actively involved peasants in seed breeding, but also provided systematic support to nurture grassroots seed breeders, in addition to consciously avoided the commodification of seed and the monopolization of seed breeding by formal agricultural research institutes. The latter provides external support for peasant training and breeding experiments. However, without overturning or stemming the drive for profit-making and the regulatory framework for proprietary seed varieties, it will be difficult for peasants to fully enjoy the benefits of collaborative breeding projects. Instead, they might be reduced as the protector of local landraces for research institutes and the targeted customers for private seed enterprises.

By focusing on the three themes, this research explains the unfolding of the neoliberalization project in China's context and examines China's agrarian change by looking into the role of seed. The research finds that the neoliberalization and agricultural capitalization in China dramatically transformed the provision system of means of production and agricultural mode of production, which both point to the concentration of profit and power in the big players. The state plays a crucial role in the creation of agricultural capitalists and large domestic seed companies that can participate in the global seed market.

The thesis is based on the six-month fieldwork conducted in Southwest China (Yunnan and Guizhou), South China (Hunan) and Northeast China (Heilongjiang) from February to August 2017. The research sites were selected to reflect the climatic and agricultural differences between China's three main regional seed markets: (a) Southwest China features differentiated altitudes and vertical climates; agricultural production is conducted by household-based small-scale farming on relatively poor soil; (b) Hunan is one of the major rice production regions and one of China's biggest regional hybrid rice seed markets; the farmland is increasingly concentrated and large-scale agricultural production starts to prevail; (c) Northeast China consists of several accumulative temperature belts and features large-scale mono-cultivation of maize and soybeans on fertile soil. The research consists of over 150 semi-structured interviews, each of which lasted for at least 1.5 hours. Research participants include multi-level government officials, researchers from agricultural research institutes, seed company managers, seed sales agents, village cadres as well as peasants and capitalist farmers. Each chapter is organized by selecting research findings from various interviews and in different research sites according to the specific research questions to be answered. The organization of each chapter will be explained in every introduction part.

Weakness and limitation of this research

The use of Marxist political ecology in this research is in a general sense, as Blaikie and Brookfield (1986) applied it in the examination of access to and control and management of resources and Bassett (1988) did in the analysis of peasant-herder conflicts in the northern Ivory coast in the US. In such studies, political ecology combines the concerns of ecology and a broadly defined political economy. Specifically, this research mainly focuses on changes in relations of production and the rural society that were brought about by seed. However, it treats political ecology, the relation between nature and human society, an essential and inherent part of Marxist pollical economy. For instance, the adoption of hybrid seed not only leads to the transformation of agricultural modes of production, but also endangers biodiversity and results in a narrower genetic base for seed breeding. Similarly, the

concentration of seed breeding in formal agricultural research institutes and commercial seed companies estranges peasants from nature as well as weakens their control of means of production.

This thesis attempts to provide an alternative narrative of the transformation of China's seed governance and seed marketization from a perspective that is different from the market-oriented view. By reviewing the development trajectory as well as the policy and market changes, the research tries to demonstrate that what happens in China's seed sector showcases the neo-liberalization of Chinese society, which results in the rising power of agro-capitals and the weakening of farmers' rights to seed. However, the thesis left a number of issues worth further exploration, including a stronger and more direct connection between the transformation of China's seed market and China's agrarian change as well as the implications of China's seed laws and regulations for the seed conservation activities.

To my regret, one of the limitations of the thesis is the inadequate investigation of seed conservation activities in China. The project did not leave enough resources for such purpose, but it will become an important starting point for the post-doctoral research. Based on the work presented in this thesis, the future investigation will explore China's experience in safeguarding farmers' rights to seed and compare them with the international peasant movements. One of key aspects of the investigation is the relation between agricultural modes of production and seed conservation. With the increase of ecological agriculture practices in China, the search for conventional seed varieties, the saving, reusing and sharing of such seed, and the significance of seed in promoting new farming practices are important directions to continue with this research.

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Chapter 2 Seed, Agricultural Capitalism, and Peasant Differentiation

Introduction

Since the Household Responsibility System (HRS) was established in the early 1980s, rural China has experienced rapid transformations in relations of production and social formation. Classic agrarian change literature often centers on peasant differentiation and the development of agricultural capitalism (Lenin, 2019; Byres, 2009; Bernstein, 2010; Yan & Chen, 2015). Drawing on historical evidence, Byres illustrates peasant differentiation in England, France and Germany, paying special attention to the nature of the landlord class, and demonstrates the implications of various landlord class for different paths of agrarian transition that these three countries took. Lenin's (2019) observation of rural Russia further confirms Byers's illustration and specifically distinguishes the Prussian path and the American path of capitalist agrarian transformation. The former path is achieved by the transformation of a feudal landlord class into a capitalist peasantry (from above), while in the latter, capitalist agriculture evolves "from below" through peasant differentiation. Inspired by Byres and Lenin, Yan and Chen (2015) examine agrarian capitalization in the Chinese context and conclude that China's agrarian change involves capitalist dynamics both from above and below.

However, a closer look at the actual process of agrarian transformation would highlight an important yet now often overlooked aspect in the classic agrarian change literature: the role of technology transition in peasant differentiation and agricultural capitalism. This aspect has drawn academic attention since the 1960s with the introduction of high-yield seed varieties (hybrid maize seed and hybrid rice seed) and the unfolding of the Green Revolution (Byres, 1981; Marglin, 1996).

The Green Revolution is commonly referred to as the period from the early 1940s to 1970 (Patel, 2013), featured by the introduction of high-yielding varieties (the HYVs) in developing countries. However, the relevant technological development had started earlier in the US. As Kloppenburg (2005) puts it, "Only in the 1930s did science become an important and productive force in agriculture," by which, he refers to the creation of hybrid maize seed. Hybrid maize seed was first developed in the US and was commercially released in the 1930s (ibid.). The new seed reversed the declining maize yield in the US. Ten years later, US maize seed rapidly shifted from open-pollinated to hybrid varieties. By 1965, over 95% of US maize acreage was planted with the new seed (ibid.). The success of hybrid maize in the US contributed to the popularity of maize breeding programs using hybridization, which were conducted by the Food and Agriculture Organization of the United Nations (FAO), in Central

American and Latin American countries. In Africa, hybrid maize breeding programs were funded by the US Agency for International Development and the Rockefeller Foundation. In mid-1960s, the Green Revolution reached India with the hurried introduction of HYVs from the International Rice Research Institute (IRRI), which again, was set up by the Rockefeller and the Ford Foundations (Shiva, 2014).

The economic, social and ecological implications of the Green Revolution were closely examined in the following years. Marglin (1996) raises the question of sustainability about the HYVs. He asserts that enormous food production increases due to HYVs comes with a price. To begin with, the genetic base of seed breeding was narrowed, and the uniformity of seeds makes them more vulnerable to sudden natural disasters. Moreover, the HYVs can only perform well in favorable conditions provided by abundant water, fertilizers, and pesticides, which not only results in environmental degradation (e.g. soil erosion) and resource exhaustion (e.g. water), but also increase farmers' dependence on the market for agricultural inputs (Kloppenburg J. , 2005). It is then not surprising that the IRRI seeds were called "Seeds of Imperialism" (Shiva, 2014) in the Philippines to refer to the debt and a new dependence on agrochemicals and seeds that were created by the IRRI practices.

In terms of Green Revolution's social consequences, Byres (1981) argues "that technology and technological innovation cannot be usefully separated from the mediation of class relations and class interests". He uses India's case to illustrate new technology's role in class re-configuration and the consequent class action during India's transition from feudal to capitalist mode of production. There were two kinds of technological innovations at work in India countryside during the Green Revolution, one was biochemical and the other is mechanical[21]. Byres starts with overturning a populist Utopian fantasy that biochemical innovations desirably provide a wide diffusion of benefits for all classes of cultivators, while the mechanical innovations were only accessible to large cultivators. He argues that, with the possible penetration and development of capitalism in the countryside, whether to adopt either of these innovations depends on "the impact of these innovations on the production process, the rate of profit, and the capacity to accumulate". Besides, the biochemical and mechanical innovations were inextricably linked. Those who can afford to displace canal irrigation with tube-well irrigation gain greater control over the supply of water. The application of the HYVs further intensifies seasonal peaks of labor requirement and therefore increases the demand for tractors, mechanical threshers, reaping machines, and combine harvesters.

21 The former comprises the HYVs, chemical fertilizers, pesticides, and the regulated flow of irrigation water, while the latter consists of tractors, threshers, drills, mechanical pumps for irrigation, mechanical reapers, and combine harvesters.

As to class formation and class action, Byres compares the agrarian structures before and after the Green Revolution and highlights the differentiation of the peasantry, with special attention paid to rich peasants and rural proletarianization. Rich peasants adopted both biochemical and mechanical innovations and consolidated themselves as a powerful, dominant class. On the other hand, the process of peasant differentiation was hastened, and it resulted in rural proletarianization. This was done through resumption (rented out land was taken back by landlords or rich peasants), tenant-switching (from poor to rich) and land renting out by poor peasants to rich peasants.

Other studies, for instance, the livestock industry does not address seed issues or directly refer to the relationship among technology, agricultural capitalism, and peasant differentiation. However, the dynamics of rural development resonate with the Green Revolution in India. Bernstein (2010) discusses capital's "problem" with nature and how farming's and husbandry's close connection with nature poses obstacles for capital to invest "more generally, and more directly" in such production. The first obstacle is the uncertainties of natural environments and ecological processes. Natural conditions, like weather and land, are the bases for farming, which largely affect the growth rhythms of plants, but are not easy to control. The second obstacle is the difference between labor time and production time, which is against capital's nature of fast circulation in order to make profits. Having said that, Bernstein further explains how agri-input industries and agro-food industries attempt to industrialize farming through technological innovations and "to simplify, standardize, and speed up its (farming's) natural processes as much as possible".

Kloppenburg (2005) and Goodman, Sorj and Wilkinson (1987) share the criticisms of modern capitalist agriculture explained by Bernstein, and also share the focus on seed. The former adopts the concept of commodification and explains how hybrid seed and GMO seed were created to turn the seed into a commodity for profit making. The latter comes up with the term of "appropriationism":

> This discontinuous but persistent undermining of discrete elements of the agricultural production process, their transformation into industrial activities, and their in-corporation into agriculture as inputs we designate as appropriationism. (Goodman, Sorj, & Wilkinson, 1987, p. 2)

Goodman, Sorj and Wilkinson (1987) use "appropriationism" to refer to agro-industrial capital's attempt of reducing nature's role in agricultural production and replacing natural

inputs with agro-inputs. Similar to Kloppenburg, Goodman, Sorj and Wilkinson also argue that different elements of agricultural production (e.g. labor process, land, seed) are changed by agro-industrial capitals for profit making and capital accumulation. Further, they distinguish the different impacts that mechanical, chemical and genetic innovations have on agricultural production and the rural environment. Comparing with the former two innovations, genetic innovation (hybridization, recombinant DNA methods) realizes the real appropriation of the natural production process and becomes the foundation of intensifying agro-industrial capital's accumulation in agriculture, for it contributes to new and more inter-dependent patterns of appropriation. Thereafter, mechanical, chemical and genetic innovations are more closely intertwined with each other.

The study of technological innovation in relation to agricultural capitalism and peasant differentiation can follow theoretical threads from both political economy and political ecology. With the help of political economy, we will be able to examine the social and political consequences of technological innovations through the development of agricultural capitalism. While political ecology assists us in understanding the characteristics of the technological innovation in question and how they enable the capitalist mode of agricultural production.

This chapter attempts to follow the footprints of the above studies and examine the development of maize production in Heilongjiang, Northeast China. The introduction of a new maize variety, *Demeiya*, among other reasons, contributed to the widespread adoption of maize production in Heilongjiang in only a few years. In the cropping pattern transition, maize replaced soya and became the dominant crop. More importantly, maize production transformed the agricultural mode of production: the intensification of mechanization, the increase of farming scales, the increasing demand for capital investment and the marketization of agricultural produce. In turn, peasant differentiation was also accelerated. Recent government policy intends to reduce the maize production area; however, the agricultural mode of production remains and is now popular in other crop production modes. This chapter intends to explain how seed became a key factor in the development of capitalist agriculture and peasant differentiation, and why the capitalist mode of production prevails regardless of the changes in cropping patterns.

Collective farming and rural egalitarianism: agricultural transitions before the hybrid maize seed

My fieldwork sites for this chapter include two counties, Nenjiang County and Nehe County, in China's largest agricultural province, Heilongjiang. Historically, they were major soya production regions. Nenjiang County, which enjoys the reputation as "the hometown of soya" (大豆之乡, dadou zhi xiang), has 12 million mu of farmland, including 4 million mu in state farms and a 1.53 million mu of production base for the Nenjiang based military. In 2014, "Nenjiang soya" became a geographical identification (GI) registered at the Trademark Office of the State Administration for Industry and Commerce of the People's Republic of China. According to the GI introduction, the cultivated area of soya in Nenjiang is 8 million mu, which annually produces 1.2 million tons of non-GMO soya, accounting for one-tenth of the total national output (Intellectual Property Protection in China, 2014). The other field site, Nehe County (see also in chapter 1), is also an ideal soya production region. It is located south of Nenjiang, with better light and warmth for agricultural production. At the peak time, five-sixth of its farmland (5 million mu) was used for soya production, but the number went down to 2.4 million mu in 2012 and was further reduced to less than 2 million mu in the following year (Yan & Chen, 2013).

In China's collective era (1956-1978), however, soya was not the dominant crop in either Nenjiang or Nehe. The first and foremost goal of agricultural production during the agricultural collectivization period was to meet the nation's food needs. As mentioned in chapter 1, in Heilongjiang, the main crops in the collective era were wheat, maize and soya. Like other places in China, under the collective farming system, agricultural production in Nenjiang and Nehe was conducted according to unified and centralized plans. In Nenjiang[22], farmland was divided into four equal parts for various crops. One fourth was used for wheat, another for maize, while soya only took the third fourth. The rest grew potatoes, beets and millet. Agricultural produce first needed to meet government procurement and the remainder was distributed to the production team members for household consumption. Production teams also had gardens for vegetable production (eggplant, pepper, celery, Chinese chive, garlic, etc.). Garden harvest was partly sold on the market, the income from which belonged to production teams. Team members could also purchase from the gardens. In 1953, to meet the food demand of urban dwellers, to support national industrialization and to maintain food market stability, the state launched *the planned purchase and distribution policy* (统购统销, tong gou tong xiao). Collectively produced grains, cotton, oil plants and other key agricultural products were purchased by the state and distributed according to unified plans.

22 Interview with Su Tianwen, May 18, 2017

On the production side, under the collective farming system, all the important agricultural means of production, including seed, land, machinery, and farm livestock, were collectively owned and coordinated by production team leaders. In this way, farmland could be consolidated and used to grow various crops according to particular soil, light and warmth conditions of each plot. Consolidated land also enabled the use of large farming machinery in order to achieve economies of scale (Bramall, 2008; Hinton, 1997). As mentioned in chapter 1, the collective farming system was the institutional base for grassroots seed provision and peasant collective seed rights. The de-commodification of seed not only reduced farming input costs but also enabled the fast dissemination of better seed varieties.

On the consumption side, the food needs of team members were met at the production team level. Agricultural produce was distributed to team members based on their membership and varied according to gender and age. Team members' cash income was based on the *work points* (工分, gong fen) they earned through labor contribution in collective farming. However, work points were not calculated strictly according to the labor contribution. Rather, they were mediated by the collective and equality was prioritized over efficiency to avoid income gaps. Only controlled extra work points were given to those who made a greater contribution to the collective farm. In the 1970s, the majority of team members were given 9 or 10 work points and the income gap was so little that it could be ignored (Unger, 2016; Bramall, 2008).

The collective farming system was essentially a systematic socialist form of social formation instead of a mere production organization. Besides agricultural produce and cash, production team members were also entitled to health care and other social benefits, for apart from the money distributed to team members, the collective cash income was also used for accumulation funds and welfare funds (Jin, 2007). The accumulation funds were for reproduction, expanded reproduction and public facility construction, while the welfare funds provided health care, education and other social securities. Rural industrialization was also under way in the Mao era. Rural factories first produced fertilizer, cement, steal, farm machinery and electric generators before expanding to food processing, bike manufacture, light industry and so on. Rural industrialization not only provided scarce agricultural inputs for collective farming, reduced the pressure on urban industrialization by supplementing daily supplies, but also offered job opportunities for the labor released from agriculture (ibid.).

In the Mao era, agricultural production and rural development were collectively organized. Therefore, the benefits of seed variety improvement and technological advancement were also

collectively shared. By this arrangement, the collective farming system created an egalitarian rural society where production team members could obtain basic means of livelihood and social security based on their membership and their contributions to the collectives. The collective farming system was established to narrow income gaps in rural China, and peasant differentiation was consciously avoided and systematically excluded.

The Household Responsibility System and commercial farming

Resistance to family farming and the continuity of planned agricultural production

The Household Responsibility System was implemented in rural China since the early 1980s. As a key part of China's Reform and Opening up, it was meant to bring back family farming by dismantling the previous collective farming system. In Heilongjiang Province, however, the implementation met obstacles at various levels, from the provincial government to the production team. The then provincial governor insisted that family farming would undermine Heilongjiang's agricultural production because it would discourage the introduction of large farm machinery, as also argued above by Bramall (2008) and Hinton (1997). Peasants also did not wish to give up collective farming[23] for, in the past, agricultural production was collectively organized while now they would have to individually purchase means of production (livestock, seed and machine) and prepare the land on their own. Eventually, a government working team was sent to Heilongjiang in 1983 to see through land re-distribution in order to implement HRS. Table 1 shows Heilongjiang's grain output from 1983 to 1992. As can be observed, the grain output remained at the similar level from 1983 to 1989. It indicates that agricultural production after the return to family farming did not increase as much as the reform intended.

Table 2.1 Heilongjiang's Grain Output 1983-1992 (million tons)

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
15.49	17.57	14.3	17.76	17.64	16.43	16.22	23.13	21.64	23.66

Data source: National Bureau of statistics of China

Heilongjiang has one-tenth of China's total farmland and its agricultural development is pivotal to China's food security. Although HRS was eventually implemented in this province, agriculture was still organized by the government years after family farming was restored. In

23 Interview with Su Tianwen, May 18, 2017

1989, Nehe started a policy named "*three one-third*" (三个三分之一, san ge sanfenzhiyi)[24], which called for production teams (now natural villages) to divide the village farmland into three parts, each of which respectively grew wheat, soya and minor grain crops (sorghum, maize, potato, etc.) in turn: wheat-soya-minor grains-wheat. Crop rotation was a basic farming law to increase soil fertility, well-known in the collective era, but it was difficult to carry out in family farming. The "three one-third" policy was accompanied by unified provision of wheat and soya seed in the beginning. However, with the intensification of seed marketization, peasants were allowed to freely purchase seed, but the crop structure remained.

Since 1984, maize was no longer listed as an agricultural tax crop, and its planting area started to decline for various reasons. To start with, not only was the productivity of maize low, its market price was also only around 0.1/kg. In addition, the harvesting and threshing of maize were labor-consuming and back-breaking. During this period, maize cobs were still manually reaped off the stems. Similar to maize, wheat's position in the crop structure was also altered. Wheat flour replaced millet and became peasants' staple food. After paying the agricultural tax, the leftover wheat would be stored at home. Peasants would take out a portion to mill whenever they needed fresh flour. A normal peasant household[25] usually stored enough wheat for two years' needs. In the late 1990s, however, wheat production also went down. By then, wheat flour transported from main wheat production areas in Central and Southern China, like Henan Province and Shandong Province, was easily accessible and of better quality. Other reasons also contributed to wheat's decline. On the one hand, wheat did not grow well in times of drought; on the other, like maize, wheat production was labor-intensive. Wheat stubble needed to be turned over and the farmland had to be ploughed in every growing season. Besides the bad weather and additional preparation work, the high production costs did not make wheat a profitable crop. Therefore, since 2000, soya became the dominant crop in both Nenjiang and Nehe until around 2012, when maize production spread in this area.

Soya production, seed commodification, and commercial farming

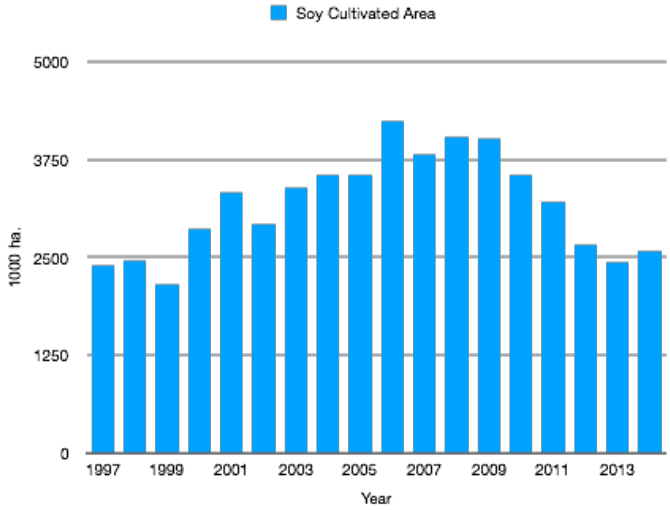
Table 2 shows the cultivated area of soya in Heilongjiang from 1997 to 2014. Although it does not exactly represent the development of soya production in Nenjiang and Nehe, the general trajectory was similar. Soya production started picking up in the late 1990s and reached to its peak in 2006, increasing by 77.4%. In the following years, soya production decreased, and in 2013, it fell back to the production scale in 1997. In Nengjiang, soya production remained

24 Interview with village secretary Dong, May 17, 2017 and with Su Tianwen, May18th, 2017

25 Interview with Ruanmei, June 16, 2017

around 6 million mu before 2013, but thereafter it fell by half. Nehe's climate was better for maize production (maize became the dominant crop after soya), so soya production decreased more than that in Nenjiang. In 2013, at least 60% of former soya cultivated area was used for maize production.

Figure 2.1 Soya cultivated area in Heilongjiang, 1997-2014 (1000 ha.)



Data source: National Bureau of statistics of China

From the late 1990s to 2012, soya was the dominant commercial crop in both Nenjiang and Nehe. A new agricultural mode of production was established during this period. To begin with, all agricultural inputs were acquired from the market, including soya seed. Soya seed is conventional seed, which means soya harvested this year can be used for the next growing season after selection. It has been a peasant practice for thousands of years. Even so, since the late 1990s, the peasant majority purchased seed from the market. The primary reason was the low price of soya seed, which was due to both the social and biological characteristics of conventional seed. First, conventional seed had not acquired intellectual property rights yet, therefore, any producers with seed production qualifications could freely produce the most popular varieties to sell. Second, requirements for conventional seed production were less strict than those of hybrid seed. The essential conditions were isolated production sites and seed selection facilities. After China's seed market was liberalized, a great many of the villages in Nenjiang and Nehe were chosen by local seed companies as contract production sites. Seed selection was at times carried out simply at soya assembling sites using conventional soya selection facilities. Local craftsmen were able to make simple iron selection machines for family farming use. These two characteristics contributed to price stability of

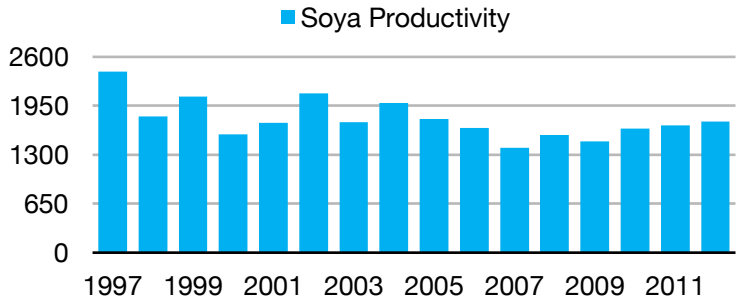
soya seed. One Nehe interviewee recalled[26] that in 1992, soya seed was about RMB 1.5/kg while the soya price then was RMB 0.9/kg. In 2017, the price for soya seed was around RMB 5/kg, in comparison to RMB 4.2/kg for soya. Therefore, soya price only increased by 4 times in the past 25 years, while soya price is still close to its seed price (see Table 2.2). At the same time, the fluctuation of soya productivity was also small (averagely, 1772kg/h), as Figure 2.2 shows.

Table 2.2 Soya and Soya seed prices in 1992 and 2017 (RMB/kg)

	1992	2017
Soya price	0.9	4.2
Soya seed price	1.5	5
Seed/grain ration	1.67	1.19

Data source: Interview with Wang Tian, May 16, 2017

Figure 2.2 Soya productivity in Heilongjiang, 1997-2012 (kg/h)



Data source: Heilongjiang Bureau of statistics

The second feature of the new agricultural mode of production was the full marketization of agricultural produce. Before wheat production was given up, peasants could produce grains for household consumption and labor reproduction did not entirely depend on the market. However, when all soya must be sold on the market for agricultural and labor reproduction, family farming's subjection to market forces greatly increased. Following this logic, peasants must be sensitive to market fluctuations and make production decisions accordingly in order to make profits and stay competitive. All the three features point to an emerging capitalist mode of production.

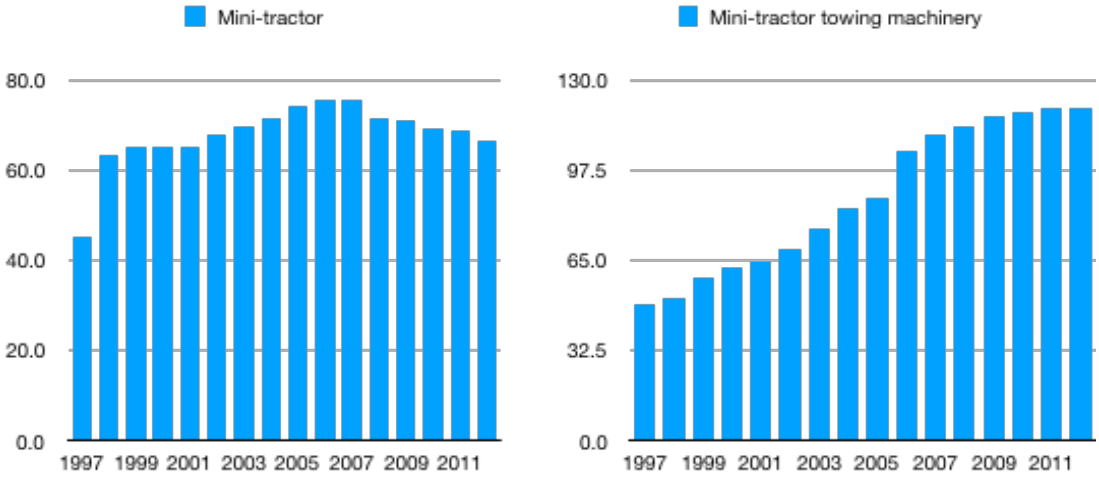
Before 2012, soya production in Heilongjiang experienced certain fluctuations, but in general the production mode did not go through dramatic transitions. In addition to cultivated area and productivity, as discussed above, the adoption of farming machines was also steady. Figure

26 Interview with Wang Tian, May 16, 2017

2.3 shows that the peasant ownership of mini-tractors had been increasing before 2007 and experienced a slow decrease afterwards, while mini-tractor towing farm machinery increased steadily during the whole 15 years. These factors indicate a slight increase of mechanization in soya production. As to farm size, in my fieldwork, interviewees recalled that land transfer between peasants existed before 2010 but its magnitude was incomparable with that after 2010. In other words, the size of family farms also did not significantly change before 2010.

Changes in soya production were closely related to those in China's domestic soya market. Liu Xuehuang[27], founder of Nenjiang Soya Association, remembered that the demand for soya was high before 2000 while the domestic production could only meet one-fourth of it. Accordingly, purchase prices for soya steadily went up. Since China's access to WTO, competition from imported soya resulted in every-four-year rises and falls in China's domestic soya market. Even so, soya prices could still be anticipated to a certain extent. A local soya trader[28] in Nehe recalled that the increase was annually RMB 0.18/kg.

Figure 2.3 Farm machinery in Heilongjiang, 1997-2012 (10,000 units)



Data source: Heilongjiang Bureau of statistics

A game changer: hybrid maize seed and the intensification of capitalist agriculture

The food security crisis and the promotion of maize production

In the past 8 years, agricultural production in Heilongjiang went through unprecedented rapid transformation on all grounds and capitalist agriculture was consequently intensified. The

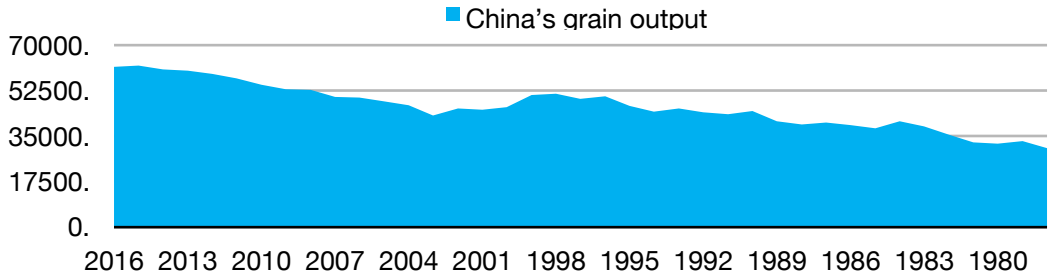
27 Interview with Liu Xuehuang, June 1, 2017

28 Interview with Lao Chang, June 15, 2017

transformation was the result of a convergence of influences: state policies, China's domestic economy and new maize seed varieties. The latter was the technological foundation for the transformation. Even after maize production started declining in 2016, the newly formed agricultural mode of production remained and continued to construct a new agrarian society.

As demonstrated in Figure 2.3, from 1978 to 1998, China's grain production went through small fluctuations, but in general it maintained an upward tendency. However, since 1999, the total grain output continuously declined for four years and reached a low in 2003, dropping by 16% from the 1998 peak and returning to the 1991 level. The deterioration of grain self-sufficiency alarmed the state and induced a series of policies to promote grain production. In 2004, a direct subsidy for grain production was given to producers. In the same year, several provinces were chosen as pilot sites for agricultural tax abolishment, and the policy was eventually nationally implemented in 2006. In main grain production regions, seed and large agricultural machinery purchase was also subsidized. In 2008, maize became an agricultural product purchased by the National Reserves Bureau. As the largest agricultural province, Heilongjiang was faced with great pressure in meeting the state's expectation for increasing grain production, and maize became the chosen crop. In 2005, Heilongjiang's maize production acreage reached 2.73 million hectares and exceeded the highest previous record in 1996 (2.67 million hectare). In the following 10 years, the acreage increased by 2.8 times.

Figure 2.4 China's Grain output, 1978-2016 (10,000 ton)



Data source: National Bureau of statistics of China

The rapid increase in maize production was not only attributed to favorable state policies, but more importantly, to the introduction of new hybrid maize seed, Demeiya, and the consequent technological transformation of agricultural production. Hybrid maize seed was not new in Heilongjiang Province, but it had been incorporated into collective farming in a completely different manner from Demeiya's introduction. Hybrid maize seed was introduced by the state to Heilongjiang in the 1960s in an effort to raise agricultural production. Hybrid maize parent plants were given for free to agricultural technicians in production teams for hybridization

experiments. If success was achieved, harvested maize would be used as seed for the next growing season. In addition, production teams could also purchase hybrid maize seed from seed bases.

The establishment of HRS left production decisions within peasant households. As discussed above, the abolishment of agricultural taxes and the popularity of soya production contributed to the reduction of maize acreage. Thereafter, maize production remained at a smaller scale. Before the increase of maize production in 2004, maize was only a secondary crop and used by peasant households as supplementary food, animal feed and cooking fuel. In 2000, the new Seed Law permits peasants the freedom to purchase seed from the market. Peasants' choice of maize seed was flexible and was often in compliance with the particular need that maize was expected to meet. Before Demeiya seed was commercially released in Nenjiang and Nehe, the maize seed that peasants usually used had similar characteristics: They were mostly flour maize with soft particles; they were thinly planted, and the increase of productivity was achieved by yield increase from each plant. These characteristics of the seed also determined the particular ways of farming: maize needs to be thinned to ensure the growth of stronger seedlings; the relatively low crop density enables manual harvesting. On the other, Nenjiang and Nehe's agricultural conditions constrained the introduction of new maize seed. Nenjiang and Nehe are both in the northern part of Heilongjiang where the light and warmth conditions are less favorable than other places in Northeast China. Therefore, hybrid maize seed that was widely adopted in other places often turned out to be unsuitable for the cold climate.

Demeiya was introduced by the largest seed company in Heilongjiang, Kenfeng in 2004. According to the company profile (Kenfeng, 2017), Kenfeng was established after Jiusan seed company of Heilongjiang Beidahuang Group (Beidahuang) absorbed capital from individuals. Beidahuang was the result of the merger between seed enterprises from both Heilongjiang Farms and Land Reclamation Administration (heilongjiang nongken zongju) and its Jiusan Branch. According to the ex-deputy manager of Jiusan Seed company (Jiusan)[29], Jiusan and Kenfeng were both branch companies of Beidahuang in the beginning. The former sat in the northern state farm and specialized in soya, wheat and sugar beet seed, while the latter concentrated solely on hybrid maize seed in Harbin in the south of Heilongjiang. The fast development of Kenfeng resulted in its meger with Jiusan and eventually, Kenfeng integrated seed enterprises and resources of the entire Heilongjiang Farms and Land Reclamation Administration. Demeiya's introduction was against the expansion background of Kenfeng and thanks to Kenfeng's close relation with the state farms.

29 Interview in June 3, 2017

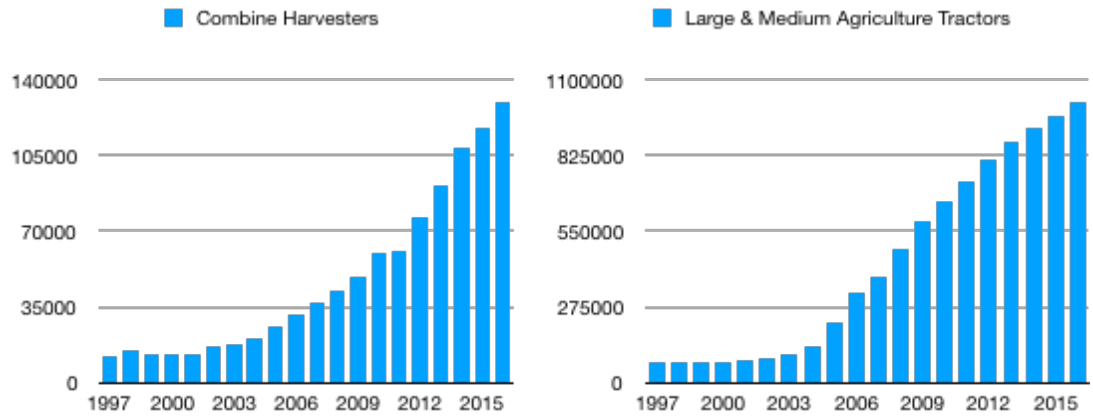
After Kenfeng formed a joint venture with KWS SAAT AG, a world leading plant breeding and seed company, headquartered in Germany, Demeiya was introduced as its signature product. In 2004, Demeiya obtained the variety approval in Heilongjiang Province and was soon released on the south Heilongjiang market. The north market, where Nenjiang and Nehe are located, was only opened in 2009 because the company feared that Demeiya would not perform well in the low accumulated temperature region. In 2008, the ex-deputy manager's experiment with Demeiya on 100-hectare land showed that it was also suitable for North Heilongjiang's cold climate. Through this production experiment, Demeiya demonstrated three exceptional traits. First, Demeiya is flint maize and dehydrates fast, which significantly shortens the drying time and is good for storage. Second, Demeiya could be sowed between mid-April and early May. The earlier seeding time makes the best use of the light and warmth condition in North Heilongjiang. Third, Demeiya has high planting density of 90,000 plant/h, in comparison with average 60,000 plant/h in 2008. With its additional high lodging resistance, Demeiya was the ideal variety for mechanical harvesting. The production experiment received inspection from the leadership of Jiusan State Farms (Nenjiang) and the provincial government. The next year, Demeiya was promoted in the state farms. The demonstration effect of the state farms[30] and the high profits in maize production led to Demeiya's popularity among peasant producers and the further increases of maize acreage in Nehe and Nenjiang.

Commercial farming and capitalist modes of agricultural production had already been in place in Heilongjiang with the development of soya monoculture. However, the introduction of Demeiya significantly changed the magnitude of agricultural capitalization. To start with, hybrid maize seed costs more than conventional soya seed. The price of Demeiya was RMB 13/kg the first year it was released on the northern market. Two years later, the price reached RMB 40/kg and remained at a high level. Annual soya seed cost was around RMB 500/h, while Demeiya cost almost three times more (RMB 1400/h) at its peak.

30 In China, the state-owned farms and ordinary rural household farms are two very distinct sectors in agriculture. This chapter only focuses on peasant differentiation that happened among household farms. It should be noted that Demeiya hybrid maize seed was first adopted on state-owned farms, while household farms only started growing the seed after seeing the demonstration effect. On Nenjiang state-owned farms, land was distributed to formal employees and hired labors in the 1990s, but agricultural production was still carried out collectively by forming family farms, production teams or agricultural cooperatives. Agricultural cooperatives were promoted since 2011 on state-owned farms. The cooperatives collectively make production decisions while the members pay for land rent, agricultural input, insurance and other expenses. There is also differentiation among state-owned farms employees and hired labors. Those who transfer land from other members or own large agricultural machinery are generally better off than those who transfer land to others and migrate out for non-agricultural job opportunities.

Secondly, Demeiya's harvest required large combine harvesters. Figure 2.5 shows that from 2004 to 2016, the number of combine harvesters increased six-fold. Following the large combine harvesters was the increase of farming scale to better fit the machine's operational size requirement, which in the end, led to more investment in other large farming machines all together. During the same period between 2004 and 2016, large and medium agriculture tractors increased eightfold (see Figure 2.5). Increased capital investment in large agricultural machines was beyond many small producers' financial capacities. For instance, one combine harvester cost around RMB 2.2-2.3 million. Therefore, small producers had to hire harvesters, instead. In high seasons, sometimes they were faced with the challenge of a short supply of harvesters because the larger producers were often prioritized by combine harvester owners.

Figure 2.5 Large agricultural machinery (unit)



Data source: National Bureau of statistics of China

Thirdly, favorable state policies and Demeiya's productivity performance made maize production more profitable than soya, the former being RMB 7000-8000/h, while the latter RMB 2000/h. High profits of maize production led to high land rent, which increased by over 60%, from RMB 3000/h to over RMB 5000/h. The increasing land rent put great pressure on small producers to raise enough money in every growing season, since conventionally, land rent has to be paid before farming starts.

With the adoption of Demeiya, the increase in farm size and rising costs in agricultural inputs, such as seed and farming machinery, created an intensified capitalist mode of agricultural production. In addition, the tendency was reinforced by the state's agricultural modernization agenda. In 2008, the Third Plenary Session of the Eleventh Central Committee of the CPC promoted land transfer in rural China, which signified the state's support for land concentration in the hands of new agricultural agents, namely, specialized big households, cooperatives, family famers and dragon-head enterprises, in order to establish large-scale

farms (Xu & Fuller, 2018). Thereafter, land transfer increased in China at an unprecedented rate and the transfer scale reached 470 million mu in 2017, accounting for 35.1% of the HRS farmland (CCTV.com, 2017). The acceleration of land transfer in Nehe and Nenjiang happened after the introduction of Demeiya. For instance, in Qianjin Township[31], Nenjiang County, the per capita farmland was 8-9 mu in the flat area and 5-6 mu in the mountainous area. Land transfer started from 2011 in Qianjin, and only three years later, the entire township farmland had been transferred, except for scattered plots and household vegetable gardens. Farmland was transferred mainly to nominal cooperatives, most of which were formed by a few people, but were not operated in any cooperative way[32]. There were over 80 cooperatives at the peak moment, but since 2014/2015, shell cooperatives went bankrupt one after another and only 12/13 still functioned when I conducted my fieldwork in 2017. Among these surviving cooperatives, seven individually operated over 10,000 mu of land and the smallest 3000-5000 mu. In addition to the support for land concentration, the state also provides free seed, fertilizer and subsidizes a machinery purchase fund (up to 60%) for eligible large-scale new agents of agriculture.

The implications of maize production: rural differentiation and the continuity of capitalist agriculture

Demeiya's variety characteristics fitted well into the state's agricultural modernization agenda, which made it the "seed of the hour". The intensified capitalist mode of production was featured by land concentration, the increase of capital investment and more market dependency. Undoubtedly, the increase in maize production significantly contributed to China's food security; but at the same time, it also created a more differentiated rural society.

By 2017, almost half of Heilongjiang's HRS farmland was concentrated in the hands of cooperatives, family farms and dragon-head enterprises, with a declining number of peasant households that were still primarily involved in agricultural production. A great number of peasants out-migrated in seeking urban job opportunities. In several Nenjiang townships, the remaining population was less than one-third and many of them already sold out farming machines. Peasants who managed to stay in agricultural production were faced with fierce competition from large producers. At both upstream and downstream of agricultural production, large producers enjoyed better conditions than small producers. They could negotiate better deals and long-term cooperation with seed, fertilizer and other agricultural

31 Interview with township chief, deputy township chief and township office director, May 23, 2017

32 More on fake cooperatives, please see Yan and Chen (2013).

input suppliers. In the harvest season, their maize often enjoyed better prices and more stable marketing channels, either when maize was purchased by the State Reserve Bureau or random middlemen.

In recent years, selling agricultural produce on time became more critical than ever as producers needed capital for the next growing season as well as settling various kinds of debts and loans. The increase in capital investment drove many producers to borrow money or take loans. One soya producer[33] in Nenjiang estimated that any farm that managed over 300 mu of land could not continue agricultural production solely on private capital. Considering this, in Nenjiang, the farming scale threshold for family farms is 500 mu and for cooperatives 3000 mu, nearly all the new agents of agriculture have to borrow to finance their production needs. Conventionally, peasants prefer borrowing money from friends and relatives, and this debt often does not require interest. However, rising capital demand for large scale agricultural production exceeds the extent of private lending, and zero interest becomes inappropriate to expect. Instead, producers have to take loans from agricultural banks, *rural credit cooperatives* (农村信用社, nongcun xinyongshe) or other newly emerging formal or informal financial actors. However, access to production capital becomes another means to differentiate agricultural producers.

China's credit system is designed to meet the capital needs of industry and commerce, but it is not yet well suited for agricultural development. To begin with, small producers are unable to provide mortgages to apply for bank loans. The only items they can mortgage to provide collateral are family houses and farmland, the legal status of which for mortgages is still debatable. Even when this is allowed in Nenjiang[34], the amount of the bank loan is far from sufficient for the new scale of agricultural production.

A small producer who mortgaged his 10 hectares of land and a three-room house managed to find two peasant households to vouch for him but only obtained a loan of RMB 10,000 from the rural credit cooperative. In fact, land rent alone would cost him about RMB 45,000 in 2017, let alone other agricultural inputs. On the other hand, large producers, especially those who took up agriculture in the movement of "*capital going to the countryside*" (资本下乡, ziben xiaxiang), have urban housing properties and vehicles as mortgages and can more easily obtain larger bank loans. In comparison with formal financing channels like agricultural banks and rural credit cooperatives that require mortgages, vouchers and complicated paperwork to

33 Interview with Yan Qinlin, May 26, 2017

34 Interview with Yu Wozheng, May 25, 2017

get loans, private financing proves to be a more convenient means. However, this channel is often only available to cooperatives and charges higher interest.

The introduction of Demeiya intensified the significance of capital and the market for agricultural production and furthered rural differentiation. Even after maize production decreased in Heilongjiang, the same mode of production and the stratified structuring of agrarian society are still at work. From 2003 to 2015, maize production in Heilongjiang continuously increased for 12 years. In 2014, China's maize production exceeded that of the US and became the largest maize producer in the world. However, since 2013, maize overproduction became a severe issue (chinanews.com, 2016). In 2016, maize stocks in the State Reserve Bureau reached 250 million tons, the annual stock cost of which was RMB 63 billion (xinhua.com, 2016). Maize overproduction eventually led to policy changes towards crop structure adjustment. In the 2016 No. 1 Document (一号文件, yi hao wenjian), the state called for supply-side reform in agriculture for the first time. Soon afterwards, the National Development and Reform Commission declared the cancellation of national maize storage. Maize prices were to be decided by the market and subsidized by the state, should the market price be below the target price set by the state. As the largest maize production region, Heilongjiang agreed to reduce maize acreage by 34 million mu in 2016 and 2017.

Against this background, both Nenjiang and Nehe called for the increase of rice, soya, wheat and minor grain production. One policy is to encourage the transition of dry land into paddy field for rice production, which is accompanied by government subsidies for land transfer, cooperative operation, as well as basic infrastructure construction. The other is to subsidize crop rotation of wheat, soya and other crops and forbid maize production for three years. However, the intended subsidy receivers of the crop rotation policy are large producers, not ordinary peasant households. In order to apply for the crop rotation subsidy, the producer must have an integrated land base of at least 1000 mu. Heilongjiang provincial government set acreage targets of crop rotation for each county. During the policy implementation, local governments found it hard to meet the target, so the policy was eventually loosened to include maize production, and this reduced the scale threshold to 200 mu[35].

Supply-side reform and crop structure adjustment brought back soya production in Nehe and Nenjiang, but the landscape of soya production had already been changed, among which, the increase of protein soya production was most noticeable. Conventionally, the distinction between oil soya seed and protein soya seed did not exist in soya production. However,

35 Interview with the director of township agricultural station, May 16, 2017

imported soya from the US and Brazil outcompeted China's domestic soya as cooking oil and animal feed. Faced with continuously worsening market conditions, soya assemblers in Nenjiang founded the local soya association to jointly explore new market opportunities for local soya production. Eventually, they formed business relations with soya protein factories in Shandong Province and started promoting protein soya production in this region.

The promotion of protein soya production was against the backdrop of Demeiya's development. Maize production's high profit obscured the increase of soya acreage, but at the same time, created the alliance between soya assemblers and producers. 60% of the association members are soya dealers and the remaining 40% are soya producers. The partnership was meant to secure marketing channels for the newly emergent soya production as well as maintain stable supplies for soya protein factories. On the other hand, the increase of farm size in maize production also led to the scaling up of protein soya production. In the first year, the largest producer of the association operated less than 100 hectares of land. In 2017, farm size of producer member is from 300 to 3,000 hectares. Since the crop structure adjustment policy was announced, many producers chose protein soya as the first rotation crop. Capitalist agricultural production is not overturned or weakened; rather, agricultural producers become locked into monoculture and market dependency.

To begin with, the choice of crop was mainly decided by the market and state policies. The commodification of agricultural produce has increasingly deepened after the monoculture of soya and maize over the years. The introduction of Demeiya not only increased farm sizes but also introduced profit-making in agricultural production. Capital investment in land concentration and large farm machinery due to maize production locked many producers into capitalist agricultural production, as seen in other studies (Hallie, Bausch, & Sweeney, 2014). Even faced with market deterioration and the decrease of profit on every hectare, large producers still have to continue capital-intensive farming, if not even more so. On the one hand, they needed to choose the most profitable crop on the market and go on farming in the same capitalist manner. On the other, they have to follow the state policy in order to obtain a subsidy to cover decreased profits. In addition, the declining unit profit and the increasing significance of marketing channels brought large producers into alliances. In recent years, the existing 12/13 cooperatives in Qianjin Township[36], have considered forming a united cooperative that will integrate resources of marketing channels, agricultural technologies and farm machinery from each of the cooperatives and better utilize them jointly. By doing so,

36 Interview with township chief, deputy township chief and township office director, May 23, 2017

they expect to reduce farming costs, increase production efficiency and develop market opportunities.

Discussion and conclusion

Chapter 2 has focused on the implications of technological innovations (new hybrid maize seed) for the transition of agricultural modes of production and rural differentiation. By reviewing the trajectory of rural transformation in Nenjiang and Nehe, Heilongjiang from 1949 to today, this chapter describes three periods of agricultural development, with special attention paid to the characteristics of seed and the particular mode of production that they shaped. The Demeiya case demonstrates that the introduction of a new seed variety leads to the increase of farm size and the adoption of large agricultural machinery, which significantly raises the level of capital input of agricultural production and creates large-scale maize monoculture. As Taylor (2019) argues, citing Borlaug, that seed is "the catalyst for a wider social transformation of agriculture". All the new changes have locked producers into the new agricultural mode of production and raised their dependency on the market. However, the benefits of this technological transformation and new agricultural developments were not shared evenly among peasants. Large producers enjoyed substantial state subsidies and took advantage of rising market prices. Small producers, on the other hand, were faced with increasing pressure from both upstream and downstream forces. Therefore, adoption of Demeiya accelerated rural differentiation and pushed many small producers out of agriculture.

However, the relationship of seed and agriculture must be analyzed in a broader framework of rural development. Political and social implications of any technological innovation reflect the characteristics of specific social formations. The latter can effectively accelerate, decelerate or even completely change the nature of the former.

In the Mao era, the collective farming system was initially designed to diminish the income gaps between rural stratifications and ensure equal share of agricultural development in rural society (Meisner, 1999). Therefore, collective organization of agricultural production, socialist distribution policy and the provision of social benefits not only contributed to agricultural development, but also created an egalitarian agrarian society. However, since the implementation of the Household Responsibility System, the main form of agricultural production returned to family farming. With the commodification of agricultural inputs and agricultural produce, family farming transited from subsistence farming to commercial agriculture, which laid the foundation for increasing peasant differentiation after the Demeiya seed was introduced. Demeiya's introduction was in the context of state support for large-

scale modern agriculture. Therefore, both land concentration and the purchase of large agricultural machinery were subsidized by the state. As a result, rural differentiation has intensified more dramatically than that in the previous period. More importantly, capitalist agricultural production was not substantially impaired after the decrease of maize production, for once profit-making was set in motion as the purpose of farming, the capitalist mode of production will continue in the same logic (Wood, 2002). The resilience of the capitalist mode of production can already be observed in Nenjiang and Nehe. Large producers attempt to form an alliance in order to jointly stay competitive up against policy changes and market fluctuations.

As the largest agricultural province in China, the trajectory of rural transformations in Heilongjiang is probably one of the best examples of the state's policy on agricultural development. In the case of Demeiya's popularity, the opening up of China's domestic seed market to foreign seed and the promotion of large-scale capitalist agriculture overlapped. Although the configuration of factors created the temporary dominance of Demeiya seed for only a short time, the influences were far-reaching. Firstly, it demonstrated the political side of seed or technological innovation in general. Contrary to the understanding that technological advancement indiscriminately benefits producers, the case shows that, without appropriate social arrangement of benefit distribution, agricultural development can actually contribute to inequality in rural society. Secondly, once capitalist agriculture takes place, the motion of profit-making will drive producers to continue improving productivity and stay competitive on the market. The moment of crisis sometimes serves as an opportunity for capitalist producers to recognize their class interests and form cooperation to further their class benefits, which will further consolidate their dominant position in rural society.

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Chapter 3 Seed, capital and technology: Capital accumulation in agriculture in a new era

Introduction

Four decades of market reform has significantly transformed China's agrarian society and agricultural production. The Household Responsibility System (HRS) re-established small-scale family farming in rural China. Without the collective plan for agricultural production, market mechanisms play an increasingly important role in the agrarian transformation. Commercial farming came a long way through marketization of agricultural inputs and commodification of agricultural produce. Although agricultural modernization has long been on the government's agenda, it received more attention after 2006 with the state's strong advocacy for large-scale, mechanized, market-oriented new farms. To achieve this end, the state has given great support to land concentration and provided large subsidies in purchasing seed, fertilizer and large agricultural machinery, which paves the way for the development of capitalist agriculture in China. As argued in Chapter 2, the penetration of capitalism in rural China has resulted in the acceleration of peasant differentiation as small producers give up agriculture and give way to large capitalist producers.

With the deepening of market reform, China's agriculture has arguably moved from guaranteeing national food security, which has been claimed the top priority of the government, according to collective plans to depend on profit-oriented commercial farming. However, commercial agricultural producers tend to choose to grow profitable cash crops (e.g. vegetable, fruit, cotton and flower) rather than grain crops. In the past two decades (1997-2016), China's crop planting area only rose from 154 million hectares to 166 million hectares, while during the same period, vegetable and fruit tree planting areas respectively increased by 98% and 50% (National Bureau of Statistics of China, 2019). The rising of vegetable and fruit production increased the commodity rate of agricultural produce (Huang & Huang, 2010). In grain production, the commodity rate of rice increases from around 40% before 2004 to nearly 80% in 2012 (Chen, 2015). To remain competitive on the market, agricultural producers are compelled to improve agricultural productivity and increase the volume of agricultural produce. To do so, agricultural production is increasingly moving to the direction of monoculture that is conducted on large farms with the help of heavy agricultural inputs and large farming machinery. However, in recent years, with market fluctuations and information asymmetry, agricultural producers constantly find themselves faced with an unexpected drop of commodity prices while urban customers oddly do not enjoy the decrease of market prices.

In the 2017 No.1 Document (一号文件, yi hao wenjian), the state brought the over-capacity issue on the agenda and initiated the supply-side reform (供给侧改革, gongjice gaige), which is aimed at replacing the quantity-oriented agriculture with quality-oriented, green and ecologically sustainable agriculture.

As argued in Chapter 2, seed plays a pivotal role in enabling the transition of the agricultural mode of production and peasant differentiation in rural China. On the other hand, the transformation of agricultural production also reinforces the development of China's seed sector and the power shift of China's domestic seed industry. My research focuses on one of most important crop seeds in China-- the hybrid rice seed. Since the liberalization of China's domestic seed market, the emerging profits in the seed industry have attracted a great deal of investment and a rapid increase in the number of seed enterprises. By the end of 2000, there were more than 2,300 registered seed enterprises in China (Jiang, Guo, & Li, 2015) . Within 6 years, the number had increased to over 9,000 (Yang, Wang, Gong, & Wang). In the past two decades, the seed market has seen the release of an unprecedented number of seed, legitimate or otherwise. China became the second biggest seed market in the world in 2005, the trade value of which was RMB 35 billion (Ma, 2010). The number soared to RMB 50 billion in five years, increasing by 57%. The value of China's domestic seed market was estimated at 9 billion USD in 2011 (ISF, 2012). The fast expansion of China's seed market lead to the overproduction issue in the seed industry since 2010. In both the hybrid rice seed and hybrid maize seed industry, overproduced seed exceeds the nation's annual need by 100%.

While the seed industry alone is faced with pressing overproduction issue, the transformation of China's agricultural production only made the situation more severe. The growing importance of cash crops over grain crops in China's crop structure and the transition from double-cropping to single-cropping in rice production significantly cut down market demand for grain crop seed. In addition, the supply-side reform in 2016 altered the market needs for seed from yield improvement to diverse trait enhancement, for instance, taste improvement, water saving and soil purification. Therefore, on top of marketing the overproduced seed, the seed enterprises are also pressured to change the directions of seed breeding.

Meanwhile, peasant differentiation has not only reduced the number of agricultural producers and increased the farm size, but also changed the seed marketing network. When China's domestic seed market was first liberalized, seed was marketed through a three-tiered distribution system in which seed companies relied on seed merchants at the province, county and township level to reach numerous family farm customers. This system is particularly

important when the seed market is full of homogeneous products that seed merchants play a key role in deciding which seed product will be recommended to customers (Luo, Fu, Luo, & Zhu, 2014). Therefore, seed merchants also enjoy a significant share of the seed profits. However, the overproduction issue forced many seed companies to cut down seed merchants and flatten the seed distribution system in order to concentrate the decreased seed profits in their hands. Large-scale agricultural producers, who emerge from peasant differentiation, need a large amount of seed and prefer to negotiate better prices from seed companies or higher-level seed merchants, which puts lower-level seed merchants out of their jobs.

The structural transformation of China's agricultural production and agrarian society converge on the changes in China's domestic seed market and seed industry, which together leads to a rising group of agricultural producers who re-organize agricultural activities along the entire agricultural production chain, ranging from the upstream inputs, the production process, and downstream processing. The key feature of this re-organization is the control of seed, through which agricultural capitalists take the market opportunity of ecological agricultural products and incorporate ecological production into capitalist agriculture. To achieve such transformation, the agricultural capitalists in question not only need to possess enough production capital and social capital to integrate the agricultural production chains, but also need to grasp the knowledge of seed and the technological transitions associated with seed.

Chapter 3 will draw on my fieldwork in Guangxi and Hunan Province and explore the new dynamics in China's agrarian change featuring the supply-side reform in agricultural production and the re-configuration of China's domestic seed market. This new transformation signifies the increasing penetration of capitalism in agriculture and capital accumulation along the entire agricultural production chain. It also highlights the significance of seed in the intensified market competition of capitalist agriculture during the new development of China's economy.

Overproduction issue as an opportunity for capital accumulation

This chapter will draw on my fieldwork in Guangxi Province and Hunan Province for examining the reinforcement relationship between China's agrarian change and the transformation of China's domestic seed industry at the turning point of China's economic development. Contrary to Heilongjiang Province whose agricultural production and seed market were discussed in the previous chapter, Guangxi locates in Southwest China where the climate and geographical conditions are more diverse and per capita farmland is less than 1 mu in most regions. The mountainous area is mainly used for maize production while the plain

is known for rice. Hunan, on the other hand, is a major rice production area in Central China and one of China's biggest regional seed market, where China's leading domestic hybrid rice seed enterprise Longping High-tech (隆平高科, longping gaoke) has its headquarter here. In this chapter, I will draw on interviews with local seed merchants and depict their business trajectory, which presents a short narrative of how the overproduction issue in China's domestic seed market serves as an opportunity for capital accumulation.

When China's domestic seed market was first liberalized, the majority of seed merchants came from the government system (see Chapter 1). In Hezhou City of Guangxi Province, I was introduced by the Director of the Seed Bureau to the top two local sales agents, Wei Jian and Long Pingsheng. They worked in the same office of the state-owned provincial seed company and Long used to be the office director. In 2009, the seed company underwent structural adjustment, which detached the governance function from the company and reorganized it into an independent enterprise and self-responsible market entity. However, before the changes in the provincial seed company happened, Wei and Long already resigned their jobs and established their own seed sales businesses. Both of them had two ex-colleagues working for them. The timing they entered the seed market, 2005, was a crucial year for Guangxi seed market. On this year, a great number of local private seed enterprises were established and seed enterprises from other provinces (e.g. Hunan) also rushed in. Seed merchants were faced with a great opportunity to profit from the rising competition between seed enterprises because the existing marketing channels were controlled by them and seed enterprises needed to rely on them to reach peasant customers. Wei used to have over 100 retail stores in Hezhou City, and in a good year, he alone could sell 300,000 kg of hybrid rice seed.

In the following 5 to 6 years, Wei and Long enjoyed the best profiting period of seed marketing. Tang Huangrui[37], marketing manager of Guangxi Hengmao Seed Company, who worked at Longping High-tech's Jiangxi and Hunan branches after graduation in 2000, recalled that between 2007 and 2011, profit in selling hybrid rice seed increased by 5 times since the seed market was liberalized. Sales profits from 30 million kg of hybrid rice seed was RMB 30 million for Longping High-tech in early 2000. Between 2005 and 2010, simultaneously with the rising seed selling price, the sales profits also jumped to RMB 150 million for the same amount of seed. However, China's domestic seed market was soon overwhelmed with over-supplied seed that the market cannot absorb. In addition, new seed varieties kept being introduced and waiting to be sold. In following chapters, I will discuss how China's domestic seed enterprises responded to the overproduction issue on the seed

37 Interview with Tang Huangrui, April 7, 2017

market. In this chapter, I will focus on how seed merchants take this opportunity to diversify their business and accumulate capital from the entire agricultural production chain.

The first measure that seed merchants took was to cut down the number of retail stores and concentrate the shrinking profits in the upper level of the marketing channel. In the past, for every kilogram of hybrid rice seed sold in Guangxi's seed market, the profit for county sales agents was RMB 15, and for retail store RMB 10[38]. Around 2010, the majority of China's seed enterprises no longer sought seed merchants at the provincial level, and instead, relied on the county-level seed merchants to sell their seed. By the time I interviewed Wei, his retail stores had been reduced to about 80, leaving only one or two in most townships. The other measure was to accumulate capital from agricultural production in order to create a stable demand for their seed and exert more control over the entire agricultural production chain.

The profit decrease in seed marketing is an important factor for seed merchants going to agricultural production. However, without the capitalization of agriculture, seed capital's penetration in agriculture would not be possible. To begin with, seed merchant would not consider cooperating with peasant producers when the production scale was small and seed needs were diverse so that long term cooperation between producers and upstream seed suppliers was not necessary. By 2017, however, large scale producers had significantly increased in number. According to the Ministry of Agriculture (MOA) (gov.cn, 2016), in 2016 there were over 870,000 family farms in China that covered 176 million mu of farmland, accounting for 13.4% of the national acreage. The average size of MOA certificated family farms was 170 mu. By November 2017, after ten years of development, the number of agricultural cooperatives reached almost 2 million, 76 times of that in 2007, and they incorporated half of Chinese peasants. In 2007, there was one agricultural cooperative in averagely 23 villages, while 10 years later, each village had three cooperatives (MARA, 2018).[39] The increase in the number of large scale farms made cooperation with agricultural producers now more convenient and profitable for seed merchants.

Secondly, the commodification of agricultural means of production (e.g. seed, fertilizers, pesticides) has increased capital investment for agriculture and large producers are faced with the pressure to raise a large amount of cash for the growing season (see Chapter 1). Thirdly, the development of capitalist agriculture makes the market the most important factor in

38 Interview with Li Wu, April 5, 2017

39 In March 2018, the first session of the 13th National People's Congress (NPC) approved of the State Council institutional restructuring plan. According to this plan, Ministry of Agriculture was reorganized, and its responsibilities were assumed by the new established Ministry of Agriculture and Rural Affairs.

deciding the particular arrangement of agricultural production. For agricultural producers, to sell their products is the priority for choosing what to produce, how to produce and under what conditions to produce. Under this circumstance, agricultural producers are more easily submitted to arrangements that can provide marketing channels for their products. The development of capitalist agriculture in China inevitably points to the increasing involvement of upstream and downstream agro-capitals in agricultural production. As Bernstein (2010, p. 65) argues, in modern (capitalist) economies, "agriculture" or "the agricultural sector" means "farming together with all those economic interests, and their specialized institutions and activities, 'upstream' and 'downstream' of farming that affect the activities and reproduction of farmers."

Different approaches to the concentration of control over agricultural production

Concentration of profit through contract farming

Contract farming emerged in China in the late 1980s (Guo, Jolly, & Zhu, 2007). Through contract farming, agribusiness (e.g. seed or fertilizer merchants, agricultural machinery owners) signs market-specification contracts with agricultural producers and accumulates agro-profits from both pre-production and post-production (Zhang, 2012). Contract farming is also an important mechanism to incorporate individual small-scale peasant farming into commercial agriculture and increase the commodity rates of agricultural produce. It improves the significance of market competition and profit making in agricultural production. With the capitalization of China's agriculture, the state's support for agriculture social services has also increased. For more than a decade, the annual No. 1 Document, the pivotal policy document released by the Central Committee of the Communist Party of China to set the tone for national agricultural development, would include the establishment of agricultural social service system. Various actors in the upstream and downstream of agriculture are encouraged to provide agriculture social services for agricultural producers. In 2017, state finance allocated RMB 653 million for 237 demonstration projects of agricultural social service system (MOF, 2017). They were meant to facilitate the concentration of farmland in order to increase the farm size, to subsidize agricultural services providers and to advance the integration of agricultural production, the processing industry and the service industry. The state's advocacy for agriculture social services further increases the popularity of contract farming. For seed merchants like Wei Jian, it's good opportunity to move on the agricultural industry chain and encompass agricultural production and produce marketing in their businesses.

In 2014, Haoshi Agricultural Company was established in Heizhou City, where Wei Jian's business locates. This company is based on a demonstration site for full mechanization of rice production, an agricultural social service project supported by Hezhou government. 60% of project costs (RMB 2 million) came from the company while the other 40% was subsidized by the local government. After the demonstration site is put in place, the company provides mechanical services for agricultural producers in rice seedling, transplanting, harvesting, drying and paddy field ploughing. In searching for seed varieties suited for mechanization, the company found Wei Jian through Hezhou Bureau of Agriculture. However, in addition to giving seed suggestions, Wei took the chance to form a deeper partnership with Haoshi and encouraged the company to take up agricultural production by itself. Wei finds that the profits of agricultural social services are generated only in the rice planting and harvesting seasons, while in other times, the company does not have any business activities. By expanding to agricultural production and rice processing, profits can be created along the agricultural industry chain. On the other hand, Wei's contribution to the company becomes essential by controlling the upstream agricultural input of seed.

Following Wei's suggestion, Haoshi Agricultural Company started rice production in 2015. Instead of using high-yield rice seed and producing for the general market, Haoshi saw the rising market opportunity for high-quality rice with better taste and decided to take up ecological agriculture. Haoshi owns a production base of 400 mu, which was transferred from neighboring peasants with the help of the village committee. Besides ecological fertilizer application, all the production activities are mechanized, and the efficiency of mechanization enables double-cropping, a farming practice that had been given up by the majority of local peasants. To process the harvested paddy, Haoshi purchased a production line from an existing processing company and let this company be a shareholder of Haoshi. By doing so, Haoshi not only extended its business to agricultural downstream but saved RMB 2 million for its total investment. Further along the agricultural industry chain, Haoshi also managed to explore marketing channels on its own. The price of rice on the general market was RMB 3-4/kg in 2015, but Haoshi's ecologically produced rice was set at RMB 6-9/kg. To look for consumers who can afford such a high price, Haoshi obtained customer lists from local banks and directly contacted the potential consumers to promote its rice. Local restaurants and specialty stores were also Haoshi's stable consumers. The former were large buyers and a lower price was given to them to form long term cooperation. Besides the production base, Haoshi also took up contract farming that covered over 4000 mu of farmland. Under the contract farming arrangement, the company provides rice producers with seed, fertilizers and technical instructions. Rice produced using the company's input package and according to technical

guidance will be purchased by the company at a price 10% to 15% higher than the market price.

Since Haoshi took up agricultural production, Wei Jian also obtained a stable seed marketing channel as Haoshi's sole seed supplier. Compared to manual rice transplanting, seed input has to be increased to 2kg/mu for mechanical rice transplanting in order to compensate seedling loss during machine operation. For each growing season, seed use on Haoshi's production base is 800kg, while on contract farming area over 5000kg. In other studies on China's contract farming (Chen, 2017; Zhang, 2012), the common motivation for agribusiness agents to undertake agriculture is to maintain or increase seed sales. However, the significance of Wei's cooperation with Haoshi is beyond opening seed marketing channels. Wei's participation in Haoshi's agricultural production is vital for the vertical integration of agricultural industry chain.

In discussion of peasant's motivation of joining contract farming, technical difficulties in agricultural production often come forward (Chen, 2017; Zhang, 2012; Guo, Jolly, & Zhu, 2007). The neoliberalization rolled out China since the 1980s has significantly undermined the public agricultural technology extension system and limited peasants' channels in obtaining new information and technical training to increase agricultural productivity. At the same time, large producers are also faced with more pressure to seek technical assistance. However, the reason is different. With the fast development of land transfer and the scaling-up of agricultural production, capital plays a more important role in undertaking agriculture. The newly emerged large agricultural producers, especially those with mega scale farms, are not always equipped with farm management skills, which makes them particularly dependent on agro-capitals that can provide technology. In Jinshi County, Hunan, a main rice production region on the "land of fish and rice" (鱼米之乡, yu mi zhi xiang), I interviewed a seed merchant, Huang Genglin[40], whose annual seed sales account for about 25% in this region. His primary customers are local large rice producers. Among them, 40% are sufficient in production capital and farm management skills, while another 40% only possess abundant money to transfer land for their large farms. The latter is prone to collaboration with agro-capitals. In Haoshi's case, the success of its contract farming was in need of Wei's assistance. As an experienced seed merchant, Wei provided Haoshi with popular seed varieties on the market and selected the best variety that was suitable for mechanized production. He also supervised the entire production process and offered technical guidance for seed seedling and

40 Interview with Huang Genglin, April 23, 2017

rice transplanting. By joining Haoshi's contract farming, Wei also extended his service to rice processing and marketing based on his knowledge of the rice characteristics.

Wei's cooperation with Haoshi diversified his business activities and increased his profits. More significantly, through contract farming, he gained influences in agricultural production, processing and marketing. The development of ecological rice production and the introduction of mechanization give rise to new demands for seed varieties and related agricultural technology. It gives agro-capital an opportunity to enter the production process and accumulate more capital not only by stablizing seed sales, but also by further influencing seed choices through the organization of rice processing and rice marketing. So far, Wei's main business focus has moved from the upstream input to agricultural production, processing and marketing.

Consolidation of profit through class alliance

The second chapter mentioned the alliance between large agricultural cooperatives in Nenjiang, Heilongjiang. Faced with growing competition in market-oriented agricultural production, these cooperatives integrated marketing channels, agricultural technologies and farm machinery in order to consolidate their strength. Whereby, agricultural capitalism was also intensified. In this chapter, using Huang Genglin's case[41] (see previous part), I will elaborate how agro-capital endeavors to form direct cooperation with large producers and facilitate alliances among them in order to stabilize seed sales and further profit from agricultural production.

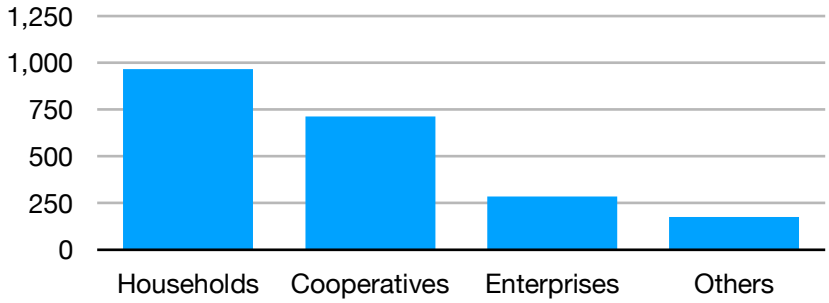
In Hunan Province, land transfer has been steadily rising[42] and large-scale capitalist agriculture has spread in most regions. The acreage of transferred farmland was respectively 13.79, 14.49 and 18.94 million mu from 2013 to 2015. In 2016, the acreage reached 21.37 million mu, accounting for 41.71% of Hunan's total farmland. In the same year, 7.13 million land went to peasants' cooperatives and 2.84 million mu to industrial and commercial enterprises, each accounting for 33.36% and 13.27% of the transferred farmland (see Figure 3.1). Table 3.2 shows the number of land transfer cases according to the acreage ranges in 2016. Insofar as large-scale farms are increasing, the majority of farms are still those of 100 to 500 mu of land. According to the second round of land survey in Hunan (MNR, 2014), the

41 Unless otherwise stated, all the case information mentioned here come from interview with Huang Genglin.

42 Unless otherwise stated, data on Hunan's agricultural development was obtained from office director Liu at the Department of Agricultural Management and Governance in Hunan Agricultural Committee. Data in this part is included in one document drafted by this department titled "Summary on management rights transfer of rural contracted land in 2016 and work plans for 2017 in Hunan Province".

per capita farmland in this province is 0.9 mu, 59.2% of the national average. Therefore, every year the land of millions of peasants is transferred to large producers.

Figure 3.1 Agents in land transfer in Hunan, 2016 (million mu)



Source: Interview with Huang Genglin, April 23, 2017

Table 3.1 Land transfer in Hunan Province, 2016

Land transfer acreage	100-500mu	500-1,000mu	1,000-2,000mu	>2,000mu
Cases	30475	5125	3014	451
Percentage	78%	13%	8%	1%

Source: Interview with Huang Genglin, April 23, 2017

Huang Genglin worked the state-owned seed company in Jinshi County and then the agricultural extension agency before becoming a seed merchant for Longping High-tech Company. In 2013, state policy forbade government workers from undertaking business activities while keeping a position in the government. They were expected to choose either to stay in the public service or remain in the private sector. Huang was 52-year-old then and would retire in a few years. To secure his pension, he returned to the County Bureau of Agriculture. In fact, he only relocated his seed business back to his hometown and continued to sell seed on the side. From then on, he explored a new mode of seed sales, a direct cooperation with large agricultural producers.

In 2013, 30% of Jinshi County farmland was transferred and the establishment of large-scale farms became the trend. Therefore, Huang no longer kept retail stores selling seed in townships and started contacting large producers on his own to establish long-term cooperation with them. In Jinshi County, there were over 80 large producers whose farm sizes ranged between 100 mu to 1000mu, and Huang cooperated with more than 50 of them, though these large producers also buy seed from other seed merchants. Among these large producers, 70% of their farms were over 200mu, 20% over 500mu, 10% over 500mu. In 2017, 70% of Huang's seed sales went to large producers, 25% to seed merchants, and 5% to small

producers who were his old customers. Jinshi County has double cropping area of 10,000 mu, with single cropping at 60,000mu. The total rice seed demand is 105,000kg. Huang's annual seed sales were 25,000kg. To attract large producers, Huang sold single-cropping rice seed to them RMB 20/kg below the market price, RMB 10/kg lower for both early season rice seed and late season rice seed. In comparison, township retailers' profit for single cropping seed was RMB 20/kg, for early season rice seed RMB 10/kg and for late season rice seed RMB 12/kg. Therefore, the first measure that Huang took to build cooperation relation was to give large rice producers wholesale prices.

Table 3.2 Rice seed price for large producers and township retailers (RMB/kg)

Rice seed	**For large producers** (below market price)	**For township retailers** (below market price)
Single-cropping	20	20
Early season	10	10
Late season	10	12

Secondly, to establish and maintain cooperation relation, Huang increased contact frequency and provided technical services throughout the rice production process. His position in the Bureau of Agriculture and his working experience at Longping High-tech helped him on his first contacts with large producers. Compared with other seed merchants, he possessed more technical knowledge and more accountability. Huang's second visits to large producers came after he learnt their expectations for single-cropping and double-cropping rice seed. Every year prior to and after the Spring Festival, he would visit large producers again to learn of their upcoming production plans, in order to prepare himself for the next round's seed promotion. Huang provided follow-up technical service first by text messages. He sent instructions on rice cultivation, plant diseases and pest controls, as well as prevention measures for unfavorable weather and climate conditions. He also went to large producers' rice fields two to three times every season and offered them with on-site technical advice. Large producers learned advanced farming technologies and new management concepts from Huang.

Thirdly, Huang's marketing strategy that targets at large producers required high capital investment. Every year he needed to prepare RMB 2 million of cash, for every kilogram of single cropping rice seed costed RMB 80/kg, early season rice seed RMB 34/kg, and late season rice seed RMB 40/kg. Huang stop marketing Longping High-tech's rice seed because the rice prices were relatively higher, and the profits concentrated largely at the company. Instead, he purchased seed from Hunan Hoping Seeds (thereafter Hoping), the manager of which company had been Longping's marketing manager and was a friend of Huang's.

Through this social capital, he managed to purchase seed on credit from Hoping and pay the full amount after the large producers paid him. In such way, large producers could pay Huang for the first half of the seed money in the growing season and the other half after rice was sold, which significantly reduced their pressure to raise production capital.

By the above measures, Huang became the only seed merchant that I interviewed who had the resources and skills to form long term partnership with large agricultural producers and to establish stable seed market channels. The new features of agricultural development in Hunan Province made such cooperation more appealing to seed merchants and they had an important role to play in the class alliance among large agricultural producers.

Before the 2017 No. 1 Document launched the supply-side reform, in 2010, Hunan Province, which has the largest rice cultivated area and highest rice output in China, had already initiated structural change in rice production, the Hunan Rice Project (湘米工程, xiang mi gongcheng) (agri.huan.gov.cn, 2010). This project aimed to increase good-quality rice production and reduce the cultivate area of conventional high-yield rice, for the market price of the former is 20% higher than of the latter. To achieve this goal, Hunan Department of Agriculture plans to establish a 4.5 million mu production bases that covers farmland from 270 townships. These townships were selected from 43 counties and have favorable production and environmental conditions for rice production. In 5 years, the cultivated area of good-quality rice is expected to reach 15 million mu. In Hunan Rice Project, seed choice changed mostly from high yield to better taste. However, it still calls for large-scale mechanized monoculture and strongly advocates for the cooperation between production bases and agricultural processing enterprises in order to realize the integration of agricultural production, processing and marketing.

In Jinshi County, good-quality rice production started later than the government agenda. Mr. Xin and his wife have undertaken rice production for more than two decades, but the change of their mode of production did not happen until 2012 (see Table 3.3). Before 2012, they only farmed family land contracted from the rural collective. Thereafter, they transferred land and enlarged the farm size, but the transfer fee increased alongside the rise in production scale. In 2016, Xin's farm expanded to 1000mu and rice production entirely transited to double cropping. In the same year, Xin also experimented with good-quality rice production by adopting conventional rice seed for the first time. Like other producers in this region, the increase of farm size was driven by the government's subsidy for family farms. A farm between 100 to 200 mu can qualify as a family farm. Under 200 mu, each mu will be

subsidized with RMB 100, in addition there is RMB 20/mu for farm machinery. Qualified family farms have to change to double cropping in complying with the government's responsibility for food security. Besides conventional rice seed, conventional sticky rice seed and ratooning rice seed have also become popular choices among Jinshi large producers. Though productivity of the three seed varieties is at least 100kg/mu less than hybrid rice seed, the rice taste is better, and the market price is higher.

Table 3.3 Rice production on Mr. Xin's farm, Jinshi County, 2012-2017

Year	Farm size (mu)	Transfer fee (RMB)	Single/double-cropping	Seed variety
2012	30~40	none	single-cropping	one super RS
2013	30~40	none	single-cropping	two super RS
2014	100	100	single-cropping	one super RS
2015	400	200	single-and double-cropping (100mu)	three super RS
2016	1000	300	double-cropping	four super RS & one conventional RS (300mu)
2017	1000	300	double-cropping	conventional RS

Source: Interview with Mr. Xin, April 23, 2017.

Note: 2017's data only reflects the latest production arrangement in the spring. Super RS and conventional RS respectively stand for super rice seed variety and conventional rice seed variety.

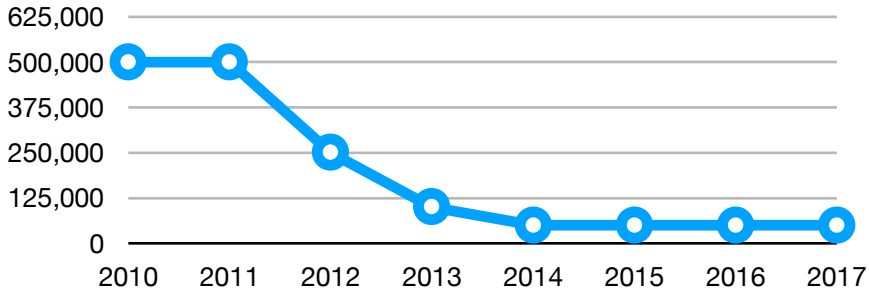
The increase of good-quality rice production resulted in the popularity of conventional rice seed, which brought great challenges to seed merchants. In other regions of Hunan, where good-quality rice production was adopted earlier, seed merchants had experienced a sharp seed sales decrease. In Ziyang City, I interviewed a close friend of Huang Genglin, Peng Weifan[43], who also started his independent business and became a major local seed merchant. Before 2009, hybrid rice seed had 80% market share and conventional rice seed was rare. Table 5 shows that Peng's hybrid rice seed sales in 2010 and 2011 both reached 500,000 kg, accounting for 30%-40% of the local seed market. However, thereafter, market dominance of hybrid rice seed was replaced by conventional rice seed. In 2012 and 2013, Peng's seed sales were only half of the previous year. From 2014 to 2017, Peng's seed sales reduced to 10% of that in 2010. In comparison, conventional rice seed's market share jumped from 40%-50% in 2010 to 80%-90% in 2017. In addition to the decrease of seed sales, conventional rice seed lessened agricultural producers' dependence on seed merchants for conventional seed could be saved and used for the next growing season. Even if producers wished to purchase seed

43 Interview with Peng Weifan, April 25, 2017

from the market, the cost of conventional seed was RMB 20/mu in contrast to RMB 120/mu for hybrid rice seed.

Figure 3.2 Peng's seed sales in Yiyang City, 2010-2017 (kg)
Source: Interview with Peng Weifan, April 25, 2017

Faced with challenges from good-quality rice production, Peng chose to take up agricultural production on his own and switched his main occupation from a seed merchant to a large



producer[44]. However, in preparation for the upcoming marketing difficulties, Huang Genglin avoided risks in direct undertaking of agricultural production, but to profit from his close cooperation with large producers in times of crisis. To begin with, he thoroughly investigated production costs of every agricultural input and did cost-benefit analysis of large farms. Huang even took into consideration of the material incentive given to farm employees for production exceeding expectations and extra costs for building social connections. According to Huang's calculation, in 2016 when the rice market price decreased, 70% of large producers lost money and only 10% managed to profit. Moreover, Huang also learned government subsidy policy for scaling-up, farming machinery, rice seedling, basic infrastructure construction, agricultural processing and technology training, so that he would be able to offer suggestions to large producers.

Lastly, in practice, Huang was actively involved in the establishment of a large producers' cooperative. He listed large producers in his marketing region and made contacts with them about an agricultural cooperative plan. Based on his knowledge of local large producers, they were confronted with six critical issues in agricultural production: unstable land tenure, lack of technology, poor production infrastructure, low added value, shortage of government support, and short-term investment. A cooperative, on the other hand, could help them with the last four issues. With his assistance, several local large producers founded a cooperative

44 Peng transferred over 1,600 mu of land in 2014 and another 1,800 mu in 2016. He attempted to become one of the top 50 large producers in Hunan Province. He also purchased 10 drying facilities and built warehouses of 10 ton storage capacity as well as greenhouses that can provide rice seedlings for 10,000 mu. Peng was also planning on a rice processing factory and a farmer training center. These agricultural service facilities were subsidized by the government to encourage certain large producers to also become agricultural service providers.

that covered 5,000 mu of farmland. The cooperative had invested RMB 3 million on drying facilities, warehouses, rice processing machines, offices and a training center. Large farm machinery was purchased by one large producer and hired by all the cooperative members. The expenses would be compensated by renting out the machinery to other producers and government subsidies. If the government subsidy exceeded the machinery cost, the remaining money would be shared by all the cooperative members. Huang became the cooperative's technical consultant since its founding. In 2016, the cooperative used seed varieties recommended by Huang and unified its agricultural produce. However, insofar the cooperative was still at the beginning stage. These large producers were independent and solely responsible for gains of losses of individual agricultural production.

It is premature to assess the implications of the large producer cooperative for agro-capital and agrarian transformation, but tentative trends can be outlined at this stage. To begin with, Huang's active participation in the formation of large producer cooperative furthered his cooperation with large producers and also consolidated his influences on agricultural production. Huang not only gave suggestions on seed choices, but also learnt about market demands for rice quality and producers' needs in seed selection. It provided him with acute information to provide seed for the cooperative. More importantly, the cooperative intensified competition in agricultural production and furthered large producers' advantages over small producers.

The adoption of large farm machinery put greater pressure on large capitalist producers to increase farm size and stabilize agricultural production, which consequently drove up land transfer fees and weakened the financial capacity of small producers to obtain farmland. In Jinshi County, the annual land transfer fee was RMB 300/mu. However, large producers raised the cost to RMB 500/mu in order to integrate the farmland and extend land tenure. Moreover, the cooperative accelerated agricultural mechanization and extended agricultural production to agricultural downstream of processing and marketing. Through added value of rice processing and marketing, large producers would be able to increase agricultural profits and accumulate more capital to consolidate capitalist modes of production. On the other hand, small producers who still sell unhusked rice would become increasingly less competitive on the rice market and be replaced by large capitalist producers, which consequently would intensify peasantry differentiation. The large producer cooperative also increases capital demands for agricultural production and raises the entry threshold for new large producers. Studies (Byres, 1981; Rakshit, 2011) on capitalism penetration in Indian agriculture have found that the adoption of new technology will exacerbate peasantry differentiation through the increase in farm productivity. The large producer cooperative's case presented in this

chapter indicates that integration of agricultural upstream, production and downstream stages in the industrial food chain has similar social implications for agrarian transformation. However, more empirical evidence needs to be explored to elaborate on the dynamics of class differentiation.

The dynamics and fluidity of agro-capital's participation in agricultural production

In recent years, mounting studies on China's agrarian transformation (Yan & Chen, 2015; Huang Y. , 2015; Zhang Q. F., 2015) have come to the conclusion that capitalist farms have been rapidly growing in rural China and capitalist relations of production have been established in Chinese agriculture. In these studies, agricultural capitalism in China has not developed through peasant proletarianization or land enclosure, two defining features of the classic agrarian transformation pathways, but rather it grows by the spread of commodity relations and market imperative (Zhang Q. F., 2015). The market demand shift from rice quantity to rice quality in the supply-side reform resulted in changes of seed variety and created new cooperation between agricultural producers and seed merchants. On the other hand, the overproduction issue on the seed market also urged seed merchants to seek for new profit-making opportunities. Therefore, the structural transformation of Chinese agriculture and seed market mutually contributed to agro-capital's participation in agricultural production. This section will compare the previous two cases and elaborate on the dynamics and fluidity of the cooperation between agro-capitals and large agricultural producers. It aims to explain the stability of the cooperation and class alliance among large producers and its implications for China's seed industry and agrarian transformation.

First, the primary condition for agro-capitals to form cooperation with capitalist producers is their access to large amounts of capital or close connection with seed enterprises to allow late payment for seed. With the rising degree of capitalization in agricultural production (Zhang Q. F., 2015), large producers expect to delay partial seed payment until after the rice harvest to reduce the total costs of the means of production during the harvest season[45]. Delay of seed payment is also a strategy that large producers use to hold seed merchants accountable for seed quality. In case of crop failure, producers expect to refuse the full payment to compensate their losses. As one of top seed merchants in Hezhou, Wei Jian accumulated significant capital during the prime years for seed marketing. Huang Genglin, on the other hand, relying on his friendship with Hoping company president, obtained favorable conditions that reduced his annual capital investment by half. Therefore, as the linkage between agricultural producers

45 Interview with Chen Jin, Hoping seed marketing manager, April 20, 2017

and seed companies, seed merchants are faced with double squeezes of rising capital investment, on the one side, and high risks of late payment or even no payment, on the other.

Second, along with the rising capital demand, seed merchants need also to be equipped with agricultural technology to deepen the cooperation with large producers. With the decline of public agricultural technology extension service (see Chapter 1), commercial technology consulting service provided by seed, pesticide and herbicide merchants becomes essential for agricultural producers (Chen, 2018). The state's agricultural modernization agenda accompanied by supportive policies regarding land transfer and agricultural subsidies has resulted in the establishment of a great number of large capitalist farms. However, a significant number of these large capitalist producers are sufficient in capital, they lack farming experience and technological knowledge for efficient operation of their farms. In Jinshi County, there were over 50 agricultural cooperatives ranging from vegetable and crop production, livestock husbandry and agricultural machinery operation. In an interview with office director Huang[46] from the County Bureau of Finance, he admitted that only 20% of these cooperatives were successful while the rest had invested in agriculture was to seek government subsidies. The latter has a higher dependency on external technology consulting service. In the backdrop of weakening public technology service and increasing large agricultural agents seeking technology externally, the combination of seed variety with according technology guidance throughout agricultural production, extending to processing and marketing, that seed merchants can provide develop their comparative advantage and competitive power.

Third, China's agrarian change is experiencing a new phase of increasing agricultural investment and capital accumulation through the integration of the food production sectors. Since the implementation of HRS, the state's agricultural modernization agenda was to transform the agriculture system into a large-scale, market-oriented and technology-intensive one, the primary focus of which is to improve agricultural productivity, increase agricultural production and enrich agricultural producers (Zhang & Donaldson, 2013; He, 2015). However, in recent years, agricultural practices that aim at promotion of sustainable production systems, quality improvement of agricultural produce as well as advocacy for agricultural multi-functionality have gained growing popularity with the introduction of ecological agriculture and consumer movements, such as community support agriculture (CSA) and nested market (Yang & Wen, 2008; Van der Ploeg, Ye, & Schneider, 2012; Schumilas, Scott, Si, & Fuller, 2012).

46 Interview with Huang, April 24, 2017

The supply-side reform, to a certain extent, further gave rise to quality-oriented agricultural production, but it does not change the development of agricultural capitalism. On the contrary, this reform encourages the integration of agricultural production, processing and marketing and intensifies capitalist agriculture, for it requires more infrastructure construction and larger capital investment in processing facilities, storage, transportation and product marketing. The accelerated capitalization in the agricultural sector not only excluded individual small producers but also put significant pressure on large producers to stay competitive. The newly emerged agricultural industry integration served to be an opportunity for industrial and commercial capital to incorporate small producers into contract farming, as demonstrated in Haoshi's case. On the other hand, faced with fierce market competition, individual agricultural capitalists that had already taken root in rural China were financially incapable of capital accumulation in agricultural processing and marketing. To remain competitive, as seen in the Jinshi County case, agricultural capitalists formed class alliances by establishing a large producer cooperative in order to obtain government subsidies in agricultural production and processing. Through the new organizational structure, agricultural mechanization was accelerated, and the concentration of farmland also increased the cooperative farm size. Therefore, agricultural industry integration intensified agricultural capitalism and thereby capital accumulation was extended through the agricultural industry.

However, so far, the cooperation among large agricultural producers is still at the primary stage, where the cooperative is formed by agricultural capitalists to first and foremost seek government support while production unification, processing standardization and marketing strategies are yet to be fully achieved. On the other hand, short term land transfer hinders the stability of land concentration and discourages agricultural capitalists' long-term investment and production planning. Moreover, despite government's subsidies in agricultural production, agricultural capitalists are faced with increasing pressure to raise production capitals and have to cope with rising production risks and market fluctuations.

Since 2010, transformations in China's domestic seed industry and agricultural production both points to profit concentration in large agro-capitals and agricultural capitalists. Capital accumulation is increasingly achieved through the control of large capital and technology, which undermines peasant's competitiveness in comparison with large capitalist producers. The new mechanism of profit making necessitated agro-capital's participation in agricultural production as well as the attempt to form long-term and stable cooperation between agro-capitals and large capitalist producers. Presumably, this collaboration will further exclude peasant producers from agricultural production or incorporate them into contract farming.

However, due to the tight fieldwork schedule and limited access to local peasant producers, this research inadequately explored the social implications of the transformation in China's seed industry and the parallel agrarian change for peasant producers.

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Chapter 4 Restructuring of China's Seed Industry and the State's Role in Agribusiness Development

Introduction

Since 2015, six international agribusiness companies have controlled about two thirds of the global seed market and more than 70% of global pesticides (ETC Group, 2018). In the past three years, three mega-mergers (Dow-DuPont, Syngenta-ChemChina, Monsanto-Bayer) have further transformed the global agribusiness landscape, resulting in four transnational corporations dominating 65% of global agrochemicals and pesticides and about 60% of the global seed market (Brasil de Fato, 2018). Capital concentration and market monopoly of major transnational agribusiness have increasingly intensified. In the new wave of transnational corporation mergers, ChemChina, a Chinese leading state-owned chemical company[47], drew international attention. The heated debate around this merger is first because ChemChina's acquisition of Syngenta is by far China's biggest foreign takeover. Syngenta was the world largest pesticide and the third largest seed agribusiness, the market shares of which in pesticide and seed were respectively 20% and 8% (xinhuanet.com, 2017). Second, the merger marks the rise of China's agribusiness in capital accumulation on the global seed and agro-chemical market. ChemChina sat among the top four global agribusiness corporations upon the completion of the acquisition of Syngenta and gained access to Syngenta's global marketing network covering more than 90 countries.

In 2008, Howard (2009) argued that globally in the last 40 years "It (the commercial seed industry) has shifted from a competitive sector of agribusiness, composed primarily of small, family-owned firms, to an industry dominated by a small number of transnational pharmaceutical/chemical corporations". In the background of the global agribusiness consolidation, the merger with Syngenta seems to demonstrate ChemChina's intention of adopting the global capital accumulation strategy; the same as other major transnational agro-capitals. The transformation trajectory of China's domestic seed industry in the last 10 years indicates that ChemChina's acquisition of a giant transnational agribusiness is a turning point in China's agro-capital strategy.

47 In the Chinese context, ChemChina can be confused with another leading Chinese chemicals, rubber and agriculture group, Sinochem. Same as ChemChina, Sinnochem is also a state-owned company under the administration of State-owned Assets Supervision and Administration Commission of the State Coucil, the PRC. In 2007, with the State Council's approval, a state-owned seed company, China Seeds, merged into Sinochem and became its wholly-owned subsidiary. (State-owned Assets Supervision and Administration Commision of the State Council, 2007).

In 2016, there were 4,316 registered seed enterprises in China, 50% (8700) less than 5 years ago (MOA, 2017). The consolidation of China's seed industry has accelerated since 2010[48]. China's domestic seed market was liberalized in 2000, much later than any of the home countries of the above-mentioned transnational corporations. Yet, in less than two decades, China's seed market has witnessed rapid rises and falls of small private seed companies, the immense growth of foreign direct investment in China's seed industry, as well as the "going out" of China's agro-capital in the global market. How has China's seed industry been restructured since the seed market was liberalized and what were the factors that shaped this process? These are the questions to be addressed in this chapter.

Chapter 1 briefly depicts the development of China's seed industry since 2000, which means to provide a general understanding of the transition trajectory underlying the rise of China's agro-capitals. This chapter, in comparison, attempts to specifically discuss the structural changes of China's seed governance policies and Chinese agribusiness's capital accumulation strategies. It will also further probe the state's role in China's seed industry transition with particular reference to policy making and the state's interactions with agro-capital interests. Last but not least, this chapter will explore how China's seed industry restructuring affects China's agrarian change and the related social and political implications.

The data for this chapter will mainly be based on interviews with seed breeders, managerial employees in private seed companies and government officials at China's seed governance departments in Yunnan, Guangxi, Hunan and Heilongjiang provinces. It will also draw on fieldwork observations of the connections and interactions between seed companies and government sectors. Regarding policy changes and the status quo of China's seed industry, this chapter will refer to government statistics, published literature[49] and other documents (for instance, media reports). The selection of interviewees is meant to provide a more in-depth description of China's seed industry and, more specifically how the role of state changes with the development of China's agro-capitals.

48 However, as Gaudreau (2018)'s observation that "There is no handful of companies that holds majority market share in any given grain crop; however, there are serveal dozen domestic agribusiness in China's seed industry that have significant national and/or regional presence." China's seed industry consolidation is a recent phenomenon. Fast as it is, the extent of seed industry monopoly is still limited. Gaudreau, M. (2018). State food security and people's food sovereignty: competing visions of agriculture in China. *Canadian Journal of Development Studies/Revue canadienne d'études du développement*, 1-17.

49 In China, there are several published journals that focus on China's seed market and seed industry such as Seed Technology (zhongzi keji), China Seed Industry (zhongguo zhongye) and Seed World (zhongzi shijie). However, the majority of the authors are seed breeders, seed company employees and government officials in the seed governance departments. These journal articles are generally written from the technological, managerial and administrative angles. Sociological analysis of China's seed industry is insufficient in the journals.

Policy transition in seed governance, 2010-2017

Food security is a primary concern for the Chinese government and this emphasis has contributed to the rise of China's agribusiness. Zhan (2017) argued that the benefits of the state's agricultural input subsidies were mostly reaped by China's agribusiness while the rising costs of agricultural inputs undercut the profits of grain farming. In addition to the indirect state intervention that resulted in the development of China's agribusiness, in the transformation of China's seed industry, recent policy changes also directly altered the industry's capital accumulation strategies and contributed to the concentration of power. This, again, came about in the name of safeguarding food security. As Han Changfu (MOA, 2014) the Minister of Agriculture stated, "Seed is an irreplaceable means of production…The 'rice bowl' of the Chinese must be held by the Chinese, filled mostly with Chinese grains that are produced by Chinese seed."

The No. 1 Document of 2009 states that the key to agricultural technology advancement is seed breeding. The state will continue supporting genetic modification technology research and pursue the industrialization of genetically modified seed varieties. At the same time, it will advocate for mergers among seed enterprises and the re-organization of China's domestic seed industry. In the following years, the state's determination in transforming China's seed breeding technology and domestic seed industry is repeatedly demonstrated in annual No. 1 Documents as well as State Council policies and national-level conferences. In 2011, the State Council launched the project to build a modern seed industry (现代农作物种业, xiandai nongzuowu zhongye) (State Council, 2011), which was premised firstly on an emphasis on intellectual property rights. Second, seed enterprises were to play a dominant role in the modern seed industry. In particular, large enterprises that enjoy major market share, are equipped with advanced breeding technology, and realize the integration of seed breeding, production and marketing, are the main receivers of government support. Third, the state encouraged the injection of social capital in China's seed industry and the flow of genetic resources and researchers to seed enterprises. Fourth, the state was to increase support for fundamental and public research in research centers and universities.

Hunan is the largest rice producing province in China and also one of China's major domestic seed markets. Therefore, Hunan has witnessed the fastest transformation of China's seed industry and also has established the most advanced seed governance model. Important conferences regarding China's seed industry are mostly held in Hunan, and key government policies are drawn up after consulting Hunan's seed industry and seed governance

departments[50]. In May 2011, the State Council held the National Seed Industry Working Conference (全国现代农作物种业工作会议, quanguo xiandai nongzuowu zhongye gongzuo huiyi) in Changsha, the capital city of Hunan. The high-end conference was attended by parties from the national-level government departments (Ministry of Agriculture, National Development and Reform Commission, Ministry of Science and Technology and the Ministry of Finance), major seed companies (China Seed and Longping High-tech) and research institutes (Jilin Academy of Agricultural Sciences). It marked the transition from a conventional seed industry to a modern seed industry. At the end of 2012, the State Council issued an eight-year (2012-2020) national development plan for China's modern seed industry (全国现代农作物种业发展规划, quanguo xiandai nongzuowu zhongye fazhan guihua), which lists the objectives for seed research and seed production by 2020. For grain crop seed research, the main research objectives are to breed new varieties for large cultivation areas and increase commodity rates of conventional seed. Regarding grain crop seed production, national-, regional- and county-level seed production bases were to be established.

Since 2010, the state has significantly invested in basic infrastructure for seed breeding and seed production. For instance, in 2015, the Ministry of Agriculture, National Development and Reform Commission, Ministry of Finance，Ministry of Natural Resources, and Hainan Provincial government jointly issued a plan for the construction of Nanfan base (南繁基地, nanfan jidi), a protected and concentrated area for agricultural research and seed breeding. This area covers 269,000 mu and has received at least RMB 370 million from the central government (MOA, 2017). Guangxi Provincial government took a step ahead of the national plan[51]. In the past, individual seed enterprises had to make private contacts in Hainan to build their own research and production base. However, in 2011, the vice president of Guangxi provincial government directly contacted the vice-governor of Hainan on land transfer issues. With the government's assistance, land tenure for Guangxi Nanfan base was for over 30 years and the transfer fee was paid off on the first year. In addition, the total construction cost of RMB 84,859 million came from Guangxi Bureau of Finance. However, the improvement of basic infrastructure for seed breeding and seed production is only a small aspect of seed industry transformation in China. Policy changes regarding the protection of intellectual property rights, industry concentration, and agro-capital's dominance of the seed market are more important considerations.

50 Interview with Gong Zhenmin, Bureau of Seed Governance, Hunan Agricultural Committee, May 5th, 2017

51 Interview with Liang Renfan, deputy director of Guangxi Nanfan base, April 10th, 2017

Growing importance of intellectual property rights

In 1999, China joined the Union for the Protection of New Plant Varieties (UPOV) and thereby adheres to regulations under the 1978 Act of the UPOV Convention for the protection of seed breeders' right. The 1978 Act gives breeders the right over their commercial varieties and prevents anyone else from producing the same seeds for commercial purposes. In 2001, when China became a member of WTO, it was also brought under the regulations of the Trade-Related Intellectual Property Rights Agreements (TRIPS). TRIPS require member countries to provide protection of plant varieties, either by patents or by an effective *sui generic* system or any combination thereof (Article 27.3(b)). Prior to obtaining UPOV and WTO memberships, China released a domestic version of UPOV in 1997 (Regulations of the People's Republic of China on the Protection of New Varieties of Plants, PVP) (中华人民共和国植物新品种保护条例, zhonghua renmin gongheguo zhiwu xinpinzhong baohu tiaoli) and also included the protection of new plant varieties and breeders' right in the 2000 Seed Law. However, when China's domestic seed market was first liberalized, the protection of intellectual property rights was compromised by the protection of farmers' seed rights and China's domestic seed industry. The 1978 version of the UPOV convention's regulation on farmers' rights was less strict than the 1991 version (Deng, 2007; GRAIN, 2015). Accordingly, China's 2000 Seed Law also leaves farmers more freedom regarding seed saving, re-use and exchange. It states that farmers are allowed to sell and exchange the remainder of conventional seeds that are produced for their own use at rural fairs without a license. On the other hand, China was faced with complaints from transnational seed companies for insufficient protection of intellectual property rights. In my interviews with government officials at seed governance departments, they often referred to the case of Xianyu 335 to explain China's protection of variety rights before 2010.

Since the liberalization of China's domestic hybrid corn seed market, Xianyu 335 from DuPont Pioneer became the first foreign seed variety to enjoy great market popularity (also see chapter 1). In 2006, Xianyu 335 obtained seed variety rights in China. Five years later, the cultivation area reached 80% in both Jilin's and Shanxi's maize production regions, and 30% in Liaoning (Dong, 2013). Faced with this market monopoly challenge from transnational agribusiness, China's domestic seed enterprises appealed to the Ministry of Agriculture to repeal Xianyu 335's variety right. Although the Ministry of Agriculture denied the appeal, it could not stop domestic enterprises from illegally breeding Xianyu 335. According to the ex-department director of Qiqihar Bureau of Seed Governance[52], the majority of the maize

52 Interview with Wang Jinhai, May 19, 2017

production regions of Heilongjiang and Jilin used illegally propagated Xianyu 335 seed. Some small enterprises would secretly purchase seed from Xianyu 335's official propagation base in Gansu and sell unpacked seed on the market. Mr. Luo[53], the manager of Shihe Seed Company, one of few local seed companies that undertakes seed breeding in Dali, Yunnan Province, admitted that Yunnan maize seed varieties share high homogeneity because the female parent plant of most varieties was that of Xianyu 335, stolen by domestic seed enterprises or seed breeders. "It is an essential genetic resource for every maize seed breeder," as Mr. Luo noted.

In 2015, the Standing Committee of the National People's Congress (NPC) adopted the revised Seed Law which would be enacted in 2016. In the revised version, one of the controversial issues was the incorporation of the whole text of the current PVP regulation in the Seed Law (farmer.com.cn, 2015; Third World Network, 2016). The state's intention was to advance the PVP regulation in China's legal hierarchy and impose more severe consequences for breaking plant variety rights. It also wished to introduce some significant provisions of UPOV 1991(for instance, provisions regarding essentially derived varieties) into the revision. However, in the final version of the new Seed Law, the state's intention was compromised. Instead of incorporating the entire text of PVP into the Seed law, only the general provisions on PVP were included as a separate chapter and UPOV 1991-like provisions were eventually removed. Therefore, at the current stage, UPOV 1991 still has no place in the new Seed Law (Third World Network, 2016).

The new Seed Law was enacted in 2016. Though the radical changes in seed governance were denied, the 2016 Seed Law still advanced the protection of plant variety rights and weakened farmers' seed rights. First, the new Seed Law maintained regulations regarding farmers selling and exchanging self-saving seed and only limited the location of such exchange and sale to "local" rural fairs. However, the supporting regulations to the 2016 Seed Law, Administrative Measures for the Crop Seed Production and Management License (农作物种子生产经营许可办理办法, nongzuowu zhongzi shengchan jingying xuke banli banfa), set more limits on this article: unlicensed seed saving, exchanging and saving behaviour to be restricted to individual farmers who contract farmland under the Household Responsibility System; the location of seed exchange and sale to be confined to the township only ; the amount of seed to be exchanged or sold is not to exceed the annual seed demand on a peasant's contracted farmland. In the backdrop of China's agrarian transformation (see Chapter 2 and Chapter 3), agricultural production was increasingly characterized by the rise of farm size and the

53 Interview with Luo Yongfeng, March 12, 2017

commodification of agricultural inputs. Added restrictions on seed exchange and seed sales in fact would prevent a significant number of farmers from practising farmers' seed rights. Second, China has not yet established a separated law for the protection of intellectual property rights, but the incorporation of PVP provisions in the 2016 Seed Law substantially strengthened the implementation of plant variety rights protection. The new Seed Law has significantly increased the punishment for plant variety rights infringement. It has also increased the efficiency of plant variety rights protection by empowering county-level agriculture and forestry departments to adjudicate infringement acts.

Change of market threshold and transition of accumulation strategies

In reviewing the transition of China's seed governance in Chapter 1, it was illustrated that the market threshold for domestic seed companies occurred in 2001. Since then, China released several versions of Administrative Measures for License and Certification of Main Crop Seed Production and Management (主要农作物品种审定办法, zhuyao nongzuowu pinzhong shending banfa) along with the changes of Seed Laws. In this section, I will use regulations on seed production and management license to demonstrate how the configuration of China's seed industry and the mechanisms of market competition have been altered by state laws. As hybrid rice and hybrid maize seeds are the most important seed resources for China's agricultural development and food security, I will use regulations on these two types of seed companies as examples.

Table 4.1 Law transitions regarding market thresholds of China's seed industry

Year	Registered capital (RMB)	Basic infrastructure	Testing equipment	Processing facility	Technical personnel	Seed variety rights
2001	5 million	Sunning grounds (500m²), drying facilities, warehouses	required, but non-specific	none	2 testing & 3 production	authorized
2011	30 million	sunning grounds (1000m²), drying facilities, warehouses （500m²), test room (150m²)	required & specific	none	5 each for testing & production, 3 storage	authorized
2016	none	office space (200m²), warehouses （500m²), test room (150m²)	required & upgraded	Processing plant (500m²), processing capacity above 5ton/h	5 each for testing, production & storage	1 self-bred, or 2 collaboratively bred, or three authorized

Source: Data compiled by the author from various sources.

As shown on Table 4.1, registered capital for seed production[54] increased by six times between 2001 and 2011, when the state launched the project to build a modern seed industry. However, after the new Seed Law was enacted in 2016, the requirement for registered capital was cancelled upon the production license application. On the other hand, other requirements for seed production have significantly increased. From 2001 to 2016, the state added requirements for physical assets (basic infrastructure, testing equipment, processing facilities), technical personnel and seed variety rights, among which, the last condition (seed variety rights) is the most crucial for the configuration of China's seed industry. Although the Ministry of Agriculture insists that the cancellation of registered capital eases the financial pressure for seed companies to apply for production and management licenses and lowers the market thresholds (MOA, 2016), seed enterprises are faced with increasing pressure in seed breeding or purchasing seed variety rights.

In addition to the above qualification regulations on private seed companies, the 2016 Administrative Measures for the Crop Seed Production and Management License set additional rules on large seed companies that integrate seed breeding, seed reproduction and seed marketing (选育生产经营一体化, xuan yu shengchan jingying yitihua). They are a new category of seed companies that are emphasized by the new 2016 Seed Law, which are main beneficiaries of the changed law regulations and market environment. For such seed enterprises, the key qualifications are R&D investment and market share. Regarding R&D investment, during the three years prior to license application, average annual R&D investment of the applicant enterprise shall be no less than 5% of annual seed sales revenue. Yet, for hybrid maize seed enterprises, the average annual R&D investment was no less than RMB 15 million; for hybrid rice seed enterprises, RMB 8 million; and for other seed enterprises, RMB 3 million (Article 9-4, Chapter two). Regarding market share, in at least one of the three years prior to license application, the seed sales of hybrid maize seed enterprises shall be over RMB 200 million or able to show accounts for over 1% of the national hybrid maize market; for hybrid rice seed enterprises, the requirements are respectively RMB 120 million and 1% (Article 9-7, Chapter two).

It's the first time in China that the state has set specific and high requirements for large seed enterprises. It indicates the state's support for seed industry leading enterprises that possess high R&D capacities and market influence. In accordance with changes in seed market agents, the state also altered regulations on seed variety certification (品种审定, pinzhong shendin). Large seed enterprises are faced with enhanced qualification requirements, but they will also

54 In 2016, licenses for seed production and management are no longer separately issued.

enjoy greater market freedom and competitive advantages. In an interview with Mr. Chen[55], deputy director of the Grain Crop Institute, Dali Academy of Agricultural Sciences (大理农科院粮作所, Dali nongkeyuan liangzuosuo), Yunnan Province, who has ownership over four seed variety rights, he explained the changes in China's seed variety certification. Before 2016, seed variety certification usually took five to six years and consisted of preliminary tests (预备试验, yubei shiyan), regional tests (区域试验, quyu shiyan) and production tests (生产试验, shengchan shiyan), which were mainly organized by the government. However, since 2010, restrictions on seed variety certification were loosened. In the 2013 Certification Measures for Main Crop Seeds, seed enterprises of registered capital RMB 100 million that integrate seed breeding, seed reproduction and seed marketing could individually conduct regional test and production test (Article 24, Chapter four). In 2016, the above seed enterprises are given more favourable conditions for new seed variety certification. At the same time, new agents are qualified for self-organization of variety tests (regional test, production test, and DUS test[56]). The 2016 Seed Law advocate for joint research unions (联合体, lianheti) among seed companies (企业联合体, qiye lianheti), among seed companies and research institutions (科企联合体, ke qi lianheti), and among research institutions (科研单位联合体, keyan danwei lianheti). Each union consists of at least five members and such unions can also conduct variety tests on their own. Due to the new regulations on self-organized variety tests, the state's governance in seed variety certification transforms from pre-supervision to post-supervision, and from process supervision to material review.

Industry concentration after 2016 Seed Law

According to the Ministry of Agriculture, China's 2016 Seed Law and its supportive policy documents lowered the market threshold for China's domestic seed enterprises. In fact, the hidden requirements for seed companies to join market competition were enhanced. In the new market environment created by the 2016 Seed Law, large seed enterprises that are equipped with high R&D capacity and enjoy major market share are the most competitive market agents. Since 2010, seed industry concentration in China has accelerated and major agro-capitals that will enjoy increasing market share are also in the making. The new configuration of China's seed industry is influenced by the law revisions and policy changes, on the one hand; and direct state intervention, on the other.

55 Interview with Mr. Chen, March 3rd, 2017

56 DUS test is abbreviation for distinctness, uniformity and stability test. It is a way of determining whether a newly bred variety is "distinct (D) from any other variety whose existence is a matter of common knowledge at the time of the filing of the application and that it is sufficiently uniform (U) and stable (S)" (UPOV: http://www.upov.int/export/sites/upov/resource/en/tg_1_3.pdf).

Industry concentration and appropriation of seed variety rights

The 2016 Seed Law marks China's determination to protect intellectual property rights. Despite the fact that in China there hasn't been heated debates around the nature of intellectual property right and its social implications, doubts have been long cast on the issue in the international academic and social movements. China's government believes that the protection of intellectual property rights will stimulate agricultural research and increase the investment of seed enterprises' in R&D, which will eventually produce better seed varieties and increase agricultural productivity. However, studies have shown that intellectual property rights are used by seed enterprises, and capitals in general, as a tool to exert control over genetic resources, life and nature, in order to acquire monopolistic positions and intensify capital accumulation.

Before 1940, in the United States, the seed industry was regarded as the "weak sister of agribusiness" (White, 1969:66, in Kloppenburg, 2005) since sexually reproduced plant varieties were not given proprietary rights. Therefore, unlike the fertilizer or pesticide industry, capital accumulation in the seed industry was hindered. In 1970, the Plant Variety Protection Act (PVPA) was passed in the United States against the fear of seed price increases due to monopolistic control of commercial varieties and the suggestions for quality maintenance of newly released varieties. Kloppenburg (2005) argues against the assertion that the PVPA will stimulate private plant breeding. He shows that the seemingly increase of private seed breeding should in fact be traced back at least to the 1960s, before the PVPA was enacted. In addition, the increase of private seed breeding was not seen in vegetable or forage crops but was significant in cereals and soybeans. This is probably because profits in cereal and soybean seed marketing was higher than that in vegetable and forage crop seeds marketing. Moreover, the research intensity (relation between R&D and sales) grew more strongly in the 1960s than in the 1970s.

The passage of PVPA also contributed to the wave of acquisitions and mergers in the US seed industry since the 1970s (Kloppenburg J. R., 2005). Other factors contributing to the consolidation trend including the rise in commodity prices and export markets, the opportunity to rationalize and coordinate the marketing of agricultural inputs, and the intensification of seed commodification (Howard, 2009). In the post-PVPA period in the US, with the increase of large seed companies, the relative intensity of research in the US seed industry has actually flattened out (Kloppenburg J. R., 2005). Schimmelpfennig, Pray and Brenna (2004)find that, "There is an inverse relationship between firm concentration in maize, cotton and soybean

seed markets, and R&D intensity in these US markets". They further explain that the decrease of R&D intensity is caused by the decline of market competition and is due to mergers and acquisitions.

Since 2010, China's seed industry has also seen increasing industry consolidation and the decreasing number of domestic seed enterprises. Unlike the industry concentration in the US since 1970s which was undertaken mainly by transnational agribusinesses, in China, the main actors in mergers and acquisitions were China's domestic large seed enterprises. The reconfiguration of China's seed market is also underlined by intellectual property rights protection. The direct implications of the new law and policy changes regarding intellectual property rights and seed company qualifications are the increase of market entry thresholds through the emphasis of seed variety rights and through the high demand for capital investment due to new regulations on seed variety certification. The dual pressures in technology capability and capital availability forced a significant number of smaller seed enterprises to reach agreement in merger and acquisition proposals. At the same time, the state's direct intervention in China's domestic seed industry furthered large seed companies' strength in industry concentration.

Hierarchy in China's domestic seed industry and the trajectory of industry concentration since 2010

Seed enterprises obtain seed variety rights in three ways: to establish its own research center, to collaborate with research institutes or agricultural colleges, or to directly purchase from seed breeders. Seed breeding is a long-term, capital-intensive and high-risk investment. In an interview with Pang Chaoxiong[57], manager of a major Guangxi-based rice seed company, who has been in the seed industry for about 30 years, he categorized China's domestic seed companies into a five-level hierarchy, based on research capacity and financial strength (see Table 4.2).

Level 1 companies are China's seed industry leaders and major participants on global seed markets. Since China's domestic seed market was liberalized, these large seed enterprises have invested in seed breeding and their research and development (R&D) input has greatly increased. Longping High-tech, the most reputed hybrid rice seed enterprise, was established by Hunan Academy of Agricultural Sciences (湖南省农业科学院, hunansheng nongye kexueyuan), Hunan Hybrid Rice Research Center (湖南杂交水稻研究中心, hunan zajiao

57 Interview with Pang Chaoxiong, April 6th, 2017

shuidao yanjiu zhongxin), and "father of hybrid rice", Yuan Longping. Win-all High-tech Seed (荃银高科, quan yin gao ke), a top-ten seed enterprise in China, established research collaborations with China National Rice Research Institute, China Academy of Sciences, China Academy of Agricultural Sciences and several other leading agricultural research institutes. In 2016, the R&D input of Longping High-tech alone reached RMB 223 million, accounting for 9.73% of its annual revenue (people.com.cn, 2017).

Table 4.2 Hierarchy in China's domestic seed industry

Level	Market coverage	Research capacity	Financial strength	Representative companies	Others
1	National	Most have research centers or research collaborations.	Stock market listed, registered capital RMB 100 million	Longping High-tech, Jinsenonghua, Denghai, China Seed, CNADC	State-supported, main participants in global competition
2	Regional	Strong, research institute founded or holding share	Registered capital RMB 100 million (or less)		Most transformed from public institutions or state farms
3	Provincial	Self-breeding capacity, regionally specific seed varieties	Stable profits, registered capital RMB 30 million	Guangxi Lvhai, Guangxi Baixiang	
4	Municipal / county-level	Social capital invested, purchased seed variety rights	Registered capital RMB five million, restricted investment		High-risk investment, success depends on purchased seed variety rights
5	Local	None, marketing representatives, no seed produciton	Annual profit RMB 200,000 to 300,000,		Small-scale family-run enterprises

Source: Interview with Pang Chaoxiong, April 6th, 2017

Note: CNADC refers to China National Agricultural Development Group Co., Ltd.

The second and third level companies are usually in possession of research capacity and self-bred seed varieties that are suitable for regional geographic and climate conditions. Capital accumulation of these companies is mainly through the release of new seed varieties and the control of a stable market share. Without dramatic market fluctuations, the second and third level companies are able to make stable profits and enjoy regional importance in the local seed industry. However, the financial strength of these companies is increasingly challenged by the elevation of market thresholds. Guangxi Province and Yunnan Province are located in Southwest China, where variable geographic and climate conditions determine the great diversity of seed varieties. Therefore, unlike China's main regional seed markets in Heilongjiang, Hunan and Anhui where most level 1 seed companies are based, Guangxi and

Yunnan are characterized by smaller-scale specialized seed companies as in level 2 and level 3. In my fieldwork in these two provinces, changes of these companies in recent years is quite typical.

Case A

In China's modern seed industry project, agricultural research institutions are advised to retreat from the seed market, the resources of which are motivated to focus on basic research or to be re-allocated to private seed companies for their R&D (State Council, 2011; State Council, 2013). However, before China's domestic seed market was liberalized, government restrictions on research institutions setting up seed companies were neither strict nor clear[58]. Agricultural researchers were allowed by their institutions to undertake seed production and seed marketing. Against this background, Maize Research Institute, Guangxi Academy of Agricultural Sciences (广西农科院玉米研究所, Guangxi nongkeyuan yumi yajiusuo), established its maize seed company. With this company, Maize Research Institute's seed varieties were easily released on the seed market, the profits of which returned to the institute and subsidized further seed breeding. In research institutions, seed breeders' work performance was assessed according to the area of their seed usage and this requirement was also conveniently met through the company.

However, being in the policy grey area, the development of Maize Research Institute's seed company was restricted by the Academy. When the registered capital was raised from RMB 2 million to RMB 5 million, and eventually to RMB 30 million, lack of finances became a severe problem for the Academy. At the same time, Guangxi Zihai Seed Company was considering expansion from hybrid rice seed market to the hybrid maize seed market in order to diversify business activities and reduce market risks. The financial problem of the Academy gave Zihai an opportunity to purchase the seed company in 2011. In light of the policy changes since China's modern seed industry project, the Academy also permitted researchers to provide Zihai with technical services.

Case B

Around the same time as the Maize Research Institute set up its seed company, researcher Gao Xueguo at Grain Crop Institute, Yunnan Academy of Agricultural Sciences (云南农科院粮

58 Interview with deputy general manager of Zihai seed company, researcher of Guangxi Academy of Agricultural Sciences, April 7th, 2017; Interview with Gao Xueguo, general manager of Zhenhe seed company, research of Yunnan Academy of Agricultural Sciences.

作所, Yunnan nongkeyuan liang zuo suo) was also making preparations for entering the local seed market[59]. In 1999, Gao and three colleagues borrowed RMB 100,000 from the Grain Crop Institute for an independent maize breeding project. The research fund was insufficient at that time and the borrowed money left the four researchers responsible for the success or failure of the breeding project. In 2000, Gao obtained permission from his institute to establish a branch office under Yunnan Jinrui Seed Company (Yang & Li, 2012). The branch office marketed new seed varieties from the institute and 20% of the sales revenue returned to the institute for research work. In 2013, Yunnan Seed Group Co., Ltd. was founded by Yunnan Supply and Marketing Cooperative (云南省供销社, Yunnan sheng gongxiaoshe). This state-owned seed company was set to integrate Yunnan's seed industry and strengthening market control through the large marketing network of Yunnan Supply and Marketing Cooperative that owns over 40,000 retail stores in Yunnan villages. Gao was invited on the planning committee, but he had reservations about the Seed Group's integration project. However, China's seed overproduction drove seed enterprises to increase marketing input and expand sales volume. The capital-intensive market competition eventually drove Gao to join the Seed Group.

On the increasingly competitive seed market, the majority of level 4 and level 5 companies gave up seed production and transformed themselves into seed merchants. As shown from the above two cases, in light of the growing competition and rising market threshold in the seed industry, level 2 and level 3 seed companies also faced difficult choices. They either raise enough capital to join the new market competition or re-organize themselves and form alliance with other seed enterprises. At the same time, these seed enterprises are often approached by merger and acquisition propositions from level 1 seed companies for their proprietary seed variety rights and regional influences.

In an interview with Luo Yongfeng, manager of Shihe Seed Company, Yunnan, he explained the particularity of Yunnan seed market. In Yunnan Province[60], 80% of the seed is produced by local seed enterprises, for vertical climate differences in this region constrain the applicability of seed varieties and prevents large seed enterprises from dominating the Yunnan seed market. In Yunnan, Chia Tai Group (泰国正大集团, taguo zhengda jituan) and China Seeds (中国种子集团, zhognzhong jituan) are the most important non-local seed enterprises. However, Chia Tai Group's market area is limited to Xishuangbanna, South Yunnan. It used to take 70% of the local seed market, but in recent years, Chia Tai Group's market share has

59 Interview with Gao Xueguo, general manager of Zhenhe seed company, research of Yunnan Academy of Agricultural Sciences.

60 Interview with Luo Junpeng, manager of Shihe Seed Company, Yunnan. March 12th.

been declining. Similarly, China Seeds' products can only be grown in one county (Funing County) and holds 30% of the market share. Therefore, manager Luo explained, large seed enterprises would not invest in breeding seed varieties for such limited regional seed markets. Instead, large seed enterprises sought to exert control in such markets through mergers and acquisitions with local seed enterprises and consequently took possession of seed variety rights.

China's domestic large seed enterprises, such as Longping High-tech, initiated mergers and acquisitions around 2010 and accelerated industry concentration in the following years. In 2016, the China International Trust & Investment Corporation (CITIC Group) purchased 18.79% equity interest in Longping High-tech and became the controlling shareholder. CITIC Group's capital injection provided Longping High-tech with financial capacity for taking over smaller seed enterprises. Table 4.3 shows Longping High-tech's merger and acquisition deals from 2015 to 2018. As indicated, the acquired seed companies consist of those with strong research capacities, stable marketing channels and seed products that enjoy regional market influences. The total transaction amount of the eight merger and acquisition deals reached over RMB 10 billion. Despite Longping High-tech being the leading hybrid rice seed company in China, its recent takeovers targeted at enterprises that hold variety rights over maize, wheat, millet, vegetable, sunflower and other crops.

Table 4.3 Longping High-tech's merger and acquisition deals

Time	Acquired company	Company Profile	Transaction amount	Transaction condition	Seed
June 2015	Tianjin Derit Seeds (天津德瑞特)	A vegetable seed company that integrates seed breeding, seed reproduction and seed marketing	RMB 320 million	80% shareholdings	Vegetable seeds (Cucumber seed)
October 2016	Guangxi Hengmao Agricultural Technology Co., Ltd (广西恒茂)	A dominant seed company in China's Southwest seed market	RMB 210 million	51% shareholdings	Hybrid maize & hybrid rice seed
March 2017	Hubei Huimin Agricultural Technology Co., Ltd (湖北惠民)	A significant seed company in Longping's main hybrid rice seed market; annual turnover of over RMB 100 million	RMB 164 million	80% shareholdings	Hybrid rice seed
June 2017	Hunan Golden Rice (湖南金稻种业)	One of Hunan's major hybrid rice seed company that enjoys high sales volume	RMB 124 million	80% shareholdings	Hybrid rice seed

November 2017	Hebei Universe Agricultural (河北巡天农业科技有限公司)	China's leading minor grain crop seed company that integrates seed breeding, seed reproduction and seed marketing	RMB 378 million	51% shareholdings	Millet, maize, rice, wheat and potato seed
November 2017	Sanrui Agricultural Technology Co., Ltd (三瑞农科)	China's leading sunflower seed company that integrates seed breeding, seed reproduction and seed marketing	RMB 515 million	49% shareholdings	Sunflower seed
December 2017 (together with CITIC Group Agri Fund)	Dow AgroSciences Sementes & Biotecnologia Brasil Ltd.	Dow AgroSciences is a subsidiary of US chemical giant Dow Chemical Co.	USD 1.1 billion	The non-exclusive usage right of Dow AgroSciences' Brazilian corn germplasm bank and a license for the use of the Morgan seed brand and the Dow Sementes brand for a certain period of time	Hybrid maize seed
March 2018	Beijing Lantron Seed Corporation (北京联创种业有限公司)	A Beijing based seed company that integrates seed breeding, seed reproduction and seed marketing	RMB 1.39 billion	90% shareholdings	Hybrid maize seed

Source: The table is compiled by the author from various sources.

The impact of China's domestic seed industry concentration remains to be assessed, but questions are raised regarding the nature of mergers and acquisitions in the seed industry. In an interview with Li Wu[61], marketing manager of China Seed's Guangxi branch, he reveals that in the merger contract between Longping High-Tech and Guangxi Hengmao, it is stated that the former would pay the merger fee when the latter realized the promised sales volume. He also adds that even in times of overproduction on China's domestic seed market, Hengmao could still profit from Longping High-tech's merger offer by making false sales record and this is commonly seen in current merger and acquisition deals. It suggests that the ongoing takeovers in China's seed industry are an assembly of seed products and marketing channels, rather than an organic integration of research resources that will upgrade China's seed industry, as the state intended. Another interviewee, Ding Xiancan[62] , president of Hope Seed

61 Interview with Li Wu, March 4, 2017.

62 Interview with Ding Xiancan, April 17, 2017

in Hunan Province, explains that the state's support for large seed companies and the overproduction issue on the seed market are vital for the making of market monopoly:

> *When the market is blooming, every seed company can make profits and it's not easy to stand out. The winter of China's seed industry (the overproduction issue) provides large seed companies with a great opportunity to outcompete smaller companies. There were over 8700 seed companies before 2010 and now (2017) only 4300 remain, half of which remain only in name. In the next five years, China's hybrid rice seed market will be dominated by ten large seed companies, while the smaller seed companies will specialize in seed breeding, seed production or seed marketing.*

The state's intervention in domestic seed industry transition

The 2016 Seed Law paves the way for a new market environment and results in increasing industry concentration in China's domestic seed sector. The changes since 2010 in law and regulation regarding China's domestic seed industry are underlined by the state's role in adopting neoliberalism. According to Harvey (2007, p. 64), in theory, "The neoliberal state should favor strong individual private property rights, the rule of law, and the institutions of freely functioning markets and free trade." In the transformation of China's domestic seed industry, in addition to creating a good business climate that favors large seed companies, the state also directly intervenes in the creation of giant players in the domestic seed industry that will also be capable of competing in the global market. It is a common characteristic in developmental states (such as China, Singapore, South Korea), as Harvey (2007, p. 71) concludes: (developmental states) "rely on the public sector and state planning in tight association with domestic and corporate (often foreign and multinational) capital to promote capital accumulation and economic growth."

The state-owned enterprises and the creation of industry leaders

Since the Reform and Opening up in 1978, a significant number of state-owned seed enterprises were privatized during the structural adjustment program, yet the state still retains control over several large seed enterprises, whereby it could exert direct influence in the domestic seed industry. In recent years, a counter-movement to the structural adjustment has occurred and the state has re-gained ownership of several key seed enterprises to accelerate industry concentration and maintain the strength of domestic seed companies against the competition from the transnational agribusinesses.

In 1999, Longping High-tech was founded by Hunan Academy of Agricultural Sciences, Hunan Hybrid Rice Research Center and Yuan Longping. In 2004, the State-owned Assets Supervision and Administration Commission (国资委, guo zi wei) approved of the state-owned share transfer from Hunan Academy of Agricultural Sciences to Hunan Xindaxin Co. Ltd. (湖南新大新股份有限公司, Hunan xindaxin gufen youxian gongsi), a private real estate and agricultural processing enterprise. Hunan Xindaxin became the controlling shareholder of Longping High-tech and transformed it into an entirely private seed company. In 2007, Hunan Xindaxin was acquired by Vilmorin& Cie (via its subsidiary Vilmorin Hong Kong), a leading seed enterprise based in France and jointly established Changsha Xindaxin Group. The core shareholder of Vilmorin & Cie is Limagrain, the 4th largest seed company worldwide (Limagrain, 2019). Through the share transfer, Vilmorin& Cie held 46.5% interest of Xindaxin Group and 22.2% of Longping High-tech (Vilmorin& Cie, 2008). Indirectly, Limagrain controlled about 10% of Longping High-tech. Foreign capital therefore earned a presence in Longping High-tech.

In 2011, Limagrain proposed a merger and acquisition deal to Longping High-tech which raised great public concern (people.com.cn, 2011). The two companies did not eventually strike a deal, and state intervention is often hinted in news reports as the reason. Although Longping-High tech denied there was external pressures to reject the proposal, two government documents released in the same year suggest differently. In February 2011, the State Council issued a notice on establishing a security review system to scrutinize merger and acquisition proposals by foreign investors for China's domestic enterprises (people.com.cn, 2011). Three weeks after Limagrain withdrew its share from Changsha Xindaxin Group (January 2011), the State Council launched the project to build a modern seed industry which aims to integrate resources in the domestic seed industry and increase government support and investment for domestic seed enterprises. To achieve such an end, the state also directly reached out to large domestic seed enterprises and expressed its support. Since winter 2010, government officials from the Ministry of Agriculture had several conversations with Longping High-tech executives and urged Longping to set an example for other domestic seed enterprises (iceo.com.cn, 2011). In an interview with Wu Zhi[63], executive of Longping High-tech's agricultural service company, he revealed the untold story about the merger and acquisition deal between Limagrain and Longping High-tech.

After the state disapproved of Xindaxin's plan to sell Longping High-tech's controlling share to a foreign company, the state itself had been seeking to obtain control over Longping High-

63 Interview with Wu Zhi, April 5, 2017

tech. The opportunity arose when Longping High-tech bought a piece of land in Changsha development zone and illegally used agricultural land for real estate purposes. One government official was arrested for this incident. The state forced Longping High-tech to accept CITIC Group's capital injection by threatening to arrest Longping High-tech's responsible executives. After the capital injection, CITIC Group eventually became the controlling shareholder of Longping High-tech. As CITIC Group is a state-owned conglomerate, Longping High-tech was in fact re-owned by the state (the Ministry of Finance).

Wu further explained:

In private conversations, the government officials from the Ministry of Agriculture predicted that in the future there would be at most ten nationwide domestic seed companies. The state would encourage mergers and acquisitions in the domestic seed industry. This intention was already embodied in the changes of the 2016 Seed Law for registered capital and seed variety certification. However, one should not believe that the industry concentration project was designed by the Ministry of Agriculture, when the idea was actually first introduced to the ministry by some high executives of large seed enterprises. In the past, the state intervened in the development of domestic seed industry through private conversations, while the state's direct intervention will deepen and be more effective with the controlling share.

The overproduction crisis in China's domestic seed industry addressed in Chapter 3 parallels with the state's globalization agenda (Lyu & Zheng, 2014; Zhang & Zhang, 2016). Among the grain crop seeds, China's hybrid rice seed is the most competitive on the global market. Since the1980s, China's surplus seed (seed exceeding market demand) has been exported (Li, Zhang, Mao, & Zhang, 2011). With the seed production mounting and overproduction normalizing, China's seed industry started to lobby for loosening policy restrictions on seed export (yicai.com, 2016). In the Seed Project, the state expresses its further encouragement and support for the globalization of China's seed industry. "Seed going out" is also included in the Belt and Road Initiative, as a part of the international agricultural cooperation.

Before the CITIC Group became the controlling shareholder of Longping High-tech, Longping High-tech's vision was to become the nationwide leading seed company and the dragonhead of the domestic seed industry (种业龙头, zhongye longtou). The CITIC Group dramatically changed Longping's development strategies. In an interview with a Chinese business journal, China Economic Weekly, the president of Longping High-tech, Liao

Cuimeng, claimed that Longping High-tech will sit among the global top eight seed companies by 2020, and the top five by 2025. "The progress is probably faster than we anticipated[64]", Liao added (people.com.cn, 2017). On a rare occasion, Longping High-tech held a media conference and introduced the transformations brought about by the CITIC Group, in particular, Longping's globalization agenda. According to several news reports (jiemian.com, 2016; hunan.voc.com.cn, 2016), besides China, 95% of the rice planting area was located in Southeast Asian, South Asian and African countries along the routes of Belt and Road Initiative. However, in these regions, hybrid rice only accounts for less than 3% of the total rice planting area and the rice yield is half of that in China. If the planting area of hybrid rice reaches 30% and the usage amount of seed conforms to China's standard, the annual market demand for hybrid rice seed will reach 600 million kg.

As observed from Table 5.3, since 2016, Longping High-tech's mergers and acquisitions in China's domestic seed industry have intensified. On the other hand, with the CITIC Group's help, it also successfully completed an overseas merger and acquisition deal of Dow AgroSciences. Dow AgroSciences is a subsidiary of US chemical giant Dow Chemical Co., which in recent years, controlled 18.5% of the Brazilian corn seed market, ranking in the top three in Brazil (nbd.com.cn, 2017). However, it would require (more thorough interviews) further research enquiries with executives from Longping High-tech to know the real extent of CITIC Group's influences in Longping High-tech's domestic and overseas mergers and acquisitions.

In Longping High-tech's case, the state's intervention in China's domestic market is to articulate industry reconfiguration via the control of major seed companies. It results in the stratification of China's seed industry, and thereby, the concentration of market share and research resources. Large seed companies, in this process, are able to exploit the state's support for capital accumulation. A mutual reinforcement relationship is formed between the state and agro-capital in China's seed industry concentration.

Discussion

This chapter has focused on the transformation of China's domestic seed industry and seed market which is characterized by the decrease in the number of seed companies and the increase in industry concentration that favors large seed companies. Underlying the recent changes is the concern for China's seed sovereignty with the introduction of foreign seed from

64 According to Longping High-tech's 2018 annual report (sohu.com, 2019), it already became one of the global top eight seed company in 2019.

transnational companies. To meet this challenge, the state facilitated the development of large domestic seed enterprises. The enactment of China's 2016 Seed Law altered the legal framework and market environment. It first and foremost raised the market threshold. On the one hand, although registered assets are no longer a prerequisite for seed companies, the new Seed Law specifies infrastructure, personnel and other conditions that seed companies are supposed to meet, which in fact raises capital requirements. On the other, the emphasis of the new Seed Law on R&D capacities advocates for the establishment of large seed enterprises that integrate seed breeding, seed reproduction and seed marketing and the rise of research unions among seed enterprises, among research institutes as well as among seed enterprises and research institutes. These new changes in the Seed Law drive smaller seed enterprises out of market competition and result in the reconfiguration of China's domestic seed industry.

In addition to the creation of a market environment and competition rules that stratifies market actors and favors the bigger players, a typical neoliberal way of market development, the state also directly intervenes in China's domestic seed industry and creates large seed enterprises that will both dominate the domestic seed market and are capable of joining global competition. In dealing with the lasting overproduction and overcapacity issue in recent years in China's domestic seed industry and launching the Belt and Road Initiative, the state also takes the same path and prioritizes large seed enterprises.

In the transformation of China's domestic seed market and seed industry, large seed enterprises not only exploit the opportunity for capital accumulation, but also actively influence the state's policy in order to create favorable legal and market environment to strengthen their market position. Formally, large seed enterprises are often consulted for law making and the drafting of government policies; in private, large seed enterprises have more opportunities to obtain special favors from the government officials in the relevant department. However, tensions do exist between the state's concern for national seed sovereignty and the agro-capital's eagerness for profit-making. In such cases, the state's priority may overcome agro-capital's interest through the state's participation in the business activities of the large seed enterprises. More research is needed to look into the interactions between the state and agro-capitals in order to specify China's neoliberal path in the domestic seed sector. Such research will not be easy to conduct considering the difficulties in accessing large seed companies and high-level seed governance departments. It also requires vigorous critical thinking to penetrate the mist of neoliberal discourse in combination with nationalism.

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Chapter 5 The globalization of China's domestic seed industry: Promising research directions

Introduction: overproduction, an opportunity or a problem?

In Chapter 4 I discussed the changes in China's seed laws and government policies regarding the domestic seed industry and seed market. The issue of industry centralization and concentration is raised and examined. This chapter follows up and further explores the state's direct participation in the transformation of China's domestic seed industry. Additionally, this chapter will also link the reorganization of China's domestic seed industry with the state's globalization initiative in addition to pointing out promising research directions deriving from this project that the researcher didn't have the time and resources to look into.

In reviewing the development of China's seed provision system and the unfolding of seed marketization, Chapter 1 draws attention to the problem of overproduction in China's domestic seed industry. The problem originates from the liberalization of China's domestic seed market, when thousands of private seed enterprises emerged to take advantage of the rising profits in the seed industry. Before 2010, the imbalance between seed supply and seed demand occurred occasionally and volatile price fluctuations on the seed market was the result. However, the gap between supply and demand was never over 50% (Yu, 2014). From 2010, due to the changes of profit-making strategy and the rising profit margin, blind production was pushed to a new level. Overproduction and oversupply became the "new normal" (新常态, xin changtai). In both the hybrid rice seed and hybrid maize seed industry, overproduced seed exceeded the nation's annual need by 100% (ibid.). Nevertheless, the interpretation of the overproduction problem varies a great deal.

One voice is to treat the overproduction problem as an opportunity to eliminate smaller seed enterprises and to optimize China's domestic seed market structure. The premise of this perspective is to promote the development trajectory and market structure of the seed industry in the developed countries as an example to follow. Prior to 2010, the rising market share of transnational agribusiness companies in China caught public attention. On the one hand, it alarmed China's domestic seed enterprises, researchers and the state; but on the other, it also provided inspiration for solving the overproduction issue in China's domestic seed industry. Before 2010, the world's top 10 seed companies accounted for 35.0% of global trade, while China's top 10 only took up 0.8% (Zhao & Lin, 2009). Moreover, in 2009, the research and development input of China's 5 listed seed companies (RMB 44 million) barely reached 1%

of Monsanto's 2008 input (Chen & An, 2013). In comparison, the domestic seed enterprises were criticized for being "small, decentralized and weak" (小散弱, xiao san ruo) (Zhao & Lin, 2009; State Council, 2011; Chen & An, 2013) and the seed industry was advised to "get on the global track" (接轨, jiegui), as it was often the answer to problems on China's development path in the post-reform era (Lin, 2015). Following the transnational agribusiness companies, China's domestic seed enterprises were encouraged to increase the company size, strengthen their research capacities and increase their market share. In addition, they were also expected to "go out" and join the competition in the global seed market.

However, another voice would consider the overproduction in China's domestic seed industry as a problem that was inherent in China's market liberalization strategy dating back to 2000, and that the suggested solutions to the overproduction problem did not yield as positive results as the policies would have us believe. In the Marxist understanding (Socialist Voice, 1983), the overproduction problem is bound to happen within an economic system that is driven by profit-making and capital accumulation. This system consists of separate and independent ownership and they step up production in order to make as much profit as they can in the prosperous times. With the flooding of commodities onto the market, the profit rate drops, and a crisis is triggered. Such a crisis would drive the smaller and weaker competitors to go under, while capital is increasingly centralized among larger and stronger competitors through takeovers and mergers. As a result, "Even the market economy begins with small-scale, highly competitive firms, it is almost certainly going to be rapidly transformed through centralization of capital and end up in a state of oligopoly or monopoly" (Harvey, 2013, p. 272). The market economy is praised for stimulating productivity through competition. Yet, the result of competition, driven by profit-making, turns out to be monopoly, the contradiction to competition. Looking at the overproduction problem through the Marxist lens, the mergers and acquisitions initiated after 2010 are only a temporary solution to the crisis in China's domestic seed market.

To make the second voice more valid, and as Marx suggests, a driving force underlying the concentration of capital is the credit system, or financialization. With the development of an economic system that is fueled by profit-making, "There also takes place a development of the two most powerful levers of centralization—competition and credit" (Harvey, 2013, p. 272). Concentration results in a new and upgraded round of productivity increases, but to achieve that, a great deal of finance is required to complete mergers and acquisitions. As will be shown in this chapter, financial institutions and the capital injection from the state-owned

enterprises are essential to complete mergers and acquisitions in China's domestic seed industry after 2010.

Another solution to the overproduction problem, according to Marxist theory, is to expand the market to export overproduced seed in the short term; in the long term, it will resolve overcapacity at home and lead to a new circle of productivity increase. Historically, European industrialized countries dismantled natural economies in less developed countries and resolved the domestic overproduction issue through the establishment of colonial markets. In the late 19th and 20th century, another colonial expansion was also initiated by such industrially developed countries. Lenin's interpretation of colonization in this period is the most notable and it is closely relevant with neoliberal globalization (Bernstein, 2010, p. 79) beginning in the 1970s. According to Lenin, the European colonial expansion by the late nineteenth century was different from the previous colonization in that it was driven by the urge to export capital more than manufactured goods. On the other hand, the accelerating capital accumulation in the industrially developed countries needed "increasing sources of raw materials and ever larger markets for its manufactured goods" (Bernstein, 2010, p. 42). On the other, the falling rates of profit resulting from the intense competition in Europe forced these countries to look for investment opportunities overseas.

Neoliberal globalization intensifies the export of capital and is a broader project than resolving the problems of overproduction and the decrease in profit rates. Bernstein illustrates four features of the contemporary globalization and the first three are the most helpful for the discussion in this chapter:

a. deregulation of financial market and "financialization" of all aspects of economic activity;
b. increasing deregulation of international trade;
c. shifts in the production, sourcing and sales strategies and technologies of transnational agribusiness and manufacturing corporations… (Bernstein, 2010, p. 79)

This chapter will discuss the status quo of the centralization and globalization of China's domestic seed industry over the last decade. As a preliminary review, typical merger and acquisition deals will be presented and discussed, key actors will be identified, and the primary dynamics will be tentatively explored. To accelerate industry centralization, the state acquired strategically important seed enterprises and integrated them into state-owned agribusiness companies. In addition, to directly inject capital into large seed enterprises, the state founded financial institutions that would invest in large seed enterprises with strong research and development capacities and a high market share.

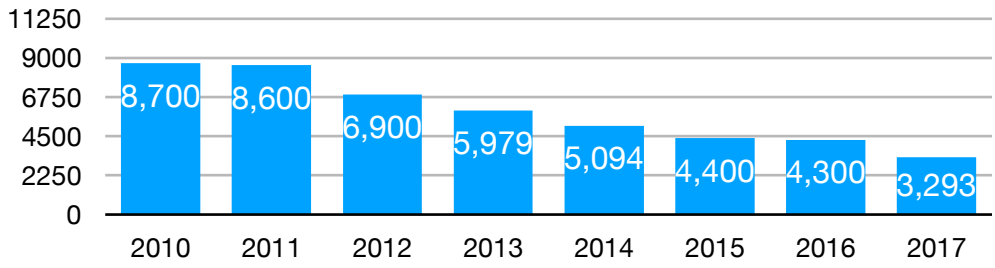
China's seed exports date back to the 1980s and even further in the international aid programs prior to the Reform and Opening up. However, the state's increasing intervention in the globalization of China's domestic seed enterprises altered the their going out strategies and helped Chinese enterprises participate more directly in overseas seed markets. In the discussion and conclusion, the role of the state will be addressed in light of the latest transition of China's domestic seed market. This chapter will largely rely on news reports, academic literature and, at times, fieldwork interviews. The overall aim is to illuminate issues regarding the intensifying marketization of China's domestic seed industry, and to suggest research directions that future investigations might follow.

Mergers and acquisitions that created the main players in China's domestic seed industry

In an interview with Ding Xiancan[65], the president of Hope Seeds (希望种业, xiwang zhongye), who worked in the seed industry for 36 years, he drew my attention to the latest transition in China's domestic seed industry. According to Ding, since market liberalization in 2000, China's domestic seed industry is moving from a free competition period to a new market monopoly period. He estimated that in the next 5 years, the hybrid rice seed market will be controlled by 10 giant seed companies, while other seed enterprises will be specialized in research, production or marketing. The decreasing number of seed enterprises in China confirms that the domestic seed industry is indeed increasingly centralized. From 2010 to 2017, the number of China's seed enterprises dropped from 8700 to 3293 (see Figure 5.1), based on which, a similar prediction was made that by 2025 only 8 large seed companies will remain (NOVOSEED, 2017). Besides improved company qualifications for registration in the revised Seed Law, mergers and acquisitions among China's seed enterprises have also contributed to industry centralization.

65 Interview with Ding Xiancan, April 17, 2017

Figure 5.1 The declining number of China's domestic seed enterprises (2010-2017)



Source: (NOVOSEED, 2017)

The potential profits in the domestic seed industry, especially since the State Council launched the project to build a modern seed industry (现代农作物种业, xiandai nongzuowu zhongye, see Chapter 4), have attracted industrial and commercial capitals from various sources to invest in the Chinese seed industry and consequently accelerate mergers and acquisitions (Wang, 2013; nongshijie.com, 2018). Among these mergers and acquisitions, the increasing control of state-owned enterprises over the domestic seed industry is most notable (Wang, 2013; ifeng.com, 2012; people.com.cn, 2017; agropages.com, 2015; eeo.com.cn, 2014). Chapter 4 provides the example of CITIC Group becoming the controlling shareholder of Longping High-tech to explain the implications of government intervention in industry centralization and concentration. Table 5.1 lists five merger and acquisition cases initiated by state-owned enterprises that created large state-owned seed enterprises, although the importance of each case to the transition of China's domestic seed industry varies.

Table 5.1 Mergers and Acquisitions that Create Large State-owned Seed Enterprises

Year	Capital	Seed Enterprises
2005	COFCO	Xinjiang Tunhe Seed
2007	SinoChem	China Seed
2011	SinoGrain	Zhangye Seed
2012	**CNADC**	Hubei Seed Group
2016	**CITIC Group**	Longping High-tech
2018	**ChemChina**	SinoChem

Source: Compiled by the author based on public accessed data

a. COFOC: early player, low market participation

China National Cereals, Oils and Foodstuffs Corporation (中粮, COFCO) entered the domestic seed sector through the acquisition of Xinjiang Tunhe Seed, but COFCO's main business focus with Tunhe is the production, processing and export of tomato, sugar and fruit. In 2014, COFCO also acquired 51% share of Nidera and wholly owned it in 2016. However,

in 2017, COFCO expressed its intention to sell its Nidera seed business to Syngenta. It suggests that seed is not or no longer COFCO's main business.

b. SinoGrain: retreating from the seed industry

Zhangye Seed is located in one of China's biggest seed production bases, Gansu Province (the other two being Sichuan Province and Hainan Province). It was reorganized by SinoGrain (中储粮) in 2011, however, two years later, it was transferred by the latter to China Forestry Group Corporation (中国林业集团公司), for SinoGrain was directed by the central government to retreat from business activities and to focus on grain reserve. In 2014, Zhangye Seed was renamed as China Forestry Group Zhangye Jinxiang Seed Corporation (Zhangye Jinxiang). Zhangye Jinxiang specializes in hybrid rice seed propagation, production, processing and marketing, the market position of which is incomparable to China Seed or Longping High-tech. Moreover, in recent years, it has been heavily criticized for illegally producing GMO maize seed (caixin.com, 2018[66]).

c. CNADC: listed state-owned seed enterprise

China National Agricultural Development Group Co., Ltd (中国农业发展集团有限公司 or 中农发, CNADC) is a state-owned comprehensive agribusiness company. It is also the actual controller of Zhongnongfa Seed Industry Group. Ltd (农发种业, Nongfa zhongye), the only listed state-owned enterprise that specializes in seed. From 2011, Nongfa zhongye has been known for holding various domestic seed enterprises (wheat, rice and maize) that enjoy regional importance or possess key seed varieties. Listed in Table 6.1 is one of the merger and acquisition deals that formed Nongfa zhongye as it is now. The other party in this deal, Hubei Seed Group, is a nationally renowned hybrid rice seed enterprise and China's top seed exporter for years, which made it the ideal target to acquire. It will both increase Nongfa zhongye's market share and pave the way for the state-owned seed enterprise to go global. In 2012, Zhongken Agricultural Resource Development Co., Ltd. (中垦农业资源开发股份有限公司 or 中农资源[67]) acquired 52% of Hunan Seed Group shares. In 2010, Zhongnong Ziyuan's actual controller became CNADC, so Hubei Seed Group also became a member of Nongfa zhongye.

d. ChemChina and SinoChem: an emerging giant agribusiness company

66 Betting on the green light for GMO maize seed, http://weekly.caixin.com/2018-10-20/101337189.html

67 In 2014, Zhongnong Ziyuan changed its name to Zhongnongfa Seed Industry Group. Ltd (zhongnongfa zhongye jituan gufen youxian gongsi, nongfa zhongye). http://www.znfzy.com/

In 2007, one state-owned enterprise, Sinochem (中化), a leading Chinese chemicals, rubber and agriculture group, wholly owned another state-owned enterprise, China Seed (中种), with the approval from the State Council. Along with the merger, there were also changes at the managerial level. In 2016, Ning Gaoning, the previous president of COFCO, was transferred to SinoChem and became the new president. Ning earned the reputation of the King of mergers and acquisitions (并购之王, bing gou zhi wang), for transforming COFCO into a giant company in China's food industry through 50 merger and acquisition deals at home and abroad over 11 years, including the Nidera deal mentioned above (qq.com, 2016; wallstreetcn.com, 2018). Ning's transfer raised reasonable beliefs that China Seed would have more advantages in the domestic seed market competition (eeo.com.cn, 2014). In 2018, SinoChem and ChemChina (中国化工集团) announced their merger shortly after ChemChina closed the acquisition deal of Syngenta, a Swiss-based transnational agribusiness company (caixinglobal.com, 2018). Ning again, became the president of an even larger state-owned agribusiness company.

The mergers and acquisitions shown in Table 6.1 created three large-scale state-owned enterprises that have great influence on China's domestic seed market: CNADC, CITIC Group and ChemChina. In 2013, Modern Seeds Development Funds (现代种业发展基金, xiandai zhongye fazhan jijin) was jointly founded by the Ministry of Finance (MOF), the Ministry of Agriculture (MOA), China Agricultural Development Bank (CADB) and SinoChem. Respectively, MOF, CADB and SinoChem contributed RMB 500 million. Modern Seeds Development Funds is positioned to attract social capitals to participate in equity investment in large-scale domestic seed enterprises that have strong research capacity, high market share and that can integrate seed breeding, propagation and marketing. Thereafter, the reorganized state-owned enterprises, CNADC, CITIC Group, ChemChina and Modern Seeds Development Funds, are the main players driving mergers and acquisition and they have greatly reshaped China's domestic seed market.

Table 5.2 Mergers and Acquisitions in China's Domestic Seed industry (2010-2017)

Year	Number of Mergers & Acquistions	Amount (RMB 10,000)
2010	6	18832.10
2011	9	42361.90
2012	5	49004.50
2013	17	206915.70
2014	14	142477.60
2015	22	190679.40
2016	26	98699.50
2017	15	164926.90
In total	114	913897.60

Source: (Lyu , Luo, Zhao, & Xie, 2018)

As shown in Table 5.2, from 2010 to 2013, mergers and acquisitions had just started to happen; but since 2013, a wave of mergers and acquisitions set in (Lv, et. al, 2018). On average, there were 19 merger and acquisition cases every year. According to Modern Seeds Development Funds (NOVOSEED, 2018), from 2010 to 2016, there are 86 publicly disclosed mergers and acquisitions, increasing annually by 62.84%, and the total value of transactions reached RMB 7.3 billion, with an annual increase of 191.64%. NOVOSEED also issued [68] (2018) a report on mergers and acquisition in China's domestic seed industry which is consistent[69] with the statistics of Modern Seeds Development Funds. It further reveals that the number of mergers and acquisitions included in this report is only 40% of the actual deals completed, estimated by an expert at the National Agricultural Technology Extension Service Center (全国农业技术推广服务中心, quanguo nongye jishu tuiguang fuwu zhongxin). Table 5.3 lists mergers and acquisitions completed by seed enterprises that are controlled by the above state-owned enterprises. It is evident that CNADC started mergers and acquisitions since its foundation; while China Seed, Longping High-tech quickly joined the process since they became members of large state-owned enterprises. From 2010 to 2016, these three seed enterprises alone completed 19 merger and acquisition cases.

Table 5.3 Mergers and acquisitions of three major state-owned agribusiness companies

Year	CNADC	China Seed	Longping High-tech
2007		Henan Lianfeng Wheat Seed	
2010		Guangzhong Jindao Seed	

68 Novoseed was founded by Beijing Xinrui Agricultural Information and Technology Co. Ltd. in 2016. It releases reports on China's domestic seed market based on data collected from company announcements, data bases and other sources.

69 According to NOVOSEED, from 2010 to 2016, there were 88 merger and acquisition (M&A) deals with a total value of RMB 10.152 billion. The annual increase of M&A deals and the total value is respectively 63.94% and 206.77%.

2011	Henan Dishen Seed	Hunan Dongting High-tech Seed	
	Guangxi Gelin Agricultural Technology		
2012	Hubei Seed Group		
2013	Zhongken Jinxiuhuanong technology	Shandong Luyan Seed	
	Shangxi Luyu Seed	Sichuan Yibian Yizitou Seed	
2014	Jiangsu Jintudi Seed		
2015			Tianjin Derit Seeds
2016			Guangxi Hengmao Agricultural Technology Co., Ltd
2017		Sichuan Chuanzhong Seed	Hubei Huimin Agricultural Technology Co., Ltd
			Hunan Golden Rice
			Hebei Universe Agricultural
			Sanrui Agricultural Technology Co., Ltd
			Dow AgroSciences Sementes & Biotecnologia Brasil Ltd.
2018			Beijing Lantron Seed Corporation

Source: Compiled by the author based on accessed public data

The financialization of China's domestic seed industry: a new mechanism for capital accumulation

In reviewing the history of neoliberalism, Harvey (2007) reaches a definitive conclusion: "Neoliberalization has meant, in short, the financialization of everything." It not only means that finance holds tight over all other areas of the economy, but that it also has strong impacts on the state apparatus and daily life. According to Harvey, in the 1980s, financialization formed a wave in the developed countries. Financial activities, instead of manufacturing and trade, became the main driver for capital accumulation. More specifically, with the establishment shareholding corporations, financialization means that corporates are dedicated to drive up stock prices and increase the wealth of their shareholders, on the firm level; while in terms of national economies, the new mode of capital accumulation is to react to "the declining profit rate in productive activities and has the effect of further 'crowding out' fixed asset investments by its discouraging long-term investment" (Wang Y. , 2015). In contrast with production capital, finance capital does not produce anything. "Finance serves both to control social production and to extract the value it generates in the form of rent" (Hardt & Negri, 2017). Financial capital is extremely mobile and always seeks high rates of profit through "speculation, predation, fraud, and thievery" (Harvey, 2007, p. 161). The result is the

increasing concentration and monopoly of economic interests and power in the hands of a small social group.

Since the 1980s, China's state-owned banks gradually became the institutions to provide credit for the SOEs, the township and village enterprises and the private sector players. A little later, in the 1990s, the state initiated a corporatization program that meant to convert SOEs into shareholding companies. However, the unfolding of financialization in China is at odds with what happened in developed economies earlier (Harvey, 2007; Wang Y. , 2015). What distinguishes China the most is that "The Chinese state itself owns massive amount of state assets and invests on the financial market. It is also the vanguard of financial technology and innovation" (Wang Y. , 2015). The Chinese state effectively sets limits on the participation of international capital in China's domestic market, and only allows the state-owned banks and financial institutions to be the eligible investors. Therefore, instead of being overwhelmed by the wave of financialization, the Chinese state asserts control and finds new ideas, instruments, and positions in it to regulate the domestic economy. China continues to invest heavily in the construction of basic infrastructures and the development of manufacturing and trades. In the meantime, the state's influence in SOEs remains strong.

Since 2010, changes in China's domestic seed industry provide a case in point that demonstrates the state's support for industry centralization through state controlled financialization. The corporatization in China's domestic seed industry started in the late 1990s. In 1997, Hefei Fengle Seed Co. Ltd became the first seed enterprise that was listed in the Shenzhen Stock Exchange. By 2017, there are 55 listed seed enterprises in China, among which, 8 are listed in the A-share market (See Table 5.4) and 1 overseas[70]. However, the number of listed companies in the A-share market did not increase much since the late 1990s.

Besides Shengzhen and Shanghai Stock Exchange, China's State Council also permitted the establishment of the National Equities Exchange and Quotations (NEEQ) (The New Third Board, 新三板, xinsanban) as a financing platform for small- and medium-size innovative, growing and start-up enterprises. It soon became a favorable financing channel for China's domestic seed enterprises (Shao, et al., 2017; Lyu , Luo, Zhao, & Xie, 2018). In 2014, NEEQ became a national stock exchange market, and the number of listed seed enterprises jumped from 8 in 2014 to 26 in 2015 (Lyu , Luo, Zhao, & Xie, 2018). By the end of 2017, there were 74 domestic seed enterprises listed on NEEQ (ibid.). With the development of China's stock

70 Origin Agritech Ltd, founded in 1997, is China's leading agricultural biotechnology company. In 2005, it was listed on the NASDAQ. Until today, it remains the only seed enterprise in China that is listed overseas.

market, financial institutions found opportunities to exert more influence on China's domestic seed enterprises, and the state-owned financial institutions become the main investors. According to the NOVOSEED report, there were 99 investment cases from 2010 to 2016(ibid.), which involved 444 investment parties in total. While the state-owned institutions[71] only participated 74 times, their investment accounted for 55.27% of the total amount.

Table 5.4 China's domestic seed enterprises listed in the A-share market

Seed enterprise	Founding year	Listed Year	Capital Stock (million RMB)	Stock Market	Others
Hefei Fengle Seed Co. Ltd	1984	1997	29,888	Shenzhen	The first listed seed enterprise; the state as the controlling shareholder
Longping High-tech	1999	2000	131,697	Shenzhen	Global top 10 in 2017
Zhongnongfa Seed Industry Group Co. Ltd	1999	2001	108,219	Shanghai	Listed state-owned seed enterprise
WanXiang Doneed Co., Ltd.	1995	2002	22,506	Shanghai	
Gansu Dunhuang Seed Co.,Ltd	1998	2004	52,780	Shanghai	Joint venture with DuPont Pioneer
Shandong Denghai Seed Co. Ltd	1985	2005	88,000	Shenzhen	Joint venture with DuPont Pioneer
Win-all Hi-tech Seed Co., Ltd	2002	2010	43,033	Shenzhen	
Beijing Dabeinong Technology Group Co., Ltd	1993	2010	424,299	Shenzhen	In 2001, Dabeinong established Beijing Kings Nower Seed Science & Technology Co., Ltd
Hainan Shennong Gene Technology Co.,Ltd	2000	2011	102,400	Shenzhen	
Jiangsu Provincial Agricultural Reclamation and	2011	2017	137,800	Shanghai	State-owned large agribusiness company; Jiangsu Dahua Seed Enterprise Co., Ltd is its wholly-owned subsidiary

71 Investment institutions under the CITIC Group, Modern Seeds Development Funds and CNADC are the main players.

Development Co., Ltd

Source: Compiled by the author from data collected from stock market and seed company websites

In the previous section the Modern Seeds Development Funds were mentioned, a financial institution with a government background that was established for accomplishing centralization in China's domestic seed industry. In 2013, the Modern Seeds Development Funds set the goal of investing RMB 1.5 billion in China's domestic seed enterprises over the next three years. Every year, 5 to 10 enterprises with clear assets, sound operation, standard management, advanced technology and good teams would be selected and financially supported. In the same year, Modern Seeds Development Funds invited 14 renowned domestic seed enterprises for an investment and collaboration meeting. Afterwards, the deputy director of the Bureau of Seed Governance, Liao Xiyuan received an interview from Farmers' Daily (2013), a central government level newspaper directly under Ministry of Agriculture, during which he spoke of the necessity for domestic seed enterprises to raise funds and attract social capital:

> *Now many of our domestic seed enterprises are still busy with seed. However, at the new development stage of the modern seed industry, what the enterprises really need is a brand-new commercial mode, and the new mode can be introduced along with capital injection*.

On the role of the Modern Seeds Development Funds, Liao continued:

> *…Our domestic seed enterprises should develop in groups. Similarly, capital investment should also gradually take the form of consortium. The Modern Seeds Development Funds' investment in one individual project is RMB 70 million, but I think the scale is not large enough. The Funds should have various investment modes according to various aims. Only when seed enterprises move along in groups and capital is invested by consortiums, will there be world class seed companies… I hope the Modern Seeds Development Funds will be the "seed of funds" (zhongzi jijin) for building seed industry consortiums.*

The message conveyed through the interview is clear. First, capital will play an ever more important role in building a modern seed industry. The financialization of China's domestic seed industry not only means that more capital will be invested in seed enterprises, but that the exchange value of seed will significantly override the use value and profit-making will be a stronger motive. Financial institutions will demand considerable returns for their capital investment on top of the profit rates expected by seed enterprises. Second, financialization becomes a crucial way to move China's domestic seed industry to another development stage where China's seed companies will be capable of competing with transnational seed giants. It indicates, to say the least, that the globalization of China's domestic seed enterprises is already on the state's agenda, and that the key to competition will be the company size and capital scale. By the end of 2018, two of China's seed companies ranked in the top ten in global seed sales, ChemChina and Longping High-tech. Both of them are strongly supported by the government and are significantly larger than the rest of China's domestic seed enterprises. Third, the financialization in China's domestic seed industry is guided and coordinated by the state. State-owned financial institutions are the front runner for injecting capital into domestic seed enterprises and a platform for inviting industrial, commercial, and private capital to join them.

China's seed globalization pathway: agricultural aid projects and agribusiness investment

Rice is the staple food for half the world's population, which makes it one of the most crucial grain crops for food security. The main rice production regions are Asia and Africa. Ninety per cent of the world rice is produced in Asia, where 60% of the global rice sowing area is located; Africa, on the other hand, holds 6% of the global rice sowing area and produces the second most rice output for the world population (Chen & An, 2013). In the Mao era, Chinese seed was introduced to certain Asian and African developing countries through agricultural aid projects. China's agricultural aid to Africa took root in 1959, and since then Chinese agricultural technologies and practices have helped to promote agricultural development in Africa (Yan & Barry, 2010).

China has a long-standing rice-growing history, dating back as far as 7,000 years (Yuan, Geng, Liu, & Zhu, 2004). However, in the late 1970s, the successful breeding of hybrid rice seed laid the foundation for China's long-term leading position in rice seed hybridization technology. Among all the crop seeds, hybrid rice seed is China's most competitive seed on the global seed market (Du & Zhan, 2012; Deng, 2016). In the 1980s, China signed hybrid rice seed technology transfer contracts with the US and introduced this technology to more

countries thereafter (Du & Zhan, 2012; Yuan, Geng, Liu, & Zhu, 2004). Since the Reform and Opening up, the spread of Chinese seed in Asia and Africa is through international trade and foreign direct investment.

In the 1980s, China exported a small amount of hybrid rice seed to Southeast Asia; while in the late 1990s, China's seed export to Southeast Asia, South Asia and Africa started to increase (Yuan, Geng, Liu, & Zhu, 2004). With the commodity rates remaining low, Asia and Africa are the largest potential hybrid rice seed markets. In Southeast Asia and South Asia, only 15% of rice seed is purchased on the market and in Africa, the figure is 10%; in comparison, the commodity rate of rice seed is 60% in North America, East Asia and Europe Union, and 50% in Latin America (Chen, Cai, Jing, & Qiu, 2013). Chen, et al. (ibid.) estimate that East Asia, South Asia and Southeast Asia will consume over 90% of the world's commodified rice seed in the future, should the commodity rate rise in such regions as most seed enterprises expect. In 2004, Yuan, et. al (2004) estimated that in the next 10 to15 years, the global sowing area of hybrid rice will reach 1 billion hectares and annual need for hybrid rice seed will amount to 1.5 to 2 million tons, the market value of which will be USD 12 to 16 billion. By 2012, Vietnam, Bangladesh, the Philippines, Pakistan and Indonesia are the main destination countries in Asia, and 90% of China's hybrid rice seed was exported to these five countries (Chen, Yuan, & Deng, 2011; Du & Zhan, 2012). Africa and South America also have a high demand for hybrid rice seed yet, until now, China's hybrid rice seed has been introduced to such areas in the form of agricultural aid rather than commodity export (Chen, Yuan, & Deng, 2011; Deng, 2016).

For the pioneer enterprises in China's domestic industry that attempted to introduce China' hybrid rice seed to other developing countries, they were faced with a great number of problems and often were in need of the state's assistance. In an interview with Gong Zhenmin[72], he recalled the experience he had when working for Hunan Ava Seeds Co. Ltd. (Ava, 亚华种业, yahua zhongye) and Yuan's Seed Co., Ltd. (袁氏种业, yuanshi zhongye) to test the water in Ecuador, South America. After graduating from Hunan Agricultural University in 1997, Gong worked at the provincial seed company, which later was reorganized as an independent seed enterprise, Ava, during market liberalization around 2000 and was acquired by Longping High-tech in 2008. From 2004 to 2008, Gong was deployed by Ava to do hybrid rice seed experiments and production demonstrations in Ecuador, Peru and Columbia. In the following two years, he was employed by Yuan's Seed Co. Ltd., which was

72 Interview with Gong Zhenmin, May 5, 2017

established by Yuan Ding'an, Yuan Longping's oldest son, to undertake a similar task in Vietnam and Indonesia.

In 2004, with the Chinese government negotiating with South American countries, Ava managed to set up demonstration sites for seed experiment and production in these countries. Gong, along with five other breeding experts were settled at the farm of the Ecuadorian King of Banana, whose banana production counted for 30% of the nation's total banana output. In the following four years, Gong and other experts dedicated themselves to selecting local varieties and breeding improved varieties that could be adapted to local ecological conditions and also meet market demands. The warm climate in Ecuador shortens rice's growth period, which is 80 to 90 days, while in China, it is 130 days. The warmth also makes weed and pest control more challenging than that in China. In addition, the Chinese prefer soft-tasting rice while the Ecuadorians are the opposite. It took these breeding experts years to select 5/6 varieties from over 100 that were brought from China to combine with local ones and come up with 3 locally adaptive seed varieties. However, in 2008, Ava failed to supply seed from China due to conflicts within the company, the production plans in Ecuador did not follow through and the 2,000 mu of land from the King of Banana's farm reserved for seed production remained uncultivated. Even worse, the six breeding experts whose expenses were covered by the King of Banana were called back to China. In the end, the Chinese government had to step in and solve the problems for Ava before they got out of hand.

The state paving the way for Chinese seed to become established overseas

Faced with such challenges, agricultural aid projects were suggested by the Chinese government and researchers (Li, Yang, & Qiu, 2014; Brautigam, 2009) to be the carriers of Chinese seed enterprises' business ambitions:

> *Yao Xiangjun, the deputy director of the Department of International Cooperation at the Ministry of Agriculture, told China Daily in 2007: "We believe there will be great potential for trading cooperation between China and Africa in small and medium-sized farming equipment and hybrid rice seeding." Involving companies in hybrid seed multiplication in Africa would help provide a smooth transition out of the old model of aid. It would also fit neatly into Beijing's global strategy for agribusiness. (Brautigam, 2009, p. 247)*

Li, et al. (2014) use Longping High-tech's globalization trajectory to demonstrate the benefits of Chinese seed enterprise participation in the government's agricultural aid projects. First,

from 2000 to 2014, Longping High-tech undertook 20 agricultural aid projects to set up hybrid rice seed experiment, demonstration and research bases in other developing countries, such as Bangladesh, Indonesia, the Philippines, Uzbekistan, East Timor, Liberia, Sierra Leone and Brazil. The receiving countries tended to trust foreign enterprises in charge of aid projects and provide them with cooperation and assistance. In the process, and together with technique training programs, Longping High-tech established good relations with local agricultural government officials, agricultural technicians and local peasants.

Second, one of the biggest challenges facing seed enterprises when entering a foreign market is to breed seed varieties that best meet local needs. Research bases coming with aid projects become the platform to select and breed improved seed varieties that are adapted to local ecologies. The aid projects also offered stable conditions for seed enterprises to conduct long-term breeding experiments. Third, production demonstrations not only showcased the achievements of aid projects, but also became publicity events for seed enterprises. Fourth, the positive impacts that aid projects made in receiving countries made it easy for seed enterprises to find local business partners and also attracted local enterprises to collaborate with them. For such reasons, Li, et al. (ibid.) suggested that China's domestic seed enterprises should actively participate in agricultural aid projects and consider it the first step for strategically unfolding their business operations and achieving "going out" plans.

Hubei Provincial Seed Group Co., Ltd (Hubei Seed Group, 湖北种子集团公司, hubeisheng zhogzi jituan gongsi) was established in 1978 during the "Four–izations and One Supply" transition in China's seed provision system (see Chapter 1). Prior to China's liberalization of the domestic seed market, Hubei Seed Group already put "going out" (zou chu qu) on its agenda. However, before 2006, Hubei Seed Group's seed export remained at a low level. In 2001, the export volume was only 15 tons (hubeiseed, 2019). Since 2006, with the support from the Ministry of Science and Technology, the Ministry of Agriculture and the Hubei provincial government, Hubei Seed Group's globalization strategy has greatly accelerated. Hubei Seed Group's export rose to 4000 tons in 2013 and it became China's largest seed export company for several years (MOST, 2013; hubeiseed, 2019).[73]

Hubei Seed Group's successful penetration of Pakistan's seed market is another case that illustrates the significance of the government's support for the globalization of domestic seed companies. In 2006, Hubei Seed Group and, Origa (GRAIN, 2007; MOST, 2013), its business partner in Pakistan, sent delegations to each other on the invitation from both countries. The

73 Ministry of Science and Technology of the People's Republic of China.

next year, Pakistan imported 50 tons of hybrid rice seed and 45 tons of hybrid canola seed from Hubei Seed Group and the latter sent two experts to Pakistan to set up pilot fields. The productivity demonstration event of Hubei Seed Group's hybrid rice seed was attended by the Chinese embassy in Pakistan and the Pakistanian Ministry of Agriculture, which attracted great public attention. Hubei Seed Group's success in introducing China's hybrid rice seed to Pakistan, in addition, brought with it government research projects that provided much needed construction funds for agricultural technology extension and experimental stations that would further introduce China's hybrid rice seed, cotton seed, maize seed, canola seed and sunflower oil seed to Pakistan. In 2009, Hunan Seed Group became the biggest hybrid rice seed exporter in Pakistan and in 2010, it exported in total 4000 tons of various crop, cotton and oil seeds to Pakistan. In 2006, Hubei Seed Group's hybrid rice seed took 45% of Bangladesh's domestic seed market (changjiangtimes.com, 2015). By 2013, Hunan Seed Group built collaborative relations in South Asia (Bangladesh, Pakistan), Southeast Asia (Myanmar, Malaysia, Indonesia, Vietnam), Africa (Tanzania, Benin), and South America (Ecuador). It also set up several overseas seed experiment bases and established agricultural technology collaboration projects in 45 countries (MOST, 2013).

A new stage of seed globalization: joining the state's plan for going out

China had long been a net seed import country and the trade deficit had widened for years (Du & Zhan, 2012; MOST, 2013). Seed import was twice that of export from 2002 to 2004, and in 2007, the trade deficit still remained at USD 51 million (MOST, 2013). In 2009, the world top four seed export countries were the US, the Netherlands, France and Germany, which in total exported USD 2.875 billion worth of seed, accounting for 53.47% of the global seed trade; while China's seed exports only reached USD 75 million, taking up 1.39% of the global seed trade (MOST, 2013). By 2013, the annual sales of China's five listed domestic seed companies, including Denghai, Longping, Dunhuang, Denong and Fengle, in total was one-fifteenth of the US-based Monsanto (ibid.). Faced with mounting overproduction pressure in China's domestic seed industry and the challenges that individual exporting seed enterprises met in destination countries, the Chinese state's overt globalization plan not only greatly motivated domestic seed enterprises to enter the global market, but also changed the competition strategies that such enterprises adopted.

In 2011, when the State Council launched the project to build a modern seed industry, it encouraged foreign seed enterprises in China to introduce advanced breeding technologies and improved germ plasm resources to China, but their activities, such as germ plasm collection, research and development as well as seed production, marketing and trade, would

be better regulated. Moreover, mergers and acquisitions targeted at domestic seed enterprises would be closely inspected. On the other hand, it advocated for increasing international collaborations in the crop seed industry, and also expressed support for domestic competitive seed enterprises to explore the global seed market. In 2013, the third plenary session of the Communist Party of China (十八届三中全会, shiba jie san zhong quanhui) brought China's globalization plan to a higher level. It called for further liberalization of the domestic market and deeper participation in global competition. In the same year, China's President Xi Jingping proposed to build One Belt and One Road (later changed into One and Road Initiative, BRI). It encompasses various overseas investment projects that have taken places. In recent years, China's outbound foreign investment under the umbrella of BRI have invoked heated debates. However, compared with developed countries, China's agricultural FDI is still new and moderate. With the unfolding of China's globalization plan, China's domestic seed enterprises, especially large state-owned agribusiness and seed companies, are also moving from seed export to FDI, in order to establish a complete industry chain in destination countries and directly participate in local seed markets.

Long before Chinese state's globalization plan, China's domestic seed enterprises had made FDI attempts but most of them were in vain. In Guangxi Province[74], seed export started from 2000, but until today only one seed enterprise, Guangxi Wanchuan Seed Co. Ltd, managed to establish one local seed enterprise in Vietnam. Wanchuan's President, Wu Quanman, who was born and brought up in Vietnam, came back to China when the bilateral relation deteriorated between Vietnam and China. Through his connections in Vietnam, Wanchuan had earned the trust of Vietnamese clients and managed to do business there for about 20 years. However, domestic seed enterprises with stronger R&D, more capable personnel and more capital could not achieve Wanchuan's success, for the most difficult part of going out is to understand the political, socio-economic, cultural and policy environments, among other things, in destination countries. By the end of 2012, there were 1,012 Chinese agricultural enterprises invested overseas, and the total foreign direct investment (FDI) increased from USD 332 million in 2003 to USD 4.96 billion (Li, Yang, & Qiu, 2014). On the other hand, by 2016, only 9[75] of China's domestic seed enterprises established 10 local seed enterprises in Asia, 1 in North America and 1 in South America, the total investment of which reached USD

74 Interview with Tang, Deputy director of Guangxi Bureau of Seed Governance, April 5, 2017

75 According to He (2016), the 9 seed enterprises are Chongqing Zhongyi (Central) Seed Co., Ltd (Laos, Bangladesh, Burma and Vietnam), Beijing Kings Nower Seed Science & Technology Co., Ltd (the US), Shandong Guanfeng Seed Science and Technology Co., Ltd (Brazil), Henan jingyanyinhai Seed Co., Ltd (Tajikistan), Sichuan Southwest Kelian Seed Co., Ltd (India), Hunan Yuan's Seed Co., Ltd (Indonesia), Guangxi Wanchuan Seed Co., Ltd (Vietnam), Sichuan Lvdan Seed Co., Ltd (Vietnam), and Sichuan Xike Seed Co., Ltd (Vietnam). However, Guanfeng's actual investment in Brazil is palm oil production and there is little information on Zhongyi's local enterprises in the above-mentioned countries. More investigations should be carried out to find more about the FDI made by the 9 seed enterprises.

14.435 million (He, 2016). Different from these FDI seed enterprises, large state-owned agribusiness and seed companies took an alternative road—mergers and acquisitions over established transnational companies, an increasingly common practice for such companies to quickly enter overseas markets and avoid regulations and restrictions on FDI.

As briefly mentioned above, in 2014, through its overseas investment and management platform COFCO International, COFCO, China's biggest foodstuff conglomerate by revenue, acquired 51% of Nidera, a major international agribusiness and trading company based in the Netherlands. After COFCO possessed the whole ownership of Nidera in 2016, it also acquired Nidera's infrastructure, business networks and other resources in key South American countries including Brazil, Argentina, Uruguay and Paraguay. The acquisition of Nidera is a significant step for COFCO to join the global competition and transform the global agro-industrial landscape (Oliveira & Schneider, 2016). Similarly, in 2017, Longping High-tech acquired Dow AgroSciences Sementes & Biotecnologia Brasil Ltd., through which it obtained the non-exclusive usage right of Dow AgroSciences' Brazilian corn germplasm bank and a license for the use of the Morgan seed brand and the Dow Sementes brand for a certain period of time. In the same year, ChemChina purchased 94.7% of Syngenta, the world largest pesticide and the third largest seed agribusiness and closed the high-profile acquisition deal.

Discussion and exploration

China's domestic seed market was liberalized around 2000 and over the past two decades, it has experienced dramatic changes, which the seed markets in developed countries witnessed over a period of 80 years. In about 10 years, overproduction already occurred on China's domestic seed industry. To solve such problems, China's domestic seed industry went through capital centralization at home and deeper participation on the global seed market abroad. Underlying all of these changes is the role that the state plays in the intensification of financialization. Capital is of growing importance in shaping the competition rules in the seed market.

The new changes in the seed market with overproduction problems confirms Marxist theory of a crisis in an economic system driven by profit maximization. However, instead of calling it a crisis, it is portrayed as an opportunity to transform China's domestic market and strengthen the presence of Chinese seed enterprises in the global market—It is the necessary next step to catch up to transnational agribusiness companies.

A great many of questions remain to be asked and answered. What industry centralization means for agricultural producers and the agrarian change in China? How financialization plays out in China's domestic seed market and how will it affect the dynamic of profit-making in China's domestic industry? How will the participation of Chinese seed enterprises on the global seed market change the global agribusiness landscape? What Chinese seed enterprises' FDI will bring to other developing countries and the local agricultural producers?

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Chapter 6 Peasant and seed: historical experience and a new imagining

Introduction

In Kloppenburg's celebrated work First the Seed, he notes the dual character of seed in that it "links both ends of the process of crop production: It is both means of production and, as grain, the product" (Kloppenburg J. R., 2005, p. 10). The commodification of subsistence[76] (Bernstein, 2010) compels agricultural producers to sell their agricultural produce on the market. Seed, in the form of the product, as demonstrated in Chapter 2, more often than not, cannot be directly consumed by agricultural producers. It is to be sold on the market and return to producers in the form of cash. The relationship between seed (grain) and agricultural producers becomes mediated by the market. On the other side of the crop production process, the connection between agricultural producers and means of production (seed) was historically close and peasants using home-produced, open-pollinated seed was common practice. In the US, farmers, instead of public or commercial agricultural research institutes, were the principal maize breeders (Kloppenburg, 2005: 94). However, the introduction of hybrid seed and the development of biotechnology have estranged producers from their direct means of production. In between agricultural producers and seed is independent agricultural research.

The alienation of agricultural producers from seed accelerated since the unfolding of the Green Revolution, which is commonly understood to have been at work from the early 1940s to 1970, although "many of the features that would come to characterize the Green Revolution were in place by the 1920s" (Patel, 2016), one of them being high-yield varieties of seed. The Green Revolution was first promoted by the US as a way to prevent the spread of the Red Revolution and the threat of communism (Patel, 2016; Schmalzer, 2016). In 1935, the US successfully developed hybrid maize varieties that were about 10%-20% better yielding than their open-pollinated counterparts (Kloppenburg, 2004: 104). The hybrid corn seed was introduced to Mexico by the Rockefeller Foundation in 1940s and soon came to India, the Philippines and the rest of Asia, where the Green Revolution demonstrated great yield increases in the beginning years but received strong criticism since the 1970s, (Byres, 1981). However, it is not just hybrid seed that travelled from the US to Latin America, Asia and other places in the world. The transformation of the mode of agricultural research and the increasing power of private enterprises was also extended from the US to where hybrid seed was sown.

76 Bernstein defines commodification of subsistence as that reproduction cannot take place outside commodity relations and the disciplines they impose (Marx's "dull compulsion of economic forces").

The hybrid maize varieties that were promoted in the Green Revolution were developed by the public agencies (for instance, Land Grant Universities). When hybrid seed first came out (the 1920s and 1930s), public agencies supported farmers to produce their hybrid seed by offering courses in hybridization or providing farmers with parental foundation seed stocks (Kloppenburg, 2004: 106). However, the profitability of hybrid varieties attracted private seed enterprises to take up seed breeding and focus on hybridization. As Berlan and Lewontin state "Hybrids opened up enormous profit opportunities for private enterprises and for this reason all efforts were shifted to the new technique." (cited in Kloppenburg, 2004: 94). To monopolize the profits, private seed enterprises first attracted farmers to purchase hybrid seed and give up the time-honored practice of seed selection and seed saving by demonstrating the high-yield quality of hybrids.

Having done that, the next obstacle for private seed enterprises to accumulate capital was the public agencies. To solve this problem, private interests actively pushed for the division of labor in seed breeding: public agencies withdraw from the development of commercial hybrids and constrain their activities to fundamental research; private seed companies undertook applied research and directly linked themselves to the seed market and agricultural producers by controlling the commodity form of seed. Private seed breeders insist that public agencies should not conduct research activities that also attract private investment, otherwise public funds will be wasted. Instead, public agencies should reorient their focus on basic research[77]. However, Kloppenburg (2005, p. 111) argues that "To control the shape the commodity-form assumes in the market is effectively to control all upstream research", since in the capitalist system "research has value only insofar as its fruits can be applied to production in some fashion" (Kloppenburg J. R., 2005, p. 110) and that " The products of public research can enter production, and thus have value, only if seed companies choose to use them" (Kloppenburg J. R., 2005, p. 111).

The alienation of farmers and public research agencies from seed that will be directly used for agricultural production was the result of private seed enterprises' constant struggle. It not only resulted in intensification of seed commodification, but also enabled private seed enterprises free access to germplasm and improved breeding technologies from public agencies. For instance, in 1979, 72% of commercial hybrid corn lines had one or more public inbred parents (Zuber and Darrah, 1980: 241, in Kloppenburg, 2004: p. 112).

77 In China, recently, domestic private seed enterprises use the same discourse to push public agencies out of applied research.

In the Economic and Philosophical Manuscripts of 1844, Marx discusses estranged labor and explains four types of alienation: the relation between the worker and the product of labor; the relation between labor and the act of production within the labor process; the relation between man and man's own body, external nature and his spiritual aspect, his human aspect; and finally, the relation between man and the other man. Marx (2019) further states that

> Through estranged, alienated labor, then, the worker produces the relationship to this labor of a man alien to labor and standing outside it. The relationship of the worker to labor creates the relation to it of the capitalist (or whatever one chooses to call the master of labor).

By elaborating on alienation and the consequent relation between the worker and the capitalist, Marx explains an essential issue in political economy, which is the cause of private property. In political economy, the concept of alienation throws light on important concepts such as competition and division of labor and also on the direction of the emancipation of society (Musto, 2010). This chapter borrows the idea of alienation as a way to explore the socio-political implications of the estranged relation between agricultural producer and seed as well as the takeover by private enterprise of seed breeding thus alienating both agricultural producers and public institutions. Marx's alienation is crucial to understand capitalist society, while a socialist society is dedicated to remove the estrangement and restore primarily the connection between producer and means of production. For the agrarian study in China's context, application of the alienation concept is closely related to the perceptions of peasants in different historical periods, especially the comparison between the Mao era and post-reform era (after the late 1970s). The question is not only whether producer should be in control of the means of production, but more specifically, whether peasants have the capacity to master seed breeding techniques, and what social institutions should be in place to support the seed rights of peasants.

In The Peasant in Postsocialist China, Day (Day, 2013) traces the transformation of Chinese intellectual views of peasants. In China's revolutionary years, starting from the 1920s to 1949, the Chinese Communist Party (CCP) established a dialectical understanding of Chinese peasants:

> On the one hand, the peasantry was a conservative petty-bourgeois class of "small producers" (xiao shengchanzhe) that defended its small plots of land; on the other hand, the peasantry was a rebellious, exploited class of rural laborers. How this dual

> class nature was expressed depended on political and social circumstances. (Day, 2013, p. 21)

Peasants can be either conservative and backward, or revolutionary. This perception helped the CCP to distinguish the attitudes of different strata of peasants towards revolution and find the right group of peasants to achieve revolution victory. This dual character of peasant carried forward into China's construction era that began since the founding of new China, but the emphasis changed at different times. In the beginning years of new China, agricultural land was distributed to peasant households and the petty-bourgeois tendency took over. It resulted in the widening gap of rural incomes, the return of land concentration, and renewed class differentiation (Day, 2013; Schmalzer, 2016; Jin, 2007). To halt rural class differentiation, Chairman Mao supported rural cooperation and collectivization amid disagreement within the CCP leadership. In the collective era from the mid 1950s to 1970s, peasants were viewed mainly as conservative, therefore the state's intervention in agriculture was prominent, ranging from organizing labor regimes, land arrangements, to technology development and dissemination. The collective organization of rural society and agriculture is often criticized in the post-reform era since 1978, especially by the mainstream economists. In terms of agricultural production, starting from the economic stance, labels such as lack of supervision, low economic efficiency, and tight control of rural labor are often pinned on the collective farming system (Lin, 1990; Han, 2004). However, others would defend the collective farming system and argue for its merits in the construction of agricultural basic infrastructure, improvement in crop yield, advancement in agricultural technology, as well as environmental and ecological benefits in water- and energy-saving, among others (Bramall, 2009; Jin, 2007).

Despite that the collective farming system was designed to overcome the class differentiation tendency among Chinese peasants, peasant were not passive participants of the state's agrarian transition agenda. On the contrary, they were actively involved in the changes of rural China, particularly in the development of agricultural technology and seed breeding. However, in the post-reform era, the rapid unfolding of seed commodification since the enactment of the Seed Law in 2000 and the reconfiguration of seed breeding result in the separation of seed from agricultural producers. In recent years, the reconnection of seed with agricultural producers is brought to attention by ecological farming practices. Such practices aim at producing safe agricultural products, increasing the income of agricultural producers (in particular, small peasants), and promoting sustainable methods of production. They also advocate for peasant's seed rights in breeding, selecting, saving and re-using seed for their own production. Nonetheless, their discourses and justification for the seed rights of peasants are various and in contrast with those in the Mao era.

This chapter will compare the historical experience that China had in the Mao era of including peasants in seed breeding with the current social movement for peasant's capacity building in breeding techniques. The first section of this chapter will review the mass movement of agricultural technology in the Mao era, which is followed by the second section discussion on the institutional adjustment in the reform era and the concentration of seed breeding in public research institutions, which later moves on to private seed enterprises. In the same section, the transition of China's seed governance will also be discussed, which is featured by increasing bureaucratization and decreasing supervision on private seed enterprises. The third section focuses on the new farming initiatives that is attempting to remove the alienation between agricultural producer and seed. Comparison between the Mao era and contemporary peasant breeding practices will be made in this section. In the conclusion, suggestions on how to effectively protect peasant's seed rights will be offered.

Investigation of the grassroots seed breed practice in this project was conducted in Heilongjiang Province, Northeast China. The fieldwork was carried out from May to July 2017. The main interviews at this site were with older peasants who had worked as agricultural technicians at different levels within communes, retired government officials who received seed breeding training, as well as current government officials at the seed governance authorities. The discussion of the division of labor between public research institutions and private seed enterprises draws on interviews with agricultural researchers in Yunnan Province. The transformation of China's seed governance and agricultural extension is based on fieldwork data in Heilongjiang Province. The third section refers to literature and news reports on international and Chinese seed conservation social movements.

Peasant, seed, and revolutionary vision

In China, the term "Green Revolution" was not officially used in the socialist era to describe the particular agricultural technology development that contributes to the Green Revolution. However, it does not mean that China did not embark the journey of agricultural modernization. Rather, socialist China launched the "scientific farming movement" to promote agricultural mechanization, to construct irrigation systems, and to improve seed varieties. Table 6.1 shows the achievements of China's agricultural modernization in the collectivization era (1952-1979), which are comparable with those of Green Revolution elsewhere in the world. Chairman Mao stated that scientific experiment was one of the three revolutionary movements, together with class struggle and the struggle for production, for building a mighty socialist country (Schmalzer, 2016). What differentiate socialist China's

scientific farming movement from the worldwide Green Revolution from the 1940s is the philosophy of science, as Schmalzer summarizes, “The dominant position in socialist China was that science could not be divorced from politics, and modernization could not be separated from revolution” (Schmalzer, 2016, p. 11).

Table 6.1 Agricultural Modernization in China’s Collectivization Era, 1952 -1979

	1952	**1957**	**1965**	**1979**
Tractor ploughed farmland / total farmland	0.1	2.4	15.0	42.2
Irrigated farmland / total farmland	18.5	24.4	31.8	45.2
electricity irrigated farmland / total farmland	1.6	4.4	24.5	56.3
Fertilizers applied (kg/h)	0.7	3.3	18.7	109.2
Small-scale hydroelectric power stations in rural China	98	544	N	83224
Energy generation of power stations (1000KW)	8	20	N	276.3
House power of farming machineries (10000 hp)	25	165	1494	18191
Large- and middle-scale tractors (1000)	1.3	14.7	72.6	666.8
Small-scale and walking tractors* (1000)	N	N	4	1671
Engine house power of agricultural irrigation and drainage (10000 hp)	12.8	56.4	907.4	7122.1
Combined harvesters	284	1789	6704	23026
Motor fishing boats	N	1486	7789	52225

Source: Statistical Year Book of China (1983: 186, 197; 1981, volume 6: 13), in (Jin, 2007).
*The tractors were originally used for agricultural purposes, but many of them were used for cargo transportation.

Regarding the improvement of seed varieties, since the establishment of the three-tiered collective farming system that includes production team, brigade and commune from the bottom to the top, a state-supported, grassroots-based, and self-reliant seed provision system was also put in place. Chapter 1 elaborates on the combination of grassroots seed provision and the facilitating institutions. Each production team was responsible for their own seed production and supply. However, each commune or each brigade also had one production team (referred to as liangzhongchang, or collective seed base) that specialized in producing seeds and supplying seed for the whole commune or brigade in case some production teams

needed seed exchange for variety improvement or needed seed purchase due to unexpected seed shortage.

In the collectivization era, the communes and the central government set up over 40,000 Agricultural Technology Extension and Improvement Stations (农业技术推广与改良站, nongye jishu tuiguang yu gailiang zhan) that covered the entire rural area in China (Wu, 2000:181, in Jin, 2006). In 1955, the Ministry of Agriculture, Ministry of Grains (粮食部, liangshi bu), Ministry of Commerce and the National Supply and Marketing Cooperative (全国供销总社, quanguo gongxiao zongshe) jointly released instructions on improved seed varieties extension work. By 1956, over 2000 seed propagation demonstration farms emerged, which produced in total 75,000 tons of improved seed varieties, making them the foundation for improved seed varieties demonstration, propagation and extension (Huang, 2002). In addition to extension stations and demonstration farms, an even more intriguing aspect of seed provision in socialist China was the emergence of a great number of grassroots seed breeders. The case of Wang Qinlian illustrates how grassroots were supported to learn agricultural technology and how their knowledge was put to use to serve the grassroots.

Wang Qinlian[78], age 80, remembered vividly his training at the agricultural school and his work experience at the collective seed field. Wang came from a poverty struck region in Shandong Province, east China in 1956. Like many immigrants who were encouraged to come to Heilongjiang Province for land reclamation, he lived in the newly established village together with about 240 single-head households. These households were mainly male laborers over 18 years old. Only after he became a teenager, Wang was able to receive primary school education, but it still made him one of the rare literate persons. For this reason, he was named production team accountant and recommended by the brigade to study at Beian Agricultural School.

On the same years, 2000 peasants studied at the same agricultural school, including 6 or 7 from Wang's township. All the students were youngsters who at least had primary school education. They were selected and financially supported by their brigades. During their study at the agricultural school, they still received basic work credits from individual brigades. According to their education level, some of them studied for one year and others three years for more advanced training. Agricultural school teachers were all experts and each class consisted of 60 students. The training content included plant cultivation, pest control, soil

78 Interview with Wang Qinlian, June 23, 2017

(management), literacy and seed breeding. It covered in-class theory study and experiments as well as practice in the experiment field. These peasant students sat up straight and focused for four sessions in the morning and four in the afternoon, in addition to self-study at night. Although the financial support was limited and students only had 0.5kg of grain quota each day, they managed to finish their study by mixing cabbages into their meals.

The seed breeding training was not put to use right after Wang finished his study. However, in 1975, after each brigade had its own breeding team and agricultural technician, Wang started working at the commune's collective seed base, in the company of 5 or 6 technicians sharing his training background. On the seed base they conducted comparative tests on new seed varieties and selected locally adapted ones for next year's seed propagation. Among these new seed varieties were those bred by grassroots breeders. In addition to typical seed varieties in the Green Revolution that required heavy irrigation and fertilizer input, the tested varieties at the seed base also included those that were drought-tolerant and leanness-tolerant. Despite that Wang and his team came to give instruction on the seed base's work, they learnt a great deal from elder peasants. Wang frankly admitted that, "Those peasants had way more farming experience and were better than us". In 1975, Wang started working at the seed station, first as the cashier and later accountant. The station[79] was responsible for providing seed for production teams within the township. While Wang was working at the seed station, he also was responsible for training village technicians, but this work lasted for less than 2 years.

Three crucial points can be made from Wang's case. First, the training of grassroots agricultural technicians was well designed, and it was meant to disseminate agricultural technologies to the literate rural youth. After finishing study, some of the agricultural school trainees returned to their own production teams; others, especially those who received three years' training, became new trainers for an even larger group of rural youth for short-term training sessions in farming low seasons. They also made the earliest employees at seed stations and later seed companies. In later years, production team agricultural technicians also became teachers at the training sessions, and further disseminated breeding techniques to other technicians. In addition to agricultural technology dissemination and extension, grassroots breeders also had the opportunity to be recommended to receive higher education in colleges and universities as a worker-peasant-soldier student (student recruited from among workers, peasants and soldiers, see Wang Jinhai's case in Chapter 1). They would return to work as

79 There were two productions that propagated seed for the station. The produce was sold at prices that were slightly higher than grain prices. After selection, the station would sell good seed to production teams and the rest was sold as grains. The seed station obtained maize seed directly from research institutes and seed prices were set by the state (8% or 10% above grain prices).

breeders at higher levels in the collective farming system, in the brigade or commune; or take up administrative positions in seed authorities.

Second, the seed varieties that were bred and promoted in the collective era were mainly those that were adapted to local climate, soil and water conditions. For instance, Keshan Academy of Agriculture, a research institute near my fieldwork site, was known for breeding soy, wheat and potato seed that adapted to various geographic regions, varied terrains, soil conditions and growth lengths in the same geographic region (Huang, 2002; Keshan Agricultural Sciences Research Center, 1966). In the fieldwork site, several nearby peasant breeders were still remembered and respected. One grassroots breeder Shao Jiechu was given a nickname, Shao the Determined (shao da juexin), for his persistent pursuit for better seed varieties. Another's breeding outcome was named after his village Shengli (Victory) and the particular trait (early-maturity) as Shengli zao banyue (victory half a month early).

Third, contrasting to today's prevailing stress on intellectual property rights due to the growing power of private seed enterprises, in the collective era, genetic resources were transferred at very low costs within the collective farming system. To begin with, production team agricultural technicians were allowed to bring back parent plants for hybridization experiments. Also, the new seed varieties from formal research institutes were disseminated by extension agencies to collective seed sites for propagation and purchased by production teams. Improved seed varieties by grassroots seed breeders could be tested along with those of breeding experts and could also be directly purchased by production teams almost at the price of grain. Even recently, private seed breeders who have lived through the collective era in Heilongjiang are still generous with sharing their breeding achievements. In 2007, Guo Qinglan[80], then the owner of a rice processing factory and now organic rice producer, wished to take on high-quality rice production as a way to meet his own processing capacity. In a three-room mud house, he found the breeder of a fine rice seed variety (Suijing[81] No. 4), a 90-year-old man who used to be a physics teacher. The breeder sold him a bag of rice seed at the price of 5.6-6 RMB/kg when the unhusked rice price was 2.2-2.4 RMB/kg. However, now Suijing No. 4 is propagated and marketed by Heilongjiang Academy of Agricultural Sciences and the market price is 9 RMB/kg.

Commercial seed breeding and the transition of public research institutions

80 Interview with Guo Qinglan, May 14, 2017

81 The correct way to pronounce 粳 in Chinese is jing, yet in many places of China, it is pronounced as geng.

Since China's Reform and Opening up that started in the late 1970s, China's seed breeding and seed governance clearly became different from practices in the collective era. The commune's collective seed sites that were located in different brigades in Heilongjiang Province were abolished in 1978, with land returned to original villages and agricultural technicians dismissed. There were four higher level collective seed sites in Nehe County where the fieldwork was conducted. They were selected specially to represent various accumulated temperature zones in this region. In the collective era, these seed sites propagated improved seed varieties for local production teams and contributed greatly to the increase in agricultural productivity.

In the late 1940s[82], seed breeding was not practiced in Heilongjiang Province. The conventional wheat seed was prone to rust disease and yielded less than 50kg/mu. The productivity of conventional maize seed was merely 50-100kg/mu. Since seed breeding was introduced to this province, seed varieties were greatly improved. In the mid-late 1950s, the rust disease problem was resolved and in the 1960s, collective seed sites began hybridization experiments with maize seed. Around 1970, the grassroots participation in seed breeding rose to a mass breeding movement during the period of the Cultural Revolution Movement (1966-1976). Wang remembered that

> *"People had great work enthusiasm in the Cultural Revolution. There was no catastrophe in agricultural or industrial production. (People only think so) because in the last two years of the movement all the achievements were denied."*

Truth is that in the 1970s, the maize seed productivity reached 200 kg/mu, double that in the late 1940s. The output of every mu of wheat also increased from 50 kg/mu to about 130kg/mu. Wheat disease was also under control. Collective seed bases were an important arena to experiment with improved seed varieties from both formal seed breeding institutes and grassroots breeders, and to introduce them to production teams. However, from the late 1970s, together with the fading of the mass breeding movement, collective seed bases lost their importance, and so did the direct transfer of improved seed varieties from research institutes (breeding), to collective seed bases (propagation) and to production teams (production).

Since the late 1970s, China went through marketization transformation (see Chapter 1). Seed companies were established from the previous seed governance authority (seed stations) to

82 Wang Jinhai, ex-director of the Municipal Seed Governance Department, recalled the differences that the improvement of seed varieties and the grassroots breeding practices made to agricultural production in the collective era (Interview on May 19, 2017).

initiate market reform in the seed sector, in the name of realizing regionalization of seed distribution, specialization of seed production, standardization of seed quality, mechanization of seed processing and centralization of seed supply at the county level, which is often referred to as four–izations and one supply, or 'si hua yi gong'. Collective seed sites became the production bases of seed companies at the beginning of the reform; however, since the Household Responsibility System (HRS) was in place, seed companies turned to peasant households for seed production. Collective seed bases were public institutions, so when seed companies signed seed production contracts with them, there was little room for negotiation. However, contracting seed production to peasants not only reduced production costs for seed companies, it also enabled them to refuse purchasing seed from peasants should the seed quality be not to their satisfaction. In that case, peasants would have to sell seed as grain on the market. Losing the position as seed companies' production bases cost collective seed sites the purpose of their existence. Due to lack of incomes, some collective seed bases distributed part of the land property to the staff in order to pay for their salaries. The rest was contracted out to pay for retirees' pensions. Collective seed bases may still exist in name today, but they are no longer under the jurisdiction of seed governance authorities. Instead, they have become merely entities that contract out agricultural land.

Commercial seed breeding: the undermining of public research institutes and the dependency relationship

When the seed company and seed station were still in the same government agency, agricultural universities and colleges were able to obtain research funds from the state and the improved seed varieties were propagated and marketed directly by seed companies[83]. In 2000, China's first Seed Law was released, and China's domestic seed market was liberalized for private enterprises. Chinese domestic seed enterprises are differentiated (see Chapter 4). The trajectory of research institute founded enterprises is representative of the division of labor between seed breeding and the marketing of commercial seed. Most of the private seed enterprises that emerged since 2000 started with seed production and seed marketing, but rarely invested in seed breeding. They would turn to research institutes for improved seed varieties, but the collaboration was not based on the transfer of intellectual property rights. Rather, private seed enterprises would first evaluate the profitability of the seed variety in question and propose one-time payment or continuous payment based on how much seed was produced[84].

83 Interview with Zhao Zixiangg, associate professor at the Department of Agricultural Sciences and Biotechnology, Yunnan Agricultural University, March 13, 2017

84 Interview with Gao Xueguo, researcher at Grain Crop Institute, Yunnan Academy of Agricultural Sciences, March 13, 2017

At the same time, many research institutes established their own seed enterprises, or gave researchers permission to engage in seed production and seed marketing. On the one hand, research institutes joined seed market competition in order to cope with the lack of research funds and the pressure to raise incomes. On the other, the improved seed varieties bred by research institutes needed a dissemination platform. The planting area of improved seed varieties is also a crucial requirement for researchers to apply for outstanding research awards. However, research institute founded seed enterprises were in the state policy's grey area, where the state neither supported nor explicitly prohibited them from establishment. With the increasing competition on the seed market, private seed companies were driven to strengthen research and development (R&D) capacities. In the meantime, research institute founded seed enterprises were under the heavy attack of private competitors. First, private seed enterprises asserted that research institutes obtained research funds from the state, but at the same time they made profits from seed production and seed marketing. It created an unfair market environment. Second, private seed enterprises were now eligible to apply for research projects from the state, just as research institutes did. Therefore, research institutes should not enjoy any privileges. Third, research institute founded seed enterprises were not competitive market actors, for they inherited the administrative agency's low work efficiency. Under this circumstance, the state issued policies that prohibited research institutes from conducting seed production and seed marketing (State Council, 2011; MOA, 2015). All research institute founded seed enterprises must divorce from their institutes and become independent market actors.

With great reluctance, research institutes stripped off their seed enterprises and gave up the commercial form of seed. During the transition of research institute founded seed enterprises, many improved seed varieties remained in the newly independent seed enterprises, which greatly discouraged agricultural researchers and seed breeders[85]. In addition to the objection from private enterprises and the state policies to detach, in 2011, the requirement of registered assets for hybrid seed companies was raised to RMB 30 million, which many research institutes were incapable of meeting. According to the estimation of the deputy manager of Guangxi Zihai Seed Company, who is also a researcher at Guangxi Academy of Agricultural Sciences, 99% of research institute founded seed companies in Guangxi Province did not survive.

85 Interview with deputy manager of Guangxi Zihai Seed Company, April 7, 2017

The loss of business activity incomes and the competition for research funds put research institutes in a vulnerable position. Professor Zhao, at the Department of Agricultural Sciences and Biotechnology, Yunnan Agricultural University, explained:

> *Researchers need to apply for research funds from the Ministry of Sciences and Technology and the Provincial Department of Science and Technology. The distribution of research projects among researchers is already unfair. Famous scholars get grand research projects while ordinary researchers can only obtain start-up funds of RMB 50,000 from their own colleges and universities. Since 2011, the state's research funds also go to private seed enterprises for commercial seed breeding. Researchers find it easier to apply for research projects if they collaborate with private seed enterprises, especially those that have high registered assets and market share. Such projects usually last 2 to 3 years.*

The alienation of research institutes from the commercial form of seed results in seed breeders' dependence on private seed enterprises. Researchers need to form a certain kind of service contract with private seed enterprises in order to carry out the breeding work. The contract can be improved seed variety purchase, or private enterprises' continuous financial support for seed breeding. The dependence on private seed enterprises also changed the direction of seed breeding. In contrast to seed breeding in the collective era when seed was bred to adjust to local conditions, now both basic research and applied research are compelled to meet market demands[86]. For instance, in Yunnan Province, the breeding direction should be hybrid maize seed that is leanness-tolerant, disease-tolerant, high-quality and extensive-management-tolerant. The dependent relationship also undermines research directions that cannot yield immediate profits. Private seed enterprises rarely invest in conventional seed breeding, nor do they invest in seed preservation. Professor Gao spoke from his own experience:

> *Yunnan Province is endowed with rich local maize genetic resources, especially traits as drought-tolerance and leanness-tolerance. However, the local seed varieties reduced by 80% since I started working in 1987. There are two reasons for this biodiversity erosion. One is the adoption of hybrid maize seed, and the other is poor seed preservation. When I was a student, my teachers cautiously preserved seed, and the germination rate would not decrease in five years. However, seed preservation*

86 Interview with Zhao Zixiang, associate professor at the Department of Agricultural Sciences and Biotechnology, Yunnan Agricultural University, March 13, 2017

has increasingly deteriorated since commercialized seed breeding popularized. The deterioration is first because of the rising financial demand with the increase in the number of preserved seed. Second, seed preservation is regular work that requires constant inputs, yet it can hardly result in any practical and economic research outcomes. Third, the preserved seed needs to be regularly grown to test rigor and vitality, which premises on significant inputs of land for isolation in order to prevent gene flows.

The undermining of seed governance and agricultural extension

In the collective era, grassroots seed reliance meant that seed was produced for the production team and seed quality was therefore ensured, for it was directly related to local food provision and to meet the state's procurement. Seed governance in this period is rarely discussed, but it mainly refers to supervision on seed production at seed bases, and coordination of seed purchase between production teams and seed bases. In the post-reform era before the first Seed Law was enacted, seed governance took form. The mainstream belief about this period is that since the seed station and seed company were the same entity, seed governance and seed business were not independent, which would lead to insufficient and ineffective regulation on seed companies. On the contrary, in fact, inside the entity, individual staff would either work in the seed governance or business operation section. There was no overlapping of personnel or functions[87]. Chapter 1 uses Wang Jinhai's case to demonstrate that in the period of "four–izations and one supply", seed production was closely and regularly inspected. Moreover, as the seed company was still part of the government, direct orders from the seed station was an effective measure to ensure the quality of seed produced by seed companies and to exert full-process supervision.

However, since the liberalization of China's domestic seed market, there has been two contradictory tendencies in China's seed sector: increasing market chaos and the weakening of seed governance. In the late 1990s, at the advent of a liberalized seed market, seed quality issues already emerged on the market (Sheng, Zhou, & Zhao, 1997; Sun & Jiang, 1995). In the first half of 1996 alone, Zhoukou City, Henan Province, was faced with 2.7 million kg of (forged seed) and fake seed (Sheng, Zhou, & Zhao, 1997). In 1998, Ministry of Agriculture and the Bureau of Quality and Technical Supervision jointly conducted a survey on China's domestic seed industry. Statistics from the Consumers' Association showed that only 45.9% of the seed met quality standards (Tong, 2002). Since China's domestic seed market was

87 Wang Jinhai, May 19, 2017

liberalized, the low market threshold posed great difficulties for seed governance authorities. Li Guozhen, [88]the deputy chief of Nehe seed station, Heilongjiang Province, (see also in Chapter 1) recalled:

> *When the market was first liberalized, all seed market actors must receive basic training and be equipped with essential seed knowledge. They needed to first register at the seed governance authorities before applying for business certificates. Nowadays some of them barely know accumulated temperature zones. The primary requirements for seed business operation became registered assets. To make it worse, in the recent 3 to 4 years, anyone with an identification card could apply to open a seed store. The state intended to simplify administrative procedures for market actors; however, our seed station is not equipped to manage so many seed stores.*

As noted in Chapter 1, Li pointed out the under-staffing issue at the seed station, but Nehe is not an exception. In a nearby county, Nenjiang[89], there were 13 job positions at the seed station when it separated from the seed company in 1997. In the past 20 years, two staff were transferred to another department and no new staff were recruited. Without new recruits, the ageing problem in the seed station became so severe that the station director worried that there would be no staff left in a few years. This staffing issue makes it difficult for authorities to exert effective supervision of the local seed industry and seed market. As Li Guozhen argued in defence of seed stations "It's not that we are not doing anything. The real issue is *how* we can do anything" (bushi bu zuowei, shi zenme zuowei). For county-level seed stations, their main governance function is to supervise the cleanliness, moisture, and germination rate of seed on the market. Even the purity test has to be conducted at the province-level seed stations.

Along with the undermining of seed governance authorities, the agricultural extension system was also faced with great challenges. In Nenjiang[90], in the collective era, the production team agricultural technicians were both grassroots seed breeders and agricultural extension personnel. In the post-reform era and before 2000, agricultural technicians were still in place in rural China and they were paid by the village either in cash or with an extra piece of land (one hectare). Advanced training for these technicians were financially supported by the village. However, since the HRS was established, agricultural technicians gradually lost their importance. The agricultural extension vacuum left by the disappearance of village technicians alarmed the grassroots extension agency, and they reported to the higher authority

88 Interview with Li Guozhen, May 22, 2017

89 Interview with Hu Yan, May 31, 2017

90 Interview with Lin Yang, June 1, 2017

at the county level. However, the appeal to restore village technicians was eventually denied. Therefore, from 2000-2011, no agricultural technicians or any form of agricultural extension personnel existed at the village level.

Things took a different turn in 2011 when the Demonstration Household System (shifan hu zhidu) was put in place. These households have large farms (3-5 hectares) that are well-equipped with farming techniques. They are not paid, but they can receive free fertilizers and technological training which is supported by the state's agricultural extension programs and vocational skill training projects, such as the Sunshine Project[91] (yangguang gongcheng). In the Demonstration Household System, one staff at the township agricultural extension center is supposed to serve 10 demonstration households, while each household serves 100 peasant households. In practice, the demonstration effect is limited, however. In the same year, agricultural cooperatives also started earning popularity. Now one-third of the land in Nenjiang is controlled by cooperatives. According to Lin Yang, director of Nenjiang Agricultural Extension center, currently the main receivers of agricultural extension services are agricultural cooperatives. Small peasants are not only excluded from direct agricultural extension programs, but also cannot rely on demonstration households for technology dissemination.

Alienation and reconnection: new imaginings of democratic seed control

In the first section of this chapter I reviewed China's historical experience in grassroots seed breeding and the institutional foundation for securing the peasant's control of seed. In the second section I briefly traced the transformation of seed breeding, seed governance and agricultural extension since the Reform and Opening up in China, which essentially was a process of alienating peasants from seed breeding, the undermining of supervision on seed market, and the decline of agricultural extension services for small peasants. The abrupt changes in China's domestic seed market and seed governance paralleled with those in many other developing countries. The neoliberal turn in the late 1970s changed the regulatory frameworks regarding seed breeding, seed industry and seed market globally (Gómez & Torres, 2001; Friedmann, 2005). In the 1980s, Mexico adopted neo-liberal policies and according Structural Adjustment Programs. From 1981-1992, Mexican government support for rural areas reduced by 58%, so did the proportion of resources that aimed at agricultural

91 The Sunshine Project is a public financed vocational skills training program that aims at transferring rural labour in main grain production areas, out-migration areas, poverty-stricken areas and old revolutionary bases (geming laoqu) to non-agricultural sectors.

research and technology; on the contrary, private seed enterprise's seed sales grew from 15% in 1970 to 90% in 1993 (Gómez & Torres, 2001).

However, what differs China from other developing countries is that the control of private seed enterprises over seed has not been achieved through the protection of intellectual property rights, which is a crucial mechanism that agro-chemical corporations deployed to safeguard and accumulate profits especially since the 1980s (Friedmann, 2005). In 1961, six European nations created the Union for the Protection of New Varieties Plant Breeders' Rights of Plants (UPOV) to provide an international legal framework for plant breeders' rights legislation (Kloppenburg J. R., 2005). With the expansion of US and European seed companies on the global market, UPOV was also introduced to other countries so that they could profit from the proprietary rights given to the new seed varieties they developed (ibid.). This legal framework is also written into trade agreements, such as the Trade-Related Intellectual Property Rights Agreements (TRIPS) under the WTO. TRIPS require member countries to provide protection of plant varieties, either by patents or by an effective sui generic system or any combination thereof (Article 27.3(b)). "Ever since the establishment of the World Trade Organization, all countries of the world have passed laws giving corporations ownership over life forms" (La Via Campesina and GRAIN, 2015). Such legal frameworks exclude peasants from seed breeding and criminalizes them for using or exchanging the seed they save. Regarding China, prior to joining UPOV in 1999 and becoming a member of UPOV 1978 China already released its own Regulations on the Protection of New Varieties of Plants in 1997. Furthermore, obtaining the WTO membership in 2001 brought China under the regulations of TRIPS. Despite that China joined UPOV 1978 and the WTO around the millennium, the state's stress on intellectual property rights did not come until ten years later. China's delay in granting private seed enterprises proprietary rights over seed gave domestic seed enterprises time to adjust to competition from transnational seed companies, and also protected peasants from losing their seed rights. However, the direction of the law amendments and policy changes has been heading to the mainstream neo-liberal frameworks that favor private seed enterprises over peasants. In Chapter 4 I will show that the protection of intellectual property rights is a crucial issue since China launched the modern seed industry (xiandai zhongye) project in 2010. In 2016, the newly revised Seed Law further undermined peasant's freedom in seed saving and seed exchange.

With the intensification of seed commodification and the changes in seed laws that suit in the private seed enterprises' agenda, the economic, social and ecological implications were noticed by peasants, researchers and social organizations. There has been growing concerns

over the startling formation of a seed monopoly and the increasing dependence of peasants on the seed market (ETC Group, 2008; ETC Group, 2013):

> Four firms control 58.2% of seeds; 61.9%of agrochemicals; 24.3% of fertilizers; 53.4% of animal pharmaceuticals; and, in livestock genetics,97% of poultry and two-thirds of swine and cattle research. More disturbingly, the oligopoly paradigm has moved beyond individual sectors to the entire food system: the same six multinationals[92]control 75% of all private sector plant breeding research; 60% of the commercial seed market and76% of global agrochemical sales. (ETC Group, 2013)

However, in China, industry concentration in the domestic seed sector has not yet drawn sufficient attention and public awareness. The main issue is that the degree of industry concentration is not significant. In 2015, China's Top 10 domestic seed enterprises together controlled 35% of market share, and the Top 50 held 35%, respectively increasing by 3% and 5% from 2011; in 2015, less than 300 seed enterprises with registered assets over RMB 30 million remained (21jingji.com, 2016). There are many contributing factors to the low industry concentration. One is that the various climate, geographic and altitude conditions in different regional markets obscured the adaptability of single seed varieties and therefore increased R&D costs. Another reason is attributed to China's resistance in liberalizing the domestic seed market to transnational seed corporations, such as DuPont Pioneer and Monsanto. Despite that Xianyu 335, a hybrid maize variety developed by DuPont Pioneer, once took 40% of Northeast China's hybrid maize seed market (Chen, 2012). Xianyu's market monopoly was soon broken by illegal copied seed from China's domestic seed enterprises (See Chapter 1). The same happened with Bt cotton (Ho, Zhao, & Xue, 2009). Private seed enterprises or research institutes either inserted unlawfully appropriated Bt gene into conventional cotton to create their own Bt cotton seed or purchased them directly from seed production bases that signed agreements with transnational seed corporations (Monsanto and Biocentury). The latest development in China's Seed Law and policy regulation will transform the status quo of the domestic seed industry, which will only drive peasants further away from Farmers' Rights that is defined by the Food and Agriculture Organization (FAO) as the right of farmers to freely access, use, exchange and sell crop genetic resources (FAO, 2019).

There has been many social organizations and movements in the world that are dedicated to protecting Farmers' Rights and taking back seed from private seed companies to realize democratic control over seed (La Via Campesina, 2018; GRAIN, 2018; Kloppenburg J. ,

92 They six companies are Monsanto, DuPont, Syngenta, Bayer, Dow, and BASF.

2014). In China, in recent years, emerging social activities were set to restore the close relationship between peasants and seed. One of them is the participatory plant breeding (PPB) project that took place in 2000 in Guangxi with the help from the Center for Chinese Agricultural Policy (nongye zhengce yanjiu zhongxin) of the Chinese Academy of Sciences, the Canadian government's International Development Research Center, Yunnan/Guangxi-based agricultural research institutes and International Maize and Wheat Improvement Center (CIMMYT). In this project, institute breeders work hand in hand with local peasants in breeding both hybrid and open-pollinated maize seed. According to Li, et al. (2013), professional breeders start breeding based on the trait preferences and local needs of peasants. When breeding is successful, selected peasants will be trained to conduct seed breeding and seed production in their own field. For hybrid seed varieties, institute breeders sign access and benefit-sharing (ABS) agreements with local peasants for sharing both the seed and in-bred lines for community seed production and for local farmers' seed market. For open-pollinated seed varieties, local peasants can manage their own seed production by on-farm seed saving after obtaining quality seed from institute breeders in the first growing season.

Schmalzer (2016) argues that that the PPB project deeply resonates with the Mao-era agricultural sciences in terms that the it "recalls specifically the bottom-up, *tu* science[93] elements, such that its literature often reads like translations of Maoist discourse into the language of post-socialist, transnational, environmentalist social science" (Schmalzer, 2016, p. 240). Table 6.2 lists the equivalent terms between the collective-era mass scientific movement and the PPB project. Most importantly:

> *some of the most fundamental priorities of Maoist science are almost unchanged, especially the cultivation of tu knowledge and "peasant experts," the call for researchers to "learn modestly from peasants," the requirement that science "be put into practical use" and "serve production," and the need for women's enthusiastic participation and men's rapid accommodation of the new gender dynamics.* (Schmalzer, 2016, p. 242)

Table 6.2 Equivalent terms between the PPB project and the mass scientific movement

Collective-era terms	Participatory Plant Breeding
mass	participatory
technocratic	top-down

93 Maoist *tu* science is defined as the populist, nativist counterpart to professional, transnational *yang* science (Schmalzer, 2016: 58). The values associated with *tu* science is experience, practice and local self-reliance (ibid.: 55).

In the PPB project, the peasants role mainly including “establishing the breeding goals by identifying the desired traits and preferred land populations as (one of the) crossing parents” (Li, Lammerts van Bueren, Huang, & Song, 2013), evaluating and selecting potential seed, and maintaining local landraces to broaden the base population for future breeding work. In return, peasants who participate in the project have the right to use, produce and even sell the seed bred in the project. In addition, according to the ABS, participating peasants will receive a share of the loyalties if the hybrid seed’s parent line is directly adopted from a peasant-maintained landrace; in the same agreement, peasants will also be rewarded for conserving and maintaining *in situ* landraces that are collected and utilized by institute breeders (Song, Li, & Vernooy, 2012).

However, the PPB project also differs from the collective-era grassroots breeding movement in fundamental ways. To begin with, in the collective-era, the grassroots breeding movement was to realize peasant’s self-reliance in seed provision through a systematic way that ensured seed breeding, production, saving, selecting and re-using at the production team level, while the PPB project heavily relies on research institute’s on-station breeding, especially in hybrid seed breeding. Second, seed was not a commodity in the collective-era, which enabled a low-cost flow of improved seed varieties from research institutes to collective seed bases and to the grassroots. In the post-reform era, however, seed commodification determines that only the participating peasants and selected villages can utilize the seed bred through the institute-peasant collaboration. Third, the grassroots breeding movement is advocated as an alternative to professional institute breeding that only formal breeders can conduct by enabling peasants with agricultural sciences and the know-how for seed breeding. The former had a revolutionary vision. The PPB, on the other hand, combines “purposes of crop improvement, agro-biodiversity conservation and farmers’ empowerment" and support for “the public function of research institutes” (Li, Jiggins, Lammerts Van Bueren, & Leeuwis, 2013). However, within the mainstream intellectual property rights regime, PPB encounters many obstacles.

Li, et al. (2013) lists three barriers to the PPB process. First, seed or landraces selected by peasants in the PPB project are inherently unstable and may not possess the distinction required by seed laws to be released on the market. Second, “When driven by market profit, both public and private research shifts towards the most profitable crops and proprietary varieties, and away from the improvement of varieties,” which will undermine the PPB project. Third, the failure to pass the DUS (novelty, distinctiveness, uniformity and stability)

and VCU (value of a cultivar for cultivation and use) tastings prohibits peasant-selected seed from entering the market and "limits the seed exchange between peasants and/or markets". For such reasons, although the PPB project is intended to empower peasants, the institute breeders can only "*implicitly* (emphasis added) took farmer-breeders' rights into account," which is "expressed by joint negotiation of an agreement for sharing the benefits of PPB hybrids" (Song, Li, & Vernooy, 2012). Nonetheless, the formal breeder's implicit consideration and the ABS can at best allow designated peasants from selected villages produce hybrid seed for their local market. In addition, "The villages were selected based on their isolated location and remoteness from commercial markets in order to reduce the risks of bio-piracy" (Li, Lammerts van Bueren, Huang, & Song, 2013).

This is not to deny the merits of the PPB project for taking peasant's trait preferences into consideration and training peasants for breeding skills; but rather to draw attention to the constraints and limitations of such collaborative breeding projects. The PPB project was initiated when organizers recognized that the mainstream regulation framework on intellectual property rights and commercial seed breeding left out the needs of small peasants. However, faced with so many challenges, the PPB is running the risk of formalizing that peasant interests are inferior to those of research institutes and seed enterprises. Kloppenburg (2014) terms ABS as a compensationist approach and argues that it "neither protected farmers and indigenous peoples from biopiracy nor brought them any benefit, but have functioned mostly to legitimate and institutionalize their continued expropriation."

Therefore, knowing the trait preferences of peasants will help breeders find the breeding direction to come up with seed that will generate the most commercial value in the local environment. Without challenging the intellectual property rights regime that China is adopting and the intensified commodification of seed, the outcomes of the PPB project will be undermined. Having said that, the role of peasant is also different in the grassroots breeding movement and in the PPB project. In the latter, the participation of peasants is visible, yet they were not the most essential part of the project. Peasant inputs are supplementary to the institute breeding process and they are granted with partial benefits of the collaboration. In contrast, in the collective-era, the grassroots breeding movement that provided technical training, advanced education and basic breeding materials for grassroots breeders and they were in full control of the improved seed varieties.

Discussion and conclusion

This chapter unfolds under two themes, the alienation of peasant from seed and seed breeding, and the endeavours to recover or strengthen peasant control over seed. The second theme introduces China's historical experience of the grassroots breeding movement, as well as current social initiatives that encourage peasant's participation in seed breeding, for which the Participatory Plant Breeding project is used as an example. In the discussion of the collective-era grassroots breeding system, this chapter stresses the ideological and institutional foundations behind the connection of producers with one of the most important means of agricultural production. This movement not only actively involved peasants in seed breeding, it provided systematic support to nurture grassroots seed breeders, and also consciously avoided the commodification of seed and the monopolisation of seed breeding by formal agricultural research institutes. Since the Reform and Opening up, the market reform and China's adoption of the mainstream intellectual property right regime have undermined peasant control of seed and favoured private seed enterprises. Therefore, in recent years, there has been a closer connection between peasant and seed as advocated by current social movements that strives to challenge the private seed enterprises' monopoly.

These social movements usually put peasants in the central position and emphasize peasant's time-honored seed saving practices. To reconnect peasants with seed, external support is provided for peasant training and breeding experiments. However, the commodification of seed and the protection of intellectual property rights greatly undermine the expected outcomes of such projects. Without overturning or stemming the drive for profit-making and the regulatory framework for proprietary seed varieties, it will be difficult for peasants to fully enjoy the benefits of collaborative breeding projects. Instead, they might be reduced as the protector of local landraces for research institutes and the targeted customers for private seed enterprises.

Other cases

In addition to the participatory plant breeding, a long-term and institutionally supported seed conservation and seed breeding project, there are other newly emerged grassroots seed conservation initiatives that worth documenting and closely observed. Scattered and small-scale as they may be, they demonstrate increasing concerns over seed commodification and the erosion of peasants' rights to seed.

In Heihe, a northern prefecture-level city of Heilongjiang Province which neighbors Russia, a 74-year-old woman peasant, Wang Liyuan[94], spent 26 years on breeding wild soybeans. Eventually she successfully came up with two improved soybean varieties[95] with early maturity, high productivity and good resistance and obtained plant variety rights over them. Wang never received any professional training on seed breeding. Neither did she have any work experience in formal breeding institutes. Wang grew up in China's collective era and had the chance of meeting a sent-down educated youth (下乡知识青年) who taught her the basics of scientific farming and seed breeding. Wang didn't start breeding wild soybeans until the age of 48 when she accidentally found them while collecting local mountain specialties. The various colors and the indeterminate growth feature of the wild soybeans caught her attention and curiosity led her to spend the next 26 years on a breeding activity that neither had financial support or any prospect of success.

Wang doesn't expect to get any financial returns for herself from the improved seed varieties. Besides the 26 years of her life, applications for the plant variety rights almost cost her entire savings. However, when her seed can be commercially released, 20% of the incomes generated from the seed will be reinvested in seed breeding and 80% will be used to start a germplasm conservation foundation, according to Wang's wish. Wang promised to share the plant variety rights with anyone who purchased her seed for three years.

In recent years, the popularity of ecological farming and community supported agriculture (CSA) has enabled the return of traditional seed varieties and the increase of new grassroots seed breeders. Unlike Wang Liyuan, who had access to breeding techniques in the collective era and devoted to her interests in and curiosity of breeding wild soybeans, these new seed conservation and breeding initiatives are directly related to a new form of agriculture and market demands.

Guangdong Lvgeng Social Work Development Center (Lvgeng) is a professional social work service institute that dedicates to promote the development of and cooperation between urban and rural communities in China. Since 2001, Lvgeng started rural social work practices and established the framework for the rural-urban cooperation in 2007. With the help from Lvgeng, in 2007, a rural production cooperative[96] was founded in Pingzhai village, Yunnan Province. Members of the production cooperative give up the farming practice that

94 Wang Liyuan's case is compiled from various online sources: (People's Food Sovereignty Network, 2018; Heihe Today, 2016)

95 Yehe No.1 (野褐 1 号), plant variety right No. CNA20090054.2; Yehei No. 1(野黑 1 号), plant variety right No. CNA20110161.8.

96 The case of Pingzhai production cooperative is complie from various online sources: (People's Food Sovereignty Network, 2017; Lvgeng, 2019)

increasingly depends on chemical fertilizers and pesticides and starts the transition to ecological agriculture that applies ecological mature and pest control and adopts a rice-duck co-existence system. Along with the transition from chemical to ecological farming, the production cooperative also uses local traditional rice seed and introduces conventional seed from other rice production areas to replace hybrid rice seed. Without hybrid rice seed, the cooperative members start conducting their own seed selection and distance themselves from the seed market. The ecological rice produced by the cooperative is sold from fair-trade stores to urban consumers who are concerned about food safety or environmental pollution, or recognize the social values embedded in traditional seed, farming practices and the local culture.

In Jiangxi, Yao Huifeng[97] started a similar ecological farming practice as the Pingzhai production cooperative. In 2011, Yao gave up his white-collar job in the city and returned to hometown to conduct CSA. Dao xiang Nanyuan Cooperative organized by Yao provides the members with rice seed and base fertilizer. It purchases rice from these members according to agreed conditions before sending the rice for processing and packaging. Instead of relying on fair-trade stores, urban consumers are directly contacted by Yao and they can pre-pay the production costs before the seed is sown in order to receive the rice produced from their claimed rice paddy. Yao also receives individual online purchase orders. On the first year Yao started ecological farming, he grew a dozen of local traditional rice varieties. Over the years, he collected seeds from over 40 rice varieties and shared them with ecological farmers from Yunan and Guangxi.

Grassroots seed breeders in the Mao era contributed to the development of collective agriculture. The dissemination of breeding techniques also nurtured peasant breeders who still conduct seed conservation in the reform era regardless of economic rewards. On the other hand, traditional and conventional seed has enjoyed increasing attention due to the development of ecological agriculture. Despite that the choices of seeds that are conserved, selected and bred are influenced by the social, ecological and cultural values in them, in the market economy, commodification of agricultural products means that the consumers' preferences also play an important role in making the choices. Due to limited time for fieldwork, the research didn't explore the modes of production on the ecological agriculture farms, or the implications of the return to conventional seed and ecological agriculture for ordinary Chinese peasants. These questions remain to be answered in future studies.

97 Yao Huifeng's case is compiled from various sources: (jxwmw.cn, 2017; yogeev, 2014; tjmjpc, 2018)

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Glossary

collective seed base (良种场, liangzhongchang): in the collectivization era of China, each commune or each brigade had one production team as the collective seed base that specialized in producing seeds and supplying seed for the whole commune or brigade in case some production teams needed seed exchange for variety improvement or needed seed purchase due to unexpected seed shortage.

four–izations and one supply (四化一供, si hua yi gong): a seed provision and marketization policy that China adopted since the Reform and Opening up and lasted until 2000. It was to realize regionalization of seed distribution, specialization of seed production, standardization of seed quality, mechanization of seed processing and centralization of seed supply at the county level.

four self-reliance and one supplement (四自一辅, si zi yi fu): a seed self-reliance policy, under which production teams were expected to carry out their own seed selection and breeding, and to save and use their own seed. These grassroots self-reliant practices would be supplemented by some adjustments.

household responsibility system (家庭联产承包责任制, HRS, jiating lianchan chengbao zeren zhi): A land system in rural China that was established in the early 1980s, under which, each household contracts a share of land from the collective according to their family sizes and thereafter they are supposed to make their own economic decisions and be responsible for the subsequent gains and losses.

planned purchase and distribution policy (统购统销, tong gou tong xiao): In 1953, the planned purchase and distribution policy was launched in China. It was designed by Chen Yun, the then Vice Premier of China's State Council, to stabilize the domestic market and to guarantee that the planned demands for grains would be met through the government procurement (Wang, 2005). Soon afterwards, oil plants (November 1953), cotton cloth and cotton (September 1954) and other main agricultural products were also included in the policy. Under this policy, collectively produced grains, cotton, oil plants and other key agricultural products were purchased by the state and distributed according to unified plans.

production team, brigade, commune (生产队、生产大队、公社, shengchan dui, shengchan dadui, gongshe): between 1956 and 1976, rural China was organized into a three-tiered collective farming system which consisted of production teams, brigades and communes from the bottom to the top.

public institution reform (事业单位改革, shiye danwei gaige): a reform that was aimed at reducing the personnel financed by the government and transforming the public institutions which involved in production and business activities into independent enterprises

sent-down educated youth (下乡知识青年, xiaxiang zhishi qingnian): a Mao-era initiative which called for urban educated youth to live and work in rural China in order to learn from poor and lower-middle peasants and reform themselves.

two random and one public (双随机、一公开, shuang suiji, yi gongkai): a seed market inspection policy, under which both the inspected sales stores and the inspectors will be randomly chosen, and the inspection arrangements and results will be made public.

worker-peasant-soldier student (工农兵学员, gong nong bing xueyuan): a Mao-era initiative to help young people with peasant, worker and soldier family backgrounds to study at formal colleges and universities in order to learn agricultural knowledge and skills.