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Agricultural Development under Environmental Constraints: A Micro-Level Study of Houjiaying Village in Eastern Hebei

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自然环境约束下的农业发展路径探索
——以冀东侯家营村为例

程瑶瑶

Abstract
The natural environment—climate, topography, water and the like—influences and shapes rural development and peasant life. At the same time, social and economic development acts on and changes the local natural environment. The development of an agrarian economy is the result of the interactions among environmental, social, and economic factors—it cannot be explained as simply a causal relationship. This article analyzes the village of Houjiaying in eastern Hebei province to show how interactions among the natural environment, social factors, political forces, and economic conditions shaped the village's development path. Before 1949, in consideration of Houjiaying's natural constraints—sandy loam soil, a high level of underground water, and a poor irrigation infrastructure—sorghum, which requires little irrigation and is drought tolerant, was planted as the staple crop. During the collectivization period (1950s–1970s), improvement in water conservancy and drainage alleviated some of the constraints imposed by the natural environment. However, additional labor input was needed to achieve a smooth transition to growing different crops. Since China's reform and opening up (1978), the planting of water-intensive crops and rapid urbanization have led to sinking water tables in North China. Houjiaying has been especially affected since its soil is sandy loam. This, combined with the rising costs of labor resulting from competition with work outside agriculture, has not only restricted Houjiaying's transformation from "old farming" to "new agriculture," but has also led to the rapid, although not complete, decline of crop farming and the "forced" development of a risky livestock industry.

Keywords
natural environment, interaction, sandy loam, irrigation system, agricultural development

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摘要
气候、地形、水利等自然环境影响和支配着农村发展和农民生活，同时，社会经济的发展也作用于、改变着当地的自然环境条件。农业经济是在自然、社会、经济等多种因素的互动下不断发展的，而非简单的因果关系可以解释。本文以侯家营为例，纳入其自然环境约束，探讨自然、社会、政治、经济等各种因素的互动如何影响该村的农业发展路径。解放前，沙壤土质、地下水位高、缺乏灌溉等自然环境约束导致侯家营村民依赖耐涝、低灌溉需要的高粱种植来满足生存需要；集体化时期，农田水利建设一定程度上缓解了自然环境条件的制约，但也必须投入更多劳动力才能实现作物的顺利改种；改革开放以后，高灌溉需求的作物种植和城镇化发展导致华北地下水位下降，侯家营因沙壤土质受影响明显，加之非农就业引致劳动力成本上升，不仅制约了其从“旧农业”到“新农业”的转型，而且在种植业内部也发生了迅速而不彻底的退出，“被迫”从事的养殖业发展曲折、投机性很强。

关键词
自然环境、互动、沙壤土、水利、农业发展路径

The Natural Environment, Society, and the Economy

With the introduction of agriculture, human beings became especially dependent on, and restricted by, the natural environment and natural resources. However, there has been a tendency to exaggerate the influence of the natural environment (Zheng, 2002: 9). Once dominating the field of geography, the idea of “environmental determinism”—that the geographic environment has a determinative impact on society—has developed through various stages: first, it emphasized that natural conditions exercise a determinative influence on humans (both physically and psychologically) and on society; next, that the natural environment determines productivity; and finally, that the geographic environment determines social change. Although claims about the environment’s determinative influence gradually narrowed in scope as the theory developed, environmental determinism still maintains that the environment has a determinative influence on society. However, as opponents of this theory, such as Vidal de la Blache and J. Brunhes, have argued, “the natural environment is not the sole factor that plays a role in the human-environment relationship, there is also room for free human activity” (Song, 1991: 6). Social and historical processes are subject to contingency and fortuitousness. They are, in other words, processes that cannot be explained by the simple cause-effect thinking behind environmental determinism (Hao, 1990: 5, 8).

In the era of industrialization, technological advances and increases in productivity greatly strengthened humans’ influence over the natural environment. This led to the idea, which gradually came to be hegemonic, that man can conquer nature. In such an atmosphere, people tended to consciously or unconsciously separate human society from nature, and often denied natural laws, misused natural resources, and destroyed the environment. In social and economic analyses, the natural environment is frequently treated as a backdrop to historical development or as an external condition.

Any analysis would be incomplete, limited, or even further from the truth if the influence of the natural environment on society and the economy were totally ignored. However, overemphasizing the role of the natural environment neglects humans' subjective actions. According to modern ecological principles, "Humans have continuously interacted with natural systems, resulting in the formation and development of coupled human and natural systems" (Liu et al., 2007: 639). Humans are members of the Earth's biosphere, their activities are based on the Earth's biosphere system, and their socioeconomic systems are a subsystem of the Earth's biosphere system. Natural resources not only play a role in economic activities as material elements, but economic activities themselves take place in the nexus of human systems and nature as a whole (Liu et al., 2007; Wu, 1991: 4). Environmental history, established on the basis of modern principles of ecology, analyzes the relationship and interactions between humans/society and nature/environment, "returning humankind to nature, and making nature a part of history" (Li, 2006). Philip Huang's classic study of the peasant economy in North China, which analyzed the ecology of the lowland areas of Hebei and northwestern Shandong, and the interrelationships between the natural environment and the sociopolitical economy, is considered to be the first work to have promoted and practiced ecological analysis (Wang, 2013: 67; Xia, 2004: 2).

As mentioned above, agriculture as an industry tightly combines nature and society, and involves the most complicated interactions between nature and society. As Philip Huang put it, "the historian studying the people of an agrarian society can ill afford to overlook these features (climate, topography, water and the like), for the natural environment is what shapes the life and orders the day of the peasant. A rural social history needs to begin with a consideration of the interrelationship between the natural environment and the sociopolitical economy" (Huang, 1985: 53). Scholars such as Xia Mingfang (2005), Wang Jian'ge (2009), and Wang Daren (2013) have pointed to the importance of ecological-economic analysis that combines multiple dimensions. They have also provided studies of China's rural economy that apply these methods.

The environmental-historical method is applicable not only to the analysis of social and economic history, but also to the analysis of a modern agrarian economy. It is widely accepted that China's agrarian economy is experiencing a profound capitalization/modernization transformation, whether viewed from the perspective of productive forces, which defines "capitalization" of agriculture as the increase of capital inputs per unit labor (Huang and Peng, 2007; Huang, 2010a), or from the perspective of production relations, which takes capitalist relations of wage labor as the yardstick for measuring whether an economy is capitalized or not (Zhang and Donaldson, 2008). With inputs of capital, large-scale farms have emerged, animal husbandry is developing and improving, and some peasants have begun to plant capital-labor dual intensifying crops, such as tented vegetables, instead of staple food crops (Huang Zongzhi, 2007; Gao, 2011). There have been many micro-level observations of this agrarian transition, including a comparison

of the economic benefits of different agrarian entities (He, 2013), an analysis of the mechanisms behind these formations (Chen, 2013), and a social benefit analysis (Gui, 2013), and also studies focused not on production, but on the circulation of agricultural products, along with the rural social divisions caused (or potentially caused) by an inflow of capital into the village (Zhang Qian, 2013). All these social and economic analyses are informative, valuable, and enlightening.

Peasants in Houjiaying village, where I conducted my field research, however, have been excluded from this great transition and instead are experiencing unstable development. They live a relative poor life, relying on three main sources of income: traditional crops, off-farm employment, and special animal husbandry. At the same time, peasants in Jingerzhuang village, only 2 kilometers away, are getting rich by planting vegetables and have successfully achieved the transition from "old farming" to "new agriculture." Why are people who live only 2 kilometers apart experiencing totally different development paths? Why did villagers of Houjiaying choose the speculative and risky livestock industry, rather than transition to "new agriculture"? An analysis of Houjiaying's development path over the past eighty years shows that its natural environment was not constant, but rather changed with sociopolitical development. In turn, the changing natural environment impeded local socioeconomic development, and, combined with other social and economic factors, influenced the possible paths of rural development. Changes in the natural environment usually take a long time and as such scholars typically treat the natural environment as an exogenous variable or a constant in social or economic analysis. However, because of rapid development and the rural economic transition, the environment in China is an observable and changing variable. This article analyzes the interactions between nature and the social economy by applying ecological-economic methods, and reveals a way to understand the reality of the development of Houjiaying village in its different stages.

Since this article is based only on one case study, critics may contend that it is unrepresentative. However, as Robert K. Yin has pointed out, although case studies are based on existing theories, they often reveal significant principles through empirical cases (Yin, 2003: 32–33). The representativeness of a case study itself is totally different from the representativeness of the characteristics of that case study (Gobo, 2004: 452). This article, based on a study of Houjiaying village, uses field research materials, the surveys conducted around 1940 by the Japanese South Manchuria Railway (known as the Mantetsu surveys), and town and village statistical yearbooks to discuss how the interactions among natural, social, political, and economic factors influenced the development path of Houjiaying.

The Natural Environment of Houjiaying

As a rule, the constraints imposed by a village's natural environmental consist of its topography, soil, climate, and so on. Topography and soil are the basis for raising crops; soil types and soil conditions determine the range of species of crops that

Table 1. Natural Disasters in Houjiaying after 1949

Year	Affected area(mu)	Inundated area(mu)	Waterlogging	Drought	Hailstorms	Details
1968						Drought
1969	1,820	500	1,330			
1970	450	200	200			
1972						Crippling drought
1973						Drought in the spring, waterlogging in the fall
1975		300		300		
1976		370				
1977	2,380	2,282	2,282			
1978						Crippling waterlogging
1979	100			100		
1980	550			550		
1981	840	840		840		
1982	600	600		600		
1983	420	420		420		
1986	900	800	800			
1988	200		100		100	
1989	1,400	1,400		1,400		

Source: Zhang Si, 2010: 91.
Note: The figures in the Waterlogging, Drought, and Hailstorms columns are the number of mu affected.

can be grown; and the local climate and possible natural disasters affect agricultural production.

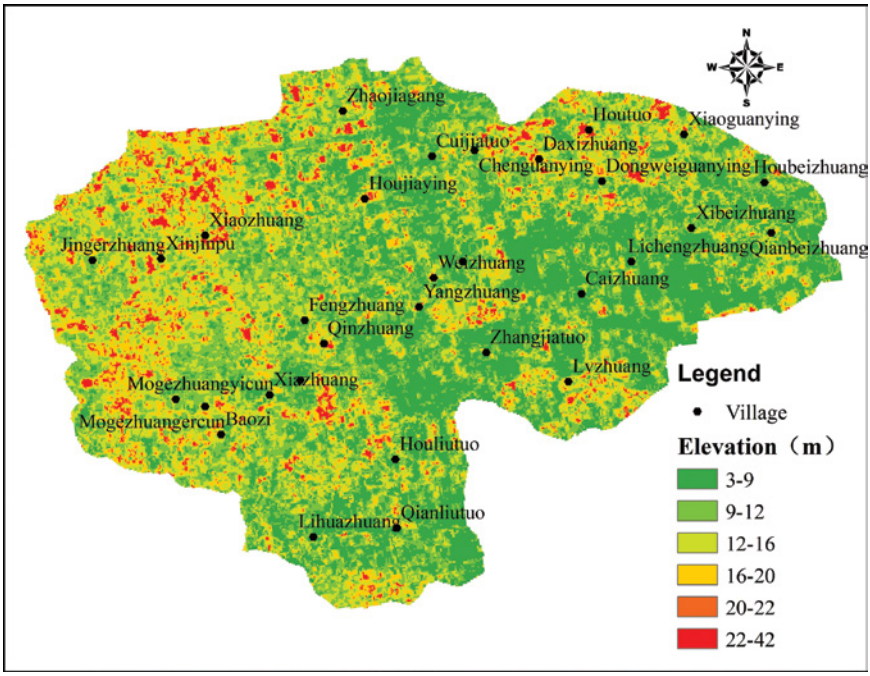
Since 1949 Houjiaying has suffered from three main types of natural disasters: waterlogging, drought, and hailstorms (see Table 1). Waterlogging and drought in particular have had a significant impact on agricultural production, whereas hailstorms occurred only once between 1968 to 1988 and did not cause large losses (Zhang Si, 2010: 91).[2]

[2] Zhang Si's team collected a large amount of local government and village archives, and did fieldwork in Houjiaying village many times, in the process acquiring valuable field research materials. The book that resulted from their research (Zhang Si, 2010) provides a wealth of photos of old records, statistical data, and interview records. Some of statistical data in this article are quoted from this book.

Waterlogging and drought, and the losses they cause, are essentially a reflection of the soil conditions and the irrigation infrastructure. Soil, of which there are many types, is formed through a very long and slow process. Once soil is formed, it is virtually impossible to convert it into another type except in places where there is serious soil erosion. Conversely, since irrigation systems are built by humans to control, regulate, utilize, and protect water resources, to mitigate or avoid waterlogging and drought, and to satisfy the needs of humans, the scale and technology of irrigation infrastructure can be significantly different in different periods or under different social and economic conditions. Hence, the natural environmental constraints facing Houjiaying, which is located on a plain, are two: the nature of its soil, and the ecological environment created by the local irrigation infrastructure.

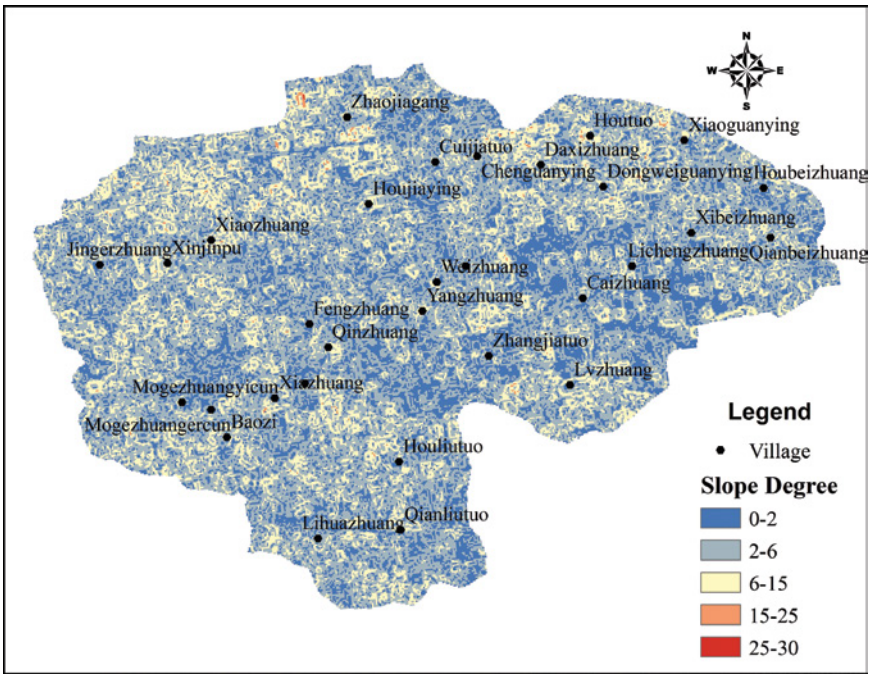
Changli county, where Houjiaying is located, faces the Bohai Sea on the east, and it is at a low elevation. Due to the short distance to the sea, the soil there is subject to desertification and the water table is high. Topographically, Nijingzhen, which encompasses Houjiaying, is high in the west and low in the east, with an average elevation of 12.3 m above sea level. More than 80 percent of the land of Nijingzhen has a gentle slope of less than 6 degrees; the average slope is 3.7 degrees (see Figures 1, 2, and 3). Generally speaking, the further east one goes in Nijingzhen,

Figure 1. Elevation of Nijingzhen



Source: Data Sharing Infrastructure of Earth System Science, www.geodata.cn.

Figure 2. Slope of Nijingzhen



Source: Data Sharing Infrastructure of Earth System Science, www.geodata.cn.

Figure 3. Slope Distribution of Nijingzhen

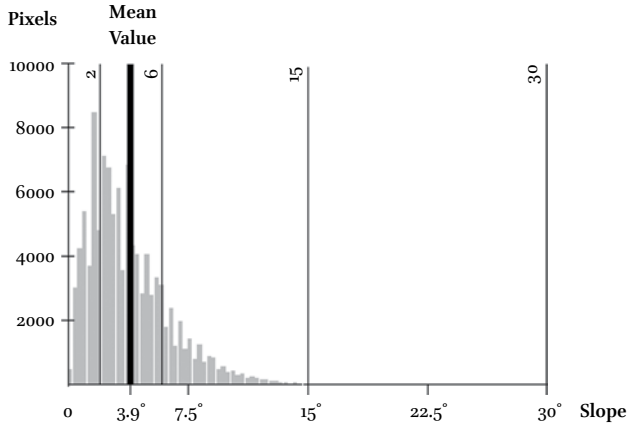
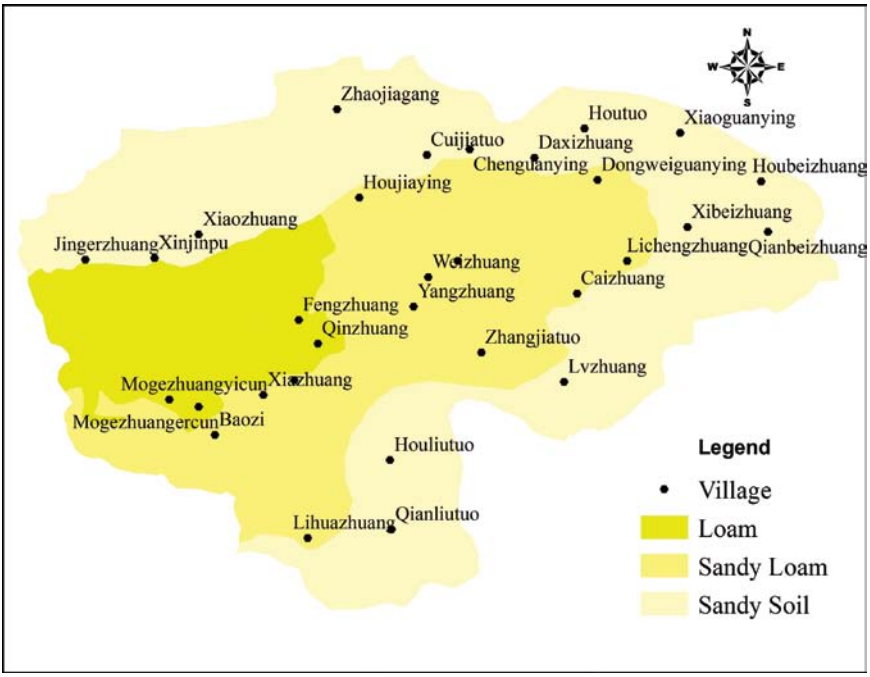


Figure 4. Soil Types in Nijingzhen



Source: Field research with Landsat TM Remote Sensing Image Interpretation.

the higher the sand content of the soil. The soil of Nijingzhen in terms of its sand content as one moves from east to west consists of the following types: sandy soil, sandy loam, and loam. In addition, the Luan River, which once flowed through the area, changed course about a hundred and thirty years ago, leaving sandy soil in the northern part of Nijingzhen. Figure 4 shows the distribution of the sand content of the soil in Nijingzhen. The higher the content of sand, the lower the ability of the soil to conserve soil moisture, and the lower its fertility, and the greater its susceptibility to salinization. Hence, in eastern Nijingzhen, it is hard for gramineous crops with shallow roots to survive while it is much easier for woody plants. On the contrary, the westernmost area of Nijingzhen has high-quality loam soil, which means that peasants living there can plant just about any crop they like. The soil in the middle of Nijingzhen contains some sand, but it is still suitable for gramineous crops if more labor and fertilizer are utilized to conquer the problem of low fertility. As a result, agriculture in Nijingzhen today demonstrates a sharp regional difference: "vegetables to the west, fruit to the east, and livestock farming in the middle."

In Houjiaying, most of the soil is sandy loam, although soil in the northernmost area, through which the Luan River once coursed, is sandy. Farmland in this village

is uneven, with little change in gradient and poor drainage, making irrigation difficult. Sometimes, some plots of land are too wet while others are too dry. Due to the combination of sandy loam, weak conservation of soil moisture, flat topography, and poor drainage, Houjiaying village is greatly affected by rainfall and the level of the ground water—it is prone to both waterlogging and drought. Due to the high water table resulting from the proximity to the sea and the flat topography, this village is susceptible to flooding after heavy rains. But, since the soil in this area is sandy and has such a poor capacity to retain water, it is also susceptible to drought. In addition, the salts in the shallow groundwater rise by capillary action and accumulate in poorly drained soil, decreasing its fertility. Finally, there is a stretch of unproductive alkaline land in the northernmost reaches of Houjiaying village.

The Path of Agricultural Development in Houjiaying

Pre-1949: Planting Flood-Resistant and Drought-Tolerant Sorghum

As indicated above, most of the land in Houjiaying village is sandy loam and has little gradient and suffers from poor conservation of soil moisture and poor drainage. Part of the land is low-lying and easily waterlogged but also subject to drought. Since the water table was relatively high before 1949, waterlogging occurred whenever it rained heavily. Philip Huang noted this in his study of the agrarian economy of North China: in the years from 1917 through 1941 Houjiaying experienced an "average of a major flood every four years" (Huang, 1985: 213, Table 12.5).

Huang also noted that irrigation in North China "was very much a matter of individual enterprise, involving thousands of small wells" (Huang, 1985: 55–56). According to a study by Sun Jingzhi published in 1957 and cited by Huang, "before the Revolution, only some 7 percent of the total cultivated area in Hebei and less than 3 percent in Shandong was irrigated; and almost all of this was by wells (80 percent in Hebei, 90 percent in Shandong)" (Huang, 1985: 56). Eastern Hebei, where Houjiaying is located, was the most poorly irrigated area. The Mantetsu surveys show that at that time (1936–1940), there were only eight wells in Houjiaying, four of them private and four public. Compared to the village of Sibeichai in southern Hebei with its 80 wells, and Lengshuigou on the piedmont plain in northwest Shandong with its 50 wells, Houjiaying village was obviously poorly endowed (Huang, 1985: 57, Table 3.1).

The easily waterlogged and poorly irrigated land led the peasants of Houjiaying to grow sorghum, a flood-resistant and drought-tolerate crop. Before the collectivization era, according to Hou Dayi,[3] a villager of Houjiaying and past village head, the main crops in Houjiaying village were sorghum, millet, and soybeans. This is consistent with the Mantetsu records, which show that before 1949 the staple crops in Houjiaying were sorghum, rye, and soybeans, while the non-staple plants were

[3] Hou Dayi has a good knowledge of the development of Houjiaying village.

millet, cotton, peanuts, buckwheat, and sweat potatoes (Chūgoku nōson chōsa kankōkai, 1981 [1952]; Zhang Si, 2010: 77). Sorghum was the villagers' staple food.

Because of the high water table and recurrent waterlogging, the land of Houjiaying was highly alkaline and unproductive. According to the Mantetsu surveys, "the average yields of sorghum or wheat here [Houjiaying village] were only two *dou* per mu, compared with four *dou* for wheat and six for sorghum in nearby Michang" (Huang, 1985: 271). Pressured by low agricultural productivity, some villagers went to Northeast China to try to make a living; some of them indeed got rich and were able to add to their landholdings and became leading households or landlords, such as Hou Qingchang, who added 153 mu of land, and Hou Baolian and his brother, who added 70 mu of land to their family's original land. Villagers who chose to stay behind worked as tenants, hired workers, apprentices, coolies, vendors or village teachers (Wu, 2007: 75). The community of Houjiaying had thus become socially stratified. According to Huang's computations, there was one resident landlord and four managerial farmers in Houjiaying village, 53.4 percent of farm households were owner peasants, and 46.6 percent were tenants or part-tenants, and 12.1 percent of the cultivated land was rented (Huang, 1985: 319, Table A.6). Responding to the heightened instability caused by frequent natural and man-made disasters, landlords preferred fixed rents to sharecropping. Furthermore, fixed rents, a simpler form of rental, were demanded as many villagers worked far away from home. Thus, fixed rents replaced sharecropping as the major form of land rent in Houjiaying as early as the 1890s (Huang, 1985: 203–14, 272).

The Collectivization Period: Planting Labor-Intensive Maize and Wheat

During the collectivization period, Houjiaying village's ability to cope with drought and waterlogging was enhanced. "In the early days of collectivization, there were no wells in the village. As a result, when there was a drought, villagers had to carry water to the fields and suffered heavy losses" (Zhang Si, 2010: 92). This situation remained unchanged until 1965, when the first pumping well was dug. At the same time, in order to reduce the losses caused by waterlogging, villagers were assembled and organized annually to dig, without pay, ditches and drain the water. This helped increase productivity, even though waterlogging and floods could not be entirely overcome. According to Zhang Si, the number of Houjiaying's pumping and drainage facilities peaked around the year 1980 (Zhang Si, 2010: 92–93).

In addition to improving irrigation and drainage, villagers practiced deep plowing and land leveling (Zhang Si, 2010: 99). Both of these played an important role in reducing soil salinity and alkalinity. Furthermore, falling water tables also reduced the likelihood of salinization and alkalization, and also contributed to the improvement of the soil and an increase in productivity. Land leveling included two operations. One was moving soil from relatively high plots to low plots and then digging drainage ditches. In this way, 750 mu of land was transformed into

platform fields and strip fields by the end of the 1980s. The other operation involved changing the direction of the field ridges that ran east-to-west into a north-south orientation in order maximize the sunlight falling on the crops. Villagers put a great deal of labor into this work. However, since Houjiaying is high in the east and low in the west, orienting fields north-to-south is not conducive to drainage, with the result that the reorientation caused waterlogging and a decline in output. Therefore, the direction of the field ridges was changed back to the old east-west orientation a year later (Zhang Si, 2010: 98–99).

Collectivization helped alleviated the restrictions imposed by the natural environment, but it also set new restrictions on what crops could be planted. In line with the national production plan, villagers had to plant maize, wheat, dry rice, and sorghum instead of the local traditional crops. This is confirmed by the Changli county gazetteer (Changli xian, 1992: 234), which noted that after 1949, with the construction of irrigation and drainage facilities and the improvement of agricultural technology, staple crops in Changli county were changed to maize, wheat, and dry rice; non-staple crops were changed to cotton, peanuts, and vegetables. "Sorghum had been planted on private plots until the 1970s when sorghum was still the staple food for the villagers," Hou Dayi recalled, "but the ears of sorghum were consumed by pests since their predators—sparrows—were killed in great numbers during the movement to 'wipe out pests' in the collectivized years. Besides, rice tastes better than sorghum. So, less and less of land was devoted to sorghum." Today, sorghum is all but extinct in Houjiaying. Since "conditions in Houjiaying are not suitable for paddy rice although there is ample sunshine and plenty of rain" (Zhang Si, 2010: 85), rice in Houjiaying was rain-fed japonica and, in any case, only made up a small portion of the staple crops. The planting of cotton—for which records exist for twenty-one years (1957–1978)—as a non-staple crop fluctuated greatly as did the income it generated since it requires relatively more work, much more careful cultivation management, and the introduction of improved varieties. This record is consistent with Tajima Toshio's observation that cotton planting is easily affected by the production of food crops and lacks operational stability (Tajima, 1998: 158). Vegetables were planted on a small scale as secondary crops to meet villagers' own needs.

Wheat and maize, the new staple corps, were more labor intensive than sorghum. The supply of labor was ensured by the policy, promulgated during the collectivization period, that villagers had to stay within the villages and concentrate on agriculture. They were forbidden from leaving and working outside. Only villagers with a poor or middle-peasant background, or those who had a needed skill, or "village bullies" could get the necessary recommendations from the production teams and production brigades to work outside (Zhang Si, 2010: 130–31). With the intensive input of labor and the use of both chemical fertilizers and farmyard manure, the production of wheat and maize of Houjiaying was maintained at a relatively stable level.

Post-Reform: Maize-Wheat Rotation, Livestock Breeding, and Off-Farm Employment

With the implementation of the household responsibility system, "pumping wells built in the collectivization period were distributed to the households; the drainage ditches were filled up and turned back into farmland; the levees were destroyed and could no longer provide flood relief and flood control. The low-lying land in the village was easily waterlogged after a heavy rain" (Zhang Si, 2010: 92–93). Moreover, Houjiaying's soil was losing its fertility because of a lack of deep plowing and desalination measures. Although maize and wheat were still cultivated, after 1980, peasants changed the rotation order into maize–winter wheat in one year followed by peanuts–winter wheat in the next year, since the soil couldn't provide enough nutrients to raise maize every year. In the 1990s, agriculture became mechanized and, in North China, there was widespread adoption of combine harvesters, which tended to lock in this pattern of crop rotation.

Land was also allotted to households and nationwide people began to move out of agriculture into industry. Some of them worked in the cities, in the "leave the land and the village" pattern, and others were employed in nearby township and village enterprises, in the "leave the land but not the village" pattern. Villagers in Houjiaying preferred the second pattern, with most of them working in construction or as carpenters or the like within Changli county or Nijingzhen.

Other villagers took up livestock breeding. Before the use of agricultural machinery, draft-animals were important in agricultural production. In 1949, the peasants of Houjiaying had seventeen oxen and one donkey, all of which were shared.[4] In the 1980s, the villagers began to farm other animals, such as hogs, chickens, ducks, and goats. The breeding of these animals, however, flourished for just a short time. Since animal breeding was very subject to market fluctuations and peasants didn't have enough money to deal with periodic and sudden price fluctuations, whenever the price fell, some peasants had a difficult time making ends meet. As a result, the development of animal breeding in Houjiaying village died down after a short period of prosperity.

In the New Century: Giving up Wheat and Developing Special Breeding

After the turn of the century, irrigation and drainage conditions in Houjiaying became even worse and irrigation costs continued to rise. In the first place, irrigation and drainage became private goods after the marketization of the irrigation and drainage system. The traditional collective irrigation system was replaced by

[4] In rural North China, peasants created many forms of mutual assistance, such as *dadao* 搭套, *banggong* 帮工, *huangong* 换工, *jieyong* 借用, raising draft animals together, and hiring laborers together. In *datao*, for instance, villagers share their draft animals, farm tools, and labor (see Zhang Si, 2003).

individual irrigation wells. As in D town, Hubei, studied by Guo Liang (2011), in Houjiaying and Nijingzhen the demand for pumping wells was huge, far exceeding the supply. A third of the wells constructed after 2000 were privately owned.[5] Furthermore, the organizational foundation of the system for construction irrigation and drainage facilities changed with the abolishment of agricultural taxes (He, 2011; Guo, 2011: 40–42). Township-level leaders came to pay more attention to attracting investment than to agricultural production; village-level leaders were also less focused on village affairs since their salaries were in effect paid by the national government.[6] They no longer needed to set aside some funds from the agricultural taxes to cover the village's expenses.[7] All this contributed to the gradual weakening of the concept of the village as a collective.

Although the Houjiaying village committee tried to expand the irrigation system, the high demand for irrigation, caused by the poor water storage capacity of the soil, was far from being satisfied. Taking advantage of some collective land located next to the provincial road, the village committee leased about 100 mu of the land (during the second round of land contracting the villagers had agreed that only about 100 mu of land would still be collectively owned) to an enterprise for 700 yuan per mu a year. But the business very nearly failed, causing the village committee to take back 60 mu of the land and allocate it to the villagers. With the limited rent, the village committee could afford to build only five pumping wells—each at a cost of 3,000 yuan—a year. The high demand for wells resulted from the poor water storage capacity of the soil and damage suffered by the old wells. The solution was for individual peasants to sink private wells, and, as noted earlier, about a third of the new wells in the village were privately owned. Even after the demand for wells had been satisfied, peasants also needed to solve the problem of the need for frequent irrigation caused by the poor water-retention capacity of the soil. Hence, for the villagers of Houjiaying, irrigation costs consist of three parts: the construction of the wells, the costs of operating the wells (e.g., the cost of electricity), and the opportunity costs of labor incurred by frequently irrigation.

Moreover, because of the increasing demand for irrigation water caused by the expansion of the area under irrigation and the switch of crops, and the

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[5] Interview of Liu Zhifa, village party secretary of Houjiaying, in September 2014 and May 2015.

[6] Before the abolishment of agricultural taxes, in order to encourage the village leaders to assist in the collection of agricultural taxes, they were allowed to set aside part of the taxes as funds for village activities.

[7] In 2009, the General Office of the CCP Central Committee and the General Office of the State Council issued "Opinions on Improving the Village Organization Operating Funds Guarantee Mechanism to Promote the Construction of Village Organizations," which clarified the guiding principles, targets, fundamental principles and policy measures of the mechanism for guaranteeing village operating funds, and suggested that the salaries of village leaders, office expenditures, and other expenditures should be an important content of guarantee. Subsidies are to be paid by the central government. In Houjiaying village, the salary of the village party secretary and village head is 9,000 yuan a year, and that of the village deputy secretary, accountant, and director of the Women's Federation is 4,500 yuan a year.

greater demand for drinking water and industrial water attendant on rapid urbanization, underground water in North China has been seriously over-exploited and the water table has been sinking. According to a report on People's Daily Online,

> Since the founding of the PRC in 1949, the underground water in North China has been over-exploited, with about 130 billion cubic meters of such water being consumed, leading to the largest area of depression in underground water worldwide, with a shallow groundwater cone of depression of over 20,000 square kilometers and an 70,000 square kilometer (accounting for around 50 percent of the total area of North China Plain) deep underground water cone of depression. (People's Daily Online, 2014; see also Boxun News, 2010)

Since its soil does not retain water, Houjiaying village has been so greatly affected by the sinking of the water table that there has been a dramatic change from an average of a flood every ten years before the 1980s, to an average of nine droughts every ten years after the 1980s. Thus, Houjiaying's villagers have needed to irrigate more but they have also faced higher irrigation costs even if they plant the same crops as peasants in other villages.

These natural constraints have foreclosed the possibility of Houjiaying's villagers, unlike peasants in neighboring villages, earning a good, steady income by raising vegetables. To increase peasants' income, the government of Nijingzhen has invested in the construction of a tented vegetable demonstration area of 150 mu, located in Xinjinpu village, one kilometer away from Houjiaying, and has made vegetable planting the major industry in western Nijingzhen (Qiang, 2013).[8] For example, in Jingerzhuang village, located in western Nijingzhen, 2 kilometers from Houjiaying, vegetable cultivation started in the 1980s and developed smoothly. Per capita annual income in Jingerzhuang is 15,000 to 20,000 yuan, two or three times that of Houjiaying. Vegetables produced in Nijingzhen are sold through brokers, who are "capable people" 能人 with good connections both within the village and beyond. A single broker is able to handle the vegetable output of two villages. In Nijingzhen, almost all vegetables are sold in this way. Even with the policy support of the local government, technical support, and marketing channels in neighboring villages that have a close relationship with Houjiaying, villagers of Houjiaying still have not been able to develop vegetable planting and make it their main line. The reason is simply that the soil in Houjiaying village is unsuitable for vegetables. Since Houjiaying's soil doesn't retain water, if peasants were to plant vegetables, which need more water than maize, peanuts, and other crops, more irrigation would be required and much higher costs would inevitably follow. The futility of trying to raise vegetables in this environment is illustrated by what happened to an ambitious villager in Jingerzhuang who was unable to find land in Jingerzhuang to lease even though rents had soared to 1,000 yuan per mu a year. His solution

[8] Qiang Zhenyong is the head of Nijingzhen. This material was acquired from Qiang during my first field research trip.

was to rent 50 mu of collective land at 700 yuan per mu a year from the Houjiaying village committee. He was very experienced in growing and managing vegetables, yet, the high cost of irrigation and the poor yield that resulted from the poor water retention and poor productivity of the soil, and the high cost of labor and high supervisory cost of managing laborers of Houjiaying village, led to him loosing all the money he had invested in this project. Thus, it makes sense that the villagers of Houjiaying devoted their surplus labor and capital to animal farming, even though it is risky, rather than raising vegetables, not because they lacked the needed technology, information, marketing channels, or policy support, nor because they lacked labor or capital, but because they lacked an irreplaceable factor—high-quality soil.

Therefore, for a time Houjiaying's villagers concentrated on animal farming even though it meant they had to face more risks and more volatility. After 2000, the raccoon, fox, and mink had replaced common livestock, such as chickens, hogs, and oxen, as the main species farmed.[9] Raccoons and foxes are easy to maintain, requiring no more than roughage and little attention. The mink, on the other, is relatively difficult to raise, requiring high technology and a better environment. But mink brings the villagers a higher income. At first, there were only a few households that farmed raccoons and sold the fur, which was exported to South Korea and Russia. The price of fur jumped one and a half times between 2004 to 2006, the so-called prime time for fur animal farming, and the scale of animal farming in Houjiaying peaked. At the end of 2005, there were five households raising minks (100 in stock, 550 slaughters), eighty raising raccoons (2,400 in stock, 6,100 slaughters), and thirty raising foxes (400 in stock, 1,190 slaughters). At the end of 2007, more than 60 percent of Houjiaying's households were farming special animals (Zhang Si, 2010: 164). All the above data illustrate that the animal farming industry in Houjiaying was booming. After 2007, however, the demand in South Korea and Russia for low-quality furs declined, and the domestic supply outstripped the demand, leading to a sharp fall in prices, inflicting large losses on farmers, many of whom even quit farming fur animals. At the end of May 2015, when I conducted my second investigation in Houjiaying, 150 households were still farming raccoons, foxes, and minks but on a small scale, and almost all had to buy animal feed on credit. In 2014, the earliest and largest farmer raising minks lost heavily and quit farming since the price of one mink fur plunged from 550 yuan to 60 yuan.

The Practical Logic of Agricultural Development under the Constraints of the Natural Environment

The above description and analysis of Houjiaying's agricultural development path over the past eighty years shows that natural constraints consist not only of

[9] According to Zhang Si (2010), the farming of raccoons started toward the end of 1980s (table 4.13 on p. 169 shows that Hou Zhigui and Hou Ligang were farming raccoons at that time). Many households, however, were not involved in the farming of special animals until late in the 1990s or the start of the 2000s.

unchanging factors, but also changing factors influenced by socioeconomic development. The village's sandy loam, with its poor capacity for water retention and its susceptibility to flooding and drought, is the unchanging baseline. The rapidly sinking water table in North China and the massive improvements in irrigation infrastructure, by contrast, are the factors that have changed.

Houjiaying, like other villages in North China, is a microcosmic unit whose development is deeply influenced by political, social, and economic factors. Like most other villages, Houjiaying has experienced several development phases: before 1949, to make a living, villagers had to farm the land and also work as hired laborers; in the collectivization period, land was cultivated collectively and villagers were forbidden to travel outside to work; in the post-reform era, villagers started working outside and non-agricultural work became their major source of income but they still could not give up farming entirely. In all these phases, especially after the 1980s, local government leaders and village heads played an important role in the village's development.

Although social and political factors play a leading role in agricultural development, a village's development path is a result of the interactions of many factors. Natural conditions, the foundation of agricultural development, have a significant impact on the planting of crops and an indirect effect on animal husbandry and off-farm employment. They also influence a village's direction of developmental, economic path, and internal relationships. This argument, however, does not lead to the conclusion that the natural environment is decisive in agricultural development and this article is not argument in favor of "environmental determinism." Socioeconomic development also affects the natural environment. What is involved is not a simple causal relationship, but rather an interaction as both cause and affect. By analyzing the mutual impact of these two factors, the development path of local agricultural can be more easily understood. Because of its sandy loam soil, Houjiaying is significantly influenced by natural conditions (such as the level of ground water) and social and political factors (such as irrigation construction), and the interactions between natural, social, and political factors. It is the influence of the latter that is more significant and observable. This interactive process and its impact on agricultural production and internal social stratification of Houjiaying, and the constraints imposed by its natural environment, are summarized in Table 2.

Since it is poor at retaining water, the soil of Houjiaying village is susceptible to waterlogging, alkalization, and degradation when the ground water level is high. Conversely, when the water table is low, it is susceptible to drought, leading to a high demand for irrigation facilities. Thus, before 1949, sorghum, which is flood resistant and drought tolerant and has a stable output, was the staple crop in Houjiaying. But output was so low that only half of Houjiaying's villagers could make a living on their own land; the other half had to find additional sources of income: some went to Northeastern China to work and few of them became landlords, but great majority were tenants or part-tenants or worked as agricultural

laborers. The amount of land owned by households was the main indicator of social stratification.

In the collectivization period, political changes led to the reconstruction of the natural environment, a change of the crops that were planted, and labor coming under the control of the collective. Against this background, communes and brigades had the ability to gather and direct the labor force to build wells and other irrigation facilities, to practice deep plowing, and to improve the soil, changing the natural environment consciously and actively. Although maize and wheat require more labor than sorghum, the shift to these crops was successful because sufficient manpower could be brought to bear and because there was a focus on the construction of irrigation facilities and related measures. At the same time, the policy that forbade villagers from leaving and working outside the village meant that manpower was bound within the village. Thus growing maize and wheat became the villagers' only source of income. They lived a relatively poor life until the 1980s.

After the implement of the "household contract responsibility system," especially after the year 2000, the interaction between the natural environment and agricultural economic development became more complicated. With de-collectivization, villagers began to leave the land and work in towns and big cities, hence the opportunity costs led to the adoption of mechanical planters, tractor-drawn plows, and combine harvesters. Because of urbanization and the expansion of land under irrigation, the water table in North China began drastically sinking. Combined with the marketization of the irrigation and drainage system that followed, there was a shortage of irrigation water, the cost of irrigation increased, and individuals had to invest into irrigation works themselves. Thus, in North China, irrigation became a bottleneck in agricultural development, and in Houjiaying village, where there was little conservation of soil water, conditions were even worse. Moreover, as township-level government had turned its attention to urbanization, villagers' sense of collective consciousness began to be crippled, and villages faced the issue of developing with little leadership and guidance. Houjiaying underwent several important changes. First, the sinking of the water table increased the need for irrigation to sustain traditional crops and denied villagers the opportunity to develop vegetable planting. Second, villagers turned to animal farming and off-farm work. Third, with the development of off-farm employment and the "privatization" of irrigation construction, the real and opportunity costs of maintaining and constructing irrigation facilities rose and led to the abandonment of wheat, which means there has been a partial exit from crop farming. Fourth, due to the sinking water table and the failure to maintain public irrigation facilities, the increase in the demand for irrigation led to the construction of private pumping wells, which in turn created an off-farm work opportunity—digging wells.[10] Fifth, villager households became socially stratified according to the number of off-farm laborers

[10] Digging wells was not the main source of income for Houjiaying villagers; it was only an option.

Table 2. The Constraints of the Natural Environment and Agricultural Development in Houjiaying, 1936–2015

		Before 1949	1950–1980	1980–2010	2010–2015
		Sandy loam soil			
Natural environmental constraints		High ground water level; average of a major flood every four years; unproductive alkaline land	Drought and waterlogging, with waterlogging predominating	Average of one flood every ten years	Average of nine droughts every ten years
Irrigation conditions		Three wells	20 pumping wells, and drainage ditches	About 40 collectively constructed pumping wells	60 pumping wells, 5 to 6 new wells per year, 1/3 constructed privately
Crop plants	Staples	Sorghum, rye, and soybean	Maize, wheat, rice, and sorghum	Maize and wheat	Maize
	Non-staples	Millet, cotton, peanut, buckwheat, and sweat potato	Cotton, peanut, and vegetables	Peanut and vegetables	Peanut
Labor & employment		Working in Northeastern China (some villagers got rich and became landlords); owners, tenants, laborers	Devoted into collective agricultural production (including irrigation construction and soil improvement)	Construction & transport workers, and self-employed business owners	Construction (including digging wells), transport workers, and self-employed business owners

Livestock species	Draft animals	Draft animals	Domestic animals and poultry	Raccoon, fox, and mink
Village economic conditions	Poor, 5 landlords, fixed rents	Poor, no social stratification	Relatively poor, unstable stratification between animal farmers and crop farmers	

Sources: 1) Soil condition of Houjiaying is from Data Sharing Infrastructure of Earth System Science, www2.geodata.cn.
2) Data before 1949: Chūgoku nōson chōsa kankōkai, 1981 [1952]; Huang Zongzhi, 1986: 55, 213–25, 280–81, 327; Zhang Si, 2010: 77; and interview records.
3) Data of 1950 to 1980: Changli xian difangzhi bianzuan weiyuanhui, 1992: 234; Zhang Si, 2010: 77–93, 99, 130–31; and interview records.
4) Data of 1980 to 2010: Zhang Si, 2010: 77–90; and interview records.
5) Data of 2010 to 2015: local investigation and interview records.

in the family and whether the family engaged in animal farming. But this stratification was unstable because special animal farming, a high-cost, high-risk endeavor with high entry barriers, is even more speculative and risky than livestock farming. Off-farm employment also contributed to stratification since off-farm income is dependent on the worker's education and skills. Here too Houjiaying was disadvantaged. Many rural schools have been closed and others have been consolidated. This comes on top of the nationwide imbalance in the allocation of education resources between urban and rural areas. Only one villager of Houjiaying graduated from college and only four or five graduated from high school. Most villagers receive no more than the compulsory education (ninth grade). Usually, these middle school graduates can get no better than low-paid jobs with few benefits (Huang Zongzhi, 2009).

Houjiaying's development pattern—a partial exit from crop farming + unstable animal farming + employment in the informal economy—is obviously not one that will lead to success. Per capita annual income is much lower in Houjiaying than in other, nearby villages. As Philip Huang has pointed out, workers in the informal economy generally are poorly paid, do not enjoy the protection of formal legal status, and receive few benefits. Since off-farm pay is generally inadequate for subsistence, the best most villagers can do is to both farm and work off the farm in the "half-worker half-cultivator" pattern (Huang Zongzhi, 2009; 2010a; 2010b; 2014). Moreover, the high risk of animal farming has also exacerbated instability. The low and unstable income structure has caused Houjiaying's villagers to rely more on faming and the cohesion of the family. Although irrigation costs increased sharply, and in response villagers gave up wheat in the short run, but they could not give up farming entirely since they had to survive. This is illustrated by the land-use pattern in Houjiaying: there was no land that had been abandoned nor any land that had changed hands except for the piece of collective land mentioned above.

Today township governments have shifted their attention from agricultural production to urbanization, village committees have lost their control over the villages after the cancellation of the agricultural taxes, and villagers lack effective leadership from government and the collective or capable people of the village. Houjiaying is stuck in a relatively poor and unstable situation, unable to find a route to sustainable development.

By contrast, since China's reform and opening up, and especially since 2000, villagers in Jingerzhuang and Xinjinpu have become wealthy and live a stable life by growing vegetables. This is a result of two factors. The first is that the soil in western Nijingzhen is loam, which has good water retention capacity; the other is that the village committees in these two villages, using the rents on collective land, have constructed many pumping wells, for an average of one well for every 50 mu (Interview with Zhu Weidong, Xinjinpu village head, May 2015). This has not only facilitated irrigation but has reduced the incidence of water disputes. The Xinjinpu village committee rented out 300 mu of collective land, most of it at a rent of 1,000

yuan per mu a year, and, since 2011, some land has been rented to the Nijingzhen government for 500 yuan per mu a year. Since Xinjinpu is a typical of vegetable-growing village, the Nijingzhen government rented some of its land and invested in the construction of vegetable greenhouses that were later rented to villagers at very low price. Hence, the Xinjinpu village committee has had enough money to construct irrigation and drainage facilities and to provide financial guarantees for vegetable planting (Interview with Zhu Weidong, May 2015). The low cost to individual households for irrigation is the key to the consistent development of vegetable cultivation in western Nijingzhen. Hence, although these villagers also need to deal with the sinking of the water table, its effect on agricultural development has been greatly reduced by the collectively constructed irrigation facilities. Even though the vegetable growers have to bear the cost of pumping wells, they consider the money well spent since, for them, the benefit from one pumping well is much greater than for peasants who raise traditional crops.

Some Further Thoughts

At the macro level, with the development of science and technology and the expansion of the population and social organization, the scope for human beings to reconstruct nature has become more and more extensive and ever more profound in its consequences. The belief that geography changes slower than the agricultural economy is unrealistic (Wang, 1992: 87). To analyze the agricultural economy without considering natural environmental factors makes it all too easy to mechanically transplant notions derived from industrial economic development to agriculture. The agricultural economy and industrial economy, however, are fundamentally different. The former is an organic economy, with a limited scope for expanding output; the later is an inorganic economy, with much more room for the increasing output through increasing inputs (Wrigley, 1988). Moreover, as Philip Huang has pointed out, agricultural development is a result of the combination of soil fertility 地力 and manpower 人力, and the factors that constrain development change as the man–land relationship changes. For China, with its "many people and little land," intensive farming based primarily on the experiences of the industrial economy is unsuitable (Huang Zongzhi, 2014: 1–8). If one views agricultural management merely in terms of scale, and worships whatever is large-scale and conforms to the Western experience, and if one thinks that the larger the scale the greater the degree of modernization, then this encourages large-scale industrialized agriculture, which can result in increased production costs and reduced efficiency in terms of per unit output. It can even lead to the phenomenon of "the government paying for and driving the emergence of large-scale wasteland, and the birth of a countryside that is non-rural, non-agricultural, and non-food-producing; exactly the opposite of the transformation of agricultural that is intended" (Zhu, 2015).

While the natural environment plays a large, but not dominant, role in agricultural development, there is still much room for the state and society to utilize and

reconstruct the natural environment. Through the construction of water management systems, society can adapt to and change the natural environment for agricultural production, which has been well illustrated by the drainage ditches and pumping wells constructed in the collectivization period. The guiding role local governments and village committees play in the adaption to the natural environment and the development of agriculture under some constraints is great and cannot be overlooked. In Jingerzhuang village, aside from the loam soil, the guidance from capable villagers and the support and investment by the county government also have played an important role in the village's smooth transition to capitalized agriculture (i.e., agriculture with increased capital inputs per unit of labor).

In Houjiaying, farming is and will continue to be an important part of the economy. Reducing irrigation costs is an urgent problem, no matter what crops will be cultivated. Reconstructing and maintaining public water infrastructure and making irrigation and drainage public goods once again could enhance the effectiveness of local irrigation and reduce its cost. Today, China's irrigation system suffers from the fact that "the central government has not been done anything about it, the collective can't manage it, the peasants themselves can't do anything, and the markets can't control it" 国家管不到、集体管不好、农民管不了、市场管不住 (Lin, 2011: 147–48). Clearly, the central government has noted the problem and focused its attention on water management in the 2011 No. 1 Central Document, which set the goal of improving the country's underdeveloped water conservancy works over the following five to ten years. A group of scholars represented by He Xuefeng have pointed out in a series of articles based on their investigations in Hubei that in order to solve the problems of China's water system, in addition to more investment, the reconstruction of the basic organizational units of irrigation is also needed (He and Guo, 2010; Guo, 2011; Lin, 2011; Gui, 2011). Crucially, in order to break the impasse in Houjiaying, the transition from raising grain in the "old-style agriculture" to capital-labor dual-intensifying "new-style agriculture" needs to be promoted. Switching to drought-tolerant cash crops is one way of accomplishing this. With the help of local government and the village committee or local capable people, villagers would be able to select and plant the cash crops that are suitable to local natural environment, such as medicinal herbs, which need little irrigation, and establish effective sales channels and form cooperatives, thereby realizing the vertical integration of agriculture and pursuing a positive and sustainable path of development. Among all the development factors, the establishment and maintenance of sales channels is the key to achieving the aforementioned objective. Houjiaying is conveniently situated next to a provincial road, and is nine kilometers from the county seat and one kilometer from the township seat. This geographical advantage makes for convenient access to sales channels.

Of course, Hebei is a major grain-producing province, and hence plays a crucial role in national food security. Any change to non-grain crops in Hebei would have

a significant impact on the country's grain supply. According to Carole Dalin and her colleagues (2015: 4589), "when [the] irrigated land area in both Inner Mongolia and the greater Beijing area [Beijing, Tianjin, and Hebei] is reduced by half . . . , national corn and wheat production decreases by only 4.3% and 4.5%," and "the decreases mainly concern corn (in Inner Mongolia and Hebei) and wheat (mostly in Hebei)."[11] For Hebei, however, saving water an urgently issue. In 2014, the Hebei Provincial Department of Agriculture launched a project in the region around the four cities of Hengshui, Cangzhou, Xingtai, and Handan in which 500 yuan grants were given to peasants who reduced the area sown in winter wheat and 148 yuan grants for peasants who planted water-saving varieties of winter wheat (Hebei Provincial Department of Agriculture, 2014). The Market Early Warning Expert Committee of the Ministry of Agriculture also pointed out that the constraints on agricultural resources and environment would lead to an adjustment of the production area and a reduction in the total area sown in wheat although yields would be increased (Market Early Warning Expert Committee, 2015). Hence, it appears the state would allow a switch to non-grain crops in Houjiaying. But this would also mean that Houjiaying would experience yet another transition in its development.

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[11] Regarding the "national corn and wheat production decreases by only 4.3% and 4.5%": the argument of Dalin et al. is that since Inner Mongolia and the greater Beijing area (Beijing, Tianjin, and Hebei) are suffering an increasingly severe water shortage, the 4.3% and 4.5% reductions in national maize and wheat production, respectively, are relatively small when viewed in light of the improvement in the efficiency of agriculture water resources and the reduction (14%) in the consumption of irrigation water across China.

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