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Production and Consumption of Staple Food Crops and the Separation of the Agricultural and Nonagricultural Sectors in China, 1952–2010: A Comparison with Japan, the United States, and South Korea

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20世纪中期以来中国粮食生产、消费与产业分工关系解读：基于Agr与Nagr表达式的分析——兼与日美韩相比较

郭爱民

Abstract
Correlative data from China, Japan, the United States, and South Korea show that since 1950, if the percentage of grain imported into a country is low, the growth of agricultural labor productivity is relatively high, which is the precondition for the separation (or further separation) between the agricultural and nonagricultural sectors. In China, agricultural labor productivity was low before the mid-1980s, a factor that contributed to rural poverty. Since the mid-1990s, however, the diet of the people of China has included a greater quantity of meat, eggs, and milk. At the same time, there has been a shortage of feed grain and the percentage of imported grain has begun to grow rapidly. If the proportion of imported grain continues to grow, the efficiency illusion that took place in Japan and South Korea will be repeated in China in the near future. Currently, China's agriculture is faced with a series of imminent tasks that include promoting agricultural science and technology, accelerating the substitution of feed grains, and making sure that there will be no further loss of arable land.

Keywords
agricultural labor productivity, consumption of grains, separation of sectors, lessons, dilemma, efficiency illusion

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摘要
20世纪中后期以来，中日美韩四国的数据表明，在粮食进口比重不大的情况下，农业劳动生产效率的大幅度提高是农业和非农产业分工（或分工进一步加强）的基础条件。在中国，1980年代中期之前，由于农业劳动生产效率较低，出现了长期的温饱问题和知青下乡问题。1990年代中期以来，在人们的饮食构成中，肉蛋奶数量趋高，饲料粮出现短缺，粮食进口比重快速增长。按照目前的趋势，如果粮食进口比重继续增长，在日韩出现的“效率假象”，将会在中国上演。进一步提高农业科技水平，加快饲料粮的替代，同时，确保18亿亩土地红线不被侵蚀，是中国农业面临的迫切任务。

关键词
农业劳动生产效率、粮食消费、产业分工、教训、困境、效率假象

Agricultural labor productivity is a measure of the output of an agricultural production unit (e.g., a single agricultural laborer or person) in a unit of time (e.g., a year). As early as the eighteenth century, classic economists emphasized the importance of greatly increasing agricultural labor productivity. François Quesnay, the founder of the physiocratic school, pointed out the crucial role of the grain produced within a country:

> The population increases in proportion to the increase of income from the fields. Some people create fortunes from plowing and growing, while others process [products from the field] so that they can be fit for enjoying. . . . For human beings and fortune to coexist, land, human beings, and fortune must first exist. . . . . In a country where there are only merchants and manufacturing, the common people cannot maintain their lives if they only depend on the income of land from other countries. (Quesnay, 1997: 85)

Later, Adam Smith absorbed the essence of the physiocratic school and stressed the function of agricultural labor productivity:

> When by improvement and cultivation of land, the labor of one family can provide food for two, the labor of half the society becomes sufficient to provide food for the whole. The other half, therefore, or at least the greater part of them, can be employed in providing other things, or in satisfying the other wants and fancies of mankind. (Smith, 1972: 157)

Smith realized that a rise in agricultural labor productivity is the basis for the separation of the agricultural and nonagricultural sectors.

Karl Marx also emphasized the importance of agricultural labor productivity: “An agricultural labor productivity exceeding the individual requirements of the laborer is the basis of all societies, and is above all the basis of capitalist production” (Marx, 1959: 766). Marx insisted that when all the labor of a portion of the people in society (necessary labor and surplus labor) can provide the necessary

food for all of society, including nonagricultural workers, then it becomes possible to separate laborers in the agricultural and nonagricultural sectors (Marx and Engels, 1974: 716). He also said that, foreign trade aside, it is obvious that the number of people employed in industry rests on the quantity of agricultural production that exceeds the needs of the agricultural laborers of society (Marx and Engels, 1972: 22). In light of Marx's theory, Pang Zhuoheng 庞卓恒, a Chinese scholar, presented a model to explain the separation of the agricultural and nonagricultural sectors:

$$\text{Agr} = 1/(1 + R) \tag{1}$$

$$\text{Nagr} = 1 - 1/(1 + R) \tag{2}$$

In the equations, Agr and Nagr are the percentage of the agricultural population and the proportion of the nonagricultural population, respectively, while R is the number of people an agricultural person can support in addition to himself (Pang, 2004: 170). Here, R is the value based on the size of the agricultural population, a central variable in measuring agricultural labor productivity. In the equations of Agr and Nagr, if the value of R tends to be large, the relative size of the nonagricultural population also tends to be large while the relative size of the agricultural population tends to be small, and vice versa. Therefore, R is the key value that measures the proportion of the agricultural population to the nonagricultural population.

In an earlier publication, I used statistics on England during its industrialization and on the Yangzi River Delta in modern times to explain why agricultural labor productivity is the basic condition for the separation of the agricultural and nonagricultural sectors in the course of the transformation from small agricultural households that dominated traditional society to a modern society characterized by socialized large-scale production and commodity exchanges. In that article, I also validated the models of Agr and Nagr (Guo, 2012).

Since 1950, and especially since the reform and opening up to the outside world, China has experienced a transformation of its economic structure from being predominantly agricultural to being predominantly nonagricultural. To explore the relationship between this transformation and agricultural labor productivity, I use the models of Agr and Nagr. Unfortunately, the data on the agricultural population from the National Bureau of Statistics of China are not perfect. The main reason for this is that since the reform and opening up, an increasing portion of the agricultural population has moved into jobs in nonagricultural industries in the countryside, towns, and cities. Furthermore, in many families in the countryside, some members are engaged in agricultural activities, while others are engaged in nonagricultural ones. Thus, any research on the separation of the agricultural and nonagricultural sectors in China since the 1950s based on R is bound to suffer from some weaknesses.

However, since 2010, when the National Bureau of Statistics of China started taking censuses on the population in the countryside, data on "the working population in the countryside" and "the working agricultural population in the countryside" have been added to the original categories of "the number of households in the countryside" and "the size of the population in the countryside." Moreover, the bureau has tracked these data back to 1978 (China Rural Statistical Yearbook, 2010: 29). Based on these numbers, the equations of Agr and Nagr can be revised to:

$$\text{Agr} = N/S$$

$$\text{Nagr} = 1 - N/S$$

In these equations, N is the number of people in the agricultural population divided by the number of agricultural laborers, while S is the number of persons that can be fed by the output of a single agricultural worker. Thus, S is the central value that measures the proportion of the agricultural and nonagricultural populations. Generally speaking, the value of N is comparatively stable in a country or an area for some period of time. Thus, if the value of S tends to grow, the percentage of the nonagricultural population also tends to grow while the percentage of the agricultural population tends to shrink. Hence, if the proportion of imported grain is not very large, the value of S is key to measuring the separation of the agricultural and nonagricultural sectors.

This article, building on the Agr and Nagr models, analyzes the trend toward the separation of the agricultural and nonagricultural sectors in China, and uses a series of values for agricultural labor productivity and S to explain some lessons learned after the 1950s and the dilemma confronting China today. It also presents comparative data from Japan, the United States, and South Korea since the mid-twentieth century.

China's Staple Food Crops by Weight, 1952–2010

Since the production period for crops is one year, we take one year as the unit of time in calculating the annual amount of staple food crops 粮食 an agricultural worker produced every five years for China during the period 1952–2010. The result of that calculation is the measure of the productivity of the agricultural worker.

To calculate the weight of food crops in China in a single year during a five-year period we begin with the statistical classifications of the Ministry of Agriculture and the *China Agriculture Yearbook*, according to which the staple food crops in China can be divided into three types: grains 谷物 (rice, wheat, corn, millet, sorghum, and coarse cereals), beans, and potatoes (China Agriculture Yearbook, 2011: 287). It is these eight kinds of staple food crops that are the main object of this article. In the data from the National Bureau of Statistics for the period 1949–1979, only the total weight of food crops is provided (China Agriculture Yearbook,

1980: 34). In the years 1952, 1957, 1962, 1965, 1970, and 1975, the total weight of staple food crops was respectively 163,915, 195,045, 160,000, 194,525, 239,955, and 284,515 thousand tons. In 1980, the weight of rice, wheat, potatoes, corn, sorghum, millet, coarse cereals, and beans was 139,255, 54,155, 27,845, 61,730, 6,775, 5,445, 15,135, and 7,880 thousand tons, respectively (see Table 1).

It is very difficult to quantify the nutritional value of different kinds of staple food crops produced in the same year. Energy, that is, nutritional value, is what maintains the normal day to day physiological functions of the human body. All vital movements of human beings are maintained with energy; for example, metabolism, muscle contractions, glandular secretions, and so on. Food is the main source of energy that maintains such activities of the human body. In terms of the standard of energy provided by different food crops, I have transformed the weight of different staple food crops into the weight of unprocessed grain. According to the Chinese Center for Disease Control and Prevention, in each 100 grams of staple foods—rice, wheat, corn, sorghum, millet, beans, potatoes, and sweet potatoes—the energy is respectively 346, 317, 335, 351, 358, 359, 76, and 99 kilocalories. In each 100 grams of coarse cereals—buckwheat, oat groats, and Job's tears (coix seed)—the energy is 324, 366, and 357 kilocalories, respectively (Chinese Center for Disease Control and Prevention, 2002: 24–46). Using this standard of energy, the energy contained in the same weight of grains and beans differs very little. The median amount of energy contained in 100 grams each of different kinds of grain is about 337 kilocalories. In the same quantity

Table 1. Weight of Staple Food Crops in China, 1952–2010.
(Unit: thousand tons)

Year	Rice	Wheat	Potatoes	Corn	Sorghum	Millet	Coarse cereals	Beans	Total weight
1952	—	—	—	—	—	—	—	—	163,915
1957	—	—	—	—	—	—	—	—	195,045
1962	—	—	—	—	—	—	—	—	160,000
1965	—	—	—	—	—	—	—	—	194,525
1970	—	—	—	—	—	—	—	—	239,955
1975	—	—	—	—	—	—	—	—	284,515
1980	139,255	54,155	27,845	61,730	6,775	5,445	15,135	7,880	—
1985	168,569	85,805	26,036	63,826	5,609	5,977	12,786	10,500	—
1990	191,748	99,356	27,681	98,823	5,682	4,564	12,887	11,200	—
1995	185,227	102,215	32,632	142,950.6	4,755	3,021.4	8,903	13,504.2	—
2000	187,907.8	99,636.5	36,853.5	106,001.5	2,582	2,125.1	6,970.2	20,099.8	—
2005	180,592	97,445	34,680	139,365	2,546	1,785	6,032	21,579	—
2010	195,761	115,181	31,141	177,245	2,456	1,573	4,154	18,965	—

Source: *China Agriculture Yearbook*, 1980, 1981, 1986, 1991, 1996, 2001, 2006, 2011.

by weight of potatoes and sweet potatoes, there is little difference in the energy: the median amount of energy in 100 grams of potatoes and sweet potatoes is about 88 kilocalories. Therefore, in terms of the energy that a staple food crop provides, the energy contained in 100 grams of grains (or legumes) is about 4 times that of 100 grams of potatoes or sweet potatoes. That is to say, the energy contained in 4 weight units of potatoes or sweet potatoes is equal to that contained in 1 weight unit of grains (or legumes). Using these proportions, we can take the weight of potatoes produced in different years (Table 1) and convert that into the equivalent of grains (see Table 2). In this way, the total weight of staple food crops as equivalent by weight of grain produced in China can be calculated (see Table 2).

Agricultural Labor Productivity in China, 1952–2010

First, the number of rural laborers in agriculture during the period 1952–1975 should be counted. According to the National Bureau of Statistics, the figures for the number of households in the countryside in 1952 and 1957 are lacking. In this article, I have reckoned these figures based on materials from the *Chronicle of the Agriculture of China*, which states that, "At the end of 1955, the number of rural households that joined co-ops [i.e., the elementary agricultural producers' cooperatives] was just over 70,000,000, which was about 60 percent of all the households in the countryside" (Chronicle of the Agriculture of China, 1982: 48). Thus the number of rural households in 1955 was about 70,000,000/0.60 = 116,667,000, which should be similar to that of 1952 and can also be regarded as the number of rural households in China in 1952. The *Chronicle of Agriculture of China* also says that "in 1956, agricultural cooperativization in the countryside was almost finished, and the number of rural households that joined cooperatives increased to 120 million, which was about 96 percent of all the households in the countryside" (Chronicle of Agriculture of China, 1982: 65). In light of these figures, at the end of 1956, the number of rural households was about 120,000,000/0.96 = 125 million, which can be considered as the number of rural households in 1957. Based on the figures calculated above and the figures provided by the *China Agriculture Yearbook* and the *China Population Yearbook*, the number of rural households and the rural population can be estimated (see Table 3).

The number of rural laborers in agriculture, a figure lacking in the materials of the National Bureau of Statistics for the period 1952–1975, can also be obtained through an indirect method. During this period, the Chinese government implemented the policy of "taking grain as the key link" 以粮为纲. The number of laborers in agriculture during this time was approximately the same as the number of the working population in the countryside. In this period, China created mutual aid teams, then elementary agricultural producers' cooperatives, followed by advanced cooperatives, and finally people's communes. There was almost no floating population in China at that time and life expectancy was about 50 years. In an ordinary family, there were 4.18–4.72 members (see Table 3). That is to say, there

Table 2. Staple Food Crops in China as Equivalents by Weight of Unprocessed Grain, 1952–2010. (Unit: thousand tons)

Year	Rice	Wheat	Potatoes, converted into the equivalent of grains	Corn	Sorghum	Millet	Coarse cereals	Beans	Total weight
1952	—	—	—	—	—	—	—	—	163,915
1957	—	—	—	—	—	—	—	—	195,045
1962	—	—	—	—	—	—	—	—	160,000
1965	—	—	—	—	—	—	—	—	194,525
1970	—	—	—	—	—	—	—	—	239,955
1975	—	—	—	—	—	—	—	—	284,515
1980	139,255	54,155	6,961.3	61,730	6,775	5,445	15,135	7,880	297,336.3
1985	168,569	85,805	6,509	63,826	5,609	5,977	12,786	10,500	359,581
1990	191,748	99,356	6,920.3	98,823	5,682	4,564	12,887	11,200	431,180.3
1995	185,227	102,215	8,158	142,950.6	4,755	3,021.4	8,903	13,504.2	468,734.2
2000	187,907.8	99,636.5	9,213.4	106,001.5	2,582	2,125.1	6,970.2	20,099.8	434,536.3
2005	180,592	97,445	8,670	139,365	2,546	1,785	6,032	21,579	458,014
2010	195,761	115,181	7,785.3	177,245	2,456	1,573	4,154	18,965	523,120.3

Source: Calculated from the data in Table 1.

were 2–3 children in an ordinary family besides the husband and wife. In view of these facts, the number of rural laborers in agriculture can be calculated by multiplying the number of rural households by 2. Thus, it is possible to flesh out the figures in Table 3.

Second, the number of laborers in agriculture during the period 1980–2010 should also be counted. With the reform and opening up, the size of the floating population began to increase, and more and more rural laborers began to work in the nonagricultural sector in towns and cities. Starting in 2011, the column for rural laborers in the *China Agriculture Yearbook* began to be divided into two parts: "the number of rural laborers" and "the number of agricultural laborers" (China Agriculture Yearbook, 2010: 268). In the *China Agriculture Yearbook 2014*, the rural population was defined as follows: "of all the population that lives in the countryside, the rural population is the permanent resident population, who often live in a rural home or stay there for over 6 months of the year, and whose finances and livelihood are linked with family members." Using the household census register from 1981 and earlier, the data from the census in 1982, 1990, 2000, and 2010, and the

Table 3. Number of Rural Households, Rural Population, and Agricultural Laborers in China, 1952–2010.

Year	Number of rural households (thousands)	Rural population (thousands)	Average number of persons per rural household	Number of rural laborers in agriculture (thousands)	*N*
1952	116,667	491,910	4.22	233,334	2.11
1957	125,000	540,350	4.32	250,000	2.16
1962	134,100	560,240	4.18	268,200	2.09
1965	135,270	591,220	4.37	270,540	2.19
1970	151,780	699,840	4.61	303,560	2.31
1975	164,480	777,120	4.72	328,960	2.36
1980	176,727	810,960	4.59	291,220	2.78
1985	190,765	844,197	4.43	311,300	2.71
1990	222,372	895,903	4.03	389,140	2.30
1995	232,815	916,746	3.94	355,300	2.58
2000	241,484.7	928,196.5	3.84	360,430	2.58
2005	252,224	949,076	3.76	334,420	2.84
2010	263,846	966,189	3.67	279,310	3.46

Sources: *China Agriculture Yearbook*, 1980, 1981, 1986, 1991, 1996, 2001, 2006, 2011, 2013, 2014; *Statistical Yearbook of China*, 2001; *China Rural Statistical Yearbook*, 2010, 2015; *China Population Yearbook*, 1985.

Note: The figures in the column "Average number of persons per rural household" have been calculated from the figures in columns "Number of rural households" and "Rural population."

Table 4. Dynamic Calculation of Agricultural Labor Productivity in China, 1952–2010.

Year	Total weight of unprocessed grain (1,000 tons)	Rural laborers in agriculture (1,000 persons)	Agricultural labor productivity (tons)
1952	163,915	233,334	0.702
1957	195,045	250,000	0.780
1962	160,000	268,200	0.597
1965	194,525	270,540	0.719
1970	239,955	303,560	0.790
1975	284,515	328,960	0.865
1980	297,336.3	291,220	1.021
1985	359,581	311,300	1.155
1990	431,180.3	389,140	1.108
1995	468,734.2	355,300	1.319
2000	434,536.3	360,430	1.206
2005	458,014	334,420	1.370
2010	523,120.3	279,310	1.873

data from the *Statistical Yearbook of China*, "the size of the rural population," "the number of rural laborers," and "the number of rural laborers in agriculture" from the year 1978 have been calculated (China Rural Statistical Yearbook, 2015). Thus, "the number of rural laborers in agriculture" for years 1980–2010 as shown in the *China Rural Statistical Yearbook 2010* is used in this article (see Table 3).

Table 4 presents the total weight of unprocessed grain and the number of yearly rural laborers in agriculture during the period 1952–2010 calculated from Tables 2 and 3. Dividing the "total weight of unprocessed grain" by the number of "rural laborers in agriculture" for the same year, gives us the yearly agricultural labor productivity. As Table 4 shows, agricultural labor productivity more than doubled between 1952 and 2010, growing from 0.702 tons of unprocessed grain to 1.873 tons.

Changes in Agricultural Labor Productivity and the Separation of the Agricultural and Nonagricultural Sectors

As agricultural labor productivity more than doubled from 1952 to 2010, the food consumption structure in the countryside also changed. From 1952 to 1990, the quantity of grain consumed per capita increased, growing from 197.67 to 262.08 kg (see Table 5). From 1990 to 2010, the pattern reversed and the quantity of grain consumed per capita decreased, from 262.08 to 181.44 kg. The reason for this phenomenon is that before 1990, grain was the principal food for humans in the countryside, and there was very little subsidiary food. During the period 1990–2010, the consumption of subsidiary foods such as meat, eggs, milk, aquatic products,

Table 5. Quantity of Food Consumed Yearly Per Capita in Rural Households in China, 1952–2010. (Unit: kg)

Year	Grain	Vegetables	Edible oils	Pork	Beef and lamb	Poultry	Eggs	Aquatic products	Milk
1952	197.67	—	2.10	5.92	0.92	0.43	1.02	2.67	—
1957	203.06	—	2.42	5.08	1.11	0.50	1.26	4.34	—
1962	164.63	—	1.09	2.22	0.79	0.38	0.77	2.96	—
1965	182.84	—	1.72	6.29	1.02	0.36	1.42	3.33	—
1970	187.22	—	1.61	6.02	0.82	0.32	1.32	2.94	—
1975	190.52	—	1.73	7.63	0.72	0.35	1.63	3.26	—
1980	213.81	—	2.30	11.16	0.83	0.80	2.27	3.41	—
1985	257.45	131.13	4.04	10.32	0.65	1.03	2.05	1.64	—
1990	262.08	134.00	5.17	10.54	0.80	1.25	2.41	2.13	1.10
1995	258.92	104.62	5.80	10.58	0.71	1.83	3.22	3.36	0.60
2000	250.23	106.74	7.06	13.28	1.13	2.81	4.77	3.92	1.06
2005	208.85	102.28	6.01	15.62	1.47	3.67	4.71	4.94	2.86
2010	181.44	93.28	6.31	14.40	1.43	4.17	5.12	5.15	3.55

Source: *Statistical Yearbook of China*, 1986, 2001, 2006, 2011.
Note: In the *Statistical Yearbook of China,* 1986, 2001, 2006, 2011, the numbers for the quantity of the principal foods consumed per capita in a given year contradict each other. I have selected the numbers that seem most reasonable.

and edible oils shot up. The consumption of poultry, for instance, increased from 1.25 to 4.17 kg per capita, and that of milk from 1.10 kg to 3.55 kg. It was this sort of diversification of food that was the main reason that the quantity of grain consumed decreased. As far as the state of agricultural labor productivity is concerned, there were three phases that corresponded to different stages of food consumption. In the first phase, 1952–1985, agricultural labor productivity was low and the per capita consumption quantity of the main food (i.e., grain) was also low. The second phase, 1985–2000, was characterized by slowly increasing agricultural labor productivity and a corresponding increase in the consumption per capita of staple food crops as well as the appearance of multiple food resources. In the third phase, starting in 2000, agricultural labor productivity grew rapidly and food resources became increasingly diversified.[1]

[1] Philip Huang has stated that "in the past, the ratio of the food consumption structure in China was about 8:1:1, i.e., the percentage of grains, meat-fowl-fish, and vegetables-fruit that were consumed were respectively 80%, 10%, and 10%. At present, the proportion is about 5:2:3, i.e., the percentage of grains, meat, and vegetables-fruit consumed are respectively 50%, 20%, 30%. . . . [T]he ratio is moving toward about 4:3:3" (Huang, 2010: 2).

In short, from 1952 to 2010 agricultural labor productivity grew while the per capita consumption of staple food crops first increased and then decreased. In this case, what was the relationship between the production of staple food crops, consumption, and the separation of the agricultural and nonagricultural sectors? The numbers for agricultural labor productivity in Table 4 and the staple food crops consumed yearly per capita in Table 5 are have been combined in Table 6. In the latter, the value of *S* in the Agr and Nagr models in each year has been calculated by dividing the numerical value of agricultural labor productivity by the quantity of staple food crops consumed per capita. In the same way the value of *N*—the number of people in the agricultural population divided by the number of agricultural laborers—can be computed by using the figures in Table 3 for the period 1952–2010. These values have been extracted and put into Table 6. In that table, based on the values of *N* and *S* during the period 1952–2010, the values for Agr and Nagr in the same period have been be computed.

Since errors are virtually unavoidable in calculations, there are some discrepancies between the values of Agr and Nagr and the data on the actual share of the agricultural and nonagricultural population in China in the years 1952–2010. Nevertheless, the values of Agr and Nagr that I have calculated more or less reflect the direction of the transformation of China's economic structure. For example, the values for Agr and Nagr make it clear that during the period 1952–2010, Agr decreased from 62 percent to 34 percent, and Nagr increased from 38 percent to 66 percent. These numbers indicate that during these years, China changed from

Table 6. Production and Consumption of Staple Food Crops in China, and the Separation of the Agricultural and Nonagricultural Sectors.

Year	Agricultural labor productivity (kg)	Staple foods consumed yearly per capita (kg)	*N*	*S*	Agr	Nagr
1952	702	197.67	2.19	3.55	0.62	0.38
1957	780	203.06	2.19	3.84	0.57	0.43
1962	597	164.63	2.19	3.63	0.60	0.40
1965	719	182.84	2.19	3.93	0.56	0.44
1970	790	187.22	2.31	4.22	0.55	0.45
1975	865	190.52	2.36	4.54	0.52	0.48
1980	1,021	213.81	2.78	4.78	0.58	0.42
1985	1,155	257.45	2.71	4.49	0.60	0.40
1990	1,108	262.08	2.30	4.23	0.54	0.46
1995	1,319	258.92	2.58	5.09	0.51	0.49
2000	1,206	250.23	2.58	4.82	0.54	0.46
2005	1,370	208.85	2.84	6.56	0.43	0.57
2010	1,873	181.44	3.46	10.32	0.34	0.66

Note: *N* = the agricultural population divided by the number of agricultural laborers; *S* = the number of people that an agricultural laborer can feed.

an agricultural-population-based society to a nonagricultural-population-based society, and that the changes in the numbers for Agr and Nagr are consistent with the trends in the transformation of China's economic structure.

Generally speaking, if the percentage of imported grain is not very high, a great increase in agricultural labor productivity is the basis for the separation of the agricultural and nonagricultural sectors. As Table 6 shows, agricultural labor productivity in China rose substantially from 702 kg to 1,873 kg of staple food crops from 1952 to 2010. The number of people that an agricultural laborer can feed yearly (i.e., *S*) is a very important measure of agricultural labor productivity (see Table 6). For example, during the period 1952–2010, the value of *S* rose remarkably, from 3.55 in 1952, to 4.49 in 1985, 5.09 in 1995, and 10.32 in 2010. In short, from 1952 to 2010, the agricultural labor productivity of China increased greatly. But what was the trend in the importation of grain? As Table 7 shows, the share of imported grain in the 1990s was not large—less than 5 percent. But from 2000, the percentage began to increase, reaching 8 percent in 2005 and 12.8 percent in 2010.

To explore the relationship between the importation of grain and the separation of the agricultural and nonagricultural sectors, England during the Industrial Revolution would be a good place to start. In an article published in 2000, Robert C. Allen discussed the importance of the ratio of grain production to grain consumption, which he labeled *r*. When $r = 1$, the weight of the grain produced domestically is equal to the weight of the grain consumed domestically. In this situation, there is no need to import grain. Allen found that the role of international trade in grain was not important in England before the mid-eighteenth century. Before the 1750s, the value of *r* was 1. After that, England became a net exporter of grain and hence the value of *r* rose. Still later, *r* began to decrease, dropping to 0.9 in 1800, but by the mid-nineteenth century it began to rise again (Allen, 2000). Mark Overton's research shows that England exported 2 percent of the grain it produced in 1701, and that after 1781 it became a net importer of grain: in

Table 7. Percentage of Imported Grain and Grain Mash in China.
(Unit: thousand tons)

Year	Weight of imported grain	Total weight of domestically produced grain	Percentage of imported grain
1995	20,830	468,734.2	4.4%
2000	13,910	434,536.3	3.2%
2005	36,470	458,014	8.0%
2010	66,950	523,120.3	12.8%

Source: *China Grain Yearbook*, 2013.
Note: The figures in the column "Total weight of domestically produced grain" are from Table 4. The figures in the last column have been calculated by the author. The percentage of imported grain = the weight of imported grain divided by the weight of grain produced domestically.

1801, England imported 5 percent, and in 1851, 16 percent, of its needs (Overton, 1996: 75). Allen's and Overton's research indicates that although England was a net importer of grain toward the end of the Industrial Revolution, the imported share was not very large. Therefore, one can conclude that the great increase in agricultural labor productivity in England was the key factor in the increase of the nonagricultural population.

Compared to England during its industrialization, China since the 1950s did not import much grain until around the year 2000. Inasmuch as the number of people that each Chinese agricultural laborer could feed constantly increased, this made possible a reduction in the relative size of the agricultural population—from 62 percent in 1952 to 34 percent in 2010—and a concomitant increase in the relative size of the nonagricultural population—from 38 percent to 66 percent—in the same period.

Agricultural labor productivity and food consumption in China went through three stages in the period 1952 to 2010 (see Table 4). During the first stage, before 1985, agricultural labor productivity was low and stagnant, and consumption was very heavily dominated by grains. Although agricultural labor productivity generally grew before 1975, it was nonetheless basically stagnant, consistently at under 800 kg. In 1975 and 1980, agricultural labor productivity broke through at 800 kg and 1,000 kg, respectively. Although many factors affect agricultural labor productivity, this article takes into consideration the two crucial factors—the system and technology—that influence agricultural labor productivity. As far the system is concerned, before 1975 agricultural laborers were bound to the land and there was no possibility of leaving agriculture and working in the nonagricultural sector. Since 1975, the government began to implement a variety of new agricultural policies, and with this some rural enterprises were established and some laborers were released from agriculture and entered nonagricultural industries. As for the factor of agricultural technology, investment was very low. China had, for example, only 70,000 large and medium-sized tractors in 1965, 120,000 in 1970, and 340,000 in 1975 (China Agriculture Yearbook, 1980: 137).

The period 1985–2000 was the second stage of change in agricultural labor productivity. During these years, productivity grew slowly, although it was almost always below 1,300 kg (see Table 4). The weight of grains consumed per capita tended to be high, and there was growth in the consumption of meat, eggs, and milk. As for the factor of technology, there were no major changes compared to the first stage, except that the number of large and medium-sized tractors increased to 740,000 in 1980 and 970,000 in 2000 (China Agriculture Yearbook, 1981: 59; 2011: 271). In terms of the systemic factor, owing to the reform and opening up policy, peasants were liberated from the land and the first generation of migrant workers emerged. Those worked away from their hometowns in nonagricultural work, with most of them returning from the cities and towns at harvest time.

In the third stage, 2000–2010, agricultural labor productivity grew rapidly and made many breakthroughs. During this period, the food structure greatly

changed. The weight of grain consumed per capita rapidly decreased, and the quantity of meat, eggs, and milk consumed per capita greatly increased. Agricultural labor productivity broke through the barrier of 1,300 kg in 2005 and reached 1,873 kg in 2010 (see Table 4). As for the factor of technology, fertilizers, pesticides, and herbicides were beginning to be used extensively, and the mechanization of agriculture made great strides forward. For example, the number of large and medium-sized tractors skyrocketed from 970,000 in 2000 to 3,920,000 in 2010 (China Agriculture Yearbook, 2011: 271; Yearbook of Agricultural Mechanization in China, 2011: 170), a threefold increase. Regarding the factor of the system, the second generation of migrant workers replaced the first during this period. These were young people who left agriculture and pursued nonagricultural occupations as their life's work. Thus, the number of laborers in agriculture greatly decreased.

Lessons from the Past and the Present Dilemma

One of the hard lessons learned from the years before the mid-1980s is that low agricultural labor productivity and consumption of grain lead to a shortage of food and clothing, a problem that long bedeviled China. During the period 1957–1980, agricultural labor productivity remained below 1,000 kg. In this period, agriculture was part of the planned economy, under which production teams were the basic unit of production, and the state monopolized the purchase and marketing of goods. In this system, grain was turned over to the state and the collective, and whatever was left was divided among the people as rationed provisions. Dwight Perkins found that the per capita output of grain in China between 1400 and 1957 fluctuated between about 200 kg and about 350 kg (Perkins, 1984: 411). The median amount of grain consumed per capita in Ming and Qing China, according to Perkins, was about 275 kg per year. In the People's Republic, even less was consumed: 197.67 kg in 1952, 203.06 kg in 1957, 164.63 kg in 1962, 182.84 kg in 1965, 187.22 kg in 1970, 190.52 kg in 1975, and 213.81 kg in 1980 (see Tables 5 and 6). In the food structure during the period 1952–1975 grains were the principal source of food with little consumption of subsidiary foods.

Thus, during the period 1952–1980, the weight of grains consumed per capita did not measure up to the standard of traditional China, and the common people often went hungry. For example, in 1957 when Fei Xiaotong revisited Jiang village (Jiangcun), where he had earlier done pathbreaking fieldwork, he recorded the hunger among the villagers:

> What can I say about the villagers? When I asked them, "How is life?" many old women answered frankly, "Life is good, but food . . . ." Someone interrupted, "It's not good to discuss this question at the first meeting. We can talk about this another day." . . . When a lot of children squeezed toward us, I suddenly felt strange. . . . Why weren't they in school today? The children smiled at me: "We don't go to school, we just cut grass for the sheep."

> An old man nearby added, "Where's the money to study? The important thing for them is to eat." (Fei Xiaotong, 2004: 257)

If the villagers of Jiangcun, located in the relatively well-off Yangzi Delta, still felt hungry in 1957, what about the people in other, less fortunate areas? Gao Wangling 高王凌 has investigated the problems concerning provisions in many areas during the people's commune era. In Shanxi, in the early stage of agricultural cooperatives, grain rations were about 360 jin (1 kg = 2 jin) per capita each year, that is, 1 jin per person per day. Many people believe that 700 jin per capita is barely enough. In Guangdong, some peasants reported they averaged 35 jin of unhusked rice per person per month, which could be processed into 24 to 25 jin of milled rice. A peasant, Lao He, said that by the early 2000s villagers had three or four meals a day, but in the past they had two meals a day, plus watery soup at noon. There was simply not enough grain for them at that time. In Hunan before 1978, it was said that villagers had to survive on 480 jin of grain per person per year; that is, unhusked rice, which, when milled, yielded only 336 jin. This amounted to just 0.92 jin per person per day, obviously not enough. In Inner Mongolia, villagers frequently stole grain from the production teams, but they still did not have enough to eat. Thus, every spring they went out to borrow grain (Gao, 2005: 11, 39, 56, 102, 157).

During the period 1950–1980, low agricultural labor productivity led to another tragic outcome: educated urban youth were driven out of the cities and sent "up to the mountains and down to the countryside." Broadly speaking, this exodus, which affected somewhere between 12 and 18 million urban youth, occurred from the late 1950s to the late 1970s. Narrowly speaking, the educated-youth-to-the-countryside movement spanned the years 1968 to 1977. In 1968, prodded by Mao Zedong, *People's Daily* published an article titled "We Also Have Two Hands and Won't Stay in the Cities Living Like Parasites" which quoted Mao's instruction that "educated urban youth should go down to the countryside and be reeducated by the poor and lower-middle peasants." The result was that a tidal wave of youth flowed into the countryside. It is generally agreed that educated urban youth were organized to go to the countryside from the mid-1950s as a simple solution to the problem of unemployment in the cities. However, we also need to look at the problem of educated urban youth from the perspective of agricultural labor productivity and grain consumption. In the mid- and late 1950s, people's communes were established all over China. The production team, the basic production unit, paid grain tax to the central government and turned over a percentage of the total crop to the production brigade. The production brigade converted what it received into public accumulation funds 公积金 and public welfare funds 公益金. The grain that was left in the hands of the production team constituted the provisions for the members. In an ordinary year, as mentioned above, it was difficult for a commune member to fill his or her belly with the typically meager allotment.

During the years 1952 to 1980, the number of persons an agricultural laborer could supply with grain was below 4.8 (see Tables 3 and 6). In a 5-person rural

household with a labor force of 2, each of those two, aside from providing for 2.5 persons in their own family, could supply staple food for only 2.3 persons outside the family. However, during the years 1949–1958 and 1962–1975, China experienced two peaks of population growth. The population grew from 645,230,000 in 1957 to 887,610,000 in 1973 (Ma, 1989), an increase of 242,380,000. But from 1957 to 1975, the number of agricultural laborers grew from 250,000,000 to 328,960,000, an increase of 78,960,000. The population that the additional agricultural laborers could feed was about 78,960,000 × 2.3 = 181,610,000. Therefore, in terms of agricultural labor productivity and the amount of grain consumed during the period 1957–1975, with the additional population of 242,380,000, there were 242,380,000 – 181,610,000 = 60,770,000 persons whom agricultural laborers could not feed. At the same time, China had very little international trade. In this situation, calling on the urban educated youth (in fact, most of them were students in primary school and secondary school) to go live and work with a production team or participate in the Production and Construction Corps was the best method to solve the grain shortage.[2]

As mentioned above, from the mid-1980s to 2010 China's agricultural labor productivity moved from stagnation to slow growth, and then rapid growth, during which the weight of grain consumed per capita per year greatly decreased, and that of meat, eggs, and milk quickly increased. Yet, problems arose from the change of the food structure with regard to grain production and consumption. During this period, because of the soaring consumption of meat, eggs, and milk, ensuring a sufficient supply of feed grain became a problem. In the summer of 2010, this author and Zhang Xitao 张希涛, a master's degree candidate in the Institute of Economic History at Nanjing Normal University, investigated the problem of insufficient feed grain in Laiwu (Shandong), Yexian county (Henan), and Ninghe county (Tianjin). According to our survey, from 1991 to 1995 livestock breeding and management changed from raising free-range animals to raising them on a large scale as a household business. In a free-range system, rural households raise livestock and poultry with table scraps, bran, and the like. To raise livestock on a large scale, the villagers began use feed grains, and as a result the output of livestock breeding began to substantially expand during the period 1990–1995, as shown in Table 8. According to the data we collected, each 100 kg of feed grain for pigs consists of 65 kg of corn, 25 kg of soybean meal, 5 kg of wheat bran, and 5 kg of mixed fodder. Sixty-five percent of feed grain, in other words, consisted of corn. At the same time, 100 kg of feed grain for poultry consists of 62 kg of corn, 25 kg of soybean meal, 5 kg of wheat bran, 5 kg of feed concentrate, and 3 kg of powdered stone or sand—in other words, corn, at 62 percent, again predominates. In short, corn has become the principal component of feed grain.

The change in how livestock are fed is connected with the spread of the household contract responsibility system beginning in 1983. Before that, the problem of insufficient food and clothing for rural households had not been solved in the

[2] The Production and Construction Corps, established in 1954, consisted of quasi-military state farms located, for the most part, in border regions.

Table 8. Output of Livestock Husbandry and Fishing in China.
(Unit: thousand tons)

Year	Pork	Beef	Lamb	Poultry	Milk	Goat's milk	Eggs	Aquatic products
1952	—	3,385	—	—	—	—	—	1,666
1957	—	3,985	—	—	—	—	—	3,116
1962	—	1,940	—	—	—	—	—	2,283
1965	—	5,510	—	—	—	—	—	2,984
1970	—	5,965	—	—	—	—	—	3,185
1975	—	7,970	—	—	—	—	—	4,412
1980	11,340	270	445	—	228	45	—	4,497
1985	16,547	467	593	1,602	2,499	395	5,347	7,052
1990	22,808	1,256	1,068	3,229	4,157	594	7,946	12,371
1995	36,484	4,154	2,015	9,347	5,764	964	16,767	25,172
2000	40,314	5,328	2,740	12,075	8,274	917	22,433	42,790
2005	50,106	7,115	4,355	14,643	27,534	1,114	28,795	51,017
2010	50,712	6,531	3,989	16,561	35,756	1,724	27,627	53,730

Source: *China Agriculture Yearbook*, 1980, 1981, 1986, 1991, 1996, 2001, 2006, 2011.
Note: From 1952 to 1975, disaggregated figures for output of pork, beef, and lamb are unavailable; the numbers for these years represent all types of meat.

three places we investigated. At that time, the staple foods were rice, wheat, potatoes, corn, sorghum, millet, and coarse cereals. After 1983, after the rural contract responsibility system went into effect and the output of wheat and unhusked rice rose dramatically (as shown in Table 2), the staple food in the diet of rural households in these three places began to consist mainly of wheat or rice, while potatoes, sorghum, millet, and coarse cereals became of secondary importance, and corn of even less importance because it was being used as animal feed. The change in the components of feed grain can be reflected in the food structure of the common people during the period 1952–2010. For instance, before 1995, the quantity of staple food crops consumed decreased slowly while that of meat, eggs, and milk increased slowly (see Table 5). The consumption of grains in the three places we investigated reflects the situation in China overall. Here the year of 1991 was a dividing line—after that year corn became the main source of animal feed.

Once this happened, corn occupied a minor position in villagers' diet. According to the data Zhang Xitao and I collected, the cycle for raising a pig in 2010 was 5–6 months in Henan, Shandong, and Tianjin, and for that period 250 kg of feed grain was required: 40 kg of soybean meal, 10 kg of wheat bran, and 200 kg of corn. The cycle for raising a chicken was about 18 months, and required 35–39 kg of feed grain, or a median of about 37 kg. As with the data mentioned earlier, the percentage of corn in feed grain for chickens was about 62 percent. Thus, the weight of the corn that a chicken consumed was about $37 \times 0.62 = 23$ kg. Table 9 lists the number of pigs and chickens live and slaughtered in 1995, 2000, 2005, and 2010.

Since the cycle for raising a pig is but 5–6 months, only the number of pigs slaughtered has been counted when calculating the total weight of unprocessed grain that they consumed, to avoid double counting. In view of the 18-month cycle for raising chickens, the total number, including live and slaughtered, has been taken into account in calculating the weight of unprocessed grain that they consumed. As Table 9 shows, the supply of grain, the pillar of stockbreeding, has been

Table 9. Output of Pigs and Poultry in China and the Weight of Corn They Consumed, 1990–2010.

	Year	1995	2000	2005	2010
Pigs	Live at the end of the year (thousands)	441,691	446,815	503,348	464,600
	Number slaughtered (thousands)	480,491	526,733	660,986	666,864
	Quantity of corn consumed by fattening pigs (thousand tons)	96,100	105,350	132,200	133,373
Poultry	Live at the end of the year (thousands)	4,108,580	4,641,130	533	5,352,510
	Numbered slaughtered (thousands)	6,302,131	8,098,571	9,864,918	11,010,000
	Total number of chickens (thousands)	10,410,711	12,739,701	9,865,451	16,362,510
	Quantity of corn consumed by chickens (thousand tons)	239,450	293,010	226,910	376,338
Quantity of corn consumed by fattening pigs and chickens (thousand tons)		335,550	398,360	359,110	509,711
Quantity of corn produced in China (thousand tons)		111,989	106,002	139,365	177,245
Corn shortfall in China (thousand tons)		223,560	292,360	219,750	332,466

Source: *China Agriculture Yearbook*, 1991, 1996, 2001, 2006, 2011.
Note: The numbers in the columns "Quantity of corn consumed by fattening pigs," "Quantity of corn consumed by chickens," "Quantity of corn consumed by fattening pigs and chickens," and "Corn shortfall in China" were calculated from the data in the current table and earlier tables.

insufficient since 1995. China's corn shortage was below 300 million tons before 2010, but ran up to 332.466 million tons in 2010. Aside from exploring the possibility of using substitute feed ingredients, China has no choice but to import corn.

The data on the "Total weight" of domestically produced unprocessed grains in Table 2 and "Staple food crops consumed yearly per capita" in Table 6 have been incorporated in Table 10. Using the data in the columns "Total population" and "Weight of grain consumed per capita" in Table 10 one can calculate the figures in the column "Total weight of grain consumed by humans" during the period 1952–2010. In comparing the figures of total weight of staple food crops consumed by humans and total weight of unprocessed grains produced domestically, it can be seen that according to the standard of grains consumed yearly per capita, China not only was able to supply grain to all its citizens, but also had a large surplus during 1952–2010. Nevertheless, as Table 7 show, the percentage of imported grain rose steadily after 1995. The main reason for this is that although the weight of staple food crops consumed by humans decreased, the consumption of meat, eggs, and milk increased. To support this increase, the number of livestock and poultry has increased dramatically to the point that domestically produced feed grains cannot supply the demands of stockbreeding.

Table 10. Comparison of Total Weight of Staple Food Crops Consumed by Humans and Total Weight of Domestically Produced Unprocessed Grain in China, 1952–2010.

	Total population (1,000 persons)	Weight of grains consumed per capita (kg)	Total weight of grain consumed by humans (1,000 tons)	Total weight of unprocessed grain produced domestically (1,000 tons)
1952	574,820	197.67	113,625	163,915
1957	646,530	203.06	131,284	195,045
1962	672,950	164.63	110,788	160,000
1965	725,380	182.84	132,628	194,525
1970	829,220	187.22	155,247	239,955
1975	924,200	190.52	176,079	284,515
1980	987,050	213.81	211,041	297,336.3
1985	1,058,510	257.45	272,513	359,581
1990	1,143,330	262.08	299,644	431,180.3
1995	1,211,210	258.92	313,606	468,734.2
2000	1,267,430	250.23	317,149	434,536.3
2005	1,307,560	208.85	273,084	458,014
2010	1,340,910	181.44	243,295	523,120.3

Sources: *Statistical Yearbook of China*, 2011; *China Population Yearbook*, 1985.

Grain Production and Consumption, and the Separation of Industry in Japan, the United States, and South Korea, 1970–2010

When looking at the relationship between agricultural labor productivity, grain consumption, and the separation of industry in Japan, the United States, and South Korea since the mid- to late twentieth century, we are faced by the fact that only limited data are available. Thus, the discussion that follows focuses on agricultural labor productivity (i.e., the weight of grain that an agricultural person produces in a year) and the value of *R*, that is, the number of persons that an agricultural person can supply with grain in addition to himself.

Agricultural labor productivity in Japan greatly increased in the period 1970–2010 (see Table 11). Nevertheless, it was low before 1980, although it rose rapidly after that, increasing from 898.3 kg in 1970 to 4,224.2 kg in 2010. Concurrently, the weight of grain consumed per capita decreased from 80.5 kg to 56.8 kg and the number of people that an agricultural person can feed increased from 11.16 in 1970 to 74.37 in 2010.

However, these data are misleading in terms of showing the relationship between agricultural labor productivity and the value of $1 + R$ in the Agr and Nagr models. According to the *Yearbook of the World's Economy*, the grain self-sufficiency rate of Japan in 2012 was about 39 percent in terms of nutritional energy supplied

Table 11. Agricultural Labor Productivity and the Separation of the Agricultural and Nonagricultural Sectors in Japan, 1970–2010.

Year	Total output of grain (1,000 tons)	Population (1,000 persons)	Agricultural population (1,000 persons)	Agricultural labor productivity (kgs)	Weight of grain consumed yearly per capita (kgs)	Number of persons an agricultural person can feed (i.e., $R + 1$)
1970	17,661	104,340	19,660	898.3	80.5	11.16
1975	17,632	111,570	18,090	974.7	70.5	13.83
1980	13,191	116,810	12,450	1,059.5	69.5	15.24
1985	15,856	120,840	9,800	1,618.0	65.5	24.70
1990	14,452	123,540	7,570	1,909.1	58.2	32.80
1995	14,119	125,200	6,600	2,139.2	55.5	38.54
2000	12,796	126,870	4,950	2,585.1	54.8	47.17
2005	12,426	127,770	3,710	3,349.3	56.3	59.49
2010	11,363	127,450	2,690	4,224.2	56.8	74.37

Sources: Zhang, 1996: 46–47, 71, 156–57; Liu, 1998: 48, 73, 163; *International Statistical Yearbook*, 2006/2007, 2008, 2010, 2013; FAOSTATJ; Department of Statistics, 1976; Statistics Bureau, 1991, 2010.

Note: The figures on consumption of grain before 1990 exclude the population in agriculture, forestry, and fishery.

(Yearbook of the World's Economy, 2013: 338). Since a great quantity of food had to be imported each year, and the quantity of grain that an agricultural worker produced was insufficient to feed a large number of people (i.e., $1 + R$), the result can be described as an *efficiency illusion*, that is, a paradox wherein agricultural labor productivity is high but the actual number of persons that an agricultural worker can supply with grain is low. Agricultural products are expensive in Japan since most grain is imported. Therefore, the impressive growth of agricultural labor productivity in Japan was not the basis for the separation of the agricultural and nonagricultural sectors.

In the United States, agricultural labor productivity rose dramatically from 18,912 kg in 1970 to 77,994 kg in 2010, while the number of persons that an agricultural worker could feed also increased, from 307.21 to 872.52 (see Table 12). The *Yearbook of the World's Economy* shows that the output of grain produced in the United States is a fifth of the entire world's output, and the U.S. has maintained its status as the world's largest food exporter over a long period (Yearbook of the World's Economy, 2013: 532). In the late nineteenth century, the United States became an industrialized country as its agricultural and nonagricultural sectors separated. It should be noted that the mean size of a farm in the United States grew

Table 12. Agricultural Labor Productivity and the Separation of the Agricultural and Nonagricultural Sectors in the United States, 1970–2010.

Year	Total output of grain (1,000 tons)	Population (1,000 persons)	Agricultural population (1,000 persons)	Agricultural labor productivity (kg)	Weight of grain consumed yearly per capita		Number of persons an agricultural person can feed (i.e., $R + 1$)
					pounds	kg	
1970	186,851	204,880	9,880	18,912	135.6	61.56	307.21
1975	248,145	213,560	9,370	26,483	139.1	63.15	419.37
1980	269,952	227,740	8,860	30,469	144.7	65.69	463.83
1985	347,390	238,490	7,640	45,470	156.5	71.05	639.97
1990	312,708	249,910	6,580	47,524	181.5	82.40	576.75
1995	276,936	263,040	7,970	34,747	190.7	86.58	401.33
2000	342,809	282,170	6,200	55,292	199.2	90.44	611.37
2005	366,516	295,560	5,610	65,333	192.1	87.21	749.15
2010	401,670	309,350	5,150	77,994	196.9	89.39	872.52

Sources: Zhang, 1996: 50–51, 73, 156–57; Liu, 1998: 50, 75, 163; *International Statistical Yearbook*, 2006/2007, 2008, 2010, 2013; Economic Research Service, 2006; Economic Research Service, 2014; FAOSTATUSAP.

Note: The agricultural population in 1975 is the median of that between 1970 and 1980, as calculated by the author.

from about 50 acres in the 1920s and 1930s to about 1,400 acres today.[3] The reason for this change is that after the Second World War, agriculture quickly became mechanized and thus a great many people were liberated from agriculture, which further contributed to the separation of the agricultural and nonagricultural sectors in the United States. Since the United States is a food exporter and was able not only to increase its agricultural labor productivity but also to produce enough grain to feed its own citizens, we can say that the great increase in agricultural labor productivity was the basis for the further separation of the agricultural and nonagricultural sectors during the years 1970–2010.

In South Korea agricultural labor productivity during the period 1970–2010 skyrocketed from 542.1 kg to 2,884.1 kg (see Table 13). The number of persons that an agricultural worker could feed also seems to have risen dramatically. However, in the course of industrialization, the grain self-sufficiency rate of South Korea declined rapidly. In 2011, the rate based on nutritional energy supplied dropped to 44.5 percent (He and Chen, 2011). Thus, although on the surface it seems that agricultural labor productivity rose dramatically, the country became heavily dependent on imported grain, and it is impossible for an agricultural person to supply the number of persons shown in the last column of Table 13. Since most of the

Table 13. Agricultural Labor Productivity and the Separation of the Agricultural and Nonagricultural Sectors in South Korea, 1970–2010.

Year	Total output of grain (1,000 tons)	Population (1,000 persons)	Agricultural population (1,000 persons)	Agricultural labor productivity (kg)	Weight of grain consumed yearly per capita (kg)	Number of persons an agricultural person can feed (i.e., $R + 1$)
1970	7,953	32,240	14,670	542.1	190.0	2.85
1975	8,856	35,280	13,720	645.5	174.1	3.71
1980	6,387	38,120	12,770	500.2	158.2	3.16
1985	8,585	40,810	11,240	763.8	143.9	5.31
1990	8,336	42,870	9,590	869.2	130.5	6.66
1995	6,831	45,090	5,440	1,255.7	117.9	10.65
2000	7,501	47,010	4,140	1,811.8	106.5	17.01
2005	6,776	48,138	3,434	1,973.2	89.0	22.17
2010	6,345	49,410	2,200	2,884.1	83.9	24.38

Sources: Zhang, 1996: 46–47, 72, 156–57; Liu, 1998: 48, 74, 163; *International Statistical Yearbook,* 2006/2007, 2008, 2010, 2013; Statistics Korea, 2004; AgNet.
Note: The agricultural population in 1975 is the median of that between 1970 and 1980, as calculated by this author.

[3] The mean farm size comes from Douglas Hurt, an agricultural historian at Purdue University, whom I spoke with on October 17, 2016.

grain is imported, Korea, like Japan, is subject to the phenomena of an efficiency illusion and high food prices.

Conclusion

The data from China, Japan, the United States, and South Korea indicate that when the percentage of imported grain is low, a great improvement of agricultural labor productivity is the basis for the separation (or further separation) of the agricultural and nonagricultural sectors. In Japan and South Korea, it appears that agricultural labor productivity is high, but these two countries depend heavily on imported grain, which gives rise to an efficiency illusion, and indicates that the separation of the agricultural and industrial sectors has not been based on the rising level of productivity. In China and the United States, on the other hand, since the percentage of imported grain is comparatively low, the dynamic of the separation (or further separation) between the agricultural and nonagricultural sectors has been based on the great improvement of agricultural labor productivity. In China, agricultural labor productivity went through three stages: growth within a state of stagnation before 1985, slow growth during the period 1985–2000, and rapid growth since 2000. In each stage, productivity has been connected with the government's agricultural policies. Matched with these different stages of growth in agricultural labor productivity are different food structures, which also went through three stages: a low quantity of grains consumed; a high quantity of grains consumed with an emerging trend of the consumption of meat, eggs, and milk; and a low quantity of grains consumed with a greater quantity of meat, eggs, and milk.

A low level of agricultural labor productivity has historically come at a great cost to China. First, it led to a long-standing insufficiency of food and clothing. For a great many Chinese, hunger was a constant companion. Second, low agricultural labor productivity was partly responsible for the "up to the mountains and down to the countryside" movement, since sending millions of urban educated youth out of the cities and down to the villages to work as peasants was, in effect, a way of dealing with China's grain shortage. Although agricultural labor productivity began to improve dramatically since 2000, the changing food structure involving more meat, eggs, and milk, and the concomitant rise in livestock breeding, has led to a shortage of feed grain. The feed grain shortfall has been met by an increasing resort to importing grain such that, by 2010, imports accounted for 12.8 percent of China's grain supply. If appropriate countermeasures are not adopted, the percentage of imported grain will only increase. Not only will this be detrimental to the further liberation of the agricultural labor force and the separation of the agricultural and nonagricultural sectors, it will also lead to an efficiency illusion, aggravate China's dependence on imported grain, and cause the same or similar problems associated with grain that occurred earlier in China's history. As for the problem that the demand for feed grain has grown so rapidly that it can be met in part only by importation, the solution lies in advancing agricultural science and

technology. For instance, "stalk cultivation" is a new method that should be widely implemented.[4]

In recent years, a land finance policy has been carried out and the local governments have boosted the economy with property markets, which is the phenomenon of taking over farmland and developing it into something other than farming. If property markets continue to be developed, the phenomenon of an efficiency illusion that has harassed Japan and South Korea will take root in China.

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[4] According to Philip Huang's research, if pigs are fed on corn, 1 mu (6 mu = 1 acre) of arable land can support only 1 pig. However, if pigs are raised on feed made from corn stalks treated with biological enzymes, 1 mu of arable land can support 5 pigs (Huang, 2010).

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