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Rural China: An International Journal of History and Social Science 11 (2014) 222-243

Rural China 中国乡村研究
brill.com/rchs

Large Farms vs. Small Farms: Grain Production in Northwestern Shandong

Yuan Gao

大农场和小农户：鲁西北地区的粮食生产

高原

Abstract

The pattern of grain production in northwestern Shandong today is a combination of machinery and labor. The mechanization of plowing, sowing, and harvesting has freed "principal labor units" (i.e., males in their prime) from agriculture, while the relatively labor-intensive operations of applying fertilizer and agricultural chemicals (pesticides and herbicides) and watering still mainly rely on "auxiliary labor" (i.e., women and the elderly), which remains abundant in the countryside. The principal family laborers of households with small farms can thus pursue off-farm work, while auxiliary family labor, which has a lower opportunity cost, can still do the farming and ensure the output of grain. Large farms on the other hand have no incentive to introduce labor-saving machinery to take over what have been labor-intensive operations as long as cheap auxiliary labor is still plentiful. Thus large farms do not have a higher level of mechanization; however, they do have a totally different managerial logic. Their production is driven by capital, which is invested in acquiring land (through land transfers), hiring wage labor, and pursuing profit. In contrast, production in small farms is driven by the family's labor, pursuing the best division of work between principal and auxiliary family labor and the maximum output per unit of land. The land scarce–labor abundant reality of China requires that agriculture pursue higher output, larger product value, and higher net returns on each unit of land. It is small farms that best meet these requirements.

* Author's note: I thank Philip C.C. Huang for his helpful criticisms and suggestions. I would also like to acknowledge my debt to all the people who have helped me greatly during the investigation in Liaocheng.

Yuan Gao is an assistant professor in the School of Agricultural Economics and Rural Development, and Institute of Advanced Historical and Social Research, Renmin University of China (中国人民大学农业与农村发展学院，历史与社会高等研究所).

DOI: 10.1163/22136746-12341254

Keywords
grain production, large farms, small farms, capital, family labor, the transfer of land-use rights, principal labor, auxiliary labor, wage labor

摘要
鲁西北地区的粮食生产呈现出机械和劳动相互结合的模式。耕地、播种和收割环节的高度机械化代替了农业生产中的主劳动力，而相对劳动密集的施肥、打农药和浇水环节，则仍高度依赖农村中依然大量存在的辅助劳动力。对小农户而言，这种模式可以在保证家庭主劳动力外出务工的同时，使用机会成本较低的家庭辅助劳动力实现自家承包地上最大的粮食收入。而对于大农场而言，农村廉价辅助劳动力的存在，使它们并无动力为劳动密集的生产环节引入机械，而是选择使用雇工生产。大农场和小农户的区别，并不在于它们具有更高的机械化程度，而在于它们组织生产的逻辑不同。大农场体现的是资本的逻辑，由资本流转入土地、雇佣劳动力进行生产，追求资本的最大利润。小农户则是围绕家庭劳动的生产，追求主、辅劳动力之间的最佳分工和小块土地的最大产出。中国地少人多的国情要求单位面积土地创造出更大的农产品产出、产值和更高的净收益，是小农户而不是大农场更体现了这种要求。

关键词
粮食生产、大农场、小农户、资本、家庭劳动、土地使用权流转、主劳动力、辅助劳动力、雇佣劳动力

Since the fourteenth century, China's farmland per capita has been decreasing, leading to the situation today in which Chinese agriculture is characterized by an abundance of labor but a scarcity of land—a sharp contrast to a land abundant–labor scarce economy such as in the United States. The features of American agriculture, such as large-scale farming, a high degree of mechanization, and a high output per labor unit, have deeply impressed China's agricultural policy makers. Since the 1990s they have been pushing for the "transfer of land-use rights" 土地使用权流转 between farmers to increase farm size. Most recently, in 2013, the Chinese central government's first policy document of the year, "Central document no. 1" 中央一号文件, for the first time mentioned supporting "family farms" 家庭农场, and implicitly suggested that such farms might be the future of Chinese agriculture (Zhonggong zhongyang, 2013). Contemporary China's so-called family farms are quite different from the typical small household farms that emerged after the elimination of the agricultural collectives in the early 1980s. As central and local officials envision the future, "family farms" will be larger (100 mu or more) than the usual household farms under the "household contracting" 家庭承包制 system, will use a higher level of technology and less labor, but will continue to be managed by rural families. These farms will enjoy economies of scale, which can improve farmers' incomes as well as ensure the security of China's food supply.

Both the new "family farms" and "big grain-growing households" 种粮大户, which had already been officially advocated, are in fact large-scale farms based on "transferred land" and hired wage labor, in sharp contrast to small household farms based on the households' own "contracted land" and family labor.[1] This very important difference, however, has to some degree been overlooked by policy makers. Clearly recognizing this difference, some scholars have criticized the "larger is better" mentality in current agricultural policies.

He Xuefeng, the leader of a well-known rural study center in central China, has argued against the policy of supporting large-scale farming. Based on field studies, He has argued that the yield (output per unit of land) on large farms is in fact much lower than that on small household farms (He, 2013). At the same time, to create large farms requires transferring many plots of land, which increases production costs. Small household farms, which are based mainly on households' own contracted land, need not pay to acquire land and thus have lower production costs. He Xuefeng's conclusion is that large-scale farming is not suitable for Chinese agriculture, and the government should not support large farms at the expense of small household farms.

Like He, Philip Huang has also stressed the importance of supporting small household farms rather than large-scale farms. Huang has argued that China's economic history shows a remarkable persistence of small farming, and that the small household farm is in fact the most suitable way to organize production for labor-capital "dual intensifying" high-value agriculture, which has rapidly developed over the past twenty years (Huang, 2011). In Huang's view, the government should support farmers' cooperatives, which have spontaneously arisen to meet the needs of small-farm households for "vertical integration" from production to processing to marketing. If the government continues to support large-scale farming based on hired wage labor, Huang has warned, the future of Chinese agriculture could possibly be a highly capitalist economy, with more and more peasants losing their land and becoming agricultural proletarians. Both Huang and He advocate an agricultural economy that consists of moderate-scale household farms, which would still be based mainly on family labor and the households' own contracted land (He, 2012; Huang, 2012).

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[1] After the rural reforms of the 1980s, farmland owned by the village collectives was contracted to individual households, which have the use rights of their "contracted land," without payment. However, large farms have to transfer in other households' contracted land, and have to pay for the "transferred land."

However, previous studies and policy discussions have paid little attention to the details of agricultural production, such as the technology employed in various operations and the corresponding need for labor, even though these deeply affect the forms and managerial logic of productive organizations. In this article, we will focus on grain production in northwestern Shandong, especially on the details of grain farming and the operative logic of two different kinds of productive units: large-scale farms using wage labor, and small household farms (which are genuine family farms) using family labor. Based on an analysis of actual farming operations and management, we will explore the economic logic of both kinds of farming and the corresponding implications for agricultural policies. In particular, we will thoroughly analyze the pattern of production on large-scale farms and show how this differs from policy makers' conceptions.

Two Different Types of Productive Units

Two different types of productive units are involved in raising grain in northwestern Shandong. The first, the small household farm, whose production is mainly based on the household's own contracted land and family labor, is the dominant productive unit in that area, where the tradition of small farming has a very long history. Actually, the small household farm is a genuine peasant family farm as conceived of in the tradition of agrarian studies. Some small household farms might transfer in a little land and hire some short-term labor, but these are trivial compared with the family's own contracted land and family labor. The other type is the large-scale farm, whose production is mainly based on transferred land and hired wage labor. In northwestern Shandong, large-scale farms, which can be 100 to 700 mu or more, are far larger than small household farms, which are usually less than 15 mu. Creating a large farm usually means transferring in a great deal of land from many households in one or more villages, and signing formal contracts with those households. With respect to labor input, large-scale farms mainly rely on hired wage labor, in sharp contrast to small household farms, on which there is little or no wage labor. The large-scale transfer of land and the use of hired labor, a quite recent phenomenon, has given birth to large farms, also managed by rural households, which usually are called "big grain-raising households," or more recently, "family farms." Though the number these large-scale farms is still very small compared with the sea of small household farms, the number is increasing because of support from the central and local governments for grain farming on an extensive scale.

That large-scale farms are based on transferred land is largely due to the "household contracting" system of farmland management. Under this system, the village collective, rather than the individual households, owns the village's farmland. At the same time, that farmland has been contracted to the village's households, each of which has the use right of its contracted land. The ownership of farmland cannot be transferred between individual households, but the use right of contracted land can be "transferred" from one household to another. Thus large-scale farms cannot "buy" land in an one-off trade, but they can "transfer" in land from small-scale farmers and pay those households "land transfer payments" 土地流转费 each year. As we will see later in the article, the yearly land-transfer payments are a heavy burden on large farms.

The reliance of large farms on hired labor is particularly noteworthy. It is commonly thought that large farms have a much higher level of mechanization than small farms and that they use much less labor. However, the large farms we surveyed in northwestern Shandong in fact heavily rely on the intensive use of hired labor and their pattern of mechanization is exactly the same as with small farms: tractors and combines have substituted for principal labor in plowing-sowing-harvesting while other operations still mainly rely on manual labor. We find no sign of a higher degree of mechanization on large farms than on small household farms. To uncover why this is so we need go into the details of farming operations, the subject of the following sections.

Grain Production in Northwestern Shandong: The Coupling of Machinery and Human Labor

Though there are key differences between large farms and small household farms in terms of the input of land and labor, they have a very similar process of grain-production operations. In northwestern Shandong, the basic mode of grain production is the winter-wheat-summer-maize rotation system, which involves the following operations:

Wheat Cropping: plowing, spreading base fertilizer, sowing, spreading additional fertilizer (1-2 times), watering (1-2 times), applying herbicides, applying pesticides (1-2 times), and harvesting.

Maize Cropping: sowing and applying base fertilizer (for maize, the two operations are done together by mixing fertilizer with seeds during sowing),

spreading additional fertilizer (1-2 times), watering (1-2 times), applying herbicides, applying pesticides (1-2 times), and harvesting.

These operations can be divided into two groups, according to the degree of mechanization. Plowing, sowing, and harvesting, on both large and small farms, are highly mechanized. This is reflected in the terminology used by peasants nowadays: "mechanized plowing" 机耕, "mechanized sowing" 机播, and "mechanized harvesting" 机收. Tractors, tractor-drawn drills, and combines have substituted for draft animals and principal labor in these highly mechanized operations. The other crucial operations—spreading fertilizer, applying agricultural chemicals (herbicides and pesticides), and watering—still mainly rely on manual labor (especially auxiliary labor—women and the elderly) rather than on machinery.

The rapid mechanization of plowing-sowing-harvesting is the result of the significant increase in the opportunity cost of principal labor in grain farming over the past two decades. Since the 1980s, China's industry and service sectors have developed quickly, providing more and more opportunities for off-farm work and drawing millions of laborers, especially principal laborers (adult men), out of agriculture. Concomitantly, many peasants have turned from grain farming to the "new agriculture" of high-value products, such as vegetables and fruit and livestock, poultry, and fish (Huang, 2011). The high income from off-farm work and the high net returns per land unit from the "new agriculture" have been pushing up the opportunity cost of principal labor in grain farming, causing a greater resort to mechanized plowing-sowing-harvesting.

Previous studies of agriculture mechanization have stressed the influence of farm size on the application of machinery and have argued that larger farms are more inclined to apply machinery to substitute for labor (Binswanger, 1986). One would expect, therefore, that the small household farms of northwestern Shandong, which are usually less than 15 mu (or 1 hectare), would be very unlikely to turn to mechanized plowing-sowing-harvesting. However, in fact small farms commonly turn to machinery in those operations by purchasing the services involved in mechanized plowing-sowing-harvesting, abundantly provided today by numerous individual machinery-owners and peasant cooperatives. A full set of services of mechanized plowing-sowing-harvesting for 1 mu of farmland costs about 200-250 yuan, which is not much more than a day's wages for a male migrant worker in the city today. Thus households with small farms are willing to buy these services to free their principal labor for off-farm employment and to avoid having to purchase and maintain expensive machinery. Even many large farms prefer to buy mechanized

plowing-sowing-harvesting services instead of maintaining their own big machines since the former is more economical.

Although the mechanization of plowing-sowing-harvesting can free principal labor from most of the exhaustive work, these operations still need some auxiliary manual labor to assist the machinery. During sowing, a tractor-drawn drill requires one or two auxiliary workers, who bring seeds to the drill and load it and also plant seeds by hand on spots the drill may have missed. During harvesting, a combine also needs auxiliary workers to help transfer the harvested grain from the combine to motorized tricycles. The workers also take sickles with them to reap the grain missed by the combine. For small farms, the auxiliary work involved in mechanized plowing-sowing-harvesting can be readily done by one or two family members, while large farms have to hire wage labor to do the work.

Compared to mechanized plowing-sowing-harvesting, the operations of spreading fertilizer (base fertilizer or additional fertilizer), applying agricultural chemicals (pesticides and herbicides), and watering, which are crucial to high grain yields, still rely on intensive manual labor rather than machinery. Fertilizer is filled into special containers, carried by peasants to the fields, and spread by hand. Agricultural chemicals are applied to crops by hand-carried power sprayers. Both operations require the intensive use of manual labor. Watering can be done by pumps powered by electric motors or diesel engines, but laborers are still needed to operate the pumps and, more importantly, to observe whether the fields have been well watered. For small farms, these labor-intensive operations can be handled by family members. Large farms, however, have to hire many wage laborers to provide the intensive work needed by these operations.

In summary, grain production in northwestern Shandong today can be understood as a coupling of the highly mechanized operations of plowing-sowing-harvesting and the relatively labor-intensive operations of spreading fertilizer, applying agricultural chemicals, and watering. This particular pattern of grain production, as we shall see, has quite different influences on small farms and on large farms.

The Economic Logic of the Small Household Farm and the Large-Scale Farm

For households with small farms, the mechanization of plowing-sowing-harvesting has freed their adult men from the most exhaustive farmwork. They can now go to the city and work in industry or service sectors and bring back to their families a larger cash income. They can also turn to the “new agriculture”

of higher returns such as growing vegetables or raising livestock. The remaining small amount of handwork in plowing-sowing-harvesting and the relatively labor-intensive work of spreading fertilizer, applying agricultural chemicals, and watering can be done by the family members who have stayed home on the farm. It is difficult for these family members, usually women and the elderly, to find off-farm employment and thus they have lower opportunity costs. Thus it is economical for households to arrange for them to do the farmwork.

Peasants in northwestern Shandong today figure that the total cost during one year of the winter-wheat-summer-maize rotation approximately equals the output value of the wheat or maize that is raised (the output values of the two crops are usually close to each other). Thus, the total net income from one production year from the plowing for wheat to the harvesting of maize approximately equals the output value of the wheat or maize grown that year. In normal years, the yield of wheat is about 1,000 jin (500 kg) per mu, and the market price is about 1.1-1.2 yuan per jin; the yield of maize is about 1,100-1,200 jin, with a price of about 1-1.2 yuan per jin. Therefore, in normal years, for small farms, the annual net income per mu from grain production is about 1,100-1,400 yuan. Furthermore, the agricultural tax on grain output was abolished in 2006, and grain-producing households in northwestern Shandong today can receive a basket of subsidies totaling 125 yuan per mu. In short, it is profitable for small household farms to continue to raise grain while their principal laborer turns to off-farm work.

Even in years with extremely bad weather, when output can drop by 30 or 40 percent, small farms can still earn a net income of about 700-800 yuan per mu. Therefore, the question of small farms raising grain is by no means of little value or interest. Growing grain has in fact been reorganized into a kind of efficient business that utilizes both the family's small plot of contracted land and the labor of the family members unable or unwilling to find off-farm work. This fact is also reflected in the increasing payments for the transfer of land-use rights, which is mainly determined by the net returns of grain production per unit of land. The economic logic behind today's small grain-raising farms is in fact to optimally allocate family labor (especially the division of labor between the principal labor of adult men and the auxiliary labor of women and the elderly) and to pursue the maximum output on every small piece of land. This logic stretches back more than six centuries; the recent trend toward mechanization to substitute for principal labor in grain production has added new muscle to it.

For large farms in northwestern Shandong, the pattern of grain production has resulted in a different managerial logic. First, a larger farm size can help to reduce the wear and tear and other operational costs per land unit of large, expensive agricultural machinery. Thus some very large farms want to have

some expensive machinery such as large tractors and combines. Nonetheless, most farms of several hundred mu, which constitute the majority of the large farms in northwestern Shandong, still prefer to buy mechanical services, since the cost of maintaining large machines is still too high for them.

Second, the remaining labor-intensive operations make it necessary for large farms to hire a significant amount of wage labor. All the large farms we investigated apparently have no interest of using machinery to substitute for labor in applying fertilizer or agricultural chemicals; they would rather hire wage labor to do the work. This is mainly because there is still a labor surplus, especially of auxiliary family labor (women and the elderly), in China. The cost of surplus auxiliary labor is relatively low, so it is economical to use hired labor instead of machinery to do labor-intensive operations. This logic is also a typical feature of traditional Chinese agriculture: when labor is abundant, there is no impetus to introduce labor-saving machinery for grain farming. The explosive growth of the nonagricultural sectors in China in the past three decades has nearly eliminated the surplus of principal labor in agriculture, but auxiliary labor is still in surplus. This can be seen from the fact that large farms in northwestern Shandong still use hired labor rather than machinery for labor-intensive operations.

The members of families who run large farms in fact rarely do farmwork. Mostly they supervise hired workers and run the agribusiness. Large-scale farms, including so-called "family farms," in fact mimic family-owned capitalist enterprises. Their production is driven by capital and is constrained by the amount of their capital, very different from the small-scale farming that is driven by family labor and is constrained by the amount of available family labor.

The costs of land are also a key difference between the small farm and the large-scale farm. Small farms based on the household's own contracted land need not pay for the land. But for a large farm, which has to transfer in many plots of land from other households, the payments for the transfer of land-use rights will be extremely large. Note that there are two types of land transfers in northwest Shandong. The first type is between small-farm households. When a peasant is going to the city for an off-farm job, he usually transfers the use right of his contracted land to his relatives, friends, or neighbors. The annual payment for the transfer is quite low (about 300-600 yuan per mu). This type of transfer is usually informal and is done without a written contract, and is regulated by the moral norms of rural communities rather than by village or township officials and the formal legal system. The second type of land transfer is between small-farm households and an individual who seeks to run a large-scale farm. The total amount of land transferred is usually very large (typically several hundred mu or more), and includes the contracted land of many households. This type of transfer is usually supported and advanced by the village

committee and the township government, and it usually entails formal written contracts and much higher payments. The annual rent such land transferred for grain production is usually 1,000-1,300 yuan per mu. (For vegetable cultivation or livestock raising, the payment is usually calculated as equivalent to the total value of 500 kg of wheat and 500 kg of maize, which would as a rule be more than 2,000 yuan.) Land costs are a heavy burden on large-scale farms, and mainly because of this, such farms have much higher production costs per unit of land than do small farms.

Empirical Cases

Farming Operations and the Allocation of Labor

In this section we turn to some empirical cases of large-scale farms and small household farms collected during field research in the rural areas of Liaocheng city in northwestern Shandong in November 2013. The research focused on the latest production year, from the plowing for wheat in September 2012, to the harvesting of maize in August 2013. We investigated and surveyed three large farms with different characteristics (Farm A in Gaotang county, and Farms B and C in Dongchangfu district), the size of which ranges from 120 mu to 736 mu. The farms are all based on transferred land and hired labor. However, they are different from each other in some aspects of machinery and labor usage.

With respect to machinery usage, Farm A has all the machinery needed for plowing-sowing-harvesting and does not buy mechanical services; Farm B has machines for plowing and sowing but buys mechanized harvesting services, since it lacks combines; Farm C has no machines for plowing-sowing-harvesting and totally depends on mechanical services, just like small farms. With respect to labor usage, all three of the farms totally rely on hired labor for the labor-intensive operations of spreading fertilizer, applying agricultural chemicals, and watering. For the remaining handwork in plowing-sowing-harvesting, Farms A and B use hired labor only; Farm C uses both hired labor and family labor. To draw comparisons with the large-scale farms, we also surveyed four small household farms (Households A and B near Farm A in Gaotang county, and Households C and D in Donge county), ranging in size from 5.4 mu to 22 mu. Households C and D are totally reliant on their own contracted land, while Households A and B also farm a little transferred land. For plowing-sowing-harvesting, they all depend on mechanical services. All other handwork is done by members of the family. The patterns of grain production of the surveyed large farms and the small farms is summarized in Table 1.

Table 1. Patterns of Grain Production in Northwestern Shandong (for the production year 2012-2013)

	Farm A	Farm B	Farm C	Four small household farms
Size of farmland	736 mu	120 mu	201 mu	5.4-22 mu
Family members involved in farming	0	1	2	2-4
Plowing-sowing-harvesting	Uses own machines	Uses own machines and buys services	Buys services	Buys services
Labor input in plowing-sowing-harvesting	Wage labor	Wage labor	Wage labor and a little family labor	Family labor
Labor input in spreading fertilizer, applying chemicals, and watering	Wage labor	Wage labor	Wage labor	Family labor

Source: Author's survey.

Let us look closer at the surveyed farms. Farm A, in the rural area of Liaocheng city, is extremely large by Chinese standards (736 mu) though very small compared with typical American large-scale farms. All its farmland has been transferred from households with small farms in two adjacent villages. The farm produces wheat and maize under the winter-wheat-summer-maize rotation system. The farming is done by hired labor with the farm's own machines, supervised by two experienced old peasants, who are good friends of the owner of the farm and do the work for free. Having supervision provided for free, of course, is a special case. Usually, owners of large farms do the work themselves, or otherwise they hire someone.

The first operation in grain production is the plowing before the sowing of wheat. This was done by two large tractors (of 100 and 110 horsepower respectively) with tractor-drawn plows. The plowing required eight days. The farm hired two drivers for the tractors at 200 yuan per day, high pay warranted by

the fact that plowing is hard and needs skill. The sowing of wheat after the plowing was done by two small tractors (25 horsepower each) with two drills. This required seven days. Two drivers were hired at 80 yuan a day, which is much less than the drivers for plowing were paid, because their work was much easier. Four auxiliary workers were also hired at about the same wage—two as *genlou* 跟耧 ("drill-followers," who load the drills with wheat seeds) and two as *la maizhong* 拉麦种 ("wheat-seed-transporters," who bring the wheat seeds to the drills using motorized tricycles).[2] Usually, the auxiliary workers are relatives of the drivers and come to the farm with them. The harvesting was done with a large combine specialized for wheat, and required six days. The farm hired an operator for the combine at 300 yuan a day, high pay but justified because of the skill and physical strength need to operate the combine and the bad working conditions (harvesting occurs during the hottest days of summer). The large farms we surveyed hired four auxiliary workers to assist the mechanical operations—two as *ba maili* 扒麦粒 ("wheat-kernel-rakers," to help unload the wheat kernels from the combine and reap the wheat missed by the combine) and two as *la maili* 拉麦粒 ("wheat-kernel-transporters," to transport the wheat kernels to the storehouses). After the harvesting of wheat, the sowing of maize began, using two small tractors each drawing a drill. This operation lasted six days, and the farm hired two drivers and two auxiliary laborers as *genlou*, who performed a function similar to that of the *genlou* in wheat sowing. The harvesting of maize, lasting eight days, was done by a large maize-specialized combine with two hired drivers (at 200 yuan a day each) and six hired auxiliary workers—two as *ba yumi* 扒玉米 (maize-kernel-rakers) and four as *la yumi* 拉玉米 (maize-kernel-transporters).

Now we turn to the labor-intensive operations. Farm A applied fertilizer four times in the production year of 2012-2013 (for wheat, base fertilizer once and additional fertilizer twice; for maize, base fertilizer once). The hired workers first filled containers like large dustbins with fertilizer. They then carried the containers into the fields and spread the fertilizer by hand. At this stage, it is easy to spread base fertilizer since there are no crops in the fields yet. However, spreading additional fertilizer is difficult and slow since the crops have grown

[2] Because farming households start plowing, sowing, and harvesting at about the same time, the demand for labor at those times rises and in response the pay for hired labor also rises. However, during other times, when farming operations do not overlap as much, there is less strain on the labor supply, and hence the pay of hired laborers is lower. Nonetheless, in some extreme situations, such as a sudden outbreak of a plant-disease epidemic or a long-lasting drought, the demand for labor for applying pesticides or watering will quickly rise and concomitantly the pay for hired laborers will also rise.

tall. The spreading of fertilizer, done exclusively by manual labor, is needless to say very different from the mechanized plowing-sowing-harvesting, in which manual labor is only a supplement.

Similarly, applying agricultural chemicals, including herbicides to control weeds and pesticides to kill pests and to prevent plant diseases, is also highly labor intensive. Farm A applied agricultural chemicals six times in the production year of 2012-2013 (for wheat and maize respectively, herbicides once and pesticides twice). The chemicals were applied by hired workers, who walked in the fields, spraying the chemicals on the crops using hand-carried power sprayers.

Compared with applying fertilizer and chemicals, watering has a relative higher level of mechanization. In the 2012-2013 production year, Farm A watered wheat once and did not water maize. The watering was done by 12 hired laborers with six pumps, four powered by diesel engines and two by electric motors. Two people were hired for each pump—one operated the machines and the other observed the progress of the watering.

All the work in the labor-intensive operations was done by wage labor hired from nearby villages. The daily pay for a worker usually fluctuates between 60 to 80 yuan, corresponding to the labor supply and demand at the time the worker is hired. The turnover of hired workers is quite high. It is possible that a worker hired and working today might not come tomorrow. Therefore, perhaps the best way to estimate hired labor input is in terms of "labor days." Data on the input of labor, measured in "labor days," in the labor-intensive operations of the surveyed farms are shown in Table 2.

The two old peasants who supervised the entire process of grain production told the author during the investigation that Farm A usually has a lower yield than small farms in normal years (about 100 jin or 50 kg less for both wheat and maize). They thought this is because the operations on large-scale farms cannot be done as carefully as on small household farms. Actually, we can give a more quantitative analysis to this empirical fact with the data on labor input, which confirms the old farmers' intuition. Table 2 shows that the labor input per land unit of the small household farms was about 3-6 labor days per mu, considerably higher than that of the large-scale farms, which was about 1 labor day per mu. The obvious difference in operations that are crucial to a high yield is a clear and quantitative reflection of the old peasants claim that "large-scale farms are less careful in farming than small farms." Technological improvement over the last six decades has brought significant change to Chinese agriculture, such as the replacement of organic manure by chemical fertilizers, the replacement of human weed-control and pest-control by herbicides and pesticides, and the

Table 2. Labor Inputs in the Labor-Intensive Operations, Production Year 2012-2013

	Labor input (labor days)						Total input (labor days)	Farm size (mu)	Labor input per land unit (labor days per mu)
	Wheat			Maize					
	Spreading fertilizer	Watering	Applying agricultural chemicals	Spreading fertilizer	Watering	Applying agricultural chemicals			
Farm A	253	72	152	114	0	114	705	736	1.0
Farm B	21	10	12	24	10	8	85	120	0.7
Farm C	44	24	39	20	0	60	187	201	0.9
Household A	2	18	3	12	6	21	62	22	2.8
Household B	3	6	3	12	4	11	39	10	3.9
Household C	10	12	9	6	12	9	58	10.8	5.4
Household D	5	6	9	3	6	4.5	33.5	5.4	6.2

Source: Author's survey.

replacement of waterwheels by power pumps, but production still depends on a considerable amount of manual labor input to ensure high yields.

The above facts reveal that Farm A has a very different managerial logic from that of the small farms. All its labor input comes from hired wage labor and the costs of labor can be clearly measured in terms of money. Farm A is in fact a capitalist farming firm based on hired wage labor and other marketable factors of production (especially transferred land).

Farms B and C also are highly reliant on hired wage labor, although they are in some respects different from Farm A. Farm B encompasses 120 mu and also produces winter wheat and summer maize. It is managed by the 58-year-old household head and his wife. Its land was all transferred from other households for a fee of 600 yuan per mu per year. This is quite low for land transfers in the neighborhood. The household attributes this to the fact that the soil used to be saline and alkaline, and although it has been improved, it is still considered to be worse than other land in the village.

For plowing, Farm B used its own big tractor (92 horsepower) and a tractor-drawn plow. Unlike Farm A, where all the plowing was done by a hired worker,

the household head of Farm B shared the work with a hired hand. Thus he paid the driver just 120 yuan a day, much less than the market wage of about 200 yuan per day. The sowing of wheat was done by the farm's own small tractor (20 horsepower) and a drill, with a hired driver and a hired auxiliary worker. The household head did not sow himself. And the harvesting of wheat was done by purchasing the services of a combine with three hired auxiliary workers; the farm does not have its own combine. The sowing of maize was also done by the small tractor with a hired driver and a hired auxiliary worker. The harvesting of maize was done by another hired team, consisting of four men, with their own machinery. Finally, the labor-intensive operations of applying fertilizer and chemicals and watering were done by hired labor from nearby villages. The household head and his wife only supervised the work.

Now we turn to Farm C, not far from Farm B. It has 201 mu (of which 191 mu was transferred from others, at 600 yuan per mu per year, the same as with Farm B, and the remaining 10 mu is the household's own contracted land). It is also managed by the household head and his wife. Unlike Farms A and B, Farm C does not have machinery for plowing-sowing-harvesting and totally depends on mechanical services. In addition, it uses some family labor for the auxiliary work during the plowing-sowing-harvesting. In the 2012-2113 production year the household head and his wife did all the auxiliary work involved in the sowing of wheat and maize and did part of the work of the harvesting of wheat and maize. They also hired some auxiliary workers for the harvest (two for wheat and six for maize) when the work was extremely busy. The application of fertilizer and chemicals and the watering were totally done by hired labor. The role of the household head was limited to making the decisions on how much and what sorts of fertilizers and chemicals to apply, and supervising the work.

Obviously, all three of the large farms have the characteristics of capitalist farming: they are all based on transferred land and rely on hired wage labor. But in their pattern of farming operations, they are very different from the American type of large farm. In a recent article, Philip Huang has point out that American large-scale farming, besides its capitalist managerial logic, tends toward more and more mechanization and the substitution of human labor in all operations (Huang, 2013). However, in Chinese agriculture, though mechanized plowing-sowing-harvesting has freed principal labor, which has the highest opportunity cost, applying fertilizers and chemicals and watering, which are crucial to ensuring a high yield, are still highly labor-intensive rather than machine-intensive. This is true of both small and large farms in northwestern Shandong. In fact, it is the surplus of auxiliary labor which is still available in rural China that has made it possible for large-scale farms to use hired labor at

a relative low cost for applying fertilizers and chemicals and watering. In the distant future it may be that the surplus of labor in China's countryside will disappear and with it intensive use of labor in some essential operations, but for now large-scale farming still shows a mixed pattern of both mechanization and intensive use of labor.

Costs and Returns

The costs and returns of the large farms surveyed are substantially different from those of the small farms (see Table 3).

The data show that the production costs of the large farms are much higher than those of the small farms (about 30-50 percent higher). This is mainly because the large farms have very high land costs, which account for 61 percent of the total costs of Farm A, 47 percent of Farm B, and 45 percent of Farm C. As noted earlier, all the land of Farms A and B has been transferred from other households. The annual land rent for these two farms is 1,000 yuan and 600 yuan respectively. Also as noted earlier, Farm C transferred in 191 mu of land at 600 yuan per mu per year; only 10 mu is the household's own contracted land. Thus the average annual cost for land rent is 570 yuan per mu. As Table 3 shows, for all three of the large farms land rent makes up the largest part of production costs.

The small farms that do not transfer in land, such as those of Households C and D, pay nothing for their land. Some small farms, such as those of Household A and B, do transfer in a little land, but in these cases the farms are still mainly based on the households' own contracted land. Household A has 14 mu of contracted land and transferred in 8 mu from a neighbor in the village at 650 yuan per mu per year. Thus its average land cost is 236 yuan per mu per year. Household B has 6.6 mu of contracted land and transferred in 3.4 mu from a relative at 300 yuan per mu per year. Thus its average land cost is 102 yuan per mu per year. Households with small farms are unlikely to transfer in much land, because the scope and scale of their farming activities, as discussed earlier, are determined by the availability of their own family labor.

The costs of seeds, chemical fertilizers, and agricultural chemicals are the second largest production costs of the three large farms (27 percent, 27 percent, and 33 percent, respectively), and are the largest of the four small farms (51 percent, 52 percent, 68 percent, and 67 percent respectively).[3] The cost of

[3] This suggests that seeds, chemical fertilizers, and agricultural chemicals are still the most important modern factors of production for both large and small farms in northwestern Shandong. And these factors in fact have been the material foundation for the development of Chinese agriculture over the past several decades (Huang and Gao, 2013).

Table 3. Production Costs per Unit of Land, Production Year 2012-2013 (units: yuan per mu)

	Expenses for mechanized plowing-sowing-harvesting				Seed	Fertilizer	Pesticides	Cost of diesel fuel for watering	Wages for hired labor	Land rent	Total
	Drivers' wages	Depreciation of machinery	Cost of diesel fuel	Mechanical services							
Farm A	12	55	46	0	80	317	45	8	81	1,000	1,643
Farm B	9	104	48	90	85	244	19	19	50	600	1,267
Farm C	0	0	0	220	100	285	33	12	47	570	1,267
Household A	0	0	0	199	115	328	71	61	0	236	1,010
Household B	0	0	0	200	110	240	28	45	0	102	725
Household C	0	0	0	235	121	430	47	48	0	0	881
Household D	0	0	0	235	116	420	48	48	0	0	867

Source: Author's survey.

mechanized plowing-sowing-harvesting is much less than the cost of seeds, fertilizers and chemicals—only about 30 percent to 50 percent of the latter, for both large and small farms. This suggests that substituting machinery for manual labor is less important than the production factors aiming to increase grain yields, though mechanization in Chinese agriculture has expanded rapidly in recent years due to the huge amount of labor that has left farming. The object of the mechanization of grain production in northwestern Shandong, as discussed above, is to replace the principal labor that once was indispensable in plowing-sowing-harvesting, not to replace all the labor involved in growing grain. This is true not only of small farms but also of large farms. The principal laborers of a small-farm household can earn more in off-farm work, so it is economical to replace them in plowing-sowing-harvesting and pay for the mechanical services from the income they earn from off-farm work. Whatever work remains unmechanized can be done by women and the elderly who are unable or unwilling to find an off-farm job. From Table 3 we can see the cost of wage labor is low compared to the costs of land, machinery, and the yield-increasing factors of seeds, fertilizers, and pesticides. Thus it is also economical for large farms to hire wage labor to apply fertilizers and chemicals and to water the crops rather than use labor-saving machines such as power fertilizer-distributors, tractor-borne sprayers, and sprinkler systems.

The data on the output and the net returns per land unit of the surveyed farms (see Table 4) show, first, that the yield of winter wheat on both the large and small farms is quiet close: the yield on the latter is about 900-950 jin per mu; on Farms A and C the yield is 100-200 jin per mu lower, and on Farm B, 100 jin per mu higher.[4] Although we cannot deduce statistically reliable conclusions on whether large-scale farms or small farms have a higher yield from a mere seven samples, some useful economic information can still be extracted from the data with the help of the earlier discussion of the details of the operations on the surveyed farms. As mentioned above, large farms rely on both machinery and manual labor, and the high-yield-determining operations of applying fertilizers and chemicals and watering are still mainly done by hired wage labor rather than by machines. This means the farming on large farms is still intensive rather than extensive, and maximizing yields is highly valued. This is very different from American large-scale farming, where the emphasis is more on saving human labor than increasing yields. Relatively intensive large-scale farming is made possible by the fact that there is a surplus of auxiliary

[4] Similar data on small farms can be found in our previous field studies in the rural areas of Liaocheng city (Gao 2010, 2011, 2012).

Table 4. Output and Net Returns per Unit of Land, Production Year 2012-2013 (units: yuan per mu, jin per mu)

Productive unit	Production costs	Charge for water	Subsidy for improved seeds	Comprehensive subsidy for grain production	Output of wheat	Output of maize	Total output value	Net return
Farm A	1,643	0	0	0	800	800	1,680	37
Farm B	1,267	0	0	0	1,000	450	1,677	410
Farm C	1,267	0	0	0	700	700	1,540	273
Household A	1,010	36	10	125	900	1,300	2,548	1,637
Household B	725	36	10	125	950	1,200	2,459	1,833
Household C	881	36	10	125	900	1,000	2,180	1,399
Household D	867	36	10	125	900	1,000	2,216	1,448

Source: Author's survey.
Note: Net return = total output value—production costs—cost of water + subsidy for improved seeds + comprehensive subsidies for grain production. Under the present agricultural policies of Liaocheng city, small farms pay a charge for water while receiving a subsidy for improved seeds and a comprehensive subsidy for grain production. Usually, if the householders have transferred their land to others, they will still pay the water charge and continue to receive the two subsidies.

family labor that can be hired at a relatively low wage. Nonetheless, hired-labor-based large-scale farming cannot be as intensive as family-labor-based small farming, just as the two old peasants who manage Farm A said.

Especially when an intensive input of labor is needed within a short period of time, large farms are more likely to act less effectively than small farms. In the summer of 2013, the rural areas of Liaocheng city received considerably more rainfall than in normal years. Consequently, a great deal of labor was needed to drain the water off in a few days. In this situation, large farms did less well than small farms. As can be seen in Table 4, the yield of summer maize on Farms A, B, and C—only 650 jin on average—was heavily impacted, while that of small farms—1,150 jin on average—was only slightly affected.

The data on returns reveal a significant defect of large-scale farms: their ability to deal with the risk of a decline of output caused by nature is weaker than that of small farms, a point that has been totally neglected by agricultural policy makers. As discussed above, the production costs of large farms are far higher than those of small farms. Thus even in normal years, when there is no decline in production, the net returns per unit of land of large-scale farms is likely to be much lower than that of small farms. When output drops because of bad weather, the already low net return per unit of land will be further

reduced—just as happened to Farm A, which had a net return per mu of only 37 yuan, caused by the bad summer weather in 2013, as shown in Table 4. In contrast, small farms are better able to maintain output. If the four surveyed small farms, for example, were to suffer a 50 percent drop in output, they would still have higher net returns than large farms that suffered no decline in output. Moreover, small-farm households usually enjoy income from off-farm work in addition to income from grain farming, and many of them nowadays also have good returns from high-value agriculture such as raising vegetables and fruit and producing meat and poultry. Compared with large farms, small-farm households have more sources of income, which has enhanced their capacity to deal with the risk involved in grain farming. Large-scale farms on the other hand typically specialize in grain, which usually is their only source of income. If large-scale farming were to prevail, the stability of China's entire agricultural economy would be threatened. As the Russian economist A. V. Chayanov pointed out, peasant family farming based on the family's own land and labor is more competitive than capitalist farming based on rented land and wage labor. The reason is simple: peasant households can still carry on farming even "in conditions where capitalist farms would go bankrupt" (Chayanov, [1925] 1966: xviii). Although some empirical studies have argued that the large farm has a lower net return per unit of land than the small farm (He 2013, Chen 2013), the financial instability of the large farm still needs more attention from both scholars and policy makers.

Conclusion

The basic pattern of grain production in northwestern Shandong is a coupling of machinery and manual labor: machinery has substituted for principal labor in the highly mechanized operations of plowing, sowing, and harvesting; the high-yield-determining operations of applying fertilizer and agricultural chemicals and watering still mainly rely on relatively intensive manual labor.

This farming pattern of coupling machinery and manual labor means different economic logics for small farms and large farms in northwestern Shandong. Small-farm households, by buying mechanical services for plowing-sowing-harvesting, they can free their principal labor for relatively high-paying off-farm work. The remaining work in plowing-sowing-harvesting, and the intensive manual work in applying fertilizer and chemicals and watering, can be done by the auxiliary family laborers who are unable or unwilling to find an off-farm job. It is economical to have those auxiliary laborers with lower

opportunity costs do the farmwork. Consequently, this new production pattern has by no means weakened small-scale household farming, rather, it has reinforced the basic economic logic of the small farm—the best allocation of family labor (especially the division of work between principal and auxiliary laborers) and the maximization of output per land unit—and has made small household farming more profitable and competitive.

However, large farms cannot rely on family labor. They have to hire wage labor for the handwork involved in plowing-sowing-harvesting and, more importantly, for the intensive handwork in applying fertilizers and chemicals and watering. Large "family farms" that only rely on the labor of a couple family members, as imagined by agricultural policy makers, are far from a reality in northwestern Shandong. Our investigation and survey show that even farms of only 100-200 mu still mainly rely on hired labor, not family labor. Since pay for rural auxiliary laborers is still relatively low, large-scale farms prefer to use these cheap auxiliary laborers to do the work in the labor-intensive operations rather than use labor-saving machinery. This kind of managerial logic is, needless to say, very different from the tendency of substituting for all manual labor in American large-scale farming.

In addition, large farms have much higher production costs than small farms, mostly because the cost of their land is much higher inasmuch as they must pay rent for transferred-in land. Thus, large farms have much smaller net returns per unit of land, which can only be made up by the fact that the farms are relatively large. This kind of economic logic is totally incompatible with the land scarce–labor abundant reality of China, which requires that agriculture pursue higher output, larger product value, and higher net returns on each unit of land. It is small farms rather than large farms that best fit those requirements.

Funding

The work is supported by 中国人民大学新教师启动金项目 ("New Teachers' Starting Fund Project of Renmin University of China") 项目批准号13XNF048 (Grant No. 13XNF048).

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