Literature Review of Agricultural Scale Management and Efficiency

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Abstract Scale management remains the core position in entire development process of the economics and is a major issue of academic research and government concern. Focusing on related problems of agricultural scale management, this paper explored 4 aspects of past literature. (i) It defined the agricultural scale management based on economies of scale theory and changes in returns to scale. (ii) From the perspective of the returns to scale of grain production, there are changes in returns to scale of China's grain production, but the measured changes are not significant. (iii) Existing analysis on factors influencing agricultural scale management mainly includes factors influencing farmers' willingness of scale management and restrictive factors of implementation of scale management. (iv) In studies of the relationship between land management scale and production efficiency, many scholars made qualitative and quantitative analysis on land scale efficiency on the basis of economic indicators they defined, but they reached different conclusions. Finally, it summarized literature and pointed out several issues needing special attention in this field.

Key words Scale management and efficiency, Returns to scale, Land productivity

1 Introduction

China's rural reform started from 1978. After more than 3 decades of development, China has made universally acknowledged achievements. The household contract responsibility system, as an innovative system since the reform and opening-up, has made an enormous contribution to increasing agricultural production efficiency and farmers' income. However, the land equalization system leads to decentralized management and segmentation of small scale land[2]. The small scale management with small peasant as unit is difficult to satisfy market demands and retards development of modern agriculture. From 1985, grain production suffered three years of stagnation and the gross yield declined obviously. To solve the problem of decline in grain production efficiency, with reference to successful experience of developed countries in agriculture, some scholars put forward realization of scale management through gradually expanding the existing land management scale. The introduction of scale management rapidly increased the grain production level in certain period. Besides, expansion of scale also gradually adapts to development requirements of modern agriculture. As a historical trend of agricultural development[1], the agricultural scale management has been proved by many scholars. Studies based on the data of the USA in 1900 – 2010 and Japan in 1930 – 2010 indicate that agricultural scale management is an inevitable choice for agricultural modernization[18]. In China, especially the first introduction of scale management by central government in 1987, every department made active response, and the realization of scale management, to a great extent, promotes development of modern agricultural economy. At the same time, according to studies of some scholars, it is inadvisable to expand the management scale through merely increasing the grain yield. In existing literature, extensive researches of scale efficiency obtain quite different conclusions. Based on essential characteristics of agriculture and special requirements of grain production, it is required to take overall consideration of agricultural scale management and efficiency.

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2 Concept of agricultural scale management

According to the economies of scale theory, in a certain period, when absolute amount of products increases, average cost can be reduced through expanding management scale, to increase the profit. Adam Smith, as founder of economies of scale theory, stated that batch production with labor division as basis is the production with certain scale. In economic sense, the scale management is a method of expanding production and management of producers increasing production elements (mainly including land, labor, fund, and technology) at proper proportion in given condition. Agricultural scale management is a form of agricultural management for increasing agricultural labor productivity, land output rate, and agricultural product commodity rate with certain agricultural management scale according to farmland resource condition, social economic condition, material technical equipment and political and historical conditions. Land, as agricultural production material, is the foundation for allocation scale of other production elements. In the study of benefits of agricultural scale management, an essential indicator is land management scale. In China, the agricultural scale management was introduced in the light of too small farmer management under the household contract responsibility system, it was to expand management scale and increase scale benefits through reorganization of land circulation elements[39]. Nevertheless, expansion of land management scale is not simple addition of land amount, but further increase of land output rate, land productivity and input and output rate through

optimization of production elements[40]. With deepening of people's understanding of agricultural scale management, the definition of agricultural scale management gradually goes out of the scope of traditional agriculture, and changes to scale management of modern agriculture. It not only includes scale management of agriculture itself, but also includes external scale management of agriculture; in other words, it combines household of decentralized management through cooperative organizations[41]. In sum, agricultural scale management is a comprehensive concept. It includes internal and external scale. Since the scale economy basically belongs to the scope of productivity, the scale management firstly refers to scale production, especially scale use of production materials. Because of special character of agricultural production, land is an indispensible input element and production means in agricultural production. The scale production based on moderate scale of land is basic connotation of scale management[3].

3 Returns to scale of grain production

Agriculture is foundation of national economy, while the grain is basis of the foundation. For a long time, the scale economy in grain production is a hot issue: (i) for consideration of guaranteeing grain security, and (ii) for consideration of increasing income of farmers. In studies of returns to scale of grain production, many scholars stated that with constant expansion of grain production scale, agricultural producers have more advantages in resources, science and technology, credit, information, market, and risk resistance, thus they have higher ability of obtaining scale economy than small producers. Based on farmer survey data in Jilin, Shandong, Jiangxi, Sichuan, and Guangdong provinces in 1994, with consideration of the influence of land segmentation on the scale economy, Wan and Cheng (2001) calculated the coefficient of returns to scale of grain production is 1.026, indicating that the average cost of grain production declines with expansion of land area. Based on China's macro production data in 1980 – 2002, from the perspective of cost benefit of grain production, rice and maize production cost declines with production scale, indicating existence of returns to scale (Tian Xinjian, 2005). Su Xuxia and Wang Xiuqing (2002), based on agricultural production data of Laixi City in Shandong Province, calculated the scale elasticity of maize and wheat is 1.278 and 1.268, which means significant increase in returns to scale. However, conclusions of some scholars indicate this is not accurate. In foreign countries, Yujiro Hayami and Vernon W. Ruttan (1985) analyzed agricultural production function using data of 43 countries in 1960 – 1980, and found that 21 developed countries with per capita income above 4000 USD have significant scale benefit, while 22 underdeveloped countries with per capita income below 4000 USD do not have scale benefit. Through estimation of agricultural production function of these countries, they reached the conclusion that agriculture of developed countries belongs to increasing returns to scale, while underdeveloped countries have the characteristic of constant scale benefit; they further concluded that agricultural scale economy is mainly generated from large scale use of agricultural machinery. In domestic area, Qian Guixia (2005), on the basis of survey data of 3000 farmer samples in main grain production regions, through building C-D production function mode, found that large-scale management of agricultural land is favorable for land output rate only on certain scale; when land scale is smaller than 3 mu, the returns to scale of grain production would be smaller than 1; when land scale is 3 – 10 mu, the returns to scale would be equal to 1; when land scale is larger than 10 mu, the returns to scale will be significantly greater than 1. Using survey data of 1200 farmers in Jiangxi, Jiangsu, Jilin, Henan, and Hebei provinces in 1987 – 1988, taking rice, soybean, and cotton production as research object, Fleisher and Liu (1992) established C-D production function and estimated that the sum of input elements is 1.045, but not significant different from 1, showing constant returns to scale. Wan Guanghua *et al.* (1996), taking the sample survey undertaken by the Ministry of Agriculture and the University of Adelaide as basis, made empirical analysis of early long-grain rice, late long-grain rice, winter wheat, maize, and tubers, and obtain the index of scale economy of these five types of crops is 1.169, 0.967, 1.107, 0.985, and 0.904 respectively, showing no benefit of scale economy in China's grain production. Xu Qing *et al.* calculated returns to scale and scale economy of spring wheat, winter wheat, maize, early long-grain rice, middle and late long-grain rice, and japonica rice in China with the aid of micro household data in the 1990s, and found that when the overall returns to scale are 1.049, there is no significant change in returns to scale, and it remains at the stage of scale economy[9]. According to the above analysis, due to difference in basic national and regional conditions, the returns to scale of grain production of every country is different. Generally, the returns to scale of China's grain production have changes but the changes are not significant, and different land scale has different returns to scale.

4 Restrictive factors of agricultural scale management

Domestic scholars analyze restrictive factors of agricultural scale management mainly from two aspects: (i) factors influencing farmers' willingness of scale management and (ii) restrictive factors of implementation of scale management, and the latter includes existing agricultural land system and non-agricultural industrial development. Firstly is the survey of management willingness. Chen Yangfen *et al.*[24] made dual Logistic regression analysis based on sampling survey of 323 farmers in 3 provinces and one city in eastern coastal region, and identified key factors influencing farmers' willingness of scale management: householder employment type, agricultural land rent action, agricultural technical training, and agricultural land resource endowment. Jia Liming and Guo Qinghai (2001) surveyed 614 farmers in Jilin Province, and found that only 1/3 farmers were willing to expand production management scale, farmers' marital status, annual income, number of family members, net income of managing secondary and ter-

tiary industries, and labor use, additional contractual land cost, and pesticide cost are decisive factors of their willingness. This conclusion was proved by empirical studies of Lin Jinchao *et al*. in survey of 112 farmers in 21 natural villages in 2013. Specifically, women and aging problem, higher proportion of non-agricultural income exert significant negative influence on willingness of scale management, while preferential policies, mechanization level, and science and technology level show significant positive influence (Yang Qianqian, 2012), and regional economic development level, agricultural production working capital input have significant positive influence on expansion of production scale[45]; to a certain extent, low agricultural comparative income, weak diversification of employment and income sources are key factors of shrinking the production scale[45]. Researches also focus on restrictive factors of scale management. For example, people have realized that rural land issue is an essential factor restricting regional agricultural production scale management[35]. Shen Ping and Huang Ya'nan (2004) summarized 4 restrictive conditions of agricultural scale management: agricultural natural resources, agricultural production element input, existing institutional arrangement of agricultural resources, and ideas of farmers; specifically, Ren Zhijun (1995) held that agricultural scale management is greatly restricted by small farmland area, slow development of agricultural science and technology, and not full employment of surplus agricultural labors[14]. Government and farmers input little to agriculture, support of regular finance is limited, and rural regular finance is vacant in subject and service (Wang Xiaohong, 2010); according to empirical study of Zhao Junying (2010), there is positive correlation between agricultural industrialization level and financial support for agriculture in regions of Henan Province, financial support plays a great role in promoting agricultural industrialization; study of Wang Zhigang *et al*. (2011) indicates that farmers' age, number of labors in family, value of family agricultural machinery, and degree of land segmentation have significant negative influence on subcontract of rice production[10]; besides, policies and regional characteristics have significant influence on farmers' scale management (Ni Kunxiao, Wang Chengjun, 2012).

5 Studies of relationship between land management scale and production efficiency

5.1 Studies of positive correlation In numerous studies, most scholars agree that there is positive correlation between land scale and efficiency. According to phase report of land scale management issued by Rural Reform Pilot Region Office of the Ministry of Agriculture (1994), land scale management plays a significant role in increasing grain production efficiency. Based on the survey data of 103 scale management units in 52 villages made by Wuxi County Agricultural Bureau, Yu Jingzhong (1994) stated that land scale management is favorable for increasing labor productivity and land output rate and also favorable for increasing income of local farmers. Wang Xiuqing (2002), based on survey of 198 farmers in Shandong Province, demonstrated that land consolidation is a key approach for increasing land production efficiency and reducing cost. Guo Jiangping (2003) discussed the relationship between different management scale and indicators of agricultural production efficiency (land output rate, labor productivity, and efficiency of capital), and found that expansion of land management scale is favorable for increasing agricultural production efficiency. Through comparison between agricultural production scale of farms in France and Japan and per unit area yield, Zhang Guanghui (1996) found that scale management is favorable for promoting per unit area yield of agricultural products and there is no reverse relation[14]. Song Wei *et al*. (2007) studied grain production function of Changshu City in Jiangsu Province, and found that farmers' scale management exerts significant positive influence on the per unit area yield, and concluded that moderately expanding farmers' farmland scale can increase the per unit area yield.

5.2 Studies of negative correlation However, many domestic scholars believe that there is negative correlation between land scale management and production efficiency. In other words, with expansion of land area, the agricultural productivity declines. In the opinion of Alice (2006), fundamental reason for existence of negative correlation lies in incomplete element market leads to difference of element price between large and small farmers, accordingly leading to inconsistent land output rate. In the early period, main idea was small peasant superior theory put forward by John Stuart Mill small peasant (2009). According to John Stuart Mill, small peasant production mode is more superior. In his book *Transforming Traditional Agriculture*, Theodore W. Schultz denied the opinion of large farms having higher efficiency than small farms. Roy *et al*. (1996) listed some empirical cases to prove high efficiency of small farms. However, these cases did not consider labor cost and function of decreasing labor returns. If considering the labor variable, there may be different results. Luo Biliang (2000) proved that agriculture is not an industry with significant scale efficiency because scale management will inevitably lead to collective management, and both theories and practice have proved agricultural collective management is not efficient. Both domestic and foreign empirical data indicate that there is negative correlation between agricultural land scale and land productivity, and expansion of farmer scale will not necessarily bring higher grain yield. In 1979, Berry R. A. and Cline W. R. studied Brazil, Colombia, Philippine, Pakistan, India, and Malaysia, and found that there is negative correlation between farm scale and per unit area yield.

Domestic scholars also proved the negative correlation between land scale management and efficiency. Li Gucheng (2008) made a systematic study on negative correlation in China's agricultural production. Based on data of fixed rural observation points in Hubei Province, he pointed out that negative correlation exists universally and non-traditional factors, such as professional technical training and family background, are essential reasons influencing difference in land productivity of farmers. From the per-

spective of relation between scale and change of per unit area yield, Liu Fengqin (2006) analyzed empirical data obtained in northeast, compared difference in the per unit area yield between different land scale groups, and pointed out that there is no clear relation between land scale and the per unit area yield. Ren Zhijun (1995) stated that land scale and land production efficiency are two opposite variables, in other words, if the farms are larger, land production efficiency will be lower. From the perspective of factors determining scale efficiency of economic organizations, Luo Biliang (2000) proved that, except machinery and management technologies, other elements do not have inevitable requirement for scale management. Yao Jianfu (2000) made a field survey on large agricultural farming and found the land scale is inversely proportional with the per unit area yield with the reference to actual data both at home and abroad, and concluded that large farms in the USA are not suitable for China.

5.3 Variation relation Rui Dingjie and Kang Saiyou (2000) studied the relation between agricultural land scale and productivity of Philippine and concluded that the relation between planting area and productivity is not completely positive function, and not completely inverse function either. In 1991, researches of China's land system program team indicated that under the condition of 2 ha land for each farmer, the expansion of farmland brought about first decline then rise of the average yield, but it was still higher than that in 0.2 ha for each farmer. According to this, the team said that there exists certain variation relation. Chen Xinxin *et al.* (2000), based on data of fixed rural observation points in Zhejiang Province in 1986 – 1999, compared agricultural land benefits and variation trend of different management scale[43]. According to their studies, with expansion of agricultural land scale, the resource utilization efficiency took on U shape trend. Qu Xiaobo (2008) grouped fruit farmers of Shaanxi Province according to planting area, established stochastic frontier production function in transcendental logarithmic function form, and estimated technical efficiency of different management scale using maximum likelihood, and reached the conclusions that the relation between management scale and production technical efficiency of farmers take on inverted U shape, and farmers with medium scale have production efficiency higher than those farmers with small scale farmers[44]. Besides, he pointed out that too small scale will lose advantages in labor division, specialized cooperation and standardization, while too large scale may lead to rise of internal coordination cost and supervision cost. Zhang Zhongming (2008), taking maize production of Jilin Province as an example, made cluster group of different scale of farmers, and established the efficiency evaluation system, divided such efficiency into pure technical efficiency and scale efficiency, and finally reached the conclusion that small farmers at both ends and large farmers have higher efficiency, while farmers in the middle have low production efficiency[28]. Xin Liangjie (2009), taking Jilin Province as an example, studied the regression relation between land scale and land output, and concluded that medium scale land productivity is higher than small and large scale land productivity, so it is feasible to moderately expand land management scale in this region.

6 Conclusions and discussions

On the basis of the above literature review and analysis, we reached following conclusions: (i) Land scale management is the management of land on the basis of moderate scale of land. (ii) From the perspective of returns to scale of grain production, China's grain production is variable returns to scale, but the variation is not significant. It should be noted that different land scale will lead to different returns to scale. (iii) At present, analysis of factors influencing agricultural scale management mainly includes factors influencing farmers' willingness of management scale and restrictive factors of implementation of scale management. In these aspects, changes in land and labor resources attract wide concern. (iv) In studies of the relation between land management scale and production efficiency, many scholars made quantitative and qualitative analysis on land scale efficiency on the basis of economic indicators defined by themselves, but they reached quite different conclusions. These can be divided into three ideas. First, with expansion of land scale, the grain production efficiency will rise accordingly. In other words, there is positive correlation between scale and efficiency. Second, there is negative correlation between scale and efficiency. Third, the relation between scale and efficiency is not definite. (v) On the basis of summarizing the literature, we should further discuss several issues. First, most scholars adopted data of the 1990s, and there are few systematic researches of grain production scale in recent decades. Second, most scholars applied addition of magnitude of value, and there are few comparative studies about respective production functions of different grain varieties. Third, there are great differences between data and methods applied, the connection between different literature is weak, and it is difficult to make comparison in methods and data.

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