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Changes in and prospects for cultivated land use since the reform and opening up in China

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ABSTRACT

Cultivated land provides the basic guarantee for food production and security, and changes in its utilization have been a focus of attention in China. Since China's "reform and opening up," major changes have taken place in the country's social economy and cultivated land use. Based on statistical data analysis and literature review, this study systematically reviewed long-term changes in cultivated land use in China. On that basis, future trends are identified, which can provide new insights for future research on cultivated land use and protection management. The findings indicate that while cultivated land use is diversified, smallholder farmers still account for the main part. Further, the scale of cultivation is expanding but still fragmented, profits derived from land cultivation are slowly growing, and the proportion of those profits in total household income has dramatically declined. It was also found that the social security function of cultivated land has been weakened, cultivated land management has become more diversified, and grain output has risen steadily. To meet the needs of social and economic development, the government should promote the transfer of the "household" as a unit instead of "labor." Moreover, innovation in the land use system should be stimulated based on industrial convergence, and policy incentives for ecological farming should be increased.

1. Introduction

As a populous country, it is crucially important for China to make rational use of cultivated land and ensure food security (De Brauw et al., 2004; Liu et al., 2017a; Wang et al., 2018a). In 1978, the reform of the agricultural management system, along with the implementation of the household contract responsibility system (HCRS) initiated rural reform in China (Chen et al., 2007; Lin et al., 2015; Yuan et al., 2018). The implementation of HCRS helped to liberate and develop rural productive forces, bringing about historic changes in rural socioeconomic development (Xu et al., 2017a; Song, 2018). However, along with such development, the demand for cultivated land resource allocation has changed as well. In particular, the contradiction between the decentralized management of HCRS and the scale management of modern agriculture is becoming increasingly salient. At the same time, with the advancement of industrialization and urbanization (Chai et al., 2019), the degree of concurrent business has intensified, and the income of rural households has increasingly shifted toward non-agricultural sectors (Lin and Ho, 2003; Liu et al., 2017b; Long et al., 2016; Wang et al., 2017). Land cultivation is no longer the primary means of survival for rural households (You et al., 2018), and the phenomenon of cultivated land abandonment has appeared in some parts of China (Xu et al., 2017a; Yan et al., 2016; Zhang et al., 2014).

Since the reform and opening up, China has undergone profound socioeconomic changes. Such development has affected the allocation of cultivated land resources, bringing about changes in the use modes of cultivated land. Researchers have investigated the relationship between land use changes and socioeconomic development, industrialization, and urbanization (Lin et al., 2015; Wang et al., 2018a), as well as agricultural and rural systems (Song, 2018; Zhang and Li, 2018). Yang and Li (2000) analyzed changes in China's cultivated land area over the 20 years after the reform. Based on China's first land survey, Lin and Ho (2003) examined the total amount of change in cultivated land resources. Chen et al. (2007) conducted a comparative spatial study of changes in cultivated land use in Fujian and Taiwan. More recently, several scholars have conducted spatiotemporal analyses of changes in cultivated land use (Liu et al., 2018b; Wang et al., 2018b; Chai et al., 2019). Meanwhile, other studies have examined areas such as the policy evolution of cultivated land use (De Brauw et al., 2004; Liu et al., 2017a; Wang et al., 2012), land use and rural transformation (You

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et al., 2018), grain production patterns (Zou and Long, 2009), and planting structure (Liu et al., 2018b). Furthermore, with the deepening of supply-side reforms and the transition from traditional to modern agriculture, studies have examined the transformation of cultivated land function (Song et al., 2015), the effect of new agricultural management entities (NAMEs) on the efficiency of cultivated land use (Luo et al., 2018), and industrial integration in the transformation of land use modes (Shen et al., 2018).

China has a unique land system, and cultivated land use management is deeply affected by changes in land use policy (Liu et al., 2017a; Zhou et al., 2020). In the early days of the reform, the consolidation of cultivated land was the main mode of land development. At present, China continues to promote its Rural Revitalization strategy, and changes in cultivated land use are closely related to rural land system reforms and land protection policies (Gao et al., 2020). Against the background of resource constraints, ecological pressure, and public demands, the trend in cultivated land use has shifted toward the cultivated land protection mode represented by permanent basic farmland (Wu et al., 2017). Current research on cultivated land use is mostly based on analyses of spatiotemporal changes in different provinces and the driving forces of those changes (Chai et al., 2019; You et al., 2018). There is, however, a need for further research on temporal changes in cultivated land use at the national level (Liu et al., 2018b; Zou and Long, 2009). The implementation of the HCRS has brought about changes in China's rural production relations—that is, the relationship between farmers and cultivated land (Zhou et al., 2020). With China's ongoing land system reforms, trends in cultivated land use changes will affect urban-rural coordination processes (Gao et al., 2020), food security, and economic development. Therefore, changes in cultivated land use in China is an important research topic that needs to be continuously investigated to help advance the reforms.

This study collected statistics for the past four decades from sources such as the National Bureau of Statistics[1], China Statistical Yearbooks[2], China Rural Statistical Yearbooks[3], and fixed rural observation points in China[4] . Based on the analysis of the data, changes in China's cultivated land use since the reform are summarized, and future trends are identified. This provides a reference not only for policy formulation but also for measures to ensure world food security and stabilize international food prices.

2. Changes in cultivated land use since the reform and opening up

2.1. Diversification of cultivators

Different cultivators have diverse concerns regarding the purpose of cultivation, the intensity of input, and the long-term maintenance of cultivated land productivity. Cultivators in China have shown four distinct changes since the reform.

First, cultivator diversification is a clear tendency. Given the requirements of moderate-scale agricultural operations as well as policy incentives for cultivation managers (Lanz et al., 2018; Liu and He, 2018; Long and Qu, 2018; Šūmane et al., 2018; Xie and Lu, 2017), various cultivators have emerged with the circulation of operational rights for contracted land (Luo et al., 2018; Yuan et al., 2018). These include family farms, large grain farmers (professional households)[5], cooperatives (joint household management), and modern agricultural enterprises. In 2017, there were more than 2.80 million NAMEs of various types in China (Zhang, 2017), reflecting the clear diversification of cultivators. These diverse new entities play different roles in distinct segments and levels of modern agriculture. They activate various resource elements needed for agricultural development and promote the transformation from traditional to modern agriculture. Although these new entities have made some progress in agricultural development, their capabilities are limited in some ways, including areas such as industrial convergence, the provision of public goods, and the supply of services related to finance, information and technology (Ruan et al., 2017).

Second, smallholder farmers are still the main cultivators. According to national agricultural censuses, the number of agricultural operators in China were 193.09 million in 1996, 200.16 million in 2006, and 207.43 million in 2016 (National Bureau of Statistics of the People's Republic of China (NBS, 2017). While the number of agricultural operators has not decreased by encouraging scale operations, the number of farmers whose livelihoods principally rely on agriculture has significantly decreased (e.g., 7.20% less in 2006 compared to 1996) (National Bureau of Statistics of the People's Republic of China (NBS, 2008). Smallholder farmers today differ from the traditional small-scale rural households of the past. They are not willing to give up the operational rights of their contracted land, and most are concurrent business households. Their incomes mainly come from outside work (Lu et al., 2019; Xie and Lu, 2017), while farming is something they do for self-consumption (Peng et al., 2018).

Third, the average age of agricultural employees has obviously increased (Long et al., 2016). According to the agricultural censuses (National Bureau of Statistics of the People's Republic of China (NBS, 2008, 2017), the proportion of agricultural employees over 51 years old was 32.5% in 2006, and in 2016, the proportion of agricultural workers over 55 was 33.6%.

Fourth, the educational level of agricultural employees is still not high (Long et al., 2016). In 2006 and 2016, 86.2% and 85.4% of agricultural employees had an educational level of primary/secondary school, respectively. Specifically, in 2006, 9.5% of China's agricultural workers were illiterate, 41.1% had a primary school education, and 45.1% had a junior high school education. In 2016, 6.4% of farmers had not attended school, 37.0% had a primary school education, and 48.4% had a junior high school education.

2.2. Enlarged scale of cultivated land management

At the beginning of the allocation of contracted rural land, land distribution aimed to proceed fairly. However, it ultimately caused a prominent fragmentation of cultivated land in China (Xie and Lu, 2017; Xu et al., 2017a, b). Such fragmentation has had varying degrees of impact on agricultural planting structure, grain output, cultivated land use efficiency, technology utilization efficiency, rural labor transfer, land use patterns, and the land market.

Given the increase in rural people leaving the countryside for business or word, along with the encouragement of national policies, the circulation of operational rights has been promoted, and the scale of cultivation has been improved. Nevertheless, the fragmentation of cultivated land under the pattern of smallholder production has not changed. According to the Ministry of Agriculture and Rural Affairs, as of June 2017, 74.34 million farmers circulated 33.13 million hectares of households contracted land, accounting for 27.70% of total contracted households and 36.50% of contracted land (Department of

[1] http://data.stats.gov.cn/easyquery.htm

[2] *China Statistical Yearbook* is an annual statistical publication that reflects comprehensively the economic and social development of China.

[3] *China Rural Statistical Yearbook* contains rural socioeconomic statistics for various years and the main national statistical data in key historical years since the founding of the People's Republic of China.

[4] The Rural Fixed Observation Point Survey System is responsible for monitoring the income of farmers and the transfer and employment of rural labor, as well as collecting the sales price information of major agricultural producers.

[5] Large grain farmers usually focus on the production of certain agricultural products, which is obviously larger than that of ordinary farmers in terms of the scale of cultivation, also known as large-scale farmers or professional households.

Rural Cooperative Economic Guidance, Ministry of Agriculture and Rural Affairs of the People's Republic of China (MARA, 2018).

The third agricultural census indicated that at the end of 2016, cultivated land of less than 50 mu (or 3.33 ha)[6] managed by farmers accounted for 71.40% of all cultivated land in China. The number of farmers who partially or completely circulated out their contracted land was 67.89 million, accounting for only 29.70% of contracted farmers. According to the National Rural Fixed Observation Point Survey (Table 1), the number of fields with a size of less than 1 mu was greatly reduced, and the average number of fields per household decreased from 4.56 in 1995 to 1.85 in 2015. The number of fields with a scale of more than 1 mu also reduced from 1.88 in 1995 to 1.43 in 2015. This decrease indicates that the scale of cultivation is expanding to some extent. However, the number of fields with a scale more than 3 mu has remained basically unchanged, remaining at about 0.55 blocks since 2005 (Rural Fixed Observation Point Office (RFOPO, 2010, 2017), indicating that the fragmentation of cultivated land has not significantly changed. There are many factors affecting the scale of operation, among which the high expectations of farmers for the circulation costs of operational right are a key factor (Chen et al., 2018).

2.3. Slow growth of economic benefits gained from cultivated land management

The profits gained from cultivated land affect the operator's investment, and the proportion of those profits in the family's total income determines the economic status of cultivated land for the family. This is because cultivators are "rational economic actors," and the economic benefits derived from cultivated land will affect not only the allocation of household resources but also the degree to which cultivators value and protect land resources.

Although China has increased its support policies for agricultural production, economic benefits derived from land cultivation have grown slowly. Even individual traditional crop cultivation has shown a declining trend with the rising cost of production and labor (Lu et al., 2018). According to the China Rural Statistical Yearbook and the National Agricultural Product Cost-Benefit Data Collection (Table 2), while the yield and output value of rice increased obviously after 1978, the net profit first increased and then decreased. Specifically, the average net profit per mu increased rapidly from 6.08 yuan in 1978 to 357.90 yuan in 1995 and then decreased to 141.96 yuan in 2016 (Department of Rural Socio-Economic Investigation, National Bureau of Statistics (NBS, 2018a; Department of Price, National Development and Reform Commission (NDRC, 2017).

Rapid increases in production and land costs are the main reasons for the decrease in net profits from rice planting. Increased production cost is related to the increase in labor cost per mu, which rose swiftly from 184.54 yuan in 2005 to 495.34 yuan in 2016, for an increase of 168.42%. Meanwhile, land cost per mu rose from 66.32 yuan in 2005 to 221.94 yuan in 2016—an increase of 234.65%. Further analysis of the cost components of rice planting (Fig. 1) shows that the proportion of material and service costs increased first and then decreased while the proportion of labor costs fluctuated around 40.68%; at the same time, the proportion of land costs was on the rise.

Meanwhile, the proportion of cultivated land operating income to household income has decreased appreciably. According to statistics (Tables 3 and 4), although per-capita net agricultural income increased rapidly from 106.20 yuan in 1978 to 2,106.80 yuan in 2012, the proportion of agricultural income continued to decline, from 79.49% in 1978 to 26.61% in 2012. In the light of new statistical coverage starting in 2013, per-capita disposable income from rural residents' primary industry increased slowly, as follows: 2,839.80 yuan in 2013, 2,998.60 yuan in 2014, 3,153.80 yuan in 2015, and 3,269.60 yuan in 2016. The proportion of income during those years accounted for 30.12%, 28.59%, 27.61%, and 26.45%, respectively (Department of Rural Socio-Economic Investigation, National Bureau of Statistics (NBS, 2018a). The proportion is declining, and the gap between agricultural income and wage income is widening.

2.4. Weakening the guarantee function of cultivated land

Management objectives have diverse classifications according to the multiple functions of cultivated land (Wang et al., 2015). Song et al. (2015) classified the functions of cultivated land as basic living security, family economic contribution, employment security, social stability maintenance, food security, ecological security maintenance, and national economic contribution. However the vast number of farmers belong to two major categories: capital function and guarantee function. Cultivators aim to pursue economic benefits when the cultivated land is manifested by the capital function. If the cultivated land has the guarantee function, the rational principle for cultivators is to survive and be safe; they would rather abandon land than give up their land use rights.

China has strengthened the rural social security system, implemented a new rural cooperative medical system, and improved rural insurance standards, thereby narrowing the gap between urban and rural living standards. This contributed to the decline of the employment function of cultivated land. The number of employed people in the primary industry decreased from 390.98 million in 1991 to 214.96 million in 2016—a decrease of 176.02 million. The employment share of the primary industry fell below 50.00% in 2000 and then fell to 27.70% in 2016 (Department of Rural Cooperative Economic Guidance, Ministry of Agriculture and Rural Affairs of the People's Republic of China (MARA, 2018). However, due to a lack of confidence in non-agricultural employment, migrant workers still regard cultivated land as their ultimate livelihood retreat and survival guarantee. Not only are they unwilling to give up their right to contractual management, but they also mostly restrict the circulation of operational rights to short-term behavior. It has been found that many cultivated land circulations take the form of aid between relatives and friends; there are usually no formal contracts and sometimes no costs (Wang et al., 2020). Similarly, based on data for more than 20,000 households in the National Rural Fixed Observation Point Survey from 1986 to 2015, Wang et al. (2018b) found that the no-cost mode of circulation has exceeded 50.00% since 2002. Although small-scale contracted land does not easily fulfill the practical guarantee function, for farmers it serves as a psychological "last survival guarantee."

2.5. Diversification of cultivated land planting structure

Given the diversified market demand for agricultural products, the variety of crops produced by cultivated land has also increased, and the planting structure has become more diversified (National Bureau of Statistics of the People's Republic of China (NBS, 2018b). Figs. 2 and 3 reveal two outstanding features.

First, the proportion of the sown area of grain declined steadily. The phenomenon of "double cropping rice becoming single cropping rice" is especially prominent. In 1978, the proportion of the sown area of grain in the total sown area of crops was 80.34%, which fell to 80.09% in 1980, 69.39% in 2000, and 67.83% in 2016. The area planted with early season rice decreased rapidly, from 12,189.20 thousand hectares in 1978 to 11,110.13 thousand hectares in 1980. In 2000, it was 6,819.73 thousand hectares, and in 2016, it was only 5,619.90 thousand hectares. Although the area of sown grain decreased, grain output shot up, from 30.48 million tons in 1978 to 32.06 million tons in 1980, 44.62 million tons in 1990, 46.22 million tons in 2000, 54.65 million tons in 2010, and 61.63 million tons in 2016 (National Bureau of Statistics of the People's Republic of China (NBS, 2018b).

Second, the area planted with vegetables increased significantly

[6] 1 mu = 1/15 ha

Table 1
Average number of households with actual cultivated land, 1995–2015.

Years		1995	1997	1999	2001	2003	2005	2007	2009	2011	2013	2015
Number of fields per household		6.44	6.11	6.07	5.75	4.91	4.79	4.44	4.10	3.98	3.50	3.28
Among them	Below 1 mu	4.56	4.26	4.28	4.01	3.16	3.03	2.72	2.41	2.33	1.98	1.85
	Over 3 mu	0.51	0.51	0.51	0.52	0.52	0.53	0.54	0.55	0.58	0.55	0.55

Note: Date were obtained from the National Rural Fixed Observation Point Survey Data Collection (2000–2009) and the National Rural Fixed Observation Point Survey Data Collection (2010–2015), published by the Central Government Policy Research Office and the Rural Fixed Observatory Office.

Table 2
Rice production benefit from 1978 to 2016 (yuan mu^{-1}).

Years	1978	1980	1985	1990	1995	2000	2005	2010	2015	2016
Main Product Output (kg)	278.40	302.35	376.86	414.10	408.20	415.10	431.00	447.75	492.64	484.75
Total output value	69.27	84.82	145.07	264.44	702.50	451.72	686.02	1076.45	1377.52	1343.77
Main products	60.64	75.94	131.93	241.27	670.32	429.56	669.40	1056.69	1359.88	1326.16
By-product	8.63	8.88	13.14	23.17	32.18	22.16	16.62	19.76	17.64	17.61
Production costs	60.50	58.56	77.29	151.80	326.62	319.18	426.99	625.20	987.28	979.87
Material and service costs	30.02	33.20	44.47	91.39	187.92	173.18	242.45	358.62	478.69	484.53
Labor cost	30.48	25.36	32.82	59.65	138.70	146.00	184.54	266.58	508.59	495.34
Burden tax	2.69	2.92	4.30	6.39	17.98	18.62	0.00	0.00	0.00	0.00
Land cost	–	–	–	–	–	–	66.32	141.43	214.84	221.94
Net profit	6.08	23.34	63.48	106.25	357.90	113.92	192.71	309.82	175.40	141.96

Note: The table was compiled based on the China Rural Statistical Yearbook and the National Agricultural Products Cost-Benefit Data Compilation; data for land cost before 2005 are missing.

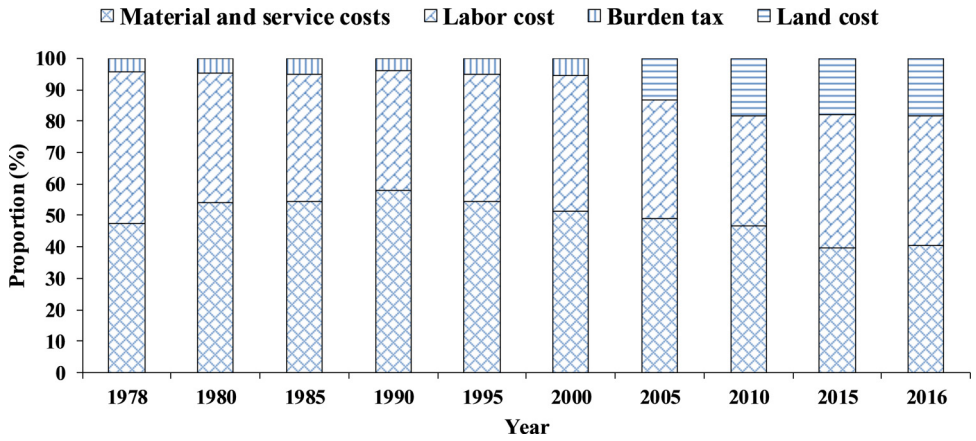

Fig. 1. Composition of rice cultivation costs from 1978 to 2016.

Table 3
Household income from 1978 to 2012 (yuan, %).

Years	1978	1980	1985	1990	1995	2000	2005	2010	2012
Per-capita net income	133.60	191.30	397.60	686.30	1577.70	2253.40	3254.90	5919.00	7916.60
Per-capita net wage income	–	–	72.20	138.80	353.70	702.30	1174.50	2431.10	3447.50
Per-capita net income from household management	35.80	62.60	296.00	518.60	1125.80	1427.30	1844.50	2832.80	3533.40
Per-capita net agricultural income	106.20	132.70	202.10	344.60	799.40	833.90	1097.70	1723.50	2106.80
Agricultural income proportion	79.49	69.37	50.83	50.21	50.67	37.01	33.72	29.12	26.61

Note: This table was compiled based on the annual database of the National Bureau of Statistics. Net agricultural income in 1978 and 1980 included collective economic income.

along with the variety of vegetables. The vegetable planting area was 3,331.00 thousand hectares in 1978 and 3,163.00 thousand hectares in 1980, showing little change. In 1990, 2000, and 2010, the vegetable planting area were 6,338.00 thousand hectares, 15,237.27 thousand hectares, and 18,999.89 thousand hectares, respectively. In 2016, it was as high as 22,328.28 thousand hectares. Liu et al. (2018b) analyzed the spatiotemporal characteristics of planting structures across China since 1980. They found that the type of single planting structure dominated by food crops showed a decreasing trend year by year. After 2002, the proportion of vegetable cultivation increased rapidly in urban areas, changing the pattern of planting structure, with a multiple planting structure replacing the single-type planting structure.

This diversification of the cultivated land planting structure may be due to the socioeconomic and demographic development brought about by rapid urbanization (Zheng et al., 2014). Meanwhile, the adjustment of the agricultural planting structure is an economic behavior (Liang, 2006), mainly driven by farmers with increasing market awareness (Qi and Tang, 2017).

Table 4
Household income from 2013 to 2016 (yuan, %).

Year	2013	2014	2015	2016
PCDI	9429.59	10,488.88	11,421.71	12,363.41
1. Wage income	3652.50	4152.20	4600.31	5021.85
proportion	38.73	39.59	40.28	40.62
2. Net income from operations	3934.86	4237.39	4503.58	4741.28
2.1 Net income from primary industry	2839.80	2998.60	3153.80	3269.60
agricultural income	2160.00	2306.80	2412.20	2439.70
proportion	22.91	21.99	21.12	19.73
2.2 Net operation income of secondary industry	252.50	259.10	276.10	287.90
2.3 Net operation income of tertiary industry	842.50	979.60	1073.70	1183.80
3. Net income from property	194.71	222.07	251.53	272.05
4. Metastasis net income	1647.52	1877.22	2066.30	2328.23

Note: This table was based on data from the China Rural Statistical Yearbook.2014–2017.

will not be completed overnight. In the coming period, the pattern of smallholder production will still be a major form of cultivated land management in rural China, and the diversification of cultivators will be formed together with family farms, large grain-growing households (professional households), cooperatives (joint household operations), modern agricultural enterprises, and other business entities.

Given that smallholder farmers will continue to exist for some time, China should play an active role in various NAMEs and agricultural service industries to help integrate smallholder farmers into modern agricultural development. For example, farmers could be led to connect with the market, resist market risks, and achieve agricultural industrialization. The agricultural service industry can not only provide smallholder farmers with various services that favor their development (e.g., trusteeship, cultivation, collection, plant protection) but also render services to promote agricultural modernization for NAMEs. In fact, there are many successful models for NAMEs that can promote common development with smallholder farmers, such as the cooperation mode of "leading enterprises, cooperatives, and smallholder

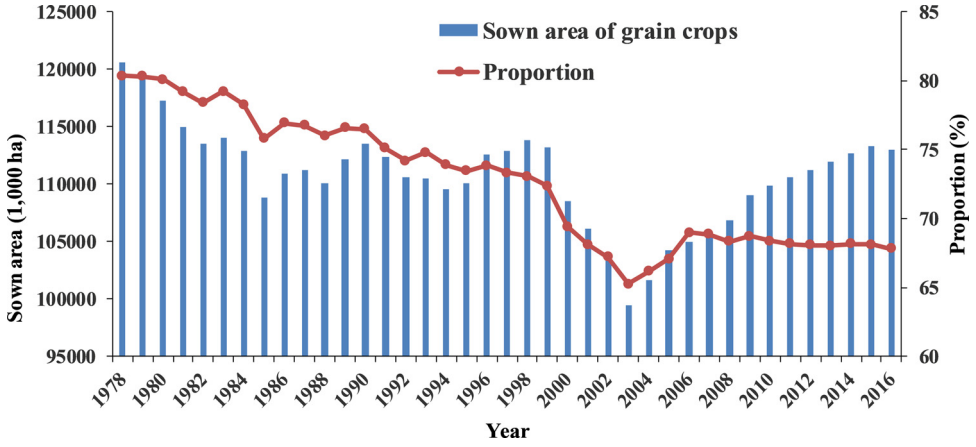

Fig. 2. Sown area and proportion of grain crops from 1978 to 2016.

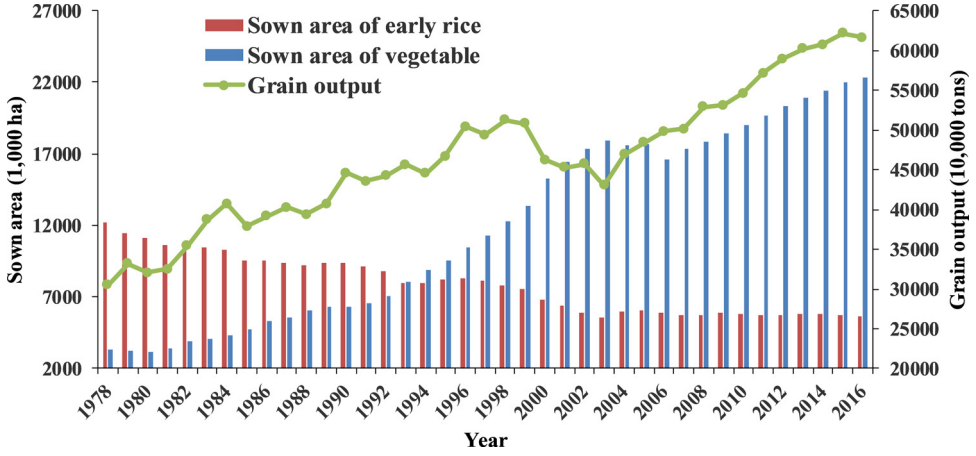

Fig. 3. Sown area of early rice and vegetables and grain yield from 1978 to 2016.

3. Prospects for cultivated land use in China

3.1. Coexistence of diversified business entities

China is a traditional agricultural country with a large agricultural population. At the end of 2016, the rural population was close to 589.73 million. It is estimated that by 2030, there will be 450.00 million rural residents. The urbanization of the agricultural population and the transfer of the agricultural labor force is an ongoing process that

farmers." As a bridge between farmers and leading enterprises, cooperatives can not only help farmers improve their discourse power in negotiations, reduce production risks, and ensure stable returns but also help leading enterprises effectively control the scale of production and product quality. They rely on each other while developing together and mutually restricting each other.

It is worth noting that moderate-scale operation is an inherent demand in modern agricultural development. Support for smallholder farmers is an objective requirement that meets the basic national

conditions of China's rural areas during a certain period. However, it must comply with the law of modern agriculture development. It should not aim to consolidate and strengthen the status of smallholder farmers in agricultural management but should guide them to withdraw from agricultural management.

First, farmers should recognize the objective value of operational rights and avoid exorbitant "profit illusion," since the annual rent for cultivated land is generally 3000–6000 yuan per hectare. At present, in China, due to considerable media publicity regarding the realization of property rights and interests under "the separation of rights," farmers generally expect more from circulation. A direct consequence of high rent expectations is that production costs increase, and it is difficult to maintain scale operations for agricultural business entities. At the same time, it also affects the farmers' enthusiasm for circulation.

Second, the number of smallholder farmers should be gradually reduced by substituting "household" as the unit for "labor" transfer. Today, the nonagricultural transfer of household labor instead of the household reflects the typical phenomenon of "family separation." This phenomenon can effectively reduce the social impact of rapid changes in nonagricultural sectors. However, this kind of "detention of concurrent business," where the main labor force of the family enters the city, and the contracted land is cultivated by the left-behind members, is not conducive to the formation of moderate-scale modern agriculture (Liu et al., 2018a; Xu et al., 2017a; Zhong et al., 2019). Moreover, it will produce large floating population, increase public burdens (e.g., transportation), and trigger social problems such as women, children, and elderly being left behind, thus hindering rural development (Li et al., 2018a).

More effort should be made to promote the transfer of farmer households. In light of various studies (Huang and Du, 2014; Gao et al., 2020; Wang et al., 2020; Zhou et al., 2020), we can identify areas that need improvement. The first pertains to the social security of migrant workers. The restrictions of the dual household registration system should be eased, and the professional skills of migrant workers should be enhanced. Second, agricultural modernization should be accelerated, and farmers left behind in rural areas should be encouraged to expand the scale of agricultural production and conduct large-scale production and management. Third, rural land system reform should be deepened, the function of land assets enhanced, and the transfer of land management rights promoted.

3.2. Multifunctionality of cultivated land use

Forty years after the reform, social productivity has increased, and living standards have been greatly improved. What China now face is the contradiction between unbalanced, inadequate development and people's increasing demands for a better life (Zhu and Ye, 2018). Further, the contradiction between supply and demand has changed from "quantity shortage" to "quality insufficiency." The demand for cultivated land in social development is not just to provide subsistence but to pursue diverse, individual, high-quality consumption. The multifunctionality of cultivated land use will become increasingly obvious (Zhou et al., 2017). Correspondingly, the nonproductive value of social and ecological functions—such as the food security inherent in cultivated land, traditional farming culture, open spaces, the unique ecological landscape of cultivated land, biological habitats, air, and groundwater purification—will be constantly highlighted. The use of cultivated land is no longer a simple pursuit of agricultural output; rather, more attention is paid to planting variety, external characteristics, and even the spatial layout and form of crops.

China's rural tourism is developing rapidly, including the emergence of a new variety of leisure agriculture (Gao et al., 2009; Su, 2011; Xue et al., 2017). This reflects people's multipurpose demands based on the multifunctional utilization of cultivated land. In 2016, leisure agriculture and rural tourism became important emerging industries in rural economic development, with revenues of more than 570.00 billion yuan. Of course, the multifunctional value of cultivated land can also depend on actual market demands. This means the better the location and the more favorable the ecological environment, the higher the multifunctional value of cultivated land.

In terms of industrial formation, the convergence of primary and tertiary industries embodies the multifunctionality of cultivated land use. It relies on traditional agricultural production as the primary industry to develop tertiary industries, such as agricultural sightseeing, technology tourism, farming experience, farmhouse entertainment, and exposition gardens. This gives full play to the production of cultivated land, farming culture, landscape, and other functions. Today, villages with flourishing industries provide models for the successful convergence of primary and tertiary industries, and farmers in those villages have achieved income diversification (Li et al., 2018b; Shen et al., 2018). For farmers, direct income from agricultural products is very small. More income comes from the property income of collective economic dividends and the circulation of contracted operational rights, as well as service industry income or stable wage income based on rural eco-tourism. This makes up for the low economic benefits of cultivated land production to some extent. The convergence of primary and tertiary industries requires input from the organizers of cultivated land use and the original construction funds, as well as innovation in the land use system.

Therefore, the construction of relevant rural economic organizations should be strengthened, including various modern agricultural enterprises, cooperatives, and collective village organizations. In this way, regional cultivated land can be planned and used to realize linkages with the market. Of course, ensuring food security is the eternal theme of cultivated land use in China. Considering the impact of international grain prices and price volatility in domestic and foreign grain markets, the government should follow its strategy of "storing grain locally and with technology." This can reserve the production capacity of the corresponding grain production in the convergence of primary and tertiary industries (Xu et al., 2018; Zhang and Li, 2018).

Second, China should pursue social capital investment in rural areas, especially by relevant enterprises with experience in developing markets. Those enterprises can enhance market competitiveness while bringing in construction funds. However, it is also necessary to prevent environmental pollution caused by such rural investment or the speculation of natural resources.

Third, the land use system should be innovated, especially in terms of the land demand for the convergence of primary and tertiary industries. Agricultural facilities and production lands that directly serve production as well as construction land for Internet service, agricultural landscape horticulture, and sightseeing facilities are all important. It is necessary to innovate current land supply and management policies classified according to conventional primary, secondary and tertiary industrial land types.

3.3. Implementation of ecological farming

As a basic natural resource, the sustainable use of cultivated land is a fundamental guarantee for the sustainable development of human society. However, the situation is not optimistic in China. Although the trend of the sharp decline in the amount of cultivated land has been effectively curbed, the quality and ecological function of cultivated land were weakened in general due to the "expropriation of superior cultivated land and supplement of inferior cultivated land," as well as increased soil pollution. The abuse of fertilizer is a classic case. According to reports, from 1980 to 2015, China's grain yield level per unit increased by 56% while fertilizer input increased by 225% (Liu et al., 2016). During the same period, Germany, France, and other developed countries' grain yields increased by 51%–52% while fertilizer input declined by 31%–47%. China is currently the world's largest manufacturer and consumer of chemical fertilizer. While China feeds more than 21% of the world's population with about 8% of the global

cultivated land (Wang et al., 2012), it also consumes one-third of the world's fertilizer. This excessive and inefficient use of chemical fertilizer has been a main cause of agricultural nonpoint source pollution in China. It not only leads to the eutrophication of rivers and lakes but also destroys soil ecosystems, which directly threatens national food security (Liu et al., 2013).

China faces problems with the sustainable use of cultivated land (Chen and Liu, 2020; Li et al., 2018a). Entering the stage of ecological civilization, the goal of protecting cultivated land has shifted toward the "trinity" of protecting quantity, quality, and ecology. Therefore, based on the ecological civilization perspective, establishing an ecological value–oriented system is the reform direction needed to build a long-term mechanism for cultivated land protection. This means ecological farming has become imperative. Ecological farming is an agricultural production behavior that abides by the basic principles of the ecosystem and avoids irreversible interference with the cultivated land system (Chen and Liu, 2020). Tirado (2009) defined ecological farming as a behavior that ensures the current and future health of agriculture and food by protecting soil, water, and climate; promoting biodiversity; and avoiding pollution through chemical inputs or genetic engineering. Implementing ecological farming is needed to not only build ecological granaries but also mitigate the nonpoint source pollution problem (Ongley et al., 2010; Strehmel et al., 2016). It is also an important condition for realizing the convergence and sustainable development of the primary and tertiary industries (Chen et al., 2017).

It is crucial to promote various new agricultural technologies, including the ecological breeding models of "rice-shrimp", "rice-fish", and "rice-duck"; a rotation system combining cash crops and soil-improving crop; and environmentally friendly technologies such as soil testing and fertilization. On the one hand, these are conducive to improving the homeostasis ability of various nutrients in the soil, maintaining a healthy ecosystem, stabilizing cultivated land productivity, reducing excessive dependence on fertilizers, and alleviating agricultural nonpoint source pollution. On the other hand, various ecological breeding models could effectively enhance the landscape value of cultivated land and support the convergence of primary and tertiary industries.

The main body of agricultural production is the real decision-maker in ecological farming behavior. Given the coexistence of various cultivated land management groups, China should determine what affects the ecological farming behavior of different groups and formulate corresponding incentive mechanisms to promote their participation. First, the government should promote the gestation of various NAMEs, popularize basic knowledge about ecological farming, and improve the acceptance of environmentally friendly technologies. Second, policy incentives for ecological farming should be increased. Ecological farming has obvious positive economic externalities, can provide ecologically safe agricultural products, and can enrich public welfare. China should change its current policy design—which mostly focuses on mobilizing farmers' production enthusiasm and increasing their income—and increase support for ecological farming incentives.

4. Discussion and conclusion

As a basic resource that humans depend on for survival, cultivated land is fundamental to the sustainable development of society. In view of China's specific rural system, this study summarized the changes in cultivated land use. These are mainly reflected in the main body of cultivated land use, the pattern of cultivated land management, and the social function of cultivated land. The trend of cultivated land use in China was also discussed, providing a reference for making policies related to land use and protection. The analysis showed that China's cultivated land use since the reform has generally met people's increasing agricultural product demands, especially the steady growth of grain production. However, the shift from the social security function to the capital function of cultivated land has not been well achieved. There has been no significant change in the pattern of cultivated land use with the rapid advancement of industrialization and urbanization. Even if China continues to increase incentives for the circulation of operational rights, it has not formed a mode of cultivated land use to accommodate modern agricultural and moderate-scale management under the system design of "the separation of rights" (collective ownership rights, household contract rights, and operational rights) (Yu and Wu, 2018). This has constrained the realization of agricultural modernization to a certain extent. The main reason is that the rural social security system is not sufficiently sound. For farmers, cultivated land is still the most fundamental form of social security. This is also related to China's long-standing tradition of land attachment complex. In particular, the proportion of household income derived from operational rights is very low, such that many farmers prefer to abandon their land rather than circulate operational rights for a long time.

We should turn now to the essence of changes in cultivated land use—that is, the changes in China's cultivated land use system. The HCRS was the prelude to China's economic transformation, which, along with subsequent reforms to the rural land system, laid a foundation for China's economic growth (Feng, 2018; Zhou et al., 2020). In this process, the basic rural management system has followed the logic of not only the relationship between population and land, survival and development, and government and market but also the "property logic" of the rural land system and the "production logic" of the agricultural management system (Zheng et al., 2019). In the meanwhile, the connotation of the cultivated land protection system shifted from "quantity" to "quantity and quality" and finally to "quantity, quality, and ecology (Niu and Fang, 2019)."

China has entered a new period characterized by the "three peaks" of population, urbanization, and industrialization. Social development faces major problems such as ensuring ecological construction, protecting cultivated land resources, and maintaining healthy, high-quality economic development. The relations between urban and rural areas and between workers and peasants have undergone profound changes (Bi et al., 2018). Looking to the future, three trends can be identified for cultivated land use in China. First, while cultivators will continue to diversify, the pattern of smallholder production cannot be ignored. Second, the multifunctionality of cultivated land use is becoming increasingly obvious, and the convergence of primary and tertiary industries will become the main development direction. Third, the implementation of ecological farming will become inevitable in the face of pressure to adopt the sustainable use of cultivated land resources.

Finally, future research on changes in cultivated land use requires further theoretical analysis. There is a need to combine social, economic, and ecological factors, among others, to build a comprehensive analysis framework. In addition, comparing cultivated land use patterns under different systems would also provide a good research perspective. This would be conducive to summarizing the experiences and lessons of different utilization patterns to improve the efficiency of cultivated land use.

CRediT authorship contribution statement

Zhaohao Lai: Data curation, Writing - original draft, Writing - review & editing. **Meiqiu Chen:** Conceptualization, Formal analysis, Supervision, Funding acquisition. **Taoju Liu:** Resources, Investigation, Validation.

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Appendix A. Supplementary data

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