

Article

# Cultivated Land Use Benefits Under State and Collective Agrarian Property Regimes in China

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**Abstract:** Agrarian property regimes interact with relevant property stakeholders' behaviors and benefits, playing a vital role in national and regional cultivated land use. In China, state and collective agrarian property regimes are the two main forms of cultivated land use. To help fully realize the multi-objectives of cultivated land use benefits provided by agrarian property regimes, our study investigated the relationship between agrarian property regimes and cultivated land use. This paper describes the role of a cultivated land use system in facilitating the relationship between agrarian property regimes and cultivated land use from a geographical perspective. Understanding the cultivated land use system is the foundation for comparatively analyzing differences in the cultivated land use benefits in two adjacent areas, a state-owned regime and a collective regime, in the city of Fujin, China, through a comprehensive evaluation. We found the following results: (1) The arrangement of agrarian property rights directly reflects capital, material and technology inputs by motivating agricultural labors to obtain different economic benefits; (2) The state agrarian property regime reflects top-down agricultural management while the collective agrarian property regime reflects bottom-up agricultural management in China. The different agricultural managements influence planting structure and land use planning, resulting in different ecological benefits; (3) Labor division and social insurance are the main drivers of different social benefits from the two regimes. Examining cultivated land use benefits provides a new comparative perspective for studying agrarian property regimes. The results show that cultivated land use benefits from collective and state agrarian property regimes are different. These findings clarify that, incentivized by the different types of agrarian property ownerships represented by collectively and state-owned regimes, local governments and organizations aim to achieve the multi-objective cultivated land use benefit goal of Chinese agricultural development, including economic, ecological and social benefits. With China's goal of conducting moderate agricultural reform in its agrarian property regime, verification of rural collective land rights is an effective form of asset management in collective areas in China, while deepening land tenure and usufruct is an important priority in state-owned regimes. Furthermore, to make full use of agricultural resources, it is necessary to have a close collaboration between the collective agrarian property regime and the state agrarian property regime.

**Keywords:** agrarian property regime; cultivated land use benefits; state-owned area; collective area; China

## 1. Introduction

Agrarian regimes determine behaviors and benefits of relevant stockholders by defining agrarian property rights. The agrarian property regime interacts with rural residents, playing a vital role in socio-economy and environment at both the national and regional scales. In China, sustained economic development, rapid urbanization and agricultural diversification have been accompanied by land use change and socio-economic transition in the past approximately 40 years [1,2]. However, stark institutional trade-offs between agrarian property regimes and cultivated land uses are increasingly apparent, with effects ranging from fragmented farmland to degraded ecosystems and imperfect socio-security [3]. Furthermore, these dilemmatic trade-offs are predicted to continue. Reforming broken-down agrarian property regimes and steering cultivated land use towards sustainable development have become focused study topics of scholars and agrarian managers.

The difficulty of identifying and explaining the intrinsic forces driving cultivated land use has inspired scholars to strengthen analyses on the history and drivers of cultivated land use [4–6]. China's agrarian property regimes were reorganized in the 1980s, and the per capita grain yield rose from 319 to 443 kg, with a growth of approximately 40%, between 1978 and 2013. Nonetheless, feeding 1376 million people on 142 million hectares of land of food grains presents challenges for cultivated land use [7]. For the agricultural regions in China, agricultural management, the farmland landscape and cultivated land use behaviors vary among townships and state farms under different agrarian property regimes [8]. Thus, central and local governments are endeavoring to promote cultivated land use with multi-objectives, though effective strategies to align agrarian property regimes with cultivated land use require adaptive theory and practice.

Different cultivated land uses under different agrarian property regimes can produce differences in cultivated land use benefits [9–11]. In addition, interactions between agrarian property rights and cultivated land uses often result in economy–society–ecosystem problems over time [12–14]. To achieve agricultural sustainability, it is extraordinarily important to implement successful strategies that focus on boosting optimization of economic, social and ecological benefits from balancing regional agrarian property regimes and conscious cultivated land uses [15,16]. Effective planning is extremely helpful for effective agricultural management and land resource allocation [17].

Optimizing cultivated land use benefits is the ultimate goal of achieving cultivated land use with multiple objectives under moderate restructuring of agrarian property regimes [18], which include not only providing food and clothing but also food security, social security and ecosystem sustainability [19–22]. Most empirical studies assessing cultivated land use benefits and their driving forces have focused on the following research areas on economy, society and ecology: production pattern recognition, social security assessment, and ecological state estimation [23–26]. The results of these studies show that the underlying drivers of cultivated land use benefits tend to be different from the different studied benefits. The complicated interactions in the economic–social–ecological system make it difficult to systematically explain the underlying mechanisms of cultivated land use benefits. Geographical theory has been documented as a useful approach to understand land use mechanisms, from coupled human–environment–society on a macroscopic scale to rural transformation on a micro-scale [27–29]. Geographical systems theory has facilitated the study of the internal relationships among agricultural productions, ecological services, and social functions in cultivated land use. However, it is necessary to use a systematical and straightforward system for evaluating the mechanism of cultivated land use benefits.

This paper attempts to improve our understanding of the relationship between agrarian property regime and cultivated land use under the different cultivated land use operation mechanisms as well as the different driving forces from the different agrarian regime perspectives via a comparative study between a collective area and a state-owned area in China. We mainly address the following research questions: How are diverse cultivated land use benefits from both state-owned and collective-owned agrarian regimes generated? What are the impacts of agrarian property regimes on cultivated land use?

The relationship between agrarian property regimes and agricultural management in China was analyzed in this study. The following section proposes a framework for describing the operation of cultivated land use systems. Using the city of Fujin as a case study, this research examined different agrarian property regimes to investigate cultivated land use benefits in China.

## 2. Agrarian Property Regime and Agricultural Management

### 2.1. Collective and State-Owned Agrarian Property Regimes

China's agrarian property regimes have been based on the public ownership of land including state ownership and collective ownership since the socialist system of 1956 [30]. According to the Chinese constitution (2004), properties of the same land use type (e.g., cultivated land) differ in the collective and the state-owned regimes [31]. The collective land is overseen by village committees and cooperative organizations, whereas the state-owned land is owned by the State Council of China.

Having a clear land ownership is a common characteristic of both the collective and the state agrarian property regimes; however, these regimes have had different agricultural goals since the early days [32]. For instance, the state agrarian property regime can be traced back to state farms, which were originally built for the national food supply after hundreds of thousands of demobilized soldiers and educated youths reclaimed wasteland in Heilongjiang Province. In contrast, the collective agrarian property regime was derived from rural regions, where cultivated land was equally shared for basic living of over three hundred million peasants (the word "peasant" refers to the social workers who live in the countryside and engage in agricultural production. In fact, Chinese peasants have long-term land use rights (generally 30 years), but there is no perfect social mechanism to protect them in the Chinese system. On the other hand, "farmhand" refers to the state workers who live on the state farm and engage in agricultural production. Farmhands do not have the land right, but have perfect social security. Generally speaking, farmhands can live well without cultivated land, but Chinese peasants are the opposite). Land tenure was separated from land ownership after taking the household contract system (the household contract system is an organic whole composed of collective economic organization as the contracting party, the family as the contractor and the contract as the link. In the contract, the family (the household contractor) gets the rights of land use for free, but needs to fulfill a series of obligations given by the state. At the same time, the family as the unit carries out agricultural production on their own cultivated land is said to family agriculture) in 1982 [33]. Family agriculture contracting on cultivated land from village committees and state farms was established to enable independent agricultural business decisions by peasants and state farmhands [34]. In addition, the Chinese government created two different two-tier agricultural management systems for managing land ownership and tenure throughout townships and state farms.

Land tenure includes specific rights, such as contract operation rights, subcontract rights and lease rights [35,36], but the collective property regime defines different limitations for these rights from state agrarian property regime. Land tenure is shared by state farms and farmhands in the state agrarian property regime, whereas all land tenure in the collective agrarian property regime is given to peasants. However, there is an unsolved question for collective ownership, namely that the amount of land to which each entity is entitled has never been clearly delineated and even boundaries are not fixed. To resolve problems of farming disputes and burdens, equivalent cultivated land was allocated to peasants with a contract of 30 years in which to exercise agrarian rights [37]. To avoid similar problems in state farms, the cultivated land was divided into two parts. The first part is the cost-free assignment of approximately one hectare of land for subsistence to each state farmhand, while the second part is the lease of the remaining cultivated land at a moderate price to farmhands with 1–5 year contracts based on market competition [38]. Under the specified cultivated land distribution, cultivated land benefits were promoted among townships and state farms.

Townships and state farms are increasingly turning to cultivated land use operation to manage agricultural benefits by granting discretionary rights. Meanwhile, the operating status of cultivated

land has been undergoing substantial change. With the goal of developing sustainable agriculture, profit seeking from cultivated land use is generally conducted for the integrated welfare of townships and state farms.

## 2.2. Agricultural Management of Townships and State Farms

Agricultural management has greatly boosted the Chinese economy since the late 1970s. The GDP increased from 600 million RMB yuan in 1978 to 1.03 billion RMB yuan in 1984 [39]. Due to expiring contracts, cultivated land was not intensively increased, leading to a 7% decline in grain output from 1985 to 1992. Until taking the 30-year cultivated land contract in 1993, cultivated land was efficiently managed under a two-tier agricultural management system: the collective management and the state management.

The collective agricultural management was initiated with the cultivated land contracts of Fengyang County in Anhui Province and then expanded throughout China [40]. Collective agricultural management largely weakened highly concentrated farming operations (e.g., the People's Commune), but inherited long-term unchanged cultivated land contracts. Along with the established personal land property rights [41], the collective agricultural management system was changed in three respects. Firstly, the household cultivated land contract was devised to manage cultivated land use by village committees or organizations; thus, supervising and guiding agricultural production have become mainly the charge of townships or high level administrations. Secondly, as agricultural operators, peasants began to manage the cultivated land and determine crop types and varieties based on the market quotations. Finally, as the main form of household cultivated land contract management the cooperation and free trade of peasants play a core role in township and villages, although new agribusinesses and organizations have been founded [42,43].

The state agricultural management formally learned from the collective agriculture experience in 1983 and has been extensively accepted by state farm managers. The obvious importance is that the state agricultural management system has taken away the highly-centralized management and imperfect wage distribution while enabling the autonomic operation of cultivated land for farmhands [44]. The detailed management can be described in two parts. On one hand, state farm managers represent the main form of combining the agricultural management with socio-economic management of state farms and agricultural production. On the other hand, state farmhands use crop type and varieties dictated by state farms in the agro-production process, allowing crop production to be balanced in response to supply and demand to meet national food needs.

In recent years, the family agriculture among townships and state farms has become irreplaceable for achieving large-scale intensive agriculture under the two-tier agricultural management and is being developed with modern science and technology [32].

## 3. Study Area and Theoretical Framework

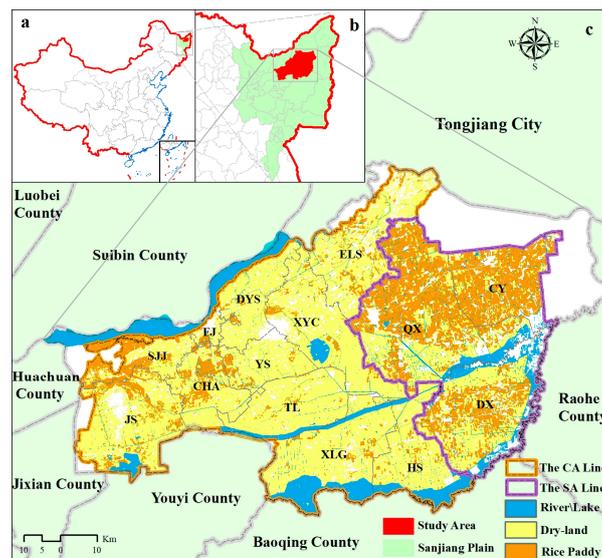
### 3.1. Study Area

As shown in Figure 1, the city of Fujin, the study area, is located in eastern Heilongjiang Province in northeastern China (at 46°45'–47°45' N, 131°25'–133°26' W), lying on the Sanjiang Plain (the Sanjiang Plain is beneficial for agricultural production, as one of only three alluvial black soil plains in the world, and is called “the northern granary in China” [45]). The city covers approximately 8277 km<sup>2</sup>, with cultivated land occupying approximately 75%, and contains 11 townships and three state farms.

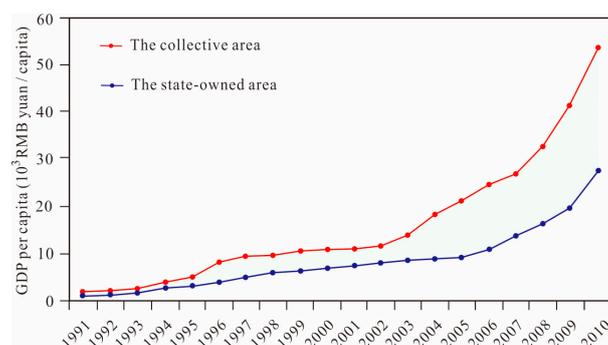
Agriculture is the major economic activity in Fujin, but there are large differences in adjacent areas with regard to state-owned and collective agrarian property regimes. Western Fujin, the collective area (CA), employs the collective agrarian property regime, which involves traditional household contract cultivation. The townships in the CA include Fujin (FJ), Shangjieji (SJJ), Chang'an (CHA), Yanshan (YS), Dayushu (DYS), Jianshan (JS), Toulin (TL), Xiangyangchuan (XYC), Xinglonggang (XLG), Hongsheng (HS) and Erlongshan (ELS). The eastern part of the city, the state-owned area (SA),

applies the state-owned agrarian property regime, in which cultivation is undertaken by state-owned organizations and household cooperation. The SA includes the Qixing state farm (QX), Chuangye state farm (CY) and Daxing state farm (DX).

From 1991 to 2010, the difference between the per capita GDP of CA (growth rate: 17%) and SA (20.36%) has been notable, and the gap doubled in 2010 (Figure 2). The agricultural economy was dominant in both CA (approximately 55%) and SA (approximately 75%) during the two decades (Figure 3). Fujin provides a valuable opportunity to undertake comparison of cultivated land use benefits under different agrarian property regimes. Differences in institutions and agricultural economy also play a vital role in studying cultivated the land use benefits of CA and SA.



**Figure 1.** Location of Fujin (c) in China (a) and Heilongjiang Province (b). The study area covers 11 townships and three state farms.



**Figure 2.** GDP per capita in the collective area (CA) and state-owned area (SA) from 1991 to 2010. Source: Statistic Yearbooks of Fujin and Agricultural Reclamation of Heilongjiang Province.

### 3.2. Cultivated Land Use System (CLUS)

In the last few hundred years, agrarian reform has benefitted cultivated land use by establishing incentives for such land use, such as agrarian property reorganization and agricultural land function transformation [46,47]. Agrarian regimes change cultivated land use according to agrarian property rights, playing a key role in agricultural production. In the last few decades, the interaction between agrarian regimes and cultivated land use has been investigated in a variety of ways by various authors. Constructing theoretical frameworks (e.g., Food and agriculture organization of the United nations,

Global land project), which is the most common approach, has been proposed based on cultivated land use [48,49].

In our study, CLUS is defined as a dynamically-integrated system by mutually coupling cultivated land use elements at a specific spatial-temporal scale (Figure 4a), with interactions among economic, social and ecological subsystems (sub-CLUSs) (Figure 4b). Cultivated land use benefits (CLUBs), as contributions of CLUS, are determined by the structural CLUS elements (e.g., soil, capital and operators). Considering the fact that essential cultivated land use contains economic, social and environmental functions, cultivated land elements must link the economy, society and ecology to serve sub-CLUSs [50,51]. In the economic subsystem, the main functions of cultivated land are to generate food and income via investing capital, material and technology. In the social subsystem, cultivated land as an important asset must be used to ensure both basic subsistence needs and national food supplies, which represent the social security role. In the ecological subsystem, cultivated land interacts with natural resources to provide ecological services under specific geographical conditions. Providing food, social security and ecological services in sub-CLUSs is affected by cultivated land use functions, which are expressed as economic, social and ecological benefits (indicated benefits refer to agricultural productions; invisible benefits are social security and ecological service goods).

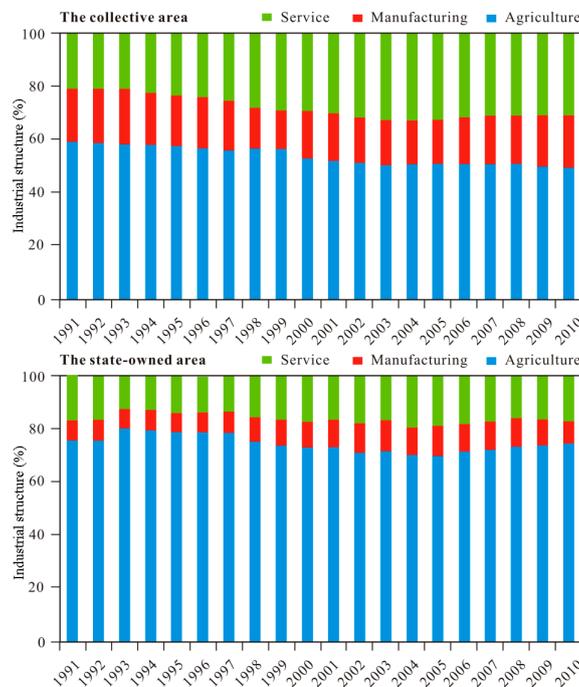
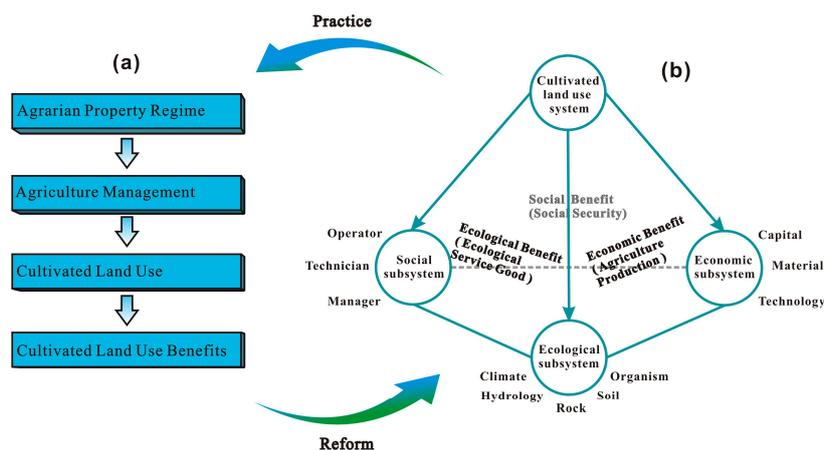


Figure 3. Agricultural economies between CA and SA. Source: Ibid.

The formulas of CLUS are as follows:

$$S_{CLU} = f_{CLU} \left( \sum_{i=1}^n CLU_i, R[r_{ij}], s, t \right) \quad \begin{matrix} B_{CLU} \\ \Leftrightarrow \\ F_{CLU} \end{matrix} \quad \begin{matrix} \\ \\ \end{matrix} \left( E_R (Econ, Soc, Ecol) \right)$$

where  $S_{CLU}$  is CLUS;  $\sum_{i=1}^n CLU_i$  refers to CLUS elements, where  $n$  is the number of elements;  $R[r_{ij}]$  is the relationship of elements;  $s$  is the geographical distribution of cultivated land;  $t$  is the time path;  $f_{CLU}$  is the CLUS structure;  $E_R$  is the CLUS environment, including the economic subsystem (*Econ*), social subsystem (*Soc*), and ecological subsystem (*Ecol*);  $B_{CLU}$  is the institutional effect on CLUS; and  $F_{CLU}$  is the CLUS practice under guidance of institution and policy.



**Figure 4.** (a) The cultivated land use system (CLUS) framework; (b) the sub-CLUS relationship. CLUS is composed of economic, social, and ecological subsystems. Elements of the economic subsystem include capital, material and technological components. The social subsystem elements consist of agricultural operator, technician, and manager. Elements of the ecological subsystem include climate, hydrology, rocks, soil and organisms. Representing achievements of CLUS, agricultural production, social security benefits, and ecological services are cultivated land use benefits.

## 4. Materials and Methods

### 4.1. Research Methods

#### 4.1.1. CLUB Model

CLUB is resulted from interactions between human activity and cultivated land, determined by the socio-economy and natural environment. CLUBs (Table 1) consist of the economic, social, and ecological benefits provided by CLUS functions.

**Table 1.** Cultivated land use benefits (CLUB) in the study.

Target	Status	Factor	Function
The comprehensive benefit of cultivated land use (CB)	Economic benefit (EB)	Food benefit (FB)	Grow food, melon, fruit, vegetables, oil-bearing and other foods
		Oil-bearing benefit (OB)	
		Vegetable benefit (VB)	
	Ecological benefit (ECB)	Water conservation benefit (WCB)	Increase water use efficiency and improve water quality
		Soil and water conservation benefit (SWB)	Improve soil quality including soil resistance to erosion
		Microclimate improvement benefit (MIB)	Increase air humidity and improve air quality
		Air quality improvement benefit (AQB)	
		Biological diversity benefit (BDB)	Facilitate survival and reproduction of species
		Soil sanitation benefit (SSB)	Reduce and eliminate soil pollutants
	Social benefit (SB)	Food security benefit (FSB)	Provide agricultural products and improve social wellbeing
		Labor social insurance benefit (LSIB)	Safeguard social stability
		Surplus labor social insurance benefit (SLSIB)	
		Entertainment and cultural benefit (ECB)	Improve living quality of the individual and organization

Recently, the vector algorithm has been proved to be capable of analyzing cultivated land use benefits. According to the three-dimensional vector algorithm, the CLUB model is defined as follows:

$$A = \sqrt{(\lambda_1 B)^2 + (\lambda_2 C)^2 + (\lambda_3 D)^2} \quad (1)$$

where  $A$  is CB and  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$  denote economic, ecological and social weights, respectively.  $B$ ,  $C$  and  $D$  represent economic, ecological and social benefits, respectively.

#### 4.1.2. Economic Benefit Calculation

Input–output is a common economic method that uses the difference between revenue and cost to estimate the surplus value of an agricultural product [52]. The input–output method uses the following equation to estimate the economic benefit:

$$B = \sum_{i=1}^n (p_i \times q_i - \sum_{j=1}^m a_{ij}) \times x_i / X \quad (2)$$

where  $B$  is the economic benefit;  $X$  and  $x_i$  are the total cultivated land acreage and individual crop acreage, respectively;  $n$  is the crop number;  $p_i$  is the unit price;  $q_i$  is the unit yield;  $m$  is the per unit cost; and  $a_{ij}$  is the unit cost of individual crops, which includes material cost, labor cost and material cost. Material cost includes costs of seeds ( $a_s$ ), chemical fertilizer ( $a_c$ ), farmyard manure ( $a_f$ ), pesticide ( $a_p$ ), row covers ( $a_a$ ), lease operating cost ( $a_l$ ), fuel expenditure ( $a_{fe}$ ), tools ( $a_t$ ), repair maintenance ( $a_{rm}$ ), and other costs such as depreciation of fixed asset ( $a_{df}$ ). In this paper, we focus on food (e.g., rice, corn, and wheat) and oil-bearing crops (e.g., soybean and sunflower seeds) and vegetables (e.g., Chinese cabbage, pepper, tomato, eggplant, and the others).

#### 4.1.3. Ecological Equivalency Factor Reference

The regional ecosystem values of forest and grassland are often assessed using the global ecosystem services model [53]. On this basis, Xie et al. (2005) created a table of Chinese ecosystem services value equivalency factors based on a questionnaire surveying. The table is targeted towards comprehensive regional ecological benefits, which make full use of the contributions from ecosystem service functions and economic values of cultivated land. The mathematic formula to estimate the ecological benefit using this method is expressed as follows:

$$C = \sum_{y=1}^m \left( \frac{1}{7} \sum_{i=1}^n \left( \frac{p_i \times q_i \times x_i}{X} \right) \right) \times u_y \quad (3)$$

where  $C$  is the ecological benefit;  $u_y$  is the ecological equivalency factor value, including water conservation (0.60), soil and water conservation (1.46), microclimate improvement (0.89), air quality improvement (0.50), biological diversity (0.71) and soil sanitation (1.64);  $y$  is the equivalency factor number; and  $X$ ,  $x_i$ ,  $p_i$ ,  $q_i$ ,  $m$  and  $n$  are the same as the aforementioned variables in Equation (2).

#### 4.1.4. Replacement Cost for Social Benefits

The replacement cost can be estimated using the surplus and non-use values of a social benefit based on the alternatively known price, including the shadow price method and the substitute market method. In this study, the shadow price is used to estimate food security benefits by calculating the sum of newly reclaimed cultivated land costs and the loss values of cultivated land revenues. The substitute market is used to estimate social security benefits instead of the indirect price of social security goods.

$$D = D_1 + D_2 + D_3 \quad (4)$$

$$D_1 = rc_1 + \frac{r}{X} \left( \sum_{i=1}^n \left( \frac{p_i \times q_i \times x_i}{1+r_1} \times 40\% \right) + \sum_{i=1}^n \left( \frac{p_i \times q_i \times x_i}{(1+r_1)^2} \times 30\% \right) + \sum_{i=1}^n \left( \frac{p_i \times q_i \times x_i}{(1+r_1)^3} \times 20\% \right) + \sum_{i=1}^n \left( \frac{p_i \times q_i \times x_i}{(1+r_1)^4} \times 10\% \right) \right) \quad (5)$$

$$D_2 = s_{min} \times (s_{ap} - \left( \frac{X \times (p_i \times q_i - a_i)}{(\alpha R_t \times \sigma) \times (p_i \times q_i)} \right) \times \sum_{i=1}^n \left( \frac{p_i \times q_i}{X} \times x_i \right)) + \left( \frac{g_m \times b + g_w \times c}{M_0} \times M_1 + \frac{1 - (1+r_3)^{-13}}{r_3} \times m \times A \right) \quad (6)$$

where  $D$  is the social benefit,  $D_1$  is the food security benefit,  $D_2$  is the social security benefit,  $D_3$  is the entertainment and cultural benefit,  $c_1$  is the reclaimed cultivated land cost,  $r$  is the income rate (3.72%), and  $r_1$  is the one-year discount rate on a regular basis from the Bank of China (Year 2010: 4.15%).  $s_{min}$  is the lowest social security standard in rural areas.  $\alpha$  is the coefficient of migrant workers' wages (0.7),  $R_t$  is the annual averaged wage of on-the-job workers,  $\sigma$  is the balanced coefficient of professional farming income (1),  $g_m$  is the net premium for male laborers,  $g_w$  is the net premium for female laborers,  $b$  is the proportion of the male population,  $c$  is the proportion of the female population,  $M_1$  is the basic living expenses,  $M_0$  is the monthly premium,  $m$  is the bearing population per unit of cultivated land areas, and  $A$  is the per capita annual training fees.  $D_3$  is evaluated according to Equation (2) with the equivalency factor value of  $D_3$  set to 0.01.

#### 4.2. Data Sources

Social-economic data were acquired through a survey, online resources, and statistical yearbooks. The statistical township data and farm data, including production, salary, and population, were obtained from the Fujin Statistical Yearbook for Regional Economy (2011), the Reclamation areas of Heilongjiang Province Statistical Yearbook for Social-Economy (2011), and the Counties of Heilongjiang Province Statistical Yearbook for Social-Economy (2011). The statistics for food prices and costs were collected from The National Agricultural Cost-benefit Data Assembly (2011). Material consumption and product sale prices were acquired through a field survey in Fujin. The land use (2010) vector data were extracted from remotely sensed data through human-machine interactive interpretation.

CLUBs are affected by the environment (e.g., temperature, precipitation), geographical conditions (e.g., elevation, slope) and religious beliefs. In this study, townships (CA) and state farms (SA) have similar environmental and geographical conditions in Fujin but exist within different social contexts. Therefore, it is necessary to calculate and analyze the cultivated land use benefits in each of these areas.

### 5. Cultivated Land Use Benefit Differences between CA and SA

#### 5.1. Integrated Benefit Differences

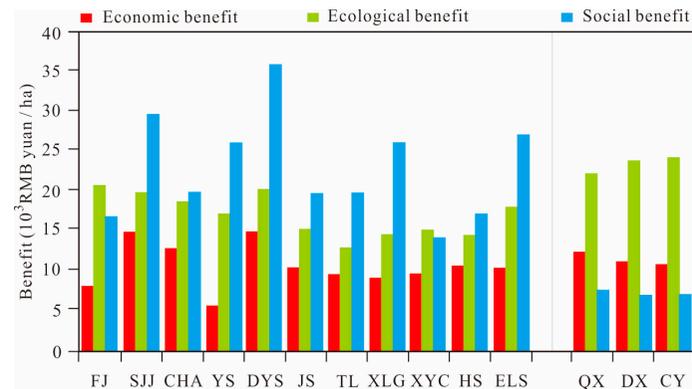
As shown in Table 2, the social and ecological benefits are 36.29% and  $-70.84\%$  from a comparison of CA with SA while the comprehensive benefits and economic benefits are  $-4.97\%$  and  $5.84\%$ . The comprehensive benefits and social benefits of CA (10,155 RMB yuan/ha and 22,961 RMB yuan/ha, respectively) are much higher than those of SA (9650 RMB yuan/ha and 6695 RMB yuan/ha), whereas the economic benefits and ecological benefits of CA are much lower than those of SA (11,306 and 11,966 in CA, respectively, versus 16,166 and 22,032 in SA; unit: RMB yuan/ha).

Figure 5 shows the cultivated land use benefits among townships and state farms in 2010. From this figure, it can be seen that obvious differences exist among townships and state farms. The benefits of the 11 townships change dramatically while those of the three state farms are steady. Comparing the maximum and minimum values, the decreases of economic, social and ecological benefits of townships are 105%, 159%, 61%, respectively, while the corresponding reductions of state farm are 8%, 21%, and 12%.

**Table 2.** Cultivated land use benefits of CA and SA in 2010.

Target	Comparison			Status	Comparison			Factor	Comparison		
	CA (RMB Yuan/ha)	SA (RMB Yuan/ha)	Difference (%)		CA (RMB Yuan/ha)	SA (RMB Yuan/ha)	Difference (%)		CA (RMB Yuan/ha)	SA (RMB Yuan/ha)	Difference (%)
CB	10,155	9650	−4.97%	EB	11,306	11,966	5.84%	FB	8745	11,708	33.88%
								OB	6761	5529	−18.22%
								VB	35,639	0	-
				ECB	16,166	22,032	36.29%	WCB	1672	2279	36.30%
								SWB	4069	5546	36.29%
								MIB	2481	3381	36.27%
								AQB	1394	1899	36.20%
								BDB	1979	2697	36.28%
								SSB	4571	6230	36.22%
								FSB	3134	4247	35.51%
SB	22,961	6695	−70.84%	SIB	19,799	2410	−87.83%				
				ECB	28	38	35.71%				

Note: 1 RMB yuan = 0.1595 US dollar (<http://forex.hexun.com/rmbhl/#zkRate>). Sources: Heilongjiang and Fujin Social-economic statistical yearbooks; agricultural cost-benefit data are assembly data. The difference showed that percentage of (CA-SA)/CA. The abbreviations of benefits are explained in Table 1, which includes CB, EB, ECB, SB, FB, etc.



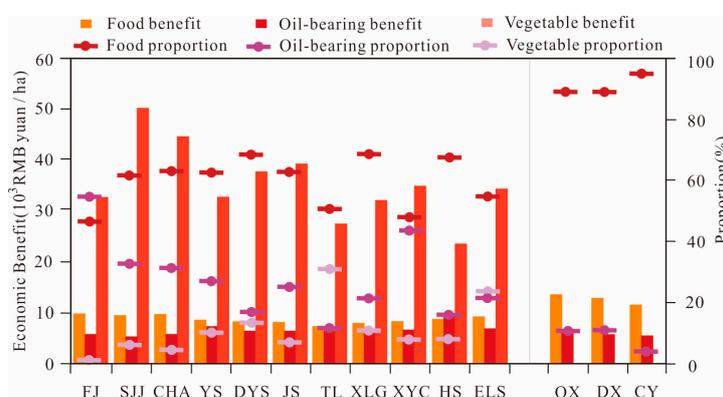
**Figure 5.** Cultivated land use benefits among townships and state farms in 2010. Unit: 10<sup>3</sup> RMB yuan/ha (benefits). The abbreviations of townships and state farms are explained in the part of “3.1 Study area”, including Fujin (FJ), Shangjieji (SJJ), Chang’an (CHA), etc.

## 5.2. Internal Benefit Characteristics

### 5.2.1. Economic Benefits

From Table 2, it also can be seen that food benefits, oil-bearing benefits and vegetable benefits show significant differences between SA and CA. Compared with CA, the food benefits of SA declined, whereas the oil-bearing and vegetable benefits of SA increased, particularly vegetable benefits.

The crop structure and costs created different economic benefits between CA and SA. The food, oil-bearing and vegetable structure ratios in CA and SA are 50:35:15 and 89:11:0, respectively. Figure 6 shows different crop structure and convergence characteristics in township state farms. Additionally, the rent, labor and material costs play key roles in differentiating townships and state farms. For example, the rent cost of SA was double that of CA; the labor cost in SA (2337 RMB yuan/ha) was also much higher than that in CA (1150 RMB yuan/ha). The mechanical operating costs and the fuel costs reflect the food costs, whereas the chemical fertilizer and the pesticide costs are indicated by the oil-bearing and vegetable costs. Compared with the rent and the labor costs, the material costs are more remarkable in townships of CA and state farms of SA.

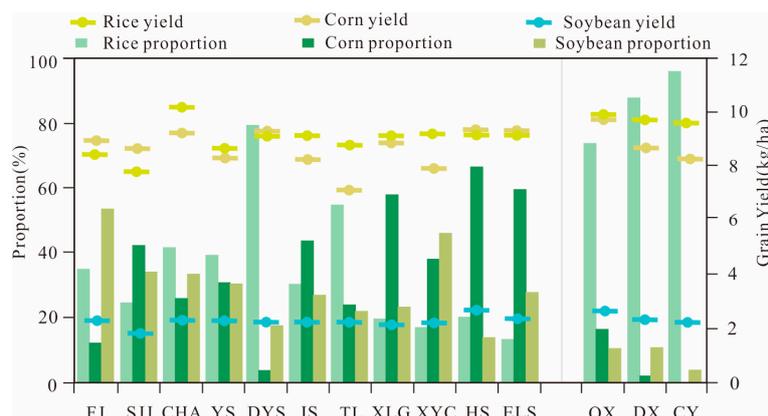


**Figure 6.** Economic benefits in townships and state farms in 2010. Unit:  $10^3$  RMB yuan/ha (economic benefits), % (proportion).

### 5.2.2. Ecological Benefits

The ecological benefits, as shown in Table 2, including water conservation benefit (WCB), soil and water conservation benefit (SWB), microclimate improvement benefit (MIB), air quality improvement benefit (AQB), biological diversity benefit (BDB) and soil sanitation benefit (SSB) are much larger in SA than in CA.

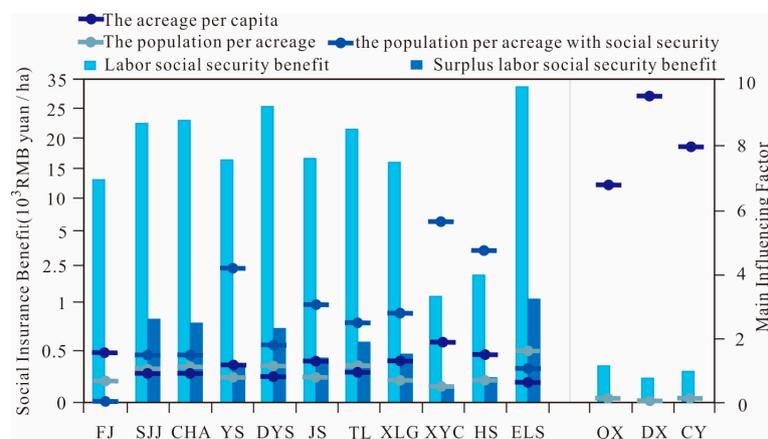
Figure 7 illustrates rice, corn and soybean proportions and yields among townships and farms in 2010. From this figure, it can be seen that different planting structures of rice, corn and soybean account for the differences in ecological benefits. Rice, corn and soybean, as the main crops, importantly, account for more than 90% of the areas in townships of CA and state farms of SA. The yields of rice, corn and soybean, to a large extent, result in differences in their planting structures (Figure 7), such as the proportions of rice planted in townships (average as 49%) and state farms (mean 91%) compared to the rice yields in townships (approximately 8647 kg/ha) and state farms (approximately 9750 kg/ha).



**Figure 7.** Rice, corn and soybean proportions and yields among townships and farms in 2010.

### 5.2.3. Social Benefits

As shown in Table 2, food security benefit (FSB) and entertainment and cultural benefit (ECB) are approximately 1.36 times higher in SA than in CA. However, the social insurance benefit (SIB) of CA is 8.22 times those in SA. The significant difference in SIB between CA and SA may be explained by the labor social security and surplus labor social security benefits (Figure 8), which are reflected in the population per acreage with social security, the acreage per capita and the population per acreage. For example, the value of 0.92 people per acreage in CA is much higher than 0.12 in SA. The acreage per capita (1.07 ha) in CA is significantly lower than the acreage per capita (8.09 ha) in SA. The population per acreage with social security is 0.45 in CA, whereas it is 0 in SA.



**Figure 8.** Social security benefits among townships and farms in 2010. Unit:  $10^3$  RMB yuan/ha (labor and surplus labor security benefits), people (the population per acreage), ha (the population per acreage with social security).

## 6. Cultivated Land Use Benefits Driven by Agrarian Property Regimes

### 6.1. Agricultural Economy's Reliance on Agrarian Property

In theory, the agrarian property rights arrangement directly reflects capital, material and technology by motivating agricultural labors. In the collective areas of China, peasants freely operate with adequate and intact management and income right, which has resulted in the diversity of agro-production factors and economic benefits in townships. Local governments and organizations have focused on new countryside construction and urban–rural development under cultivated land requisition and expropriation rights [31,54,55]. However, due to the state ownership of cultivated land, governments

and organizations are mainly responsible for agricultural technology guidance, management and service for state farms, including mechanical cultivation, agro-technical popularization, optimal breeding and production guidance, and state farmhands have energetically improved agro-production and productivity under these guidance and incentives. The economic benefits and agro-production factor differences between the collective area and the state-owned areas in Fujin, China, are compared using information in Table 2 and Figures 6 and 7.

The amount of capital input determines the expected benefits, which can be applied to both traditional and modern agricultural ideologies. After its accession to the World Trade Organization, China's agriculture cost has become the main pure-profit lever when crop prices tend toward convergence. Taking rice as an example in Fujin, the agriculture cost is determined based on the historical farming experiences in CA, whereas this cost is directly controlled using a uniform variety in SA to promote mechanical efficiency and reduce labor costs in SA, which is the opposite of the trend in CA.

Under the varied motivations, the agricultural economies of both the collective and state-owned agrarian property regimes have stably increased by devoting capital, material and technology to different degrees, especially for agricultural output. According to statistics for Fujin, the agricultural output has grown two-fold in CA and three-fold in SA from 2006 to 2010 [45]. It is not difficult to understand that CA and SA conduct agro-management based on the collective and state-owned agrarian rights, respectively. According to interviews with township and village cadres and state farm leaders, this difference is a fundamental reason why bottom-up redevelopment occurs in townships, whereas the top-down management system is popular on state farms.

### *6.2. Ecological Environment under Land Use Planning*

Agrarian property regimes determine the bottom-up agricultural management in CA and the top-down agricultural management in SA, as reflected in the planting structure and land use planning in China. In state farms, the single-crop planting structure is used to ensure national food security and achieve specified agricultural targets, and considerable land use planning has been implemented to protect state land assets. For example, high quality agricultural infrastructure was built for paddies in SA of Fujin, particularly for water conservation. In contrast, in CA of China, without high initial investment, multiple dry-land crops are planted to pursue high economic returns in townships, and construction land use planning has not effectively protected cultivated land.

To a large extent, land use planning has been redefined to include the optimal allocation of land, labor and capital, shaping long-term land use patterns. A study of Landsat photographs of Fujin revealed that regular agricultural landscapes exist in SA and irregular agricultural landscapes occur in CA, and dispersed landscapes happen throughout [32]. Fragments of cultivated land can be distinctly observed in CA. In SA, the high forest belt, dense irrigation trenches densities, and regular roads have contributed to reduced wind speeds. In addition, there are improved environmental conditions in SA such as improved soil and water conservation, air quality, microclimate conditions, and biodiversity maintenance. These improved environmental conditions are the reasons why the ecological services of SA are better than those CA.

### *6.3. Social Security Provided by Agrarian Management Systems*

Under the collective or the state-owned different agrarian property ownerships, cultivated lands, as public assets, have different social security functions (e.g., food security, social insurance and entertainment and culture). Social benefits are different between CA and SA in Fujin. During the creation of agricultural production, restricted by cultivated land scale and agrarian management, labor is allocated according to social security needs (such as basic living demands and crop prices). Based on the interview results with peasants and state farmhands, the labor behaviors of state farmhands are more autonomous with the top-down agrarian management than the bottom-up agrarian management. The use of machines can efficiently divide large-scale labors and improve agricultural production. In homogeneous cultivated land, large-scale regular cultivated land is available for contracting and

leasing. From 2006 to 2010 in SA of Fujin, the cultivated land contract population has increased 441% and the contracted cultivated land have increased by 159% with 10–30 hectares per family. To protect food security, state farms pay no more than 1000 RMB yuan per hectare of social security and agricultural insurance. In CA of Fujin, all cultivated land of townships is small and fragmented, being equally allocated among peasants. Moreover, appropriate social security insurance and medical insurance do not cover the whole rural population; thus, cultivated land is excessively used by peasants. The labor and surplus labor social insurance benefits in Fujin are more dominant in CA than in SA.

## 7. Discussion

Agrarian property rights reunification (e.g., the rural collective land right verification) has reshuffled the agrarian management systems and changed the cultivated land use differently with different economic organizations (such as townships and state farms) since 1993. Incentivized by different agrarian property ownership types (collectively or state-owned regimes), local governments and organizations are likely to achieve the goal of generating multi-objective cultivated land use benefits, including economic, ecological and social benefits [56].

To date, empirical studies have mainly focused on investigating multi-objective cultivated land use benefits [57,58]. Our study goes further by examining the internal relations among factors and the mechanisms underlying cultivated land use benefits, including economic, ecological and social benefits. To a large extent, cultivated land use benefits provide a new comparative perspective for studying agrarian property regimes. The results have shown that the cultivated land use benefits are divergent with the collective and state agrarian property regimes. The collective and state-owned agrarian property regimes in China have caused obvious differences in cultivated land use and people's livelihoods. Beyond basic living People's needs may include creating more beautiful pastoral landscapes and harmonious social structures to promote a healthy and environmentally sustainable home.

### 7.1. The Target of Chinese Agricultural Development

China's agricultural regions have been a focused subject of many studies over the past several decades. Modernizing agricultural operations is a core goal of agricultural regions' economic development in many national socio-economic development conferences, including agricultural production, harvesting and technology.

High-standard agricultural production areas were first established for rice, wheat, corn and other important economic products (e.g., vegetables and fruits). By conserving water resources and reducing pesticide use, nonpoint source pollution can be readily reduced to meet the national food security. To ensure agro-production capacity and labor quality, methods such as cultivating high-quality seeds, expanding mechanization, and providing adequate agro-information may be used to obtain optimal agricultural benefits.

### 7.2. Rural Collective Land Rights Verification

Rural collective land rights verification (RCLRV), a new asset management system, clarifies the owners' allocation and management rights of collective land.

In CA of China, the grain output of cultivated land has continuously increased for eleven years. However, we cannot ignore the institutional problems. Unclear land tenure and responsibility, a serious problem, can disturb agricultural management and interfere with cultivated land use and must therefore be inhibited by radical land reform [59,60]. Clarifying the legal status, rights and liability of cultivated land and rural housing is a core RCLRV for townships, villages, and peasants. In RCLRV, exchange and adjustment of land disposition rights are given to townships and villages so that the land transfer compensation cannot be assigned in addition to land expropriation for the public interest. For peasants, cultivated land is allocated for the long-term stability of contract rights and benefit distribution rights.

Guided by clarifying rural property rights, cultivated land and other land types are freely transferred as demutualized collective assets. This process is good for managing fragmented cultivated land through the exchange of land contract rights. It may increase peasants' property income by reducing the number of unpopulated villages and underutilized farmland.

### 7.3. State Farm Advantages

In SA of China, state farms have been developed towards profound cultivated land use by restraining land tenure and usufruct. Standard agricultural production sites (Figure 9) were built as modern agricultural demonstration zones to facilitate farming activities. Because of the agricultural infrastructure of mechanization and socialization services, state farmhands are more willing to invest in farming activities to earn extra income by leasing large amounts of cultivated land and separating cultivated land tenure and usufruct.



**Figure 9.** Agricultural production site at Qixing Farm in the Heilongjiang agricultural reclamation (photo taken from the official website of the agricultural reclamation Jiansanjiang administration bureau, <http://www.china-jsj.com/>).

The top-down management system of state farms avoids the dispersed and fragmented agricultural land patterns resulting from the equal land distribution of the household contract system, promoting large-scale and intensive management. It is important that agricultural mechanization and technology play a core role in inhibiting relatively low labor productivity. The payment of agrarian usufruct fees make state farmhands more willing to use high-powered machinery to enhance work efficiency, which is preferable to the free agrarian tenure of peasants.

### 7.4. Agricultural Reform and Its Impacts on Cultivated Land Use

The CA and SA of Fujin present many divergences in terms of collective and state-owned agrarian properties and management systems. Nevertheless, due to the similarity of agricultural goals, townships and state farms have some common characteristics.

In China, an effective food supply, improved labor income and balanced resource allocation have been the main goals of agricultural reform since the late 1950s. With the increased agricultural demand caused by urbanization, the central government found it necessary to cultivate new agricultural business entities under the existing operating mechanism. Household agriculture emerged among state farms and townships along with top-down and bottom-up agriculture managements in the 1980s, and greater mechanization became concentrated in the cultivated land. Recently, due to clearer agrarian

property regimes, agricultural modernization, sustainable development and ecological security have been the focus of national agricultural development.

In Heilongjiang Province, coexisting townships and state farms share obvious regional characteristics. During the economic transformation in China, agricultural economic growth was not affected by collective or state-owned ownerships but was slightly controlled by agrarian property rights. Local leaders and grass-root organizations have fairly large autonomy with respect to cultivated land use. As a result, distinctive regional patterns, rational labor division and complete industrial systems have been developed. For example, based on regional patterns, townships provide disaster prevention, technological research, expertise and management areas, while state farms can moderately relax agricultural management behavior to enhance state farmhand autonomy and promote cultivated land tenure transformation.

In Fujin, collaboration between collective and state farms can provide an official tool to integrate agricultural resources. Based on the difference between the state farm's mechanized production and the township's decentralized management, multi-crop industries need to be built to meet market-based regional economic coordination so that mutual benefits and common development become the main outcomes in CA and SA in Fujin.

## 8. Conclusions

Cultivated land use benefits under a stringent agrarian property regime and agrarian management system include the integrated outputs of food production, social security and ecological services. A comparative analysis of the cultivated land use benefits in the city of Fujin reveals cultivated land use disparities between collective and state-owned agrarian property regimes. The results show that the comprehensive benefits exhibit obvious differences between CA and SA in Fujin, particularly internal benefits. Affected by capital, materials and technology, the planting structure and cost are different in CA and SA, and varied degrees of land consolidation and land use planning affect ecological functions. These differences suggest that large-scale intensive production replaces extensive labor operation in state farms for agricultural modernization. Therefore, better agricultural infrastructure and moderate capital, materials and technology could contribute to regional food security and households' incomes. These findings may aid the central and local governments in understanding the importance of RCLR, which may provide a practical and solid basis for constituting stricter agrarian property protection in the near future.

This study has demonstrated different relationships between agrarian property regimes and cultivated land use with CLUS in two adjacent areas. Moreover, the hypothesis of CLUS incorporates reasonable cultivated land use diversity with coordinating system elements. In fact, the collective and state-owned agrarian property regimes, guided by top-down and bottom-up agricultural management, respectively, create a huge diversity in agricultural economy, ecological environment, and social security. To develop sustainable agriculture and protect labor interests, more agrarian properties should be given to agricultural laborers to stimulate agricultural input and balance market regulations. Meanwhile, cultivated land use under different processes in a particular agrarian regime or various agrarian regimes could also be studied for nations with considerably varying cultivated land (e.g., Brazil). A comparative analysis can enhance our understanding of cultivated land use with different agrarian property regimes and help agrarian managers and policy makers identify suitable institutions for sustainable agriculture development.

The comprehensive benefit evaluation of cultivated land use is a systematic work. It is necessary to establish a scientific and normative system model of cultivated land use and consider the mutual influence and coupling relationship between each system element and agricultural management mode. At the same time, the influence factors of cultivated land use systems are complex, and some factors are difficult to quantify, such as land property rights system, farmers' management behavior, etc. In this paper, these factors are considered as a certain impact on the comprehensive benefits of cultivated land use, as a premise of research. Therefore, it is urgent to take these factors into the index system

and carry out research on the mechanism of temporal and spatial differentiation of cultivated land use efficiency.

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