Construction of the Classification and Grading Index System of Cultivated Land Based on the Viewpoint of Sustainable Development

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Abstract In order to objectively and reasonably evaluate the actual and potential value of cultivated land, both social and ecological values are introduced into the classification and grading index system of cultivated land based on the viewpoint of sustainable development, after considering the natural and economic values of cultivated land. Index system construction of the sustainable utilization of cultivated land should follow the principles of economic viability, social acceptability, and ecological protection. Classification of cultivated land should take into account the soil fertility of cultivated land. Then, grading of cultivated land is carried out from the practical productivity (or potential productivity) of cultivated land. According to the existing classification index system of cultivated land, the soil, natural and environmental factors in plains, mountains and hills are mainly modified in the classification index system of cultivated land. And index systems for the cultivated land classification in plains, mountains and hills are set up. The grading index system of cultivated land is established based on the economic viability (economic value), social acceptability (social value) and protection of cultivated land (ecological value). Quantitative expression of cultivated land grading index is also carried out.

Key words Classification and grading of cultivated land, Index system, Sustainable development, China

For a long time, partial understanding of the value of cultivated land resources has led to the too much attention to economic and natural values in the land resource evaluation, and the negligence of the ecological and social values. Therefore, researches on the theory of cultivated land quality evaluation mainly discuss on the economic and natural values of cultivated land, but pay little attention to the ecological and social values of cultivated land[1-4], which leads to the cultivated land conversion in practice and seriously threats the food security and social stability of China. In order to promote the sustainable use of cultivated land resources, grading index system of the existing cultivated land is modified based on the reconstruction of the overall value of cultivated land resources. Conception of grading index system of the sustainable use of existing cultivated land is put forward, in order to improve the theory of classification and grading and to guide the land management of land to a certain extent.

1 Principle and basis of the grading index system construction of sustainable cultivated land

Sustainable development is to maximum the economic, social and ecological benefits. Following the concept of sustainable development means to take into account the productivity and the economic output of cultivated land in a comprehensive way during the classification and grading of cultivated land quality, as well as the social value of cultivated land, the stability of land use, and the protection of cultivated land. Quality evaluation on the cultivated land is carried out based on the attribute analysis and quantitative expression of cultivated land.

Quality evaluation of cultivated land follows the process of first classification and then grading. Classification of cultivated land mainly considers the soil fertility of cultivated land (theoretical productivity), involving the productivity of cultivated land and the stability of quality. Among them, productivity of cultivated land is mainly determined by the soil environment and the soil condition of cultivated land. And the stability of cultivated land quality reflects the impact of ecological environment on cultivated land quality, which is the measurement of the ecologic trait of cultivated land. Based on the classification of cultivated land, grading of cultivated land is carried out from the aspect of practical productivity (or potential productivity). The practical productivity of cultivated land is mainly reflected in the three aspects of economic viability of cultivated land use, the social acceptability, and the protection of cultivated land. Factors reflecting the economic value, social value and ecological value of cultivated land can be selected to evaluate the quality of cultivated land and to classify the grade of cultivated land (Fig. 1).

2 Establishment of the classification and grading index system of the sustainable use of cultivated land

2.1 Classification index system of cultivated land Gradation of cultivated land focuses primarily on the differences in productivity and income of cultivated land caused by the poten-

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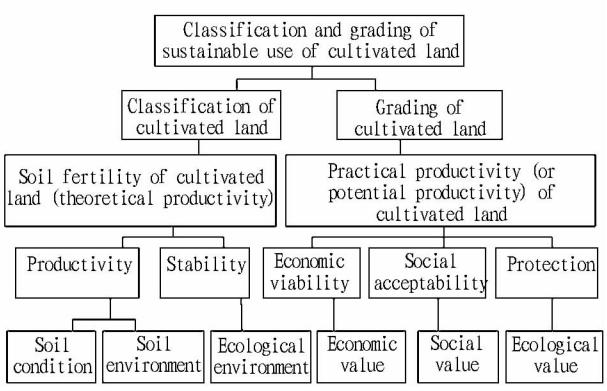

Fig.1 Basis for establishing the classification and grading index system of the sustainable use of cultivated land

tial (or theoretical) regional natural quality, the average utilization level, and the average benefit level. Therefore, except the correlative factors emphasized by existing researches, such as soil and soil environment, reflecting the productivity of cultivated land, we believe that the eco-environmental factors reflecting the quality stability of cultivated land is also an important aspect representing the soil fertility of cultivated land (Table 1).

Particularly, due to the differences in landforms in different regions, impact degree of the natural factors on cultivated land gradation varies. For instance, in the areas of plain, mountain and hill, difference in terrain feature (mainly the slope) is a leading factor, even a limiting factor, causing the quality difference in cultivated land. Therefore, when establishing the classification index system of cultivated land, the index system mentioned above should be adjusted correspondingly according to the natural conditions in different areas. According to the *Regulation for Classification on Farmland* formulated by the Ministry of Land and Resources of the People's Republic of China, major factors distinguishing the soil fertility of cultivated land in plains, mountains and hills are soil and soil environment. And the factors reflecting the ecological environment have the same influence degree on the soil fertility of cultivated land. Therefore, we mainly modify the soil, natural and environmental factors in plains, mountains and hills in the classification index system of cultivated land. And index systems for the cultivated land classification in plains, mountains and hills are set up (Table 2).

Table 1 Classification index system of cultivated land

Evaluation angle	Evaluation factor	Evaluation sub-factor	Evaluation index
Soil fertility of cultivated land	Productivity of cultivated land	Soil condition	Effective thickness of soil layer
			Soil texture in surface soil layer
			Profile construct
			Soil organic matter content
			Soil pH
			Soil barrier layer
		Soil environment	Drainage condition
			Terrain slope
			Irrigation guarantee rate
			Irrigation water
			Exposure situation of surface rock
	Stability of quality	Ecological environment	Energy consumption per unit area
			Water consumption per unit area
			Discharged volume of industrial waste water per unit area
			Discharged volume of industrial waste gas per unit area
			Discharged volume of solid waste per unit area
			Application amount of chemical nitrogen per unit area
			Pesticide application per unit area

Table 2 Classification index system of cultivated land in plain areas

Evaluation angle	Evaluation factor	Evaluation sub-factor	Evaluation index
Soil fertility of cultivated land	Productivity of cultivated land	Soil condition	Soil texture in surface soil layer
			Profile construct
			Soil organic matter content
			Soil pH
			Soil barrier layer
		Soil environment	Drainage condition
			Irrigation guarantee rate
	Stability of quality	Ecological environment	Energy consumption per unit area
			Water consumption per unit area
			Discharged volume of industrial waste water per unit area
			Discharged volume of industrial waste gas per unit area
			Discharged volume of solid waste per unit area
			Application amount of chemical nitrogen per unit area
			Pesticide application per unit area

Table 2 reports that factors affecting the soil fertility of cultivated land in plain areas are mainly in the differences of soil quality itself, but the impacts of terrain slope on the soil fertility of cultivated land are less concerned about. In the hill and mountainous areas, landform undulates terribly, causing the significant impact of irrigation efficiency and soil pH on the soil fertility of cultivated land, as well as the great differences in the design of cultivated land classification index system between the plain and the hill or mountain (Table 3).

Table 3 Classification index system of cultivated land in mountainous and hilly areas

Evaluation angle	Evaluation factor	Evaluation sub-factor	Evaluation index
Soil fertility of cultivated land	Productivity of cultivated land	Soil condition	Effective thickness of soil layer
			Soil texture in surface soil layer
			Soil organic matter content
			Soil pH
			Soil salinization degree
		Soil environment	Terrain slope
			Irrigation guarantee rate
			Exposure situation of surface rock
	Stability of quality	Ecological environment	Energy consumption per unit area
			Water consumption per unit area
			Discharged volume of industrial waste water per unit area
			Discharged volume of industrial waste gas per unit area
			Discharged volume of solid waste per unit area
			Application amount of chemical nitrogen per unit area
			Pesticide application per unit area

2.2 Grading index system of cultivated land

2.2.1 Construction of grading index system of cultivated land. Objective and scientific knowledge about the overall value of cultivated land is a prerequisite of the rational division of cultivated land. It should be highlighted that the social and ecological values of cultivated land should be taken into consideration, except its economic value. From the perspective of sustainable development, both social and ecological values have even greater significance. Table 4 reports the grading index system of cultivated land based on the economic viability (economic value), social acceptability (social value) and protection of cultivated land (ecological value).

Table 4 Grading index system of cultivated land

Evaluation angle	Evaluation factor	Evaluation sub-factor
Economic viability (economic value)	Land use intensity	Land utilization rate
		Reclamation coefficient of cultivated land
		Multiple cropping coefficient of cultivated land
	Land input-output	Output value per unit land
	Location condition	Grade of regional central town
		Distance from central town
		Road grade
		Density of road network
Social acceptability (social value)	Social security	Basic living security
		Old-age security
		Employment security
	Social stability	Food security
		Containing the loss of agricultural labor
Protection of cultivated land (ecological value)	Ecological environment protection	Proportion of groundwater overdraft area
		Proportion of water and soil loss area
		Proportion of nature reserve area
		Rate of water quality reaching standard in water function area
	Ecological environment construction	Forest coverage rate
		Proportion of the area for harmless agricultural products, green and organic food bases
		Environmental protection investment per unit cultivated land

Economic viability is based primarily on the economic value of cultivated land, considering the factors in three aspects. Firstly, land use intensity, which consists of the land utilization rate, the reclamation coefficient of cultivated land, and the multiple cropping coefficient of cultivated land. Greater index value shows the higher unitization rate of cultivated land. Secondly, land input-output. Higher output value indicates greater economic value of cultivated land. The single index " output value per unit land" is selected in order to objectively reflect the output efficiency of land and to simplify the research process. Thirdly, location condition of cultivated land, including the location of cultivated land and the accessibility of traffic. Better location condition helps to improve the economic value of cultivated land.

Social acceptability of cultivated land resources mainly reflects the huge social value during the use of cultivated land. Social value of cultivated land resources is an important reference factor for the classification and grading of cultivated land quality.

The social function of cultivated land is mainly realizing social security and maintaining social stability.

As for the national layer, cultivated land can provide food that people rely on, and ensure the national food security. At the same time, cultivated land can solve the employment problem of rural labor force, effectively contain the loss of agricultural labor force, and reflects the significance of cultivated land in maintaining social stability. As for the layer of peasant household, cultivated land is a reliable material basis for farmers' basic production and living, old age security, raising children, medical insurance and so on (Fig. 2).

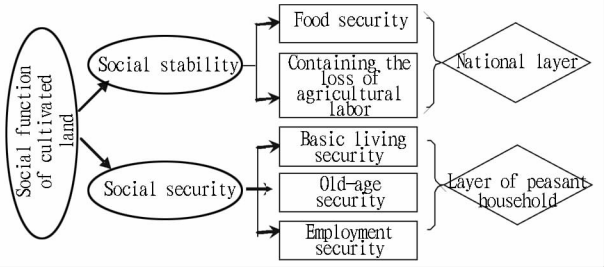

Fig. 2 Social function of cultivated land resources

2.2.2 Quantitative expression of cultivated land grading index. So far, China has not yet formed a uniform method for quantitatively measuring the social value of cultivated land resources[5-7]. And related researches are taken as the references[8-10]. Considering the operability of data collection and value measurement, social value of cultivated land is divided into two aspects of social security value and social stability value. Hence, the equation is

$$V_s = (V_w \times \beta_w + V_b \times \beta_b) \times K_s$$

where V_s is the social value of cultivated land resources, V_w is the social stability value of cultivated land, V_b is the social security value of cultivated land, β_w is the weight of social stability value in the social value of cultivated land, β_b is the weight of social security value in the social value of cultivated land, and K_s is the correction coefficient of social stability value of cultivated land.

Social stability value of cultivated land is reflected in the two aspects of food security and the containing the loss of agricultural labor. "Population fed by unit cultivated land", that is, grain output per unit cultivated land/per capita grain consumption, is used to evaluate the security value of cultivated land in ensuring the food security. "Proportion of agricultural income in total income of peasant household" is adopted to measure the value cultivated land resources in containing the loss of agricultural labor.

Social security value of cultivated land is reflected in the three aspects of basic living security, old-age security and employment security. The value of basic living security is measured by the per capita output in unit cultivated land, that is total annual output per unit cultivated land / rural population. The greater the value is, the better basic living severity the farmers have. Value of old-age security is measured by the ratio of per capita old-age security value to per capital cultivated land area in areas being evaluated. Value employment security is evaluated by the ratio of non-agricultural income to per capita cultivated land area in areas being evaluated.

At the same time, research shows that there is an inversely proportional relationship between the farmers' dependence on cultivated land and their non-agricultural income. Therefore, we modify the social security value of cultivated land in different areas by the ratio of non-agricultural net income of local agricultural population to the national average level.

Besides, the concern about ecological value of cultivated land resources is an important aspect to realize the sustainable use of cultivated land resources. It is believed that during the cultivated land grading, impact of active measures of human on the maintenance and improvement degrees of the ecological environment of cultivated land should be paid more attention to. In other words, the protection of cultivated land should be protected. Therefore, ecological value of cultivated land should be measured and evaluated from the aspects of ecological environment protection and ecological environment construction.

3 Conclusion

Cultivated land is an important resource to ensure the economic and social development of cultivated land. Comprehensive understanding and scientific evaluation of the value of cultivated land are the prerequisites of the rational utilization of cultivated land resources. Researches on the classification and grading of cultivated land mainly discuss on the economic and natural values of cultivated land, but pay little attention to the ecological and social values of cultivated land. Therefore, we rebuild the overall value of the cultivated land resource from the theories of the sustainable utilization of resources and the coordinated development of ecological environment. According to the existing research result, it is pointed out that the overall value of cultivated land is a unity of natural, economic, social and ecological values. Based on considering the natural and economic values, the social and ecological values of cultivated land are mainly discussed. Classification and grading index system of cultivated land is established from the economic viability, social acceptability, productivity of cultivated land, and stability of cultivated land, so as to further improve the classification and grading theory of existing cultivated land, to guide the management of land resources in China to a certain degree, to optimize the allocation of resources, to improve the efficiency of land use, and to realize the sustainable development of land resources utilization.

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the both. Therefore, Chongqing government should accelerate system innovation in the reform experiment of urban and county development, realizing the regular transfer of land, ensuring benefits of the both, accelerating land investment and improving land intensive using levels.

5.5 Strengthening land management and restricting land wasting Chongqing is a city typical of big urban city with big rural areas, with many villagers. While most are migrant populations, among whom wasteland is universal. The situation of wasteland weakens the intensive using levels of land. Therefore, corresponding policies should be formulated, such as wasting land to some degree may lose the management rights and so on. Strengthen management on land to improve the intensive using levels of wasteland.

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