ISSN: 2710-0170

Study on the Construction of Evaluation System of Cultivated Land Intensive Use in Different Spatial Scales

Weiwei Chen[1,2,3,4,5,*], Na Wang[1,2,3,4,5]

[1] Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710021, China.

[2] Shaanxi Provincial Land Engineering Construction Group Co., Ltd., Xi'an 710075, China.

[3] Key Laboratory of Degraded and Unused Land Consolidation Engineering, Ministry of Natural Resources, Xi'an 710075, China.

[4] Shaanxi Engineering Research Center of Land Consolidation, Xi'an 710075, China.

[5] Land Engineering Technology Innovation Center, Ministry of Natural Resources, Xi'an 710075, China.

* Corresponding Author: chenweiwei736@126.com

Abstract

The sustainable intensive use of cultivated land(SIUCL) is a strategic demand to change theway of agricultural development and promote the construction of ecological civilization. The comparative analysis of different scales and the scale transformation, extension and integration has an important influence on the sustainable and intensive use of cultivated land. This paper summarizes the construction principles of the evaluation system, and combs the evaluation of cultivated land intensive use at different spatial scales. The results show that (1) The studies on the intensive use of cultivated land at the macro-scale are the most which mainly include provinces, urban agglomerations, watersheds, economic zones, etc.. The evaluation system of intensive use of cultivated land at the macro-scale has gradually expanded from the evaluation of input intensity and output benefit to the evaluation of input intensity, output benefit, utilization degree and sustainability status. (2) The studies on the intensive use of cultivated land at the median-scale are mainly include small and medium-sized cities, counties, etc.. The evaluation indexes of intensive use of cultivated land at the median-scale includes input intensity, output effect, utilization level and sustainable utilization status, which is consistent with macro-scale studies. But all the indicators are more comprehensive. (3) The studies on the intensive use of cultivated land at the micro-scale are mainly include towns, villages, farmers, plots, etc.. Among them, in the evaluation system of cultivated land intensive use at the farmer scale, the selection of indicators is very different from that of macro-scale and median-scale studies. Most of the data come from farmer interviews, questionnaires, etc.

Keywords

Cultivated land, Intensive use, Evaluation system, Spatial scale.

1. Introduction

Cultivated land resources are a scarce resource that human beings rely on for survival from a food security perspective. In recent years, China has resolutely implemented the strictest cultivated land protection system. However, due to the deterioration of the global environment, the accelerating pace of national urbanization and ecological protection policies, there are some

ISSN: 2710-0170

problems in cultivated land resources in China, such as the decrease of quantity, the decrease of quality and the loss of cultivability[1]. As a result, the reserve resources of cultivated land are obviously insufficient, and food security and farmers' rights and interests are difficult to guarantee. However, improving the comprehensive utilization efficiency of cultivated land can be an effective way to solve this dilemma[2], which is an inevitable choice for human beings to use land under the pressure of social and economic development, land area constraints, population growth and technological progress. The evaluation of sustainable intensive use of cultivated land is to improve the output capacity of cultivated land under the action of human beings, which provides scientific support for policies such as spatial planning, rural revitalization, cultivated land protection.

Intensive use of cultivated land is the most efficient way of cultivated land use.The classical theory holds that the intensive use of land is to concentrate on a certain area of land, invest more means of production and living labor, use advanced technology and management methods, and obtain high output and income[3]. The intensive use of cultivated land evolved from the intensive use of land, and was divided into capital-intensive, labor-intensive, and technology-intensive according to the type of input of production factors[4]. At present, scholars have gradually constructed a relatively complete research system of intensive use of cultivated land[5]. As a decision-making orientation, the evaluation index system of cultivated land intensive use should not only reflect the leading idea of coordinated development of ecology, economy and society with land and cultivated land as spatial carriers, but also make each index the most sensitive, most convenient to measure and most abundant in the multiple indicators of the evaluation system of cultivated land intensive use in the region.The evaluation index should be able to directly or indirectly reflect the efficient and intensive nature of cultivated land, and should be effective and reasonable. In recent years, the government has introduced a series of policies and measures, including transforming agricultural production and resource utilization to promote the development of green agriculture[6]. Therefore, there is an urgent need to determine how to minimize the negative environmental impacts of intensification while ensuring the sustainable development of agro-ecosystems in order to achieve sustainable cropland use.

2. Principles of evaluation system construction

2.1. Comprehensiveness and Representativeness

The intensive use of cultivated land involves population, economy, land, resources, environment and so on. The construction of the evaluation system should select the indicators that are targeted, representative, conform to the connotation characteristics of the intensive use of cultivated land and can objectively reflect the level of each subsystem, and reasonably determine the number of selected indicators from a comprehensive perspective.

2.2. Totality and Systematics

The evaluation of the intensive use of cultivated land is a more complex systematic project. According to the theory of system, the evaluation system should comprehensively analyze many factors affecting cultivated land, such as economic, social, and ecological environment, and should comprehensively and systematically reflect all aspects of the degree of intensive use of cultivated land. Each subsystem should promote and coordinate with each other to form a hierarchical whole and serve the whole system together.

2.3. Scientificity and Operability

Scientificity refers to the scientific theoretical basis in the selection of evaluation index. Each index should be clearly defined, and fully reflect the operating mechanism of intensive use of cultivated land. Moreover, the source of data should be objective and accurate, and the methods

ISSN: 2710-0170

of processing data are scientific. At the same time, it is also necessary to pay attention to whether the selected indicators are operable, which can comprehensively describe the characteristics of intensive use of cultivated land and minimize indirect factors.

2.4. Regionality and Dynamics

There are differences in the natural conditions, resource conditions, and social and economic development levels of different regions.Therefore, it is necessary to take into account the unity of universal suitability and indicators reflecting regional differences when selecting evaluation indicators.The dynamics of cultivated land use shows that the use of cultivated land changes with time. The intensive use of cultivated land is the arrangement and allocation of land use structure in time and space. The speed of social and economic development and the degree of urbanization have a certain impact on the level of intensive use of cultivated land. Therefore, the selection of evaluation index should follow the principle of dynamics.

2.5. Independence and Typicality

The evaluation indicators of cultivated land intensive use often overlap with each other. Therefore, more attention should be paid to the selection of independent indicators when selecting indicators, so as to make the evaluation results more accurate and scientific. Moreover, the intensive use of cultivated land is affected by the quality, distribution structure, utilization characteristics, technical means, and social and economic development of cultivated land. Therefore, the selection of indicators should be typical, and can express the main aspects of each influencing factor.

3. Selection of evaluation system index

The comparative analysis of different scales and the scale transformation, extension and integration has an important influence on the sustainable and intensive use of cultivated land. The spatial scale of sustainable intensive use of cultivated land can be divided into three levels : macro scale (national, provincial, urban agglomeration, watershed, large area, etc.), medium scale (small and medium-sized cities, counties, etc.) and micro scale (towns, villages, farmers, plots, etc.).Based on the theoretical framework of different scales, the analysis results of cultivated land intensive use have certain differences. The study of macro-scale has advantages in grasping the trend of sustainable and intensive use of cultivated land as a whole. However, the medium scale is more specific and more operable. Therefore, the choice of analytical scale plays an important role in the construction of analytical framework. Most of the micro-scale studies take farmer households or specific plots as the analysis unit to observe the sustainable intensive use of cultivated land and analyze its influencing factors, which is more specific[8]. At present, a large number of case studies have emerged in lmacro scale such as provincial scale, urban agglomeration, river basin and economic zone. It is easier to grasp the trend and mechanism of cultivated land intensive use at the medium scale than at the macro scale, and the studies are more abundant, which are distributed throughout the country, especially in the eastern and central regions.

In addition, the research on intensive use of cultivated land at different scales is interrelated and has certain regional spatial characteristics[9]. The process of cultivated land use at the micro scale is often constrained by the process at the large scale. The large-scale process is the result of the accumulation of many micro-scale cultivated land use interactions. The characteristics of farmer scale can be moved up, and at the scale of plots, villages, and towns, the overall consistency characteristics of farmers ' land use are generated[10]. According to the existing literature, although many studies have discussed the intensive use of cultivated land from different spatial scales, the selection of appropriate scales, the selection of indicators to adapt to scale characteristics, the comparative analysis between different scales, and the

ISSN: 2710-0170

problem of scale transformation have not attracted enough attention.In particular, the research on the intensive use of cultivated land in different agricultural zones and their comparability have not been well solved.

3.1. Selection of evaluation system index at macro-scale

We summarize the macro-scale evaluation studies on cultivated land intensive use in provinces, urban agglomerations, river basins, and economic zones, and find that compared with the medium-scale and micro-scale studies, macro-scale cultivated land intensive use research is the most. The evaluation system of intensive use of cultivated land at the macro-scale has gradually expanded from the evaluation of input intensity and output benefit to the evaluation of input intensity, output benefit, utilization degree and sustainability status. The data are mainly derived from social and economic data. The research has gradually shifted from focusing on the evaluation of economic benefits of cultivated land use to focusing on the evaluation of sustainable use of cultivated land. With the upgrading of dietary structure and the improvement of consumption level in China, the diversified demand of agricultural products for urban and rural residents is highlighted. Food safety, environmental health and landscape leisure have become the focus of urban and rural residents ' demand. The situation that the ecological service value of cultivated land is lower than the price of agricultural products has gradually weakened. As a result, farmers rationally input biochemicals according to the characteristics of cultivated land and crops, and ecological agriculture and modern agriculture have developed rapidly, and ecotourism and leisure tourism have become the main sources of cultivated land value realization. Cultivated land use has changed from the traditional cultivated land use of ' high input, high consumption and high pollution ' to the green development cultivated land use of ' resource conservation, environmental friendliness, ecological balance, and coordinated development with the environment '.

3.2. Selection of evaluation system index at medium-scale

The studies on the intensive use of cultivated land at the median-scale are mainly include small and medium-sized cities, counties, etc.. The evaluation indexes of intensive use of cultivated land at the median-scale includes input intensity, output effect, utilization level and sustainable utilization status, which is consistent with macro-scale studies. But all the indicators are more comprehensive.For example, in terms of input intensity, in addition to chemical fertilizers, labor, and mechanical inputs, various indicators such as plastic film, pesticides, and electricity consumption have also been added. In terms of sustainability status, a stable yield index has been added, and the impact of the disaster situation of cultivated land on the intensive use of cultivated land has been considered.

3.3. Selection of evaluation system index at micro-scale

The studies on the intensive use of cultivated land at the micro-scale are mainly include towns, villages, farmers, plots, etc.. The evaluation indexes of intensive use of cultivated land at the micro-scale includes input intensity, output effect, utilization level and sustainable utilization status, which is consistent with macro-scale and median-scale studies. Among them, in the evaluation system of cultivated land intensive use at the farmer scale, the selection of indicators is very different from that of macro-scale and median-scale studies. Most of the data come from farmer interviews, questionnaires, etc.

4. Conclusion

The main conclusions are as follows :

(1) The studies on the intensive use of cultivated land at the macro-scale are the most which mainly include provinces, urban agglomerations, watersheds, economic zones, etc.. The

ISSN: 2710-0170

evaluation system of intensive use of cultivated land at the macro-scale has gradually expanded from the evaluation of input intensity and output benefit to the evaluation of input intensity, output benefit, utilization degree and sustainability status.

(2) The studies on the intensive use of cultivated land at the median-scale are mainly include small and medium-sized cities, counties, etc.. The evaluation indexes of intensive use of cultivated land at the median-scale includes input intensity, output effect, utilization level and sustainable utilization status, which is consistent with macro-scale studies. But all the indicators are more comprehensive.

(3) The studies on the intensive use of cultivated land at the micro-scale are mainly include towns, villages, farmers, plots, etc.. Among them, in the evaluation system of cultivated land intensive use at the farmer scale, the selection of indicators is very different from that of macro-scale and median-scale studies. Most of the data come from farmer interviews, questionnaires, etc.

Acknowledgements

This work was supported by the Scientific Research Item of Shaanxi Provincial Land Engineering Construction Group (DJTD-2024-01, DJNY2022-TD, DJNY-YB-2023-24, DJNY2024-25 and 2024-NBYY-02). This work was supported by Shaanxi Province Innovative Talent Promotion Program Young Science and Technology Rising Star Project(2023KJXX-123).

References

[1] Chen H, Yang R, Ye Y. Cultivability evaluation and conservation strategies of land resourcesin China[J]. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE),2023,39(5):192-200.

[2] Firbank L G,Elliott J,Drake B, et al.Evidence of sustainable intensification among British farms [J]. Agri-culture Ecosystems & Environment, 2013,173:58-65.

[3] Sun X., Li Q., Kong X., et al. Spatial Characteristics and Obstacle Factors of Cultivated Land Quality in an Intensive Agricultural Region of the North China Plain[J]. Land, 2023,12, 1552.

[4] Wang X, Gong J. The Empirical Research on Process Evaluation of Land Intensive Use in China [J]. Economic Geography, 2016, 36(05):17-25.

[5] Xiaoqian N, Chenggong L, Xiaoxu J, et al. Changing soil organic carbon with land use and management practices in a thousand-year cultivation region[J].Agriculture, Ecosystems and Environment, 2021,322.

[6] Niu, S.D., Lv, X., Shi, Y.Y., 2018. Spatio-temporal pattern of sustainable intensification of agricultural land use in Shandong province[J]. Chinese J Applied Ecology 29 (02), 607-616.

[7] Zhang B, Jin P, Qiao H, et al. Exergy analysis of Chinese agriculture[J]. Ecological Indicators, 2019, 105: 279-291.

[8] Lv X, Niu S, Li Z, Huang X, Zhong T. Present situation and trends in research on cultivated land intensive use in China[J]. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE), 2015, 31(18): 212—224. (in Chinese with English abstract)

[9] Li J, Song G, Guo M, et al. Spatial pattern analysis ofintensive use of cultivated land in Heilongjiang Provincebased on GIS[J]. Bulletin of Soil and Water Conservation,2009,29(1): 123-127.

[10] Vanlauwe B, Coyne D, Gockowski J, et al. Sustainable intensification and the African smallholder farmer[J]. Current Opinion in Environmental Sustainability, 2014, (8):15-22.