Research on the Methods of Cultivated Land Quality Monitoring and Evaluation

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Abstract

Through the evaluation of the quality of cultivated land, the changes in the quality of cultivated land are compared, and technical support is provided for the evaluation of cultivated land. On this basis, carry out arable land quality grade survey, monitoring and evaluation. Under the conditions of understanding and mastering the current agricultural production environment, production technology and production level, fully understand the quality of arable land, find out the current situation of arable land quality, and improve the quality of arable land and enhance agriculture. Comprehensive production capacity, adjust the layout of agricultural advantage industries and characteristic industries, and promote the development of modern agriculture to provide a scientific basis for the implementation of the national food security strategy in the new era and the implementation of the strategy of "having grain in the ground and storing grain in technology", optimizing the allocation of arable land resources, and strengthening The construction of cultivated land quality provides important support for promoting the green development of agriculture.

Keywords

Arable land; Quality monitoring and evaluation; Evaluation method.

1. Introduction

Cultivated land is the basis for human survival and development, and the guarantee of its quantity and quality is of great significance to the sustainable development of agriculture. In recent years, with the rapid growth of population and the acceleration of urbanization and industrialization, one of my country's basic national conditions is the lack of reserve resources for more people and less cultivated land, and the degradation of cultivated land quality and environmental pollution of farmland is another basic national condition of our country. The rational use of existing arable land resources, the protection of the production capacity of arable land, and the treatment of degraded or contaminated soil are the foundation and guarantee for the sustainable development of my country's agriculture and the development of the entire national economy. After joining the WTO, my country's agriculture faces greater challenges. How to adjust the agricultural structure to meet the domestic market's demand for diversified agricultural products and respond to international market competition?

Although my country has always implemented the most stringent arable land protection system and adhered to the red line of 1.8 billion mu of arable land, relative to the tangible decrease in arable land area, the decline in arable land quality is not easy to detect. Changes in arable land quality are affecting food security, ecological environment, and Social and economic development poses a

serious threat. Due to the scarcity of land resources and the short-term non-renewable characteristics, ensuring the sustainable use of existing land resources is extremely important for the healthy development of the national economy. Carrying out annual update surveys of cultivated land quality grades can be used to understand and grasp the general trend of cultivated land changes at a macro level, timely discover and solve problems in land use, make macro adjustments and strategic decisions; through the annual update surveys of cultivated land quality grades Guiding the utilization of agricultural land resources on the road of sustainable development is of great significance in the protection of cultivated land.

Strict protection of arable land is a prerequisite for protecting and improving the overall grain production capacity. The Third Plenary Session of the 16th CPC Central Committee pointed out that the strictest farmland protection system must be implemented to ensure national food security. Protecting and improving the overall grain production capacity When it comes to grain, it is necessary to stabilize a certain amount of arable land as a guarantee. China clearly stipulates that "very cherish and rational use of every inch of land, and earnestly protect arable land" is a basic state policy, requiring the establishment of an arable land protection system within a limited time to protect basic farmland. Basic farmland is the essence of cultivated land and the most basic support for maintaining national food security. The most important thing to protect farmland is to protect basic farmland, which is an insurmountable red line. Protecting arable land, especially protecting basic farmland, is an important prerequisite for protecting and improving the overall grain production capacity.

In order to fully grasp the quality of agricultural land resources in my country, scientifically evaluate and manage agricultural land, and promote the rational use of agricultural land in my country. During the "Tenth Five-Year Plan" and "Eleventh Five-Year Plan" period, agricultural land grading was completed nationwide, and the quality of my country's agricultural land resources was initially grasped. From 2001 to 2004, the agricultural land grading was completed and the agricultural land grading system was established. This was the first round of agricultural land grading. With the completion of the second land survey, and in recent years, a large number of basic farmland land consolidation, high-yield farmland construction, land development and other series of land consolidation activities have been carried out in various places, resulting in the quantity and spatial location of the cultivated land, and the quality of the cultivated land. With major changes, the original arable land quality classification system no longer meets the needs of land and resources management.

In the past ten years, the Party Central Committee and the State Council have paid unprecedented attention to the quality evaluation and protection of cultivated land, and various ministries and commissions have done a lot of work on the quality evaluation and protection of cultivated land. In 2010, the Central Economic Work Conference put forward the requirement of "focusing on improving the quality of cultivated land" and proposed to grasp the changes in the quality of cultivated land across the region. In 2011, based on the current land use database, using the results of the previous round of agricultural land grading, supplemented and improved the quality of arable land. After two years, a background database of 1:10,000 arable land quality was established. . In 2012, the "Agricultural Land Quality Grading Regulations" promulgated by the former Ministry of Land and Resources provided national standards for comprehensively grasping the quality level of agricultural land resources in my country. In 2013, the construction of high-standard basic farmland was carried out nationwide and further advanced, and the management and protection of cultivated land quality became the focus of cultivated land protection. In 2014, the Party Central Committee and the State Council put forward new requirements on strictly guarding the protection red line of 1.8 billion acres of arable land, ensuring that the area of arable land is basically stable, and protecting both the quantity and quality of arable land. In 2015, the former General Office of the Ministry of Land and Resources "Notice on Deploying the National Survey, Evaluation and Monitoring of Cultivated Land Quality in 2015" (National Land Resources Department [2015] No. 17) emphasized that the construction and management of cultivated land quality is the most stringent implementation As an important part of the cultivated land protection system, we must grasp the dynamic changes of cultivated land quality in a timely manner, and comprehensively upgrade the quality of cultivated land. During the "13th

Five-Year Plan" period, "Cultivated Land Quality Grade" (GB/T 33469-2016) was promulgated and issued, becoming my country's first national standard for cultivated land quality grade.

2. Evaluation methods and procedures

2.1 Layout of survey points

a point layout principle. According to the requirements, scientifically set up farmland quality survey points. In high-standard farmland construction areas, a map of farmland quality grade survey points will be formed based on no less than one farmland quality survey point per 1,000 mu. In accordance with the principle of site layout, the layout of all survey points was completed. A total of 6 survey points for cultivated land quality were deployed in Qinhan New Town, Xixian New District. After the survey points are deployed and constructed, they will serve as fixed points for continuous long-term positioning surveys, and they shall not be replaced at will.

b representativeness principle.Taking into account the situation of the soil testing points that have been deployed in the cultivated land quality protection improvement project, fully consider the administrative division, point distribution, point density, and the representative of the terrain, soil type, cultivated land use mode, management level, planting system and other factors Therefore, the new cultivated land quality survey points shall be rationally arranged in the whole district.

c uniformity principle. The survey points should basically evenly cover the main soil types of the cultivated land in the area (larger soil genus or soil species) and all agricultural villages, and should not be too concentrated in certain areas or soil types.

d principle of fixedness. After the survey points are deployed, fixed-point surveys will be carried out for a long period of time. They will be used as sites for on-site survey sampling work and district-level cultivated land quality evaluation every year in the future. After the fields are determined for the first survey and sampling, they shall not be changed or cancelled at will.

2.2 Investigation and sampling

2.2.1 Survey content

Carry out surveys on farmland site conditions, natural attributes, soil health, and field infrastructure conditions at each survey site. In principle, typical plots with good soil natural conditions, flat ground, relatively stable various factors, and an area of more than 1 acre should be selected as sampling sites for survey sampling plots. In hilly areas, the minimum sampling plot area shall not be less than 0.5 mu. Sampling plots shall not be set up in the following locations: ①Near residences, ditches, dung piles, waste piles, graves; ②Slopes, depressions and other places with subordinate landscape features; ③Within 50 meters of roads or railways; ④It is strictly prohibited to deliberately avoid or tend to Nearly contaminated land.

2.2.2 Sampling method

a Sample collection. When sampling, be sure to avoid ridges, ground heads, and manure piles (fertilizers); remove surface floating soil, debris, etc. before sampling, use wooden shovel or bamboo shovel to sample directly, use metal tools to collect soil, use bamboo chips, etc., which will come in contact with metal Part of the soil is stripped and removed; each time a soil sample is collected, a wooden shovel or bamboo shovel should be washed with the soil or clean water to be collected, and then the next soil sample should be collected to avoid cross-contamination between samples. At the same time, appropriate sampling methods should be selected according to the sampling terrain and plot conditions, such as the five-point quincunx method, the single diagonal method, the chessboard method or the serpentine method, etc. The serpentine method is recommended. (1) Plum blossom five-point method: suitable for plots with small area, flat terrain, relatively uniform soil composition and pollution degree, with about 5 points; (2) Single diagonal method: suitable for sewage irrigation areas For soil, the sampling points are the single diagonal equal points, generally 5 sampling points are set; (3) Checkerboard method: suitable for medium area, flat terrain, relatively uneven soil, set

about 10 points; For soil contaminated by sludge, garbage and other solid wastes, there should be more than 20 points; (4) Snake method: suitable for large areas, uneven soil and uneven terrain, set points 10-30 About. The vertical columnar method is used to collect each sample point, and the cultivated layer soil is collected in strict accordance with the principles of "equal amount", "random", and "multi-point mixing" (0-20 cm of cultivated layer soil is taken at each sample point for planting general crops , For planting fruit tree crops, 0-60 cm of soil in the cultivated layer is taken at each sampling point). When there are too many mixed soil samples, use the quarter method to reduce to about 3kg (about 2kg after air-drying, take more if the water content is high), and place it in the sample bag.

b Live photos. While sampling, you should use a mobile terminal or digital camera to select the sampling plot and surrounding landmarks to take photos based on the characteristics of the topography, together with the GPS latitude and longitude positioning display information, to record the sampling site conditions. At the same time, Also take pictures of the package information preserved by the sample, focusing on package integrity and sample labeling, and mark the date and time when the photo was taken. At least four photos of sampling plots, surrounding landmarks, GPS coordinates, and soil sample packaging bags should be taken at each point.

c Save the sample. The collected soil samples should be put into a plastic bag first, and then put on a breathable cloth bag, with an inner label between the plastic bag and the cloth bag, and an outer label on the outside of the cloth bag. The sample label shall not be stained, and the plastic bag and cloth bag The sample must not leak out. After sampling at each point, the sample label should be checked in detail on the spot, and the point code, sampling record, on-site photography, information storage, etc. should be checked to ensure accuracy before leaving the site. After the samples are brought back indoors, they should be dried in time. During the drying process, pay attention to waterproofing, preventing cross-contamination, preventing rodents, preventing mildew, and preventing labels from falling off.

2.2.3 Sample testing

The test items of soil samples at the cultivated land quality survey points are pH, organic matter, available phosphorus, quick-acting potassium, slow-acting potassium, etc.

2.3 Data review

Review the completeness, scientificity, and rationality of the data as required.

2.4 Basic database construction

2.4.1 Constructing a work space for cultivated land quality evaluation

The workspace is a special folder with a suffix of .cws, which includes six parts: attribute database, spatial database, multimedia database, model parameter library, other auxiliary files and atlas files. The workspace of the "Regional Cultivated Land Resource Management Information System" is established on a district basis, with one working space for each district. The vector data, external data tables, evaluation models, etc. required for the operation of the system all come from the working space, and the analysis and evaluation results are also Stored in the workspace.

2.4.2 Establish a database of cultivated land quality

The "High-standard farmland farmland quality survey point basic situation record form and filling instructions" formed by the high-standard farmland farmland quality grade survey is generated in the "regional farmland resource management information system" to generate the farmland quality grade survey point map. Superimpose the farmland resource management unit map with the survey site information and related farmland quality traits thematic maps, and adopt methods such as spatial interpolation, attribute extraction, and data association to assign values to each evaluation unit to achieve the matching of the evaluation unit attribute data and spatial data Connect to form a Qin Han New City cultivated land quality database integrating graphics and attributes. Among them, the spatial data includes: land use status map, administrative division map, soil map, cultivated land resource

management unit map, cultivated land quality survey point map, etc.; attribute data includes: cultivated land quality survey point result data table, soil type code table, administrative district Basic information table, cultivated land quality evaluation result table, etc.

a Data import. Data import includes spatial data import, coordinate system conversion, topological error checking and modification, data import, and data table import. Attribute data: data table of cultivated land quality survey point results, soil type code table, basic situation data table of administrative area, etc. Establish the collection standard of attribute data according to the data of the regional cultivated land resource management information system. The collection standard includes a complete definition of naming, format, type, and value interval for each indicator. When establishing the attribute database, it is necessary to formulate a unified basic data coding rule according to the data-related requirements, and carry out the entry of attribute data. All data must be reviewed before importing, field names must be standardized (without unit), and field values cannot have special symbols.

b Management unit diagram generation. Cultivated land resource management unit is a spatial entity composed of various land elements that have a key impact on land quality, and is the most basic unit, object and basic map of land evaluation. The basic natural conditions, individual attributes and economic attributes of the land in the same evaluation unit are basically the same. There are differences and comparability between different land evaluation units. Cultivated land quality grade evaluation is to determine the level of soil fertility through the evaluation of each evaluation unit, and implement the evaluation results on the field and compiled land resource maps. Therefore, whether the division of land evaluation units is reasonable or not is directly related to the results of land evaluation and the amount of work. The production of the farmland resource management unit map was made by superimposing the current land use map, the soil map and the administrative division map. The specific process is as follows:

1) Management unit map generation: ①Select and export the cultivated land (paddy field, irrigated land, dry land) according to the land use mode. ②If a patch on the cultivated land plot is composed of two or more soil types, then Divide the map into two or more map spots (units) according to the soil map. ③If a certain pattern crosses an administrative unit (village), it is divided into two or more patterns (units) according to the administrative division map. The management unit map generated by the superposition of the three images is the same village, the same soil type, and the same land use mode.

2) Cultivated land plot map

3) Three-picture overlay: Use the multi-component to single-component tool to break up the overlay spots.

4) Merge small polygons: When images from different sources are superimposed, the spots may be divided into small parts, resulting in spots that are too small. According to the survey accuracy of different scales, merge small polygons to eliminate polygons with too small area. The second national land survey technical regulations stipulate that the smallest area of cultivated land in the above map is 6.0mm2. The third national land survey technical regulations stipulate that the minimum field area of agricultural land in the above map is 400m2. Considering that the soil map is manually digitized, so the general merging principle is to allow the small area to be merged into the large surrounding area or the adjacent side long, considering the smoothing of the map when the administrative unit and land type information are the same. , The most commonly used is to merge the spots with the length of the adjacent side.

c point bitmap generation. Figure 4-2 shows the method of generating and making the bitmap of cultivated land quality survey points. Standardize fields in the cultivated land quality survey data table, load it into the cultivated land resource management information system, add XY coordinates and define the coordinate system to generate a point map. This part of the content can also be operated in ArcGIS.

d Management unit graph indicator assignment. Including spatial interpolation (mainly used to extract soil nutrient index data), normal distribution, spatial interpolation, parameter setting, point-to-surface (generally suitable for evaluation indexes with weak spatial correlation, such as bulk density, thickness of cultivated layer, effective soil layer thickness, etc.), attribute extraction (there are index data of professional maps, such as landform type, drainage modulus, irrigation capacity, etc.), 3D analysis, data query and modification.

2.5 Cultivated land quality grade evaluation

2.5.1 Determination of Cultivated Land Quality Evaluation Index System

Cultivated land quality grade evaluation index refers to the attributes of cultivated land participating in the evaluation of cultivated land quality grade.

Cultivated land quality grade evaluation factors are divided into regions according to the national standard of "Cultivated Land Quality Grade" (GBT 33469-2016), and are divided into topography, farmland forest network, altitude, effective soil layer, texture configuration, cultivated layer texture, obstacle factors, Soil bulk density, organic matter, available potassium, available phosphorus, pH, biodiversity, irrigation capacity, drainage capacity, cleanliness and many other factors are used as evaluation factors for the evaluation of cultivated land quality.

2.5.2 Determination of the evaluation weight of cultivated land quality grade

The determination of the weights of cultivated land quality grade evaluation requires the establishment of an analytic hierarchy model. The establishment of the analytic hierarchy process model mostly uses the analytic hierarchy process. The basic principle of the analytic hierarchy process is to arrange the various factors in a complex problem into several levels from high to bottom according to their mutual affiliation, and determine the level based on the comparison of the relative importance of the same level based on the judgment of a certain objective reality. The order of importance of each element.

a Establish a hierarchical structure. Arrange the selected evaluation factors into three levels according to their respective attributes and characteristics. Among them, arable land fertility is the target layer (layer A), site conditions (layer B1), profile properties (layer B2), and physical and chemical properties (layer B3) , Soil nutrients (layer B4), health status (layer B5) and farmland management (layer B6) are the criterion layer, and then the individual factors that affect the criterion layer are used as the index layer (layer C). The site conditions are composed of farmland forest network, topography and altitude. The profile properties are composed of effective soil layer, texture configuration and obstacle factors. The physical and chemical properties are composed of pH, bulk density and texture. Soil nutrients are composed of available phosphorus, available potassium, and organic matter. The health status is composed of cleanliness and biodiversity, and farmland management is composed of drainage capacity and irrigation capacity.

b Construct a judgment matrix. Suppose target layer A = cultivated land fertility, criterion layer B layer u = {u1, u2, …, uj} is the evaluation factor set. There are 6 evaluation factors in this survey, namely B1 = site conditions, B2 = profile characteristics, B3 =physical and chemical properties, B4=soil nutrients, B5=health status, B6=farmland management. Uij represents the relative importance value of ui to uj to the upper layer, and the value of uij is carried out according to Table 4-4. According to Table 4-4 In the 1-9 scale method in, experts are invited to give a quantitative evaluation according to the relative importance of each factor of B level to A level and C level to the corresponding factor of B level. The preliminary results of the experts' evaluation are appropriate After the mathematics is processed, it will be fed back to the experts for confirmation. After soliciting opinions for many times, a judgment matrix is formed.

c-level analysis model calculation results. The detailed weights and consistency verification ratios of each criterion layer and indicator layer can be viewed in the county-level cultivated land resource management information system. The consistency verification ratio must be less than 0.1 to pass, otherwise the discriminant matrix needs to be adjusted.

2.5.3 Establishment of membership function model

Establish membership function model to determine the membership degree of each evaluation factor. The establishment of the membership function model requires the use of related theories of fuzzy mathematics. Fuzzy mathematics is a mathematical theory and method for studying and processing fuzziness. One of the concepts of fuzziness is a fuzzy subset. The fuzzy subset takes any value from 0→1 (including 0 and 1 at both ends). The degree of membership refers to the degree to which the element conforms to this vague concept. The degree of membership is 1 when it is completely consistent, 0 when it is completely non-compliant, and an intermediate value between 0 and 1 is taken for partial compliance; and the membership function represents the difference between the element and the degree of membership. Analytic function between. According to the membership function, each value of the element can be calculated its corresponding membership degree.

According to the theory of fuzzy mathematics, we divide the relationship between the selected evaluation index and the productive capacity of cultivated land into five types of membership functions: quit type, quit type, peak type, linear type and conceptual type. For the first four types, the Delphi method can be used to evaluate a corresponding set of membership degrees on a set of measured values, and the membership functions can be fitted based on these two sets of data. In view of the influence of texture on other indicators of cultivated land, the indicators such as organic matter, available phosphorus, and available potassium should be fitted to membership functions according to different texture types.

2.5.4 Management unit graph indicator assignment

According to the determined evaluation index, assign the attribute data of the farmland quality survey site bitmap to the farmland resource management unit map. The indexes of pH, organic matter, available phosphorus content, and available potassium content are assigned to the evaluation unit by rasterization after spatial interpolation; the altitude index is assigned with the DEM grid map overlay; the texture configuration, effective soil thickness, and soil bulk density are indexed by soil type map Associated assignment; the topographic location index is superimposed and merged with the landform type map; other conceptual indicators such as the degree of salinization can be assigned using points instead of planes, or other methods can be used to assign values.

2.5.5 Calculation of comprehensive index of cultivated land quality

The cumulative method is used to calculate the comprehensive cultivated land quality index for each evaluation unit.

$$IFI=\Sigma(Fi\times Ci) \quad (1)$$

Where: IFI——Integrated Fertility Index (Integrated Fertility Index)

Fi——The membership degree of the i-th evaluation factor

Ci——the combined weight of the i-th evaluation factor

Using the assigned arable land resource management unit map as the basis, in accordance with the "Cultivated Land Quality Grade" (GBT 33469-2016) standard, the cumulative method is used to calculate the comprehensive index of cultivated land quality.

2.5.6 Classification of cultivated land quality

According to the calculated comprehensive index of cultivated land quality, the cumulative frequency curve method is used to determine the grading standard, and the cultivated land quality is equally divided into 10 cultivated land quality grades in descending order. The larger the comprehensive index of cultivated land quality, the higher the quality of cultivated land, the highest quality of cultivated land in first-class land, and the lowest cultivated land in tenth-grade land.

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