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Study on the Investigation and Evaluation Process of Cultivated Land Quality Grade in Well-facilitated Farmland Construction Project Area

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Abstract: Take the county (district) as the unit, set up sample points for farmland quality survey in the construction area of high standard farmland, collect basic information data, collect soil samples, conduct field surveys, sample detection and analysis, and prepare evaluation reports to evaluate the quality of farmland before and after the construction of high standard farmland. At the same time, calculate and analyze the grain production capacity and production potential of the cultivated land in the construction area of high standard farmland, compare the difference of the cultivated land production before and after the construction of high standard farmland, and scientifically evaluate the construction effect of high standard farmland.

Keywords: Well-facilitated farmland, Grade evaluation of cultivated land quality, Analytic hierarchy process, County cultivated land resource management information system.

1. Technical Route

The technical route implemented includes preliminary preparation, point layout, sampling and detection, survey data collection, construction of cultivated land quality evaluation workspace, establishment of cultivated land quality database, cultivated land quality evaluation, summary and reporting of data results, etc.

2. Investigation, Sampling and Sample Testing

2.1. Collection and sorting of basic data

The collected soil maps and other paper maps are used for data preprocessing, coordinate conversion, graphic editing and spatial database building by the county cultivated land resource management information system and ArcGIS10.7 software. The data and text materials shall include the code of the county (township, village) administrative unit, the basic information questionnaire of the sample plot, social and economic information and other relevant materials.

2.2. Layout of investigation points

In the high standard farmland construction area, at least one farmland quality survey point per 1000 mu will be formed to form the farmland quality grade survey point map.

2.3. Investigation and sampling

At each survey point, the site conditions, natural attributes, soil health and field infrastructure of cultivated land were investigated.

In principle, a typical plot with good soil natural state, flat ground, relatively stable factors and an area of more than 1 mu shall be selected as the sampling site for survey and sampling. In hilly areas, the minimum sampling area shall not be less than 0.5 mu.

2.4. Sample collection

During sampling, it is important to avoid ridge, land and fertilizer pile (fertilizer); Before sampling, remove the topsoil and sundries on the surface, use a wooden shovel or a bamboo shovel to directly sample. When using metal tools to collect soil, use bamboo chips to strip and remove the soil in contact with the metal; Before collecting the next soil sample, the wood shovel or bamboo shovel shall be washed with the soil to be collected or clean water before collecting the next soil sample to avoid cross contamination between samples. At the same time, appropriate sampling methods should be selected according to the terrain and plot conditions, such as plum blossom five point method, single diagonal method, chessboard method or serpentine method. The serpentine method is recommended.

2.5. Sample preservation

The soil samples shall be put into a plastic bag first, then put on a breathable cloth bag, put an internal label between the plastic bag and the cloth bag, and attach an external sample label outside the cloth bag. The sample label shall not be damaged, and the samples in the plastic bag and the cloth bag shall not leak out. After sampling at each point, the sample label shall be checked in detail on site, and the point code, sampling record, on-site photography, information storage, etc. shall be checked to ensure the accuracy before leaving the site.

After the samples are taken back to the room, they should be dried in a timely manner. During the drying process, attention should be paid to water proofing, cross contamination prevention, rat prevention, mildew prevention and anti label falling off.

2.6. Sample testing

The test items of soil samples at the cultivated land quality survey point include pH, organic matter, available phosphorus, available potassium, slowly available potassium, total nitrogen, unit weight, etc.

3. Basic Database Construction

3.1. Construction of working space for cultivated land quality evaluation

The workspace of the "National Cultivated Land Resource Management Information System" is established on a district basis. Each district has a workspace. The vector data, external data tables, evaluation models, etc. required for system operation are all from the workspace, and the analysis and evaluation results are also stored in the workspace.

3.2. Establishment of cultivated land quality database

Generate the survey point map of cultivated land quality grade in the "National Cultivated Land Resource Management Information System". Overlay the cultivated land resource management unit map with the survey point information and the thematic maps of related cultivated land quality traits, and adopt the methods of spatial interpolation, attribute extraction, data association, etc. to assign values to each evaluation unit, so as to realize the matching and connection between the attribute data of the evaluation unit and the spatial data.

4. Farmland Quality Grade Evaluation

4.1. Determination of cultivated land quality evaluation index system

The evaluation index of cultivated land quality grade refers to the attributes of cultivated land participating in the evaluation of cultivated land quality grade. There are many factors that affect the quality of cultivated land. According to the regional characteristics, the evaluation factors are selected by following the principles of dominant factors, differences, stability and sensitivity, and using quantitative and qualitative methods.

4.2. Determination of cultivated land quality grade evaluation weight

The analytic hierarchy process (AHP) is often used to establish the analytic hierarchy process (AHP) model. The basic principle of analytic hierarchy process (AHP) is to arrange various factors in complex problems into several levels from the top to the bottom according to their subordination relationship. According to the judgment of certain objective reality, the relative importance of the same level is compared with each other, and the importance order of each element in the level is determined.

4.3. Establishment of membership function model

The membership function model is established to determine the membership of each evaluation factor. The establishment of membership function model needs to use the relevant theories of fuzzy mathematics.

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, namely, the upper type, the lower type, the peak type, the linear type and the conceptual type. For the first four types, the Delphi method can be used to evaluate the corresponding group of membership degrees for a group of measured values, and the membership functions can be fitted according to the two groups of data. In view of the influence of texture on other indicators of cultivated land, organic matter, available phosphorus, available potassium and other indicators should be fitted with membership functions according to different texture types.

4.4. Indicator assignment of management unit diagram

According to the determined evaluation indicators, the bitmap attribute data of cultivated land quality survey points are assigned to the cultivated land resource management unit map. The indexes of pH, organic matter, available phosphorus content and available potassium content are assigned to the evaluation unit by grid method after spatial interpolation; The elevation index is superposed and assigned by DEM grid chart; Texture configuration, effective soil layer thickness and soil bulk density index are assigned by soil type map; Topographic position index is assigned by superimposing and merging with geomorphic type map; Other conceptual indicators such as salinization degree can be assigned by point instead of surface, or by other methods.

4.5. Calculation of comprehensive index of cultivated land quality

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

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

Where: IFI - Integrated Fertility Index;

Fi - membership of the ith evaluation factor;

Ci - Combination weight of the ith evaluation factor.

Based on the assigned management unit chart of cultivated land resources, the comprehensive index of cultivated land quality is calculated by the cumulative method according to the Standard of Quality Grades of Cultivated Land (GB/T 33469-2016).

4.6. 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 divided into 10 cultivated land quality grades from large to small. The higher the comprehensive index of cultivated land quality, the higher the level of cultivated land quality. The quality of cultivated land in the first class is the highest, and that in the tenth class is the lowest.

4.7. Result verification

According to the classification results of cultivated land quality, combined with the fertilizer input over the years and other data, the yield comparison, comparison of main cultivated land quality traits, field verification, expert verification and other methods are used to verify and confirm the grade results, forming the final cultivated land quality grade results.

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