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A Brief Discussion on the Quality Exploration and Restoration Technology of High Standard Farmland Demonstration Construction Projects

-- Taking Qishan Project Area as an Example

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Abstract

Based on the principles of land engineering science and relevant national, provincial, and local plans, standards, and specifications, a comprehensive, scientific, and accurate survey was conducted on the construction project area of high standard farmland. The obstacles to improving soil quality in the project area were analyzed, and the soil weight structure of farmland was carried out to improve the quality of farmland and lay the foundation for the construction of high standard farmland in the project area. This project conducts a comprehensive investigation of the soil and water quality status in the project area, combined with the characteristics of water, soil and fertilizer resources in the project area, and proposes a suitable plan to improve the quality of arable land. It provides detailed design basis for the preliminary design of the 22416 mu high standard farmland construction project in Qishan District, Baoji City, and carries out general exploration work.

Keywords

High standard farmland; Demonstration construction projects; General exploration of farmland quality; repair.

1. Project Overview

Qishan County is under the jurisdiction of Baoji City, Shaanxi Province, located in the central western part of Guanzhong and the northeastern part of Baoji City. It borders Linyou County to the north, Taibai County to the south, Fufeng and Meixian to the east, Fengxiang District and Chencang District to the west, with a length of 53.5 km from north to south and an average width of 30.5 km from east to west, covering a total area of 856 km2. It is a major transportation route from the Central Plains to the northwest and southwest. Between 107.716 and 107.749 degrees east and 34.474 and 34.510 degrees north latitude. The project area belongs to the Piaopian Plain area, and the geomorphic unit belongs to the alluvial sector. The terrain is high in the north and low in the south, with an elevation ranging from 720 to 1000 meters. The land is fertile and the conditions for light and heat resources are good. However, due to insufficient funds, the quality of arable land and agricultural infrastructure are not yet perfect. In order to

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better implement the task of high standard farmland construction, combined with the new requirements of farmland protection and capacity improvement, as well as the 2022 high standard farmland construction plan of Shaanxi Province, it has been determined to implement high standard farmland construction in five villages in Pucun Town: Zhaojiatai Village, Lujiazhuang Village, Pucun Village, Beizhuangying Village, and Xianghe Village, with a total area of 22416 acres. By improving the infrastructure of farmland, enhancing the quality of cultivated land, improving agricultural production conditions, and increasing grain production capacity.

2. Requirements for General Exploration Tasks

The main purpose of this general exploration is to investigate and collect relevant natural, geographical, agricultural, economic, social and other related information in the project area, with a focus on on-site survey and sampling analysis of the soil and water quality foundation in the project area, and to analyze the obstacles that exist in the improvement of soil quality in the project area. In conjunction with the self-developed mobile experimental vehicle (ZL 2013 2 0843430.0) equipped with more than 40 types of rapid detection equipment such as soil nutrient monitoring instruments and water quality parameter measuring instruments (Figure 1-2), rapid testing and analysis of soil and water quality in the project area are carried out. Through the environmental detection instrument installed in the experimental vehicle, online monitoring of temperature, humidity, wind speed, etc. in the project area is implemented and the data is transmitted back to the big data center for archiving. The main exploration content includes:

(1) Investigation and comprehensive geological survey of natural conditions such as water and temperature in the project area.

(2) Collection of soil and water samples in the project area, detection and analysis of physical and chemical properties such as soil layer thickness, organic matter, soil texture, nitrogen, phosphorus, and potassium, as well as environmental quality indicators such as heavy metals, total hexachlorocyclohexane, total DDT, and benzo [a] pyrene. Detection and analysis of water quality indicators such as pH, chemical oxygen demand, chloride, and heavy metals.

(3) Analysis of obstacle factors for carrying out high standard farmland construction in the project area.

(4) Based on the obstacles in the project area and the characteristics of water, soil, and fertilizer resources in the project area, a suitable plan for improving the quality of arable land is proposed. The construction content, technical requirements, and quality standards are determined to improve the quality standards of arable land in the project area.

3. General Exploration Process and Methods

The project work mainly includes preliminary investigation and on-site exploration. The preliminary investigation includes data collection and analysis, on-site investigation, and personnel interviews, providing basic information for the writing of the exploration plan. Then conduct on-site exploration according to the general exploration plan, comprehensively explore soil physics, chemistry, and biological nutrition, and identify the obstacles that affect quality improvement.

The project exploration is based on the "Technical Specification for Land Engineering Exploration" (DB61/T 1322-2020), and the natural conditions investigation in the project area is conducted through data retrieval. The sample collection is divided into sampling units based on the classification of cultivated land, topography, the degree of project area connectivity, and the results of flow experiment vehicle speed measurement, and soil and water quality samples are collected. The preservation of soil and water quality shall be carried out in accordance with

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the "Soil Testing Part 1: Collection, Treatment, and Storage of Soil Samples" (NY/T 1121.1-2006) and the "Technical Regulations for the Preservation and Management of Water Quality Samples" (HJ 493-2009), and indoor analysis shall be conducted in accordance with relevant national or industry standards.

4. General Exploration Results

By collecting soil samples from the high standard farmland construction project area in Qishan district at a depth of 0-22 cm, organic matter, texture, available phosphorus, available potassium, available nitrogen and other indicators were tested; Collect surface water and groundwater samples; Reasonably arrange soil profile points with a depth of no more than 2 meters based on regional topography, cultivated land grade, and obstacle soil layer conditions. By comprehensively analyzing the inspection and testing results, analyzing the obstacle factors existing in the project area, and based on the principles of land engineering science, implementing the farmland quality restoration project in the project area around the theory of organic soil reconstruction. The summary of project implementation and completion is as follows:

1. The high standard farmland soil in Qishan area has a high content of silt particles, and the overall soil texture is loam soil. The cultivated layer texture of high standard farmland in the region should be from loamy sand to clayey loam soil. Therefore, the newly built high standard farmland meets the texture requirements for regional high standard farmland construction; The pH value distribution range of the soil is 8.02-8.32, belonging to weak alkalinity. The salt content distribution range of the soil is 0.52-0.75 g · kg-1, and the overall soil is at a non saline level. Through later fertilization management and cultivation measures, the pH value and salt content of the soil can be appropriately reduced to meet the pH value and salt content requirements suitable for high standard farmland and healthy crop growth.

2. The soil organic matter content in Qishan area is generally deficient, the available nitrogen and phosphorus content is in a moderate state, and the available potassium content is in a moderate to rich level. The overall organic matter content of the soil is in a state of deficiency, and it is urgent to increase the organic matter content, nitrogen, phosphorus, potassium, and various trace elements of the soil in the project area through measures such as applying exogenous organic fertilizers, loosening the soil structure, and improving the overall fertility level of the soil in the project area. The overall content of available nitrogen is in a moderate state, with some in a state of deficiency and abundance; The overall effective phosphorus content is in the range of deficiency to moderate, with a small portion in the rich level; The overall content of available potassium is at a moderate to rich level; In the later stage of crop fertilization management, it is necessary to adapt to local conditions, pay attention to the application of nitrogen fertilizer, and apply phosphorus and potassium fertilizers appropriately according to the growth of crops, in order to meet the demand for mineral nutrients for crop growth.

3. Some farmland in Qishan District has a certain thickness of plow bottom and other barrier soil layers, which affect the rooting of crop roots. Based on field surveys, profile observations, and sample testing data analysis, it was found that there is a certain thickness of obstacle soil layers such as plow bottom layer in farmland in Qishan District, which affects the rooting of crop roots. In response to the problems of soil compaction and deep plow layers in the project area, a deep tillage machine was selected for moderate plowing, with a plowing area of 22416 acres and a depth of about 0-30cm.

4. Calculate the fertilizer application amount for the target crop yield based on the principle of soil testing formula fertilization. According to the difference between the required fertilizer amount for the target crop yield and the soil fertilizer supply, the balanced fertilization method

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is used to calculate the fertilizer amount for the target crop yield in the Qishan project area. The average nutrient contents of alkaline nitrogen, available phosphorus, available potassium, and organic matter in the 0-20 cm tillage layer of the project area are 56.32 mg · kg-1, 8.37 mg · kg-1, 44.54 mg · kg-1, and 13.15 g · kg-1, respectively. The range of single element fertilizer application for N and P2O5 required for a target yield of 500 kg of corn is 0.34-3.47 and 0-11.26 kg/mu, respectively. If nitrogen fertilizer is supplemented with urea and phosphorus fertilizer is supplemented with diammonium phosphate, the application rates are 0.74-7.54 and 0-24.48 kg/mu, respectively.

5. The average organic matter content in the project area is 13.15 g · kg-1, which is higher than the high standard farmland construction requirement of 12 g · kg-1 in the northwest region. However, based on the spatial differences and imbalances in soil organic matter content in the region and the project area's main recommendation to increase the use of organic fertilizers instead of chemical fertilizers, and to reduce the use of chemical fertilizers, local areas will be supplemented with organic fertilizers according to the construction standards. The average organic matter content of the soil in the 0-20 cm tillage layer of the project area is 13.15 g · kg-1, which is higher than the standard requirements of the National High Standard Farmland Construction Plan (2021-2030) and the General Principles for High Standard Farmland Construction (GB/T30600-2022) for high standard farmland construction in the northwest region, which require an organic matter content of ≥ 12 g · kg-1. However, based on the spatial differences and imbalances in soil organic matter content in the region, as well as the principle of increasing the use of organic fertilizers instead of chemical fertilizers and reducing the use of chemical fertilizers in the project area. According to the "National High Standard Farmland Construction Plan (2021-2030)", "General Principles for High Standard Farmland Construction (GB/T30600-2022)", and "Quality Grades of Cultivated Land (GB/T33469-2016)" documents, the soil organic matter content in Qishan area is divided into six levels, and fertilization is carried out according to the principle of organic fertilizer application. The required fertilization amount for different levels of organic matter content distribution is calculated, and fertilization is carried out in different zones, with a fertilization area of 22416 acres.

6. Calculate the soil nutrient supply in the project area and the fertilizer required for the target yield of corn. Based on the fertilizer required for the crop growth cycle, determine the recommended fertilizer amount for different growth cycles of corn in the project area. Following the principle of using organic fertilizer instead of chemical fertilizer for corn planting in the Qishan project area to reduce or avoid the application of chemical fertilizers, the average fertilizer application per unit area in the Qishan area was calculated to be 92 kg/mu based on the fertilizer application rates in different levels of regions. Powder organic fertilizer was selected through comparison, and mechanical fertilizer application was chosen as the application method.

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