

Analysis of Water Resource Supply and Demand Balance in High Standard Farmland Construction Projects

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Abstract

High standard farmland construction is an important measure to develop modern agriculture, increase grain production, and promote farmers' income growth in the context of rural revitalization. Based on the overview of water resources in the project area, crop planting structure, irrigation system, and quota, a detailed analysis is conducted on the available water supply and demand for irrigation, to explore whether the regional water resources can fully meet the needs of efficient and water-saving irrigation. The research results can provide detailed data support for project planning and construction, as well as reference for water resource balance analysis of similar projects in mountainous areas.

Keywords

High Standard Farmland; Irrigation Guarantee Rate; Water Resource Balance.

1. Introduction

The Central Committee of the Communist Party of China and the State Council attach great importance to the protection of arable land and the improvement of soil fertility, and firmly grasp the construction of high standard farmland to improve the construction standards and quality. Fengxiang District is located in the west of Guanzhong Plain, adjacent to Qishan County and Qianyang County in the east and west respectively, and Chencang District and Linyou County in the north and south respectively. The total area is 1179km², with long winter and summer and short spring and autumn; Rain and heat are in the same season, which is beneficial for crop growth. However, during the crop growth season, strong solar radiation, large interannual changes in temperature and precipitation, and drought are also prone to occur. In order to better implement the task of high standard farmland construction, in combination with the new requirements of farmland protection and productivity improvement, it is determined to implement high standard farmland construction in Fengxiang District. By improving farmland infrastructure, improving the quality of farmland, improving agricultural production conditions, and increasing food production capacity.

2. Overview of the Project Area

The project area is located in Liulin Town, Chencun Town and Changqing Town of Fengxiang District, involving 10 villages including Beidoufang Village, Caiyangshan Village, Dongwutou Village, Liaodi Village, Luobosi Village, Pangjiaojiao Village, Shangying Village, Shitoupo Village, Xijie Village and Zijing Village. It is divided into two zones: north and south. Zone I is located in Beidoufang Village, north of Liulin Town, with geographical coordinates ranging from 107 ° 12'36 "E to 107 ° 13'48" E and 34 ° 34'12 "N to 34 ° 36'1" N; Area II is located in the middle of Chencun Town and Changqing Town, with geographical coordinates ranging from 107 ° 13'9.46 "to 107 ° 17'47.76" E and 34 ° 31'29.13 "to 34 ° 29'5.57" N. Fengxiang is located in a composite part of the Qinling latitudinal, Qilu Heshan shaped, and Shaanxi spiral tectonic system, with a complex and diverse terrain. Mountains, rivers, and plateaus are characterized by the overall

terrain of the northern mountains, southern plateaus, and western river valleys. The Yongshui River runs through the central part from northwest to southeast, naturally dividing the tableland into two large parts. To the north is the piedmont alluvial fan plain, which is flat and complete; The south belongs to the Loess Plateau, with fertile soil. The project area belongs to the warm temperate continental monsoon climate semi humid Semi-arid climate climate area, with four distinct seasons, the annual average temperature is 8.9 °C, and the annual average precipitation is 790mm, mainly in July, August and September. The main aquifer of groundwater is sediment, gravel, and stone layers, with a thickness of 18.6 to 26.38 meters, gradually thinning from south to north. Mining shallow water and shallow confined water, with a burial depth of 20-40m and a water salinity of less than 1g/L. The Soil type in the project area is dominated by loess soil, and the soil structure profile of loess soil is composed of tillage layer, plough bottom layer, ancient mature layer, ancient plough layer, clay layer, calcareous layer and parent material layer from top to bottom. The covering layer is grayish brown with a medium to heavy soil texture. Granular block like structure, with multiple pores in hairy tubes, with an organic matter content of about 1%, a sticky layer of grayish brown, and an adhesive film on the surface of the structure, rich in bacterial growth. The loess soil layer is relatively deep, with a high nutrient content, and has characteristics such as upper deficiency and lower consolidation, water and fertilizer conservation, drought resistance and waterlogging tolerance. It is widely distributed on the flat loess plateau in the project area.

3. Water Resource Balance Analysis

The rivers in Fengxiang District belong to the Weihe River system of the Yellow River basin. The Weihe River enters the east from the west of Sanzhang Village in Chishui Town and exits from the Weikou at the northeast end of the Shanhe River, with a total length of 47.25km. There are thousands of tributaries of the Weihe River flowing through the territory. As one of the larger tributaries on the left bank of the Weihe River, the Qianhe River originates from the south side of Shizuilang on the south slope of Mount Liupan Mountain in Gansu Province (in Zhangjiachuan County and Huating County) and flows into the Weihe River at Didian, Chencang District, Shaanxi Province; It flows through Zhangjiachuan in Gansu, Longxian County in Shaanxi, Qianyang County, Fengxiang District and Chencang District, with a drainage area of 3493km², a total length of 152.6km, an average gradient of 0.58‰, and an average annual runoff of 479 million m³. In Fengxiang District, the main stream of Qianhe River flows through Changqing Town in the west and into Chencang District.

The total amount of water resources in Fengxiang District is 163 million m³, and the available water supply of water resources is 94.1226 million m³, including 44.485 million m³ of surface water and 49.6376 million m³ of groundwater. There are three reservoirs in Fengxiang District, namely Fengjiashan Reservoir, Wangjiaya Reservoir and Dongfeng Reservoir, of which the total storage capacity of Fengjiashan Reservoir is 389 million m³ and the effective storage capacity is 286 million m³.

3.1. Analysis of Available Water Supply in the Project Area

Fengxiang District is located in the Weibei dryland, with total water resources of 140.54 million m³, Among them, the total amount of surface water resources is 60.7 million meters³, The total amount of groundwater resources is 109.46 million meters³, Repeated calculation amount of 29.63 million meters³. The project area is located in the hilly slope of the pluvial fan area in Fengxiang District. The ground slope is large, the permeability coefficient is small, and the runoff coefficient is 0.15, which is conducive to runoff generation. The groundwater resources are poor, the thickness of the aquifer is small, and the groundwater is relatively scarce. According to the burial conditions, the groundwater is mainly pore phreatic water. The aquifer group is mainly composed of alluvial proluvial gravel layer and eolian loess above the Upper

Pleistocene. The thickness of the aquifer is 20~30 m, and the buried depth of the water level is 20~60 m. The water abundance is extremely uneven, with a unit water inflow of 0.1-10 m³/h m, a permeability coefficient of 4.0-5.0 m/d, and a hydraulic slope of 0.015-0.025. But the project area is close to Fengjiashan Reservoir, and water can be diverted from the reservoir for irrigation. The Fengjiashan Reservoir Irrigation Project is one of the large-scale water conservancy projects in Shaanxi Province, located in the western part of the Weibei Plateau in Guanzhong. Qianhe River is a relatively large tributary on the north bank of the Wei River, with a drainage area of 3493km². The main stream is 152.6 km long, with an average river gradient of 0.58%. The Fengjiashan Reservoir is located downstream of the Qianhe main stream, 25.0 km from the river mouth. The controlled watershed area is 3232 km², accounting for 92.5% of the total watershed area. Annual average runoff of 485 million meters³, Annual average flow rate 15.4 m³/s. Annual average sediment concentration 8.76 kg/m³. The average annual sediment transport difference is 4.69 million tons. According to relevant research statistics, in the past decade, the average annual water volume of agricultural irrigation in irrigation areas has been 15.78 million m³, accounting for only 25% of the annual average of 62.18 million m³ before 2000. After entering the 21st century, the actual annual irrigation volume of the bucket mouth is the largest at 53.85 million m³ in 2000, and the smallest at 6.81 million m³ in 2012. In summary, the Fengjiashan Reservoir has sufficient water supply.

3.2. Analysis of Water Demand in the Project Area

The water demand in the project area is mainly for irrigation. Calculated and determined based on irrigation quota and irrigation area.

(1) Basic technical parameters

- 1) Planting type: According to the natural conditions and planting structure of the project area, the planned irrigated land in the project area is mainly planted with wheat and corn wheels.
- 2) Multiple cropping index and planting ratio: The crop multiple cropping index in the project area is 2, and the total cultivated area in the project area is 1894.1382 hm² (28412.07 acres). The planned high standard farmland area is 1894.1382 hm² (28412.07 acres), and the planting ratio is 100%.
- 3) Irrigation design guarantee rate: According to the national standard "Design Standards for Irrigation and Drainage Engineering" (GB 50288-2018) and local natural conditions, soil types, and crops planted, the irrigation guarantee rate is determined to be 75%.
- 4) Irrigation method: The water sources for irrigation are Fengjiashan Reservoir (main canal) and Yinwei Canal. The water is pumped to a high-level reservoir through a newly built pump station and then connected to a low-pressure pipeline for self flow irrigation.
- 5) Irrigation water utilization coefficient: According to the "Design Standard for Irrigation and Drainage Engineering" (GB 50288-2018), the field water utilization coefficient is 0.90, the pipeline system water utilization coefficient is 0.97, and the calculated irrigation water utilization coefficient is 0.873.

3.3. Water Balance Analysis

The project involves 10 villages in Liulin Town, Chencun Town and Changqing Town of Fengxiang District, and the water resources are mainly surface water. According to calculations, it can be seen that the project area has a water supply capacity of 217.41 million m³ and a water demand of 13.37 million m³. In the design level year, the total surface water supply capacity in the project area is greater than the irrigation water demand. The selected water source meets the water use requirements and has a large amount of residual water, which can provide favorable conditions for the future construction of irrigation measures and the improvement of agricultural product returns in the project area.

4. Water Source Engineering

The layout design idea of this irrigation project is to use the surface water around the project area to lift water to the regulating pool through a new pump station and then connect it to the low-pressure pipeline for gravity irrigation. According to the relative location of the irrigation area and the reservoir, geological conditions and changes in the water level of the reservoir, the station site will demonstrate the technical reliability and economic rationality of water intake in the reservoir area, and select a location that is stable on the bank slope, close to the irrigation area, convenient for water intake, and free from or less affected by sediment deposition and freezing. The specific design of the water source engineering and water conveyance engineering for this high standard farmland construction is separately compiled. This report does not cover this part in China, but focuses on designing field irrigation engineering and other engineering contents.

The planned field irrigation and water distribution project in Zone I includes a DN 63UPVC pipeline with a length of 4042m, a DN 75UPVC pipeline with a length of 5498m, a DN 90UPVC pipeline with a length of 3301m, a DN 110UPVC pipeline with a length of 5732m, a DN 125UPVC pipeline with a length of 420m, a DN 140UPVC pipeline with a length of 1417m, a DN 160UPVC pipeline with a length of 777m, a DN 180UPVC pipeline with a length of 476m, a DN 200PE pipeline with a length of 1070m, a DN 225PE pipeline with a length of 242m, and a DN 280PE pipeline with a length of 117m. 1 two-way gate valve well (inner diameter 600mm), 8 two-way gate valve wells (inner diameter 800mm), 4 three-way gate valve wells (inner diameter 600mm), 33 three-way gate valve wells (inner diameter 800mm), and 1 four-way gate valve well (inner diameter 600mm); 6 pressure reducing valves, 47 drainage wells, 84 DN 63 outlet piles, 102 DN 75 outlet piles, and 150 DN 90 outlet piles.

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