Ecological Development and Design of River Beach Land in Heyang Section of The West Bank of The Yellow River

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Abstract. In order to optimize the allocation of soil and water resources and improve the efficiency of agricultural production and the efficiency of agricultural production, with restoring the ecological function of the Heyang section of the west bank of the Yellow River, parts of the river beach land were treated as the high-quality farmland. By the implementation of the main and auxiliary projects for the organic reconfiguration of soil along the yellow beach in Heyang. The flood land was governed as the wetland agricultural area including the paddy field system, drainage system and the road system. Strengthened the policy of making up balance of the cultivated land and the thesis of general secretary Xi. Simultaneously, the goal of developing the arable land resources and protecting the ecological environment were achieved.

1. Introduction

Due to the long-disordered management since 1980s, the ecological system of parts of the west bank of the Yellow River was damaged, including the biodiversity decrease, soil erosion on the beach [1]. The main channel of the west bank of the Yellow River (Shanxi-Shaanxi Section) sways eastward, resulted in a large number of river beaches deposited in the west bank [2]. Because of the large sediment content of river water, the river course was raised due to siltation, while the riverbank erosion was serious, and the coastal beach land collapsed and receded year by year [3].

Because the flood control engineering system in existence was still imperfect, the dangerous situation in the basin occurs from time to time, and the low land use rate and serious salinization along the river area, the safey of people life and property were seriously endangered along the coast. The healthy and sustainable development of the local economy and society were greatly restricted too. The Heyang section of the west bank of the Yellow River was abundant in light and heat resources, riched in water resources and beach [4]. The waste beach land could be developed into a high standard paddy field.
Through the implementation of land consolidation and development of modern agriculture in Heyang section, the original wetland environment was protected and the industrial structure was optimized [5]. The cultivated land and wetland had been effectively increased, which was great significance for optimizing the allocation of water and soil resources in the basin. At the same time, it also had a good reference for ecological restoration and river beach development and management [6-7].

2. Brief introduction to the Heyang section of the West Bank of the Yellow River
Heyang is high in the northwest and low in the southeast, with an elevation of 715 m. The highest elevation is 1543.8 m, and the lowest is 342 m. The northern part of the county is mountainous, the eastern part is the Yellow River beach; and the rest is typical loess plateau gully area. The density of ravines in the county is 0.83 km². The area of beach and water accounts for 12.4% of the total area. The area of ravines and plateau accounts for 18.2% and 65.6% of the total area, respectively.

The project area is located at 16.8 km northeast of Heyang County, which is high in the west and low in the east, with the Yellow River in the east. Within the project area, there were many river beaches and the open and flat ground. The groundwater level was relatively high. They were suitable for the development of land resources because of its high locations and sandy silt. In order to change the present situation of the beach area in the project area, with improving the ecological environment comprehensively. The floodplain would be rectified into a paddy field, to improve the ecological environment, protect wetlands, make rational use of resources, and increase the area of cultivated land.

3. Ecological planning and design of the project area of Heyang Section on the west bank of the Yellow River
The per capita arable land area in the project area was small, mainly dry farming. Therefore, to make full use of the abundant water resources in the project area, combining with the construction of land organic reconstruction project and the conveyance projects, such as the irrigation and drainage engineering, transmission and distribution engineering, road engineering, farmland protection and ecological environment preservation engineering and so on. The river beach along the heyang section of the west bank of the Yellow River had been harnessed into paddy fields. A wetland agricultural area with paddy field system, irrigation and drainage system and road system was formed. These behave not only conformed to the assertion that mountains, rivers, forests, fields and lakes are a life community put forward by General Secretary Xi Jinping, but also strengthened the strategic reserve of reserve land resources in the balance of occupancy and compensation. To achieve the goal of protecting ecological environment and exploiting cultivated land resources in development.

Agricultural wetlands were huge reservoirs that could store excessive amounts of water during rainstorms and river floods. It could also be used as a supplementary source of groundwater to realize sustainable utilization of groundwater resources. The constructed wetlands could also create microclimate. Wetland moisture entered the air by evaporation and then felt into the surrounding areas in the form of precipitation, increased the local air humidity and rainfall. It was conducive to improving the quality of life of local people and the industrial and agricultural production. Planting crops was conducive to beautifying the surrounding environment and forming modern agricultural landscape, and also could attract some birds, fish and amphibians.

3.1. Main engineering of land organic reconstruction
The main projects of land organic reconstruction included land physical reconstruction, land chemical reconstitution and biological nutrition reconstruction.

3.1.1. Soil physical reconstruction project. The construction of paddy fields required a high-level land formation. If the field was uneven, it would lead to local water accumulation, uneven water and fertilizer, and affected crop yield. In order to meet the requirements of the surface water depth in different growth stages of the aquatic crops, the fields were leveled. In order to form a good
infiltration layer under the tillage layer, as the basis of well-structured soil profile in later stage. The basic soil bulk density should be rolled to 1.7 to 1.8 g cm\(^{-3}\). Artificial plow bottoms with a thickness of 5 cm and a bulk density of 1.6 to 1.7 g cm\(^{-3}\) were constructed to meet the needs of water conservation and fertilizer maintenance in paddy fields. Soil layer with a thickness of 25 cm and a bulk density of 1.2 to 1.3 g cm\(^{-3}\) was constructed as a tillage layer, based on the plow bottom layer. Beating and leveling were performed before planting.

3.1.2. Land chemical reconstruction. The basic chemical indicators such as pH, electrical conductivity and cation exchange capacity of the soil layer should achieve the most basic growth requirements of the crop. If there was mild salinization in the project area or the soil pH higher than 8.5, it could be improved by using modifiers such as gypsum and quicklime.

3.1.3. Biological nutrition reconstitution. The cover soil used for the organic reconstitution and the surface soil in the project area was not a multi-year soil for cultivation. There was a certain difference between the soil components in the initial stage of soil organic reconstitution and the high standard of paddy fields, and the soil composition needed to be adjusted. In the first year, the nutrient design was mainly based on soil improvement, organic fertilizer and the amount of soil fertilizer needed were determined based on the amount of fertilizer needed for the target yield. Base fertilizer was applied to create good soil conditions for crop growth and development. In the management of fertilization for many years, soil nutrients were gradually adjusted to the standard of high yield paddy fields by means of soil testing and formula fertilization. Soil nutrient regulation should be gradual in order to avoid excessive addition of fertilizer to soil in a short time insufficient cushioning performance of soil, which resulted in soil compaction, nutrient loss, and so on.

3.2. Conveyance projects

3.2.1. Irrigation project. Shallow groundwater was used as the irrigation source, and the water quality should meet GB 5084-2005. According to the topographic characteristics, the two-level fixed channels of the integrated irrigation and drainage canal were laid out. In drainage season, the field surface water entered the irrigation and drainage integrated canal along the slope of the irrigation and drainage integrated canal. Irrigation guarantee rate was higher than 80%.

3.2.2. Drainage project. Drainage standards were adopted 10-percent annual exceedance probability flood to ensure that rainstorms were completed in three days.

3.3. Transmission and distribution project
The transformers were reasonable selected according to the production and domestic electricity load, such as power, quantity of the well pump and lighting, maintenance and so on. The laying paths and modes of conductors and cable lines should also be based on the actual situation.

3.4. Road project
Unified planning of field roads and secondary roads of production roads, field roads and production roads should reach each plot. The pavement width and shoulders on both sides in the field were 4.5 m and 0.5 m, respectively. The pavement width and shoulders on both sides in production were 2.0 m and 0.5 m. Pavement was paved with concrete and the slope coefficient was 1.5.

3.5. Farmland protection and ecological environment maintenance project
Ecological shelterbelts could play many roles, such as regulating regional microclimate, conserving water sources and soil and increasing biodiversity in the region. Ecological shelterbelts acted as an ecological isolation zone, alleviated the threat to the eutrophication of the Yellow River and protected the farmland ecological environment. In order to obtain the longest protective distance, the direction of
the forest belt should be set vertically according to the local main wind direction. When the forest belt could not be perpendicular to the main wind, a deflection angle of no more than 30 degrees was allowed.

4. Case study
The project area was located at 23 km east of Heyang county government, with 110°23'31″~110°24'32″ in east longitude and 35°18'30″~35°19'22″ in North latitude. The total area of the project was 91.03 hm². The landform type was river beach, flat and open, with the high groundwater level. The area of water surface and inland beach was 91.02 hm² and 0.01 hm², respectively. The project area belonged to warm temperate semi-arid continental monsoon climate. This region had some main characteristics, such as abundant light and heat resources, less precipitation, distinct dry and wet seasons, changeable climate, frequent disasters and so on. The annual average precipitation was 553 mm, which was uneven in distribution and varies greatly between years.

It is estimated that 87.77 hm² of cultivated land would be added, and the rate of cultivated land could be increased by 96.42% by ecological development. The statistics of engineering quantity were as follows: the bottom layer of artificial plough was 45.5 million m³, and the total soil requirement was 59.2 million m³. The cultivated layer was 227.6 million m³, and the total soil requirement was 227.6 million m³. Fourteen new 60 m deep machine wells, 14 matching well pumps and 14 well platforms were constructed. The project included the construction of 0.98 km main canal, 5.19 km irrigation and drainage integrated canal and 0.54 km interception ditch. 1.89 km for 10Kv high-voltage lines, 2.64 km for buried 380 V low-voltage cables, 4 transformers and distribution cabinets, and 4 distribution rooms were constructed. Three field roads were constructed with a total length of 2.14 km and five production roads with a total length of 4.05 km. According to the observation data of local meteorological stations in recent 10 years, the highest frequency of wind direction was N (16.6%) and NE (16.2%). The frequencies of N and NE winds were 7.2% and 7%, respectively.

5. Cost-effectiveness analysis
After the implementation of the project, it could support agricultural infrastructure, improve agricultural production conditions, and at the same time, alleviate the pressure of arable land occupation and compensation, and provide a resource basis for local economic and social development. In situ type was floodplain wetland distributed on water surface and beach land, which had large soil sediment content, easy leakage of water and fertilizer, sparse vegetation distribution, weak water storage and drought resistance, and weak benefit advantage of wetland. Soil was liable to leak water and fertilizer, and less vegetation distribution, weak water storage and drought resistance.

After comprehensive renovation, the project area changed from floodplain wetland to agricultural wetland. While retaining the benefits of the original wetland, the soil quality of the project area was improved through soil organic reconstruction design, and the vegetation coverage increased by planting lotus root and water conservancy construction of farmland. The construction of agricultural wetlands not only improved the ecological environment and the ability to resist natural disasters, but also created a beautiful living environment for the local people. After putting the 87.77 hm² of cultivated land into use, the total annual output value of rice planting (6900 kg hm⁻² per unit yield) was estimated to be about 339.14 million, and the total annual net increase value was 234.92 million, which greatly increased farmers' income and improved their living standards. The project was expected to have a 12-year payback period of static investment with a high annual return rate, which was technically feasible and would play a positive role in promoting the economic development of the project area.

6. Summary
Combined with the water conservancy and topographic conditions of the Yellow River beach, a large number of high-quality and high-yield basic farmland along the Yellow River beach and swamp had been increased through development and consolidation. These projects improved the land use
efficiency and agricultural production efficiency, and increased the vegetation coverage. The surface runoff environment and soil environment were improved at the same time. The conveyance projects had consolidated the flood control, flood drainage and drought resistance capacity of Heyang section on the west bank of the Yellow River, strengthened the regional water conservation capacity and the water storage capacity of the farmland. The situation of soil and water loss in the area was significantly improved, with obvious ecological benefits.

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