Comprehensive Reform of Agricultural Water Price

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Abstract. Agricultural water price reform is the need of social stable development and one of the main means to promote the rational use of water resources. At present, there are some cognitive problems in the comprehensive reform of agricultural water price, such as insufficient awareness of water price reform by cadres, unclear indicators of agricultural water consumption and low level of service for irrigation management. This paper analyses the situation of agricultural water use in some areas of Wulian County and determines the initial agricultural water rights. Secondly, the agricultural cost water price and farmers’ water price bearing capacity of the main irrigation areas in the region are calculated. At the same time, relevant reward and subsidy systems and sound agricultural water management system are established. The result of the reform is conducive to the formation of a good water price mechanism, while improving the water-saving efficiency of the project area.

1. Introduction

Water is the source of human life, but currently the available freshwater resources in the world are only 9,000 km³ per year. China's water resources amount to 2.8 trillion m³, and the per capita water resources are only 2,100 m³, which is a severely water-deficient country⁴. Pollution, climate change and population growth will reduce the amount of water resources available, so the emergence of water prices is one of the main methods for rational use of water resources. Prior to 1978, water price in China was mainly free water supply for public welfare. After 1978, reform and opening-up marked the beginning of the price reform journey. Water had the property of commodity. Water resources changed from free to paid, but the progress of water price reform was relatively slow¹. Mainly due to long-term living habits, the product attributes of water are not recognized or not known. Moreover, the reform of water price is not only related to price fluctuation, but also to the quality of daily life of the people, the scarcity of water resources and the construction of water conservancy facilities in various regions. Therefore, the reform of water prices must take into account multiple aspects, and constantly try and continue to advance.

The most important part of water price reform is agricultural water price reform. First of all, China's agricultural water consumption accounts for more than 70% of the country's total water consumption, which has more water-saving potential than other industries². Secondly, it is difficult to collect agricultural water price, and the commodity attribute of water is not reflected. People think that the value of domestic water comes from the processing costs of water plants, while agricultural water comes from nature, does not recognize the commodity nature of water, and is unwilling to pay water fees. Finally, the income gap between urban and rural areas is large, and the affordability of water prices is different. The income of urban residents is generally higher, and the impact of water price reform on the quality of life is low. However, for low-income farmers, the reform of water price has a
certain impact on the quality of life. In this paper, the agricultural water price in some areas of Wulian County is comprehensively reformed. Considering the affordability of farmers, appropriately adjusts the agricultural water price, and improves the service quality of water supply and equipment management.

2. Basic profile
The basic reform area of this project area covers Gaoze Street, Wanghu Town, Hubu Township and Shichang Township, totaling 4 townships (streets), and controlling effective irrigation area totaling 715,000 mu. According to the factors such as water source condition, topography, landform and irrigation mode, the agricultural irrigation mode in the project area can be divided into two types: reservoir irrigation area and pumping irrigation area. Agricultural planting in the project area is mainly wheat and maize, with a small amount of economic crops such as vegetables, melons, yellow smoke, oil, cotton and so on.

3. Reform content

3.1. Determining Initial Agricultural Water Rights
Water right is the reaction of property rights in the field of water resources, and it is also the first step in the reform of water resources allocation mode. The determination of water right is beneficial to the quota control and management of total irrigation amount. According to the actual water consumption, a scientific and reasonable water right allocation scheme is formulated to promote the application of water-saving irrigation in the project area.

According to the "Industrial Distribution Plan of Regional Water Consumption in Shandong Province", the total amount of agricultural water in Wulian County is 49635,000 m$^3$. According to the effective irrigation area of the farmland in the project area, the average irrigation water per mu and the irrigation quota per mu, the total agricultural water consumption index was determined. The total water consumption index of the project area (part of Wulian County) is 7.503 million m$^3$. The town water user association or the township management department reserves a total of 5% of the total indicators, the village water user association branch or the water supply project reserve total of 5% as a adjustment indicator, and the reserved indicators is allocated according to the proportion of effective irrigation area in each village; the remaining agricultural water control indicator is spread equally according to the effective irrigation area. The results of water rights allocation in the project area are shown in table 1.

| Township  | Effective irrigation area (million mu) | Agricultural water total control indicators (million m$^3$) | Reserved indicators for town management departments (million m$^3$) | Village water user association control indicator or water supply (million m$^3$) | Allocation control indicator project (million m$^3$) |
|-----------|----------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------------------------------------|--------------------------------------------------|
| Gaoze Street | 0.0251                                 | 2.6339                                                       | 0.1317                                                          | 0.1317                                                          | 2.3705                                           |
| Wanghu Town  | 0.0233                                 | 2.4450                                                       | 0.1223                                                          | 0.1223                                                          | 2.2005                                           |
| Hubu Township | 0.0101                                 | 1.0599                                                       | 0.0530                                                          | 0.0530                                                          | 0.9539                                           |
| Shichang Township | 0.013                                  | 1.3642                                                       | 0.0682                                                          | 0.0682                                                          | 1.2278                                           |

3.2. Establish a scientific and rational agricultural water price
The reform of water price should take into account the scarcity of water resources and the affordability of farmers. The basis of calculating the price of agricultural water supply is to verify the cost of agricultural water supply. The cost of agricultural water supply includes the cost of water supply for
backbone projects (state-owned projects) and the cost of water supply for the last canal system. The water supply price of the final canal system is composed of depreciation of fixed assets, management costs, labor costs of water distribution personnel, maintenance costs, electricity or fuel power costs. Calculation of the last canal system as in equation (2.1).

\[ P_2 = F_1 + F_2 + F_3 + F_4 + F_5 + F_6 \]  \hspace{1cm} (2.1)

Where: \( P_2 \) is the end-canal water price, yuan / m\(^3\); \( F_1 \) is the depreciation charge for fixed assets, yuan; \( F_2 \) is the management fee, yuan; \( F_3 \) is the labor fee, yuan; \( F_4 \) is maintenance and maintenance fee, yuan; \( F_5 \) is electricity or fuel power, yuan; \( F_6 \) is the water tax, yuan; \( Q \) is the annual amount of irrigation water, m\(^3\)/mu.

(1) Water supply price calculation

There are state-owned backbone projects and small-scale farmland water projects in the project area. According to the "Notice of Approval of Water Supply Price from Rizhao City Water Conservancy Project to Agriculture", the water price of state-owned backbone projects in the project area is 0.12 yuan/m\(^3\).

Table 2. Table of calculation results of engineering operation cost

| Irrigation mode             | Irrigation area (million mu) | Project depreciation fee (million yuan) | Maintenance costs (million yuan) | Operating expenses (million yuan) | Management fee (million yuan) | Irrigation water consumption (million m\(^3\)) |
|-----------------------------|------------------------------|----------------------------------------|----------------------------------|----------------------------------|-------------------------------|-----------------------------------------------|
| Water pumping irrigation area | 0.019                        | 1.42                                   | 0.5682                           | 0.94484                          | 0.2178                        | 2.535                                         |
| Reservoir irrigation area   | 0.023                        | 1.421                                  | 0.284                            | 0                                | 0.192                         | 3.48                                          |

According to the above-mentioned farmland water conservancy projects, the agricultural water prices of different irrigation types are preliminarily calculated. The results of the agricultural water prices of different irrigation types are shown in Table 3. Among them, the cost of operation and maintenance is 0.80 yuan/m\(^3\) in the terminal water price of pumping irrigation area and 0.26 yuan/m\(^3\) in the terminal water price of reservoir irrigation area.

Table 3. Agricultural water price calculation results table for different irrigation types

| Irrigation mode             | Agricultural water supply price (yuan/m\(^3\)) |
|-----------------------------|-----------------------------------------------|
|                             | backbone engineering project | Last ditch system | Terminal water price |
| Water pumping irrigation area | 0.12                                        | 0.68             | 0.8                  |
| Reservoir irrigation area   | 0.12                                        | 0.14             | 0.26                 |

(2) Estimation of farmers' bearing capacity

Many domestic studies show that the proportion of agricultural water cost to agricultural production cost is 20%~30%, the proportion of output value is 5%~15%, and the proportion of net income is 10%~20%. According to the planting structure and income of Wulian County, the evaluation of farmers' water price affordability can provide a reference for determining whether the water supply price is reasonable or not. Farmers' economic affordability can be calculated as in equation (2.2).

\[ C = \max (V*R_{f}, B*R_{p}) \]  \hspace{1cm} (2.2)

Where: \( C \) is the maximum capacity of farmers' water fee, yuan/mu; \( V \) is the average output value of mu, yuan/mu; \( R \) is the ratio of water fee to the average output value of mu, \( R \) is 5% to 8%, and its value is based on the actual situation of the irrigation area survey; \( B \) is the average net income per mu,
yuan/mu; \( r \) is the ratio of water fee to the average net yield of mu, \( r \) is 10% to 13%, and its value is based on the actual situation of the irrigation area.

In order to calculate the economic affordability of farmers’ water charges, it is necessary to understand the current economic input and output of typical farmers. Average yield per mu and net income per mu are determined according to crop cultivation system and multiple cropping index. According to the survey, the current status of input and output of typical farmers in Wulian County is shown in Table 4. It can be seen from the table that the average output value per mu in typical areas is \( V = 3110.4 \) yuan/mu, and the net income per mu is \( R = 1349.5 \) yuan/mu.

### Table 4. Input-output questionnaire of typical farmers

| Crop       | Proportion of planting area (%) | Input cost (yuan/mu) | Per mu output value (yuan / mu) | Average net income per mu (yuan / mu) |
|------------|---------------------------------|----------------------|---------------------------------|----------------------------------------|
| Wheat      | 80                              | 800                  | 3110.4                          | 1349.5                                 |
| Corn       | 80                              | 850                  |                                 |                                        |
| Vegetables | 10                              | 2680                 |                                 |                                        |
| Fruit tree | 10                              | 1729                 |                                 |                                        |

The calculation results of the maximum water bearing capacity of farmers are shown in Table 5. From the table, it can be seen that farmers’ water cost bearing capacity in typical areas is 134.95-248.83 yuan/mu, converted into water price of 0.89-1.64 yuan/m³. The results show that farmers’ affordability can meet the price of water supply.

### Table 5. Table for measuring farmers’ water fee bearing capacity in typical areas

| Average Yield Value per Mu V (yuan / mu) | Average net income per Mu R (yuan / mu) | \( R_{\text{min}} \) = 5% | \( R_{\text{max}} \) = 8% | \( r_{\text{min}} \) = 10% | \( r_{\text{max}} \) = 13% | Whether to meet the affordability of farmers |
|---------------------------------------|----------------------------------------|----------------|----------------|----------------|----------------|----------------------------------|
| 3110.4                                | 1349.5                                 | 155.52         | 248.83         | 134.95         | 175.44         | Satisfy                          |

(3) Super-fixed progressive fare increase system

Over-quota progressive price increase is an important control measure for agricultural water saving. The water for the agricultural water in the quota is charged according to the normal water price; if the water is more than 20% (inclusive), the water fee is charged at 1.2 times the water price; 50% (inclusive) of water, according to 1.5 times the price of water to collect water; more than 50% of the amount of water, 2 times the price of water to collect water. In addition, if the water quantity is purchased through the water rights transaction, the corresponding water rights transaction fee shall be paid as required, but the progressive price increase shall not be implemented.

### 3.3. Establishment of agricultural water subsidies and water saving subsidies

Agricultural water subsidy mainly has two ways, namely "implicit subsidy" and "explicit subsidy"[8,10]. The implicit subsidy is funded by government departments and directly subsidized to water supply units, thus reducing agricultural water prices. Considering the income and bearing capacity of farmers, the long-term use of covert compensation has resulted in inadequate awareness of water saving and excessive waste of water resources. Clear subsidy is to directly distribute subsidies to farmers, that is, more water and more money, less water and less money, so as to encourage farmers to form the idea that I want to save water, and improve the efficiency of water saving.

Because the economy, water-saving consciousness, climate and crops are different in different regions of the project, the method of combining the explicit and the implicit compensation is adopted to implement the precise subsidy of agricultural water use. It can be directly subsidized to the household according to the standard, or it can be subsidized to the water supply unit according to the standard first, then converted into water price as part of the water fee income, and indirectly subsidized to the household. Agricultural water subsidy encourages priority to be given to the way of clear subsidy, control the amount of hidden subsidy, and gradually change to clear subsidy. Water-saving subsidy takes into account factors such as water rights trading and repurchase, and realizes agricultural water-saving incentives by repurchasing surplus water rights of farmers.
3.4. Improve the comprehensive management system for agricultural water use
Since the establishment of the first domestic farmers’ water cooperative organizations in Hubei and Hunan in 1995, farmers’ water cooperative organizations have been established in various parts of the country. Yanhua\(^5\) studied the performance of farmers’ water cooperative organizations in major grain-producing areas. It was found that the clarity of property rights of farmers’ water cooperative organizations was conducive to improving the efficiency of the organizations, followed by the participation rate of farmers, democratic decision-making and training times. Farmers’ water cooperative organizations have been set up in the project area, which adopt the management mode of "association + village collective + water managers" and have registered. At the same time, the county water resources bureau carries out technical guidance and work supervision to water cooperative organizations, and clarifies the property rights of farmland water projects, continuously improves the social service level of water supply, water use and water management.

4. Conclusion
The reform of agricultural water price in the project area was analyzed, and the comprehensive reform of agricultural water price was promoted to form a reasonable water price mechanism. The comprehensive reform of agricultural water price has the following conclusions:

(1) To determine the initial water right of agriculture, agricultural water right is not only the quota control of the total amount, but also the basis of irrigation management in the project area. It is also the standard of water saving incentive and step water price, and the performance table of agricultural water saving efficiency.

(2) Establish a reasonable agricultural water price, take into account the cost of water conservancy projects and the final canal system, and implement a system of progressive price increase over quota on the basic water price. Reasonable agricultural water price is conducive to the transformation of subsidy for agricultural water use from implicit subsidy to explicit subsidy, and to the improvement of water saving efficiency of agriculture, which is the premise and guarantee of agricultural water price reform.

(3) Perfecting the comprehensive management system of agricultural water use, clarifying the property rights of water conservancy projects and strengthening the training and guidance of organizations are conducive to the popularization and implementation of water price reform, and are the boosters of agricultural water price.

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