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# The Study about Ecological Compensation Standard of Farmland Ecosystem in Beijing-Tianjin-Hebei Region

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**Abstract.** As a member of the terrestrial ecosystem, the farmland ecosystem is responsible for providing the material basis and food for human beings, and plays an active role in the stability of the global ecosystem. The farmland of Hebei Province has played an important role for food supply to Beijing and Tianjin in a long time. The development stage coefficient method was adopted in this study to adjust the non-market value of farmland ecosystem services. The result showed that the urban areas of Beijing and Tianjin should pay 17.934 billion yuan of ecological compensation to Hebei province, the suburban areas of Beijing and the suburban areas of Tianjin. The agricultural ecological compensation standard is 2,475 yuan per hectare. The results showed that The connection between ecosystem service function value and ecological compensation standard should be determined. The economic development level coefficient and compensation distribution coefficient played a key role.

## 1. Introduction

The coordinated development of Beijing-Tianjin-Hebei Province has become major national strategy of the CPC central committee and the state council under the new historical conditions.

As one of three ecological systems of global land, farmland ecosystem has provided important role in local and national grain security, job security for the farmers, rural natural habitat, also with a certain maintenance of biodiversity, air purification, water conservation and the function of regulating climate, etc[1]. The farmers directly got few agricultural economic value and service value as farmland in contribution to the huge ecological service value. The theory and practice are all looking forward to the establishment and implementation of ecological compensation mechanism in Beijing-Tianjin-Hebei region[2].

The nineteenth report of the communist party of China points out that "We will establish a market-based and diversified ecological compensation mechanism". Ecological compensation mechanism is a subsidy to protect the protection of the loss of economic benefits which is of great importance to the coordinated development of the region[3]. The quantification of ecological compensation standard is the key to the determination of ecological compensation mechanism.

The value of ecological service is the upper limit reference value of ecological compensation[4,5]. Because of the impact of the economic development gap, The actual ecological compensation ability



is difficult to meet the data measured by the service function of the ecosystem which will generally exceed the financial capacity of regional governments. Therefore, when we determine the horizontal financial transfer payment standard in reality, the estimation value of ecological services is used as a reference and theoretical reference for ecological compensation.

## 2. General situation in the study area

The region of Beijing-Tianjin-Hebei Province covers an area of 216,000 square kilometers with a total population of 10865,000. It is the core of the political, economic and cultural development of our country area and urbanization level is high. After the Yangtze river delta and the pearl river delta, Beijing-Tianjin-Hebei region has become the new growth pole in China. It is the highest level of economic development in north China area. The region of Beijing-Tianjin-Hebei Province involves Beijing and Tianjin municipalities directly under the central government and 11 cities in Hebei Province which included Shijiazhuang, Tangshan, Qinhuangdao, Baoding, Cangzhou, Langfang, Handan, Zhangjiakou, Hengshui, Xingtai.

In this study six districts were amalgamated into Beijing downtown which included Dongcheng , Xicheng , Haidian , Chaoyang, Fengtai and Shijingshan. Ten districts were amalgamated into Tianjin urban area which included Six zones within,Dongli , Xiqing ,Jinnan and Beichen .

Farmland area of Beijing in 2015 was 1.375 million hectares, accounting for 8.2 percent of the land area and 1.93 percent of the area in the Beijing-Tianjin-Hebei region. Farmland area of Tianjin in 2015 was 389,000 hectares, accounting for 32.6 percent of the land area and 5.45 percent of the area in the Beijing-Tianjin-Hebei region. Hebei province has 660.6 million hectares of farmland, accounting for 35.0% of the land area and 92.62% of the total area of the Beijing- Tianjin-Hebei area.

## 3. Ecological compensation range of farmland ecosystem

The value of ecosystem service function is different from the standard of ecological compensation[6]. In general, the value of ecosystem service function is very different from the actual ecological compensation[7]. When the service value of farmland ecosystem is used as the upper limit to calculate the ecological compensation standard, it is necessary to consider the value of ecological services enjoyed by the region itself which involves the supply value of the farmland ecosystem and it has been converted into money in the market mechanism. Therefore,, this part should be abandoned and only the non-market value part should be taken in the calculation of ecological compensation standard.

Gas regulation function plays a very large role in farmland ecological service function, accounting for 16.7% of the total service value in the non-market value part.

It has the function of realizing the adjustment of atmospheric components and its spillover scope is global, so the division of compensation responsibility cannot be realized.It is difficult and unprecedented for the government and the state to compensate the cross-border compensation fund for the adjustment function of atmospheric components[8]. Therefore, the value of gas regulation function is not included in the final value compensation although this value is huge.

On this basis, the ecological compensation standard of farmland ecosystem in all districts and counties of Beijing-Tianjin-Hebei region was formulated based on the benefit and compensation range of farmland ecosystem services.

The part of ecosystem function serving the region and the whole country is included in the compensation scope through the analysis of service functions of farmland ecosystem in Beijing-Tianjin-Hebei region so as to determine the theoretical basis for the study of ecological compensation of farmland ecosystem(Table 1).

**Table 1** Compensation range for farmland ecosystem service function

Primary function	Secondary function	Service function beneficiaries				Included in the scope of compensation
		Local Area	Beijing-Tianjin-Hebei Region	National	Global	
Supply	Food	√				

Service	Production				
	Production	√			
	Material				
	Water Supply		√		
	Climate			√	
Regulating Service	Regulation				
	Gas	√	√		√
	Regulation				
	Environmental	√	√		√
	Purification				
Support Service	Hydrological	√	√		√
	Adjusting				
	Soil	√	√		√
	Conservation				
	Maintain				
Cultural Service	Nutrient	√			√
	Circulation				
	Biological			√	
	Diversity				
	Aesthetic			√	√
	Landscape				

**Note: the "√" in the table means YES, and the blank means NO.**

#### 4. Determination of farmland ecological compensation standard in Beijing-Tianjin-Hebei region

##### 4.1 Horizontal Coefficient of Willingness to Pay

The development stage coefficient method which could represent the relative level of willingness to pay was used to adjust the non-market value of farmland ecosystem services[9]. The economic development level coefficient was calculated according to Engel's coefficient and growth curve.

$$L = \frac{1}{1 + e^{(3-E_n^{-1})}} \quad (1)$$

In this expression, L is the coefficient of development stage,  $E_n$  is the Engel coefficient.

The ecological compensation priority of farmland ecosystem in the Beijing-Tianjin-Hebei region was divided into four levels by 0.01, 0.03 and 0.12 respectively. Ecological priority is greater than 0.12 area was divided into level 1 area and ecological priority which was less than 0.01 the area was divided into 4 area.

In 2015, the weighted average of Engel coefficient of urban residents in four level regions was 26.38%, 25.19%, 24.7% and 22.1%, respectively. The development stage coefficient of the four levels by calculation respectively is 0.688, 0.725, 0.741 and 0.821. Then the non-market service value calculation results of farmland ecosystem in four grades were adjusted.

##### 4.2 Determination of compensation distribution coefficient

It was the key to establish a reasonable economic standard accounting method for ecological compensation on the basis of the classification of ecological compensation area[10]. The relationship between ecosystem service function value and ecological compensation standard was the key to determine ecological compensation adjustment coefficient. The non-market value of farmland ecosystem was not a reasonable ecological compensation standard[11].

Non-market value of farmland ecosystem was not reasonable ecological compensation standard, mainly because of the ecological service value result was not entirely by region to enjoy "ecological consumption", environmental improvement benefited "ecological output" type.

Therefore, the reasonable distribution coefficient was determined, and the part of "ecological consumption" allocation was taken as the basis for determining compensation.

Based on the economic development level coefficient of per capita GDP of the four ecological zones, the ecological compensation was reasonably distributed. The distribution coefficient formula was used as the basis.

$$R = \frac{e^{t_i}}{e^{t_i} + 1} \times \frac{GDP_i / N_i}{\sum_{i=1}^4 GDP_i / N_i} \quad (2)$$

In this expression,  $R$  was the distribution coefficient of four ecological zones,  $t_i$  was the inverse of Engel's coefficient,  $N_i$  is the population of each district. The distribution coefficients of 1-4 ecological grade areas were obtained through normalization treatment, which were 14.27%, 13.01%, 27.88% and 44.84%, respectively.

### 5. Ecological compensation standard of Beijing-Tianjin-Hebei region

The value of farmland ecological services was calculated. In 2015, the actual amount of compensation in the four ecological zones was higher than the theoretical amount. The actual compensation amount of ecological grade 1, 2 and 3 areas was lower than the theoretical compensation amount. The higher part of the compensation amount in the four zones of ecological grade was the less part of the compensation amount in the 1-3 zones of ecological grade. At present, the coordinated development of Beijing-Tianjin-Hebei integration had become a major national strategy, and it was more reasonable to consider farmland ecological compensation from the perspective of the overall situation of Beijing-Tianjin-Hebei region.

Therefore, the difference between the actual compensation amount and the theoretical compensation amount of Beijing and Tianjin should be the amount compensated to Hebei Province. The urban areas of Beijing and Tianjin should pay 17.934 billion yuan of ecological compensation to Hebei province, the suburban areas of Beijing and the suburban areas of Tianjin. The agricultural ecological compensation standard is 2,475 yuan per hectare. According to the area of farmland in Beijing-Tianjin-Hebei region, 16.95 billion yuan needs to be paid to Hebei province by Beijing and Tianjin urban areas, and 984 million yuan needs to be paid to the suburbs of Beijing and Tianjin (Table 2).

### 6. Discussion

Due to the influence of economic development gap, the actual ecological compensation ability is difficult to meet the data measured by the service function of the ecosystem, which often exceeds the fiscal capacity of the regional government.

When horizontal financial transfer payment criteria are confirmed, we only take it as the reference and theoretical reference for ecological compensation. By using the development stage coefficient method, which can represent the relative level of payment intention, the non-market value results of farmland ecosystem services are adjusted. Economic development level coefficient and compensation distribution coefficient can decide the relationship between ecosystem service function value and ecological compensation standard. The part of "ecological consumption-type" apportionment is taken as the basis for determining compensation.

**Table 2.** Ecological compensation of farmland ecosystem in Beijing-Tianjin-Hebei region

Types of Ecological Services	Ecological Hierarchy	Administrative Zones	Non-market Value (Billion Yuan)	Total Non-market Value (Billion Yuan)	Development Stage Coefficient	Adjusted Gross Non-market Value (Billion Yuan)	Compensation Distribution Coefficient (%)	Actual Compensation Amount (Billion Yuan)
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Ecological Output Type	1	Cheng de city	31.22	95.17	0.688	65.48	14.27	57.81
		Zhang jia kou	63.95					
		Bao ding city	59.07					
Ecological Output Type	2	Heng shui city	43.88	232.32	0.725	168.43	13.01	52.70
		Xing tai	52.75					
		Cang zhou city	61.35					
		Qin huang dao	15.27					
		Beijing	11.34					
		Suburbs						
		Tianjin	54.53					
		suburbs						
Ecological Consumption Type	3	Shi jia zhuang	42.4	227.79	0.741	168.79	27.88	112.94
		Tang shan	45.19					
		Handan city	50.55					
		Lang fang	23.78					
Ecological Consumption Type	4	Downtown	0.3	2.81	0.821	2.31	44.84	181.65
		Beijing						

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