AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Farmers' Response to Winter Wheat Fallow Policy in the Groundwater Funnel Area of China: Case Study of the Hengshui Area, Hebei Province

H. Xie;

Jiangxi University of Finance and Economics, , China

Corresponding author email: 29913108@qq.com

Abstract:

Farmers' response to the winter wheat cropping policy in groundwater funnel areas is the key factor in promoting fallow plans. Therefore, this paper discusses the farmers' responses and the influencing factors for the winter wheat policy in the Hebei groundwater funnel area by using an ordered multivariate logistic model; it aims to provide a theoretical basis for scientifically and rationally developing a rotation policy in the groundwater funnel area. The results revealed that cultivated land has a negative impact on the fallow policy. The number of households, the proportion of farmers, the per capita area of cultivated land, and machinery use have a negative impact on support for the fallow policy. The dependency ratio and land fragmentation have a significant positive impact on support for the fallow policy. Occupation has the greatest marginal effect on understanding of the fallow policy and satisfaction with fallow policy compensation, dependency ratio has the greatest marginal effect on support for the fallow policy. Finally, this paper proposes some policy and other recommendations such as the transfer of the surplus labor force, stronger government supervision of fallow policy compensation, stronger cultural education and greater promotion of the fallow policy.

Acknowledegment: This study was supported by the National Natural Science Foundation of China (No. 41561040); the Technology Foundation of Jiangxi Education Department of China (No. KJLD14033 & No. GJJ160431) and the Fok Ying-Tung Fund (No. 141084).

JEL Codes: R21, D12

#1249

Farmers' Response to Winter Wheat Fallow Policy in the Groundwater Funnel Area of China: Case Study of the Hengshui Area, Hebei Province

Abstract: Farmers' response to the winter wheat cropping policy in groundwater funnel areas is the key factor in promoting fallow plans. Therefore, this paper discusses the farmers' responses and the influencing factors for the winter wheat policy in the Hebei groundwater funnel area by using an ordered multivariate logistic model; it aims to provide a theoretical basis for scientifically and rationally developing a rotation policy in the groundwater funnel area. The results revealed that cultivated land has a negative impact on the fallow policy. The number of households, the proportion of farmers, the per capita area of cultivated land, and machinery use have a negative impact on support for the fallow policy. The dependency ratio and land fragmentation have a significant positive impact on support for the fallow policy. Occupation has the greatest marginal effect on understanding of the fallow policy and satisfaction with fallow policy compensation, dependency ratio has the greatest marginal effect on support for the fallow policy. Finally, this paper proposes some policy and other recommendations such as the transfer of the surplus labor force, stronger government supervision of fallow policy compensation, stronger cultural education and greater promotion of the fallow policy.

Key words: farmland; fallow policy; ordered logistic regression; groundwater funnel; China

1. Introduction

Due to socioeconomic development and some unreasonable land use, the North China Plain has become one of the most waterless areas in China, and the main water supply source for this region is groundwater. However, long-term overexploitation of groundwater leads to declines in the regional groundwater level, seawater intrusion, land subsidence and a series of other problems (Meng et al., 2011; Wu et al., 2010). In the Hebei Hengshui area, this series of problems is particularly prominent, making the governance of groundwater overexploitation critical. Therefore, Hebei Province has a groundwater funnel area to address the groundwater over-extraction problem; this is combined with a fallow plan proposed at the Fifth Plenary Session of the 18th CPC (Communist Party of China) Central Committee. Furthermore, the fallow plan also pointed out that 500 yuan per mu subsidy per year, the way of subsidy method is the cash or grain and we should fully respect the wishes of peasants in the pilot process .At this session, relevant policy measures were taken, such as the "Notice of Hebei Province People's Government on the printing and distributing a pilot program for comprehensive treatment of the overexploitation of groundwater in Hebei" (2015) and the "Hebei Provincial Department of Agriculture, Hebei Provincial Department of Finance issuance of the 2015 annual groundwater overdraft; comprehensive management of Hebei, notice of a pilot program for agricultural planting structure and agronomic water-savings-related project implementation". The purpose of these policies is to guide farmers in changing their planting habits, with the goal of achieving "a decrease in the area sown with winter wheat, which proves to be a practical strategy to reverse groundwater overexploitation and to promote groundwater storage." As a grain-producing province, agricultural water accounts for approximately 70-80% of total water resources in the Hebei Plain area (Wang et al., 2013); this is also the main cause of the decline of groundwater in the Hebei Plain (Xu, 2005). In some areas, an ecological fallow policy has been implemented; from the micro individual point of view, a fallow policy will reduce short-term agricultural income, while in the long run, it is conducive to reducing not only water pollution (Khanna et al., 2003) but also nonpoint source pollution and soil erosion (Ribaudo et al., 1994; Luo et al., 2006). Farmers are the most basic subject of land use (Li et al.,

2015; Xue et al., 2017). It is expected that farmers will aim to obtain the maximum profit from agriculture, so theories of farmer behavior have also been gradually introduced into the study of land use(Liu and Huang, 2015; Xin et al., 2009; Wu and Xie, 2017) .

The groundwater funnel area in Hebei Province is the national pilot area of fallow farmland. Farmers as the main body and specific implementer of the cultivated land fallow. Therefore, the degree of farmers' response to the fallow policy is critical; this is the main basis for testing the rationality of the fallow policy in the groundwater funnel area. Farmers' understanding and support of the fallow policy and their satisfaction with the amount of compensation will directly affect the implementation effect of the winter wheat fallow policy in the groundwater funnel area. So, taking farmers' understanding of the fallow policy, degree of support for the fallow policy, and degree of satisfaction with the fallow compensation into consideration, this paper discusses the theoretical framework of farmers' response to fallow policy in the groundwater funnel area. It has an important theoretical and practical value in studying the sustainable use and sustainable development of agriculture.

At present, international scholars have conducted extensive research on the effects and influencing factors of fallow policies. For example, Duesberg et al.(2017) conducted a logistic regression analysis of the impact of farmers' characteristics on a fallow policy. For families, emphasizing farming and receiving only national pensions have a negative impact on retirement intentions, indicating that pension and age have a positive impact on fallowing willingness and making fallowing recommendations. Vogelsang and Dunbar(1963) used a graphical model to analyze the impact of amount of compensation, satisfaction with the amount of compensation, the amount of fallow land and other factors on farmers' voluntary fallowing. Bremer et al. (2014)used interviews to analyze the impact of different factors on participants in the PES project and found that land ownership, land use restrictions, laws, alternative source availability and other factors had different effects on project participants. Cheng and Chen (2011) used a Tobit model and calculated the marginal effect of the impact of different factors on a fallow policy and concluded that the participants were not satisfied with the amount of fallow compensation, which was not sufficient to provide

a strong incentive.

In summary, we can see that the micro-subject of the effect of farmers' characteristics on their responses needs to be researched in depth. The main contributions of this paper are as follows. First, it uses a multiple and ordered logistic model to reveal the impact of the winter wheat fallow policy and the factors influencing farmers' response; this research is targeted to improve the farmers' response to the fallow policy. Second, the marginal effect is calculated to further analyze the response of different factors to the winter wheat fallow policy. Third, the paper proposes relevant suggestions for the winter wheat fallow policy in the underground funnel area to further improve this policy and provides a theoretical and practical basis for the effective implementation of the fallow policy in the underground funnel area.

2. Theoretical analysis, research methods and data sources

2.1. Theoretical Analysis

Farmers' economic behavior refers to the response of peasant households to external economic signals to realize economic benefits in a particular social environment.

In a different external environment, farmer behavior will be different. The main factors affecting peasant households are their individual factors, economic factors and external factors. As a farmland policy, cultivated land rotation directly affects the income of peasant households. Will farmers respond as a rational economic actor, driven by the maximization of profit? Based on the theory of farmer households, this research draws on existing research results and discusses farmer' response to the fallow policy. The functional path of peasant households in the groundwater funnel area at the theoretical level is shown in Figure 1.

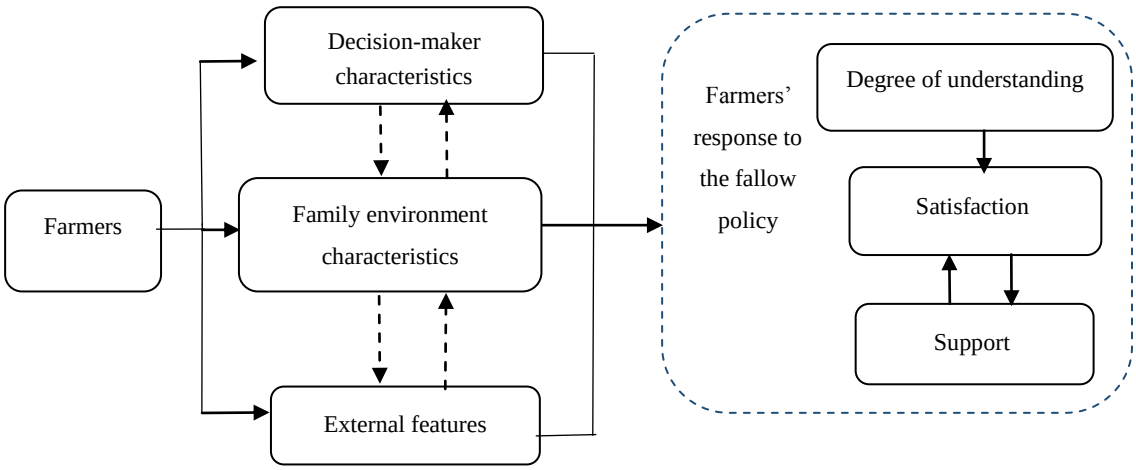

Figure 1 Framework of Farmers' response to fallow policy

The Impact of Decision-maker Characteristics on Response to the Fallow Policy. The effect of the total family population on the response to the fallow policy is uncertain. On the one hand, the greater the number of family members, the more income will be needed to maintain their livelihood. To a certain extent, the fallow policy will reduce farmers' grain output and agricultural income, resulting in lower satisfaction with the fallow policy and a lower level of support. On the other hand, the greater the total population of the family is, the greater participation there will be of non-farm laborers, bringing greater access to non-farm income, less dependence on family farming and a higher satisfaction with and support for fallow farming policies. With age, the physical strength of the laborer will decline, enthusiasm for engaging in agricultural production will be reduced, and the understanding of, support for and satisfaction with fallow farming policies will be higher. The impact of gender on understanding, support, and satisfaction is uncertain. On the one hand, men are more likely to accept new policies and new ideas and to understand the hazards posed by groundwater funnels. As a result, male farmers will better respond to fallow policies. On the other hand, as the main labor force, men are influenced by tradition, making their dependence on cultivated land stronger and their response to the fallow policy more negative. The higher the educational level of peasant households, the higher their level of awareness about the fallow farming policy and the better their understanding of the practical significance of fallowing in groundwater funnel areas, resulting in higher understanding of, support for and satisfaction with fallow farming policies.

The Impact of the Family Environment Characteristics on Response to the

Fallow Policy. Farmers' response to the fallow policy is uncertain. On the one hand, farmers with concurrent businesses are engaged in non-agricultural industries in addition to farming, making them less dependent on cultivated land and leading them to more actively respond to the fallow policy. On the other hand, most farmers have a low educational level and cannot completely rely on non-agricultural industries. Most of the rural households in the research area are primarily engaged in agriculture, resulting in low enthusiasm from the farmers in response to the fallow policy. The greater the dependency ratio, the greater the economic pressure on farmers, as their meager agricultural income will not be sufficient to support more expenses. To some extent, leaving land fallow leaves more time to engage in non-agricultural industries, resulting in higher support for fallow policies. A greater total number of farm laborers in the family will lead farmers to rely more heavily on arable land; they will fear that the fallow policy will have a certain impact on them, if they understand the fallow policy. Per capita non-agricultural income has uncertain effects on fallow policy satisfaction and understanding. On the one hand, due to cultural limitations, farmers cannot completely rely on non-agricultural industries, and agriculture remains their most basic living guarantee; then they will have a lesser degree of understanding and satisfaction with the fallow policy. On the other hand, when the per capita non-agricultural income of rural households is high and the non-agricultural economic benefits are greater, reducing their dependence on cultivated land, the result will be a higher degree of satisfaction with fallowing policies and compensation. A higher proportion of farming indicates that the number of families engaged in agricultural activities is relatively high, the income from farming is relatively high, and the dependence on cultivated land is also stronger, resulting in a less active response to fallow policies.

Impacts of External Characteristics on Response to the Fallow Policy. More per capita arable land area is more conducive to large-scale farming; as a rational broker, farmers will worry that the fallow policy will cause some economic loss, leading to a higher level of understanding of the fallow policy. However, when the per capita cultivated area is large, it is more conducive to cultivation and mechanized production, and support of and satisfaction with the fallow policy are lower. A higher use of mechanization is more conducive to large-scale mechanized production, which will, to a certain extent, reduce production costs, increasing the net benefits of planting more wheat, and leading to less support for the fallow policy. A higher degree of

cultivated land fragmentation is less conducive to farming households, increasing labor costs and leading farmers to better understand the fallow policy and to provide higher support for it. The more family cultivated land the farmer owns, the greater the dependence on cultivated land and the lower the understanding of cultivated land policy. More family cultivated land results in a relatively stronger dependence on arable land, which makes the farmers less understanding and less satisfied with the farmland policy. The higher the quality of cultivated land is, the higher the yield or income available to the farmers, resulting in lower satisfaction and support from farmers for the fallow policy.

Table 1 Variable paraphrase, assignment and expectation

Variables	Variable Definition	Expected Direction		
		Model Ⅰ	Model Ⅱ	Model Ⅲ
Total population of the family(Wang et al., 2012)	Survey data take logarithmic form		?	?
Age (Tian et al., 2012)	The age of farm decision-makers is logarithmic	+	+	+
Gender (Liang et al., 2014)	Male = 0; female = 1	?	?	?
Education level (Li and Yang, 2015)	Primary school or below = 1; junior middle school = 2; high school or secondary school = 3; college or higher = 4	+	+	+
Farmers' occupation (Yin and Xiao, 2015)	Pure agricultural farmers = 0; farmers with concurrent businesses= 1	?	?	?
Dependency ratio (Shi and Yu, 2013)	The number of farm laborers divided by the total population		+	
The total number in the agricultural labor force (Li et al., 2014)	Number of people engaged in agricultural production	+		
Per capita non-farm income (Li et al., 2014)	The ratio of non-agricultural income to population in a year, then take logarithmic form	?		?
Proportion of agriculture (Xie et al., 2017)	The ratio of the number of people participating in agriculture to the total population	-	-	-
Per capita area of cultivated land (Li et al., 2014)	The total land area divided by the total household population	+	-	-
Use of machinery (Xie et al., 2017)	Yes = 1; No = 2		-	-
Farmland fragmentation (Yin and Xiao, 2015)	The number of areas of cultivated and the total area of cultivated land	+	+	
The total area of family cultivated land (Zhong et al., 2013)	Total area of farmland	-		-
Cultivated land quality (Wang et al., 2016)	Level one and two farmland areas divided by the total farmland area			-

Note: "pure farmer" means that the family is engaged in agricultural activities only; "Farmer" means that the family is engaged in other activities in addition to agricultural activities (Model I shows the farmers' understanding of the fallow policy (Y = 1

represents “do not understand”; Y = 2 represents “somewhat understand”; Y = 3 represents “understand well”) , Model Ⅱ represents the supporting of the farmer for the follow policy (Y = 1 represents “ not support ”; Y = 2 represents “little support”; Y = 3 “more support”; Y = 4 represents “high support”;) Model III represents the satisfaction of the farmer with the amount of fallow compensation (Y = 1 represents “very dissatisfied”; Y = 2 represents “not satisfied”; Y = 3 “somewhat satisfied”; Y = 4 represents “more satisfied”; Y = 5 represents “very satisfied”) .

2.2. Research Methods

2.2.1. Ordered Multivariate Logistic Model

Because the dependent variable is an ordered variable, this paper uses an ordered logistic multiple regression model to analyze the factors influencing farmers' responses to the winter wheat fallow policy and constructs an ordered multivariate logistic model as follows:

$$T = \beta X + \varphi \qquad (1)$$

where T is a latent variable that cannot be observed, representing the latent variable corresponding to the dependent variable; X is the explanatory variable vector; βis the corresponding estimation parameter; and φ is the error term and follows a logical distribution. This article selects Y as the display variable; the value range is [1, n]. For the farmers' understanding of the fallow policy, Y = 1 represents “do not understand”, Y = 2 represents “somewhat understand”, Y = 3 represents “understand well”. In the model capturing support from farmers for the implemented policies, Y = 1 represents “no support”, Y = 2 represents “little support”, Y = 3 represents “more support”, Y = 4 represents “high support”. In the model investigating satisfaction with the amount of fallow compensation, Y = 1 represents “very dissatisfied”; Y = 2 represents “not satisfied”, Y = 3 represents “somewhat satisfied”, Y = 4 represents “more satisfied”, Y = 5 represents “very satisfied”.

2.2.2. Data Sources and Study Area Summary

The study area is the agricultural lands arounding Hengshui City, Hebei Province. This city is located in the southeastern part of Hebei Province, between longitude 115°10'-116°34' and latitude 37°03'-38°23' north; the east is adjacent to Cangzhou City and Shandong Province, the western border is Shijiazhuang City, to the south it is connected to Xingtai City, and the north junction is Baoding and Cangzhou City. The study area is located in the Hebei alluvial plain, where the terrain slowly tilts from

southwest to northeast. The soil is mainly light soil and is partly sandy and clay. The area belongs to the continental monsoon climate zone, which is warm and semi-arid. All of the data in this study come from a farmer survey questionnaire distributed in Hengshui, Hebei Province, between July and mid-August 2016. The specific research area included Jing County with Wangqian Temple and Beiliuzhi Town, from which a total of 26 questionnaires were obtained from two villages; Shenzhen City in Datun Township, Yuke Township and Gaoguzhuang Town, from which a total of 27 questionnaires were obtained from five villages; Anping County of Daziwen Township, from which a total of 27 questionnaires were obtained from four villages; Wuyi County of Heyan Town, Dengjiazhuang, from which a total of 23 questionnaires were obtained from five villages; Jizhou City of Guandaoli Township, Xiaozhai Township and Zhaochuan Town, from which a total of 32 questionnaires were obtained from six villages; Zaoqiang County of Tanglin Township, Xiao Zhang Zhen and Zaoqiang County, from which a total of 31 questionnaires were obtained from eight villages; Peach District of Hengshui City, from which a total of 10 questionnaires were obtained; and North Township, Zhou Wozhen and Sun Village of Wuqiang County, from which a total of 36 questionnaires were obtained from eight villages (See Figure 2). A total of 212 questionnaires were collected, of which there were 138 valid questionnaires, for a 93.4% response rate. The survey captures the characteristics of farm decision-makers, family production and management characteristics, cultivated land status and the degree of satisfaction and support for the fallow policy and the degree of satisfaction with the fallow policy compensation.

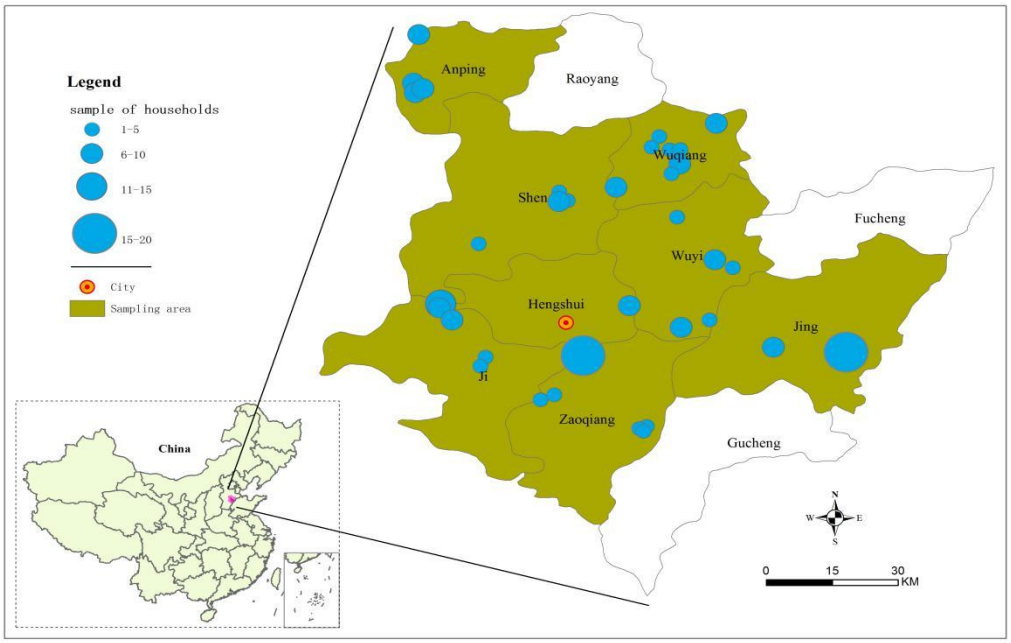

Figure 2. Distribution of survey samples

3. Materials and Results

3.1. Characterization of the Sample

As seen in Table 2, in terms of the degree of understanding, “Do not understand” accounted for 21%, and “somewhat understand” and above accounted for 79%: In general, the farmers have a high understanding of the fallow policy. However, it is worth noting that 21% of farmers did not understand the policy. In response to this situation, the government should increase publicity to improve farmers' awareness of the fallow policy. Among them, from the support side, 84.1% of farmers support the implementation. In the survey, the author found that only a small number of farmers did not expressed support for the fallow policy. There are two main reasons for this lack of support: first, the farmers are forced to travel to defined locations to buy fertilizer and pesticides by the village cadres, the local government; second, the amount of compensation is uncertain, the farmers do not know when it will be issued, and it may ultimately not be issued, among other concerns.

Table 2 Responses of farmers to the fallow policy

Farmers response	Option	Ration
Understanding	Do not understand	21%
	Somewhat understand	55.1%
	Understand well	23.9%
support	Not support	0.7%
	Litter support	13%
	More support	67.4%
	High support	16.7%
satisfaction	Very dissatisfied	0.7%
	Not satisfied	11.6%
	Somewhat satisfied	31.2%
	More satisfied	52.9%
	Very satisfied	3.6%

Notes: Calculated from the survey data

In terms of satisfaction with the amount of compensation, the satisfaction rate with the compensation for the fallow policy is 87.7%. The reason behind this support is that as the investment costs for fertilizer, machinery, pesticides, and groundwater decline increase, the majority of farmers become willing to leave land fallow; the amount of fallow compensation is also relatively satisfactory.

Table 3 shows the factors influencing farmers' responses to the fallow policy**.** First, characteristics of Farm Decision-makers. Males dominated as the main subject of the survey. Due to their limited educational level, most of the men did not have a stable job, and in addition to their farming, worked during their spare time. Most women were found to be unfamiliar with the situation of cultivated land during the investigation. The farmers were generally male; males accounted for 78.99%. The farmers were mainly middle-aged: the average age was 57 years; the oldest was 82 years, and the youngest 32 years old. A total of 5.07% were 40 years of age, and 63.04% were 50-60 years old. Farmers generally had a low level of education, mainly junior high school and below, with the following proportions: primary school accounted for 21.01%; junior high school accounted for 44.93%; high school and secondary school accounted for 27.54%; and college and above accounted for 6.52%.

Second, family and production and management characteristics. Among the 138 surveyed households, pure farmers accounted for 26.09%, and farmers accounted for 73.91%. The average dependency ratio was 36.66%. The average agricultural labor

force in the family totaled 2.39 people: the highest number was 6 people, while the lowest was only 1 person. The average non-farm income per family was 12,486 yuan, with the highest being 72,000 yuan. The average proportion of farmers in each household was 49.26%, with a range from 6% to 100%.

Third, cultivated land state. For the 138 surveyed farmers, the greatest amount of the average per capital arable land area reached 0.52 hectare, the lowest was only 0.024 hectare, the average per capita arable land area was 0.014 hectare. Of the surveyed farmers, 97.10% were found to use machinery. The average cultivated land fragmentation was 46.91%; the average land area was 0.594 hectare, the largest farmland reached 1.667 hectare of land area, and the smallest had a cultivated area of 0.133 hectare.

Table 3 Analysis of the factors influencing farmers' responses to the fallow policy

Level-Two Variables	Mean	Standard deviation	Variance	Minimum Value	Maximum Value
Total population of the family	1.46	0.50	0.25	0.00	2.48
Age	4.03	0.19	0.04	3.47	4.41
Gender	1.21	0.41	0.17	1.00	2.00
Education level	2.20	0.84	0.71	1.00	4.00
Farmers' occupation	0.74	0.44	0.19	0.00	1.00
Dependency ratio	0.37	0.33	0.11	0.00	0.83
Total number of household agricultural laborers	2.39	1.19	1.41	1.00	6.00
Per capita non-farm income	7.22	4.11	16.85	0.00	11.18
Proportion of agriculture	0.49	0.23	0.05	0.06	1.00
Per capita area of cultivated land	0.14	1.21	1.46	0.024	0.52
Use of machinery	1.96	0.24	0.056	0.00	2.00
Farmland fragmentation	0.47	0.27	0.07	0.08	2.00
The total area of family cultivated land	0.594	4.28	18.31	0.133	1.667
Cultivated land quality	0.73	0.26	0.07	0.00	1.00

3.2. Multiple Ordered Logistic Model Estimation Results and Analysis

Based on the previous selection of indicators, Stata 13.0 software was used to obtain the regression results from the logistic model and determine the influence of

different factors on farmers' response to the fallow policy, the degree of farmer’s support for the fallow policy and the degree of farmers' satisfaction with the compensation amount. Therefore, we refer to the characteristics of farm decision-makers, family and production and management characteristics, and the cultivated land state to determine the degree of response to the fallow policy and provide a theoretical basis for the scientific and rational development of a cropland policy in the groundwater funnel area.

3.2.1. Analysis of the Factors Influencing the Farmers' Degree of Understanding

Table 4 shows the regression results from the ordered logistic model for the understanding of winter wheat fallowing in the groundwater funnel area. Based on the reference index for the fit test of the model, it can be seen that the variance is adequate, and thus the original hypothesis is rejected. Table 3 shows a significance level of 0.0000, and the pseudo $R^2 = 0.2228$. These results suggest that farmers have a good understanding of the winter wheat fallowing system.

Table 4 Ordered logistic model regression results for farmers' understanding of winter wheat fallowing strategies in the groundwater funnel area

Level-One Variables	Level-Two Variables	Coefficient	Std. Error	z-Statistic	Prob.
Characteristics of farm decision-makers	Age	0.7464	1.0096	0.74	0.460
	Gender	0.7295	0.4727	1.54	0.123
	Education level	1.7141***	0.2796	6.13	0.000
	Farmers' occupation	2.3941**	1.0076	2.38	0.017
Family production and management characteristics	Total number of household agricultural laborers	0.3402*	0.2036	1.67	0.095
	Per capita non-farm income	-0.1536	0.1093	-1.41	0.160
	Proportion of agriculture	-1.4797	1.2659	-1.17	0.242
	Per capita area of cultivated land	0.4461**	0.2246	1.99	0.047
Cultivated land status	Farmland fragmentation	0.569	0.727	0.78	0.434
	The total area of family cultivated land	-0.1326**	0.0637	-2.08	0.037

Number of obs = 138
Pseudo R^2 = 0.2228
Prob>chi2 = 0.0000

Note: *, **, ***, respectively, indicate that statistical tests were at a 10%, 5%, 1% significance level.

In terms of the characteristics of farm decision-makers, it can be seen from Table 3 that the estimated coefficient of the degree of education reaches a 1% significance level, indicating that the farmer's education level has a significant impact on the understanding of the fallow policy. According to the author's research results, of those farmers who do not understand the fallow policy, 55.17% had a primary school level, 17.74% achieved a junior high school education, 5.26% had a high school education,

and none reached university and above. It can be seen that farmers with a higher degree of education had a greater understanding of the fallow policy; clearly, farmers with a higher education level,, they are highly likely to take initiative to implement the policy and these farmers clearly realize that the winter wheat fallow policy can bring ecological, economic and social benefits.

Considering the family and production and management characteristics, it can be seen from Table 3 that the estimated coefficients of the two variables of farmer occupation and the total number of household agricultural laborers are, respectively, at the 5% and 10% significance levels, indicating that farmer occupation and the total number of household agricultural laborers have a significant effect on response to the fallow policy. Within these, the farmer occupation variable positively affected the farmers' understanding of the fallow policy. In terms of those farmers who understand of the policy, the survey results show that pure agricultural farmers accounted for 21.21%; and farmers with concurrent business accounted for 78.79%. It can be seen that farmers with concurrent businesses have a higher degree of understanding of fallow policies than pure farmers; to a certain extent, this is likely because farmers with concurrent business income sources beyond agriculture have more flexibility to participate in the fallowing project, so they will be more concerned about the fallow policy. The total number of family farm laborers and of farmers also have a significant impact on the understanding of the fallow policy. In terms of those farmers understanding the policy, the survey results show that farms with 1 family agricultural laborer accounted for 30.3%, those with 2 family agricultural laborers accounted for 30.3%, and those with 3 or more family agricultural laborers accounted for 39.39%. It can thus be seen that when more people within the family are engaged in farming, a higher the degree of understanding of the fallow policy exists. Further, the higher the total number of people in the household engaged in agricultural labor is, the higher the degree of understanding of fallow policies will be. The reason for this relation is that households with a greater number of agricultural laborers are likely to have a stronger dependence on cultivated land; this leads to greater concern about the impact of fallow policy, so the farmer will pay attention to the trend of the fallow policy.

In terms of the cultivated land state, from Table 3, the estimated coefficients of per capita arable land area and the total area of family cultivated land are both at a 5% significance level. This result indicates that the per capita arable land and the amount of family cultivated land will significantly affect farmers' understanding of the fallow

policy. The per capita area of the cultivated land variable has a significant positive impact on farmers' understanding of the fallow policy. The survey results show that among farmers who are very aware of the fallow policy, those with a per capita area of cultivated land of less than two acres accounted for 36.36%, and those with a per capita arable land area of more than two acres accounted for 63.64%. It can thus be seen that the more arable land there is per capita, the greater the farmer's understanding of the fallow policy; this is likely because areas with more per capita arable land are more willing to participate in the fallow policy, which will release more labor force to tertiary industry, increasing household income and improving living standards; this leads to greater concern about the fallow policy. However, the total area of family cultivated land has a significant negative impact on farmers' understanding of the fallow policy. This shows that when more family land is cultivated, there is a lower degree of understanding of the fallow policy; when farmer households have more land for family farming, it is likely that the households will be busy with agricultural activities most of the time, and as a result, the farmers will have a low understanding of the fallow policy.

3.2.2. Analysis of the Factors Influencing the Farmers' Support for the Fallow Policy

Table 5 shows the regression results from the ordered logistic model for support of winter wheat fallowing in the groundwater funnel area. Based on the reference index for the fit of the model, it can be seen that the variance is at an acceptable level, and the original hypothesis is rejected. From Table 4, the significance level is 0.0001, and the pseudo $R^2 = 0.1395$; the results show that the farmer's support of winter wheat fallowing is ideal.

Table 5 Ordered logistic regression model of farmer's support for the winter wheat fallow policy in the groundwater funnel area

Level-One Variables	Level-Two Variables	Coefficient	Std. Error	z-Statistic	Prob.
Characteristics of farm decision-makers	Total population of the family	-1.121**	0.548	-2.05	0.041
	Age	0.6363	1.0333	0.62	0.538
	Gender	1.0416**	0.4859	2.14	0.032
	Education level	-0.0085	0.2287	-0.04	0.970
Family production and management characteristics	Farmers' occupation	-0.0089	0.5307	-0.02	0.987
	Dependency ratio	1.5534**	0.7136	2.18	0.029
	The total number of agricultural laborers	-2.0362*	1.186	-1.72	0.086
Cultivated land status	Per capita area of cultivated land	-0.4853***	0.1851	-2.62	0.009
	Use of machinery	-2.4443	0.9588	-2.55	0.011**
	Farmland fragmentation	1.4617**	0.7398	1.98	0.048
Number of obs = 138					
Pseudo R^2 = 0.1395					
Prob>chi2 = 0.0001					

Note: :*, **, ***, respectively, indicate that statistical tests were at a 10%, 5%, 1% significance level.

In terms of the characteristics of farm decision-makers, as seen in Table 5, the estimated coefficients of the total family population and gender variables were estimated at 5%. Of these, the total family population had a negative impact on support for the government fallow policy, meaning the higher the number of family number is, the lower the support for the implementation of the fallow policy. This relation mainly occurs because a greater family population leads to more expenditure, and poverty leads to a lower social status. The impact of gender variables on government policy support was significant. According to the survey, women generally do support the policy; those in support accounted for 89.65 %, while 10.35% did not support it. Men also generally do support the policy; those in support accounted for 82.52%, while 17.44% did not support it. From these results, we can also see that support for the policy varies between genders: women's preference for the fallow

policy tends to be higher than that of men.

Considering the family and production and management characteristics, as seen in Table 5, the ratio of dependents and the agricultural ratio reached a significance level of 5% and 10%, respectively, indicating that the dependency ratio and the proportion of agriculture have a significant effect on support for the fallow policy. The survey results show that among farmers who fully support the fallow policy, 39.13% had a dependency ratio of less than 50%, and 60.87% had a dependency ratio of more than 50%. Thus, it can be seen that the higher the farmers' dependency ratio is, the more likely they are to support for the fallow policy. The proportion of agriculture has a significant negative impact on support for the fallow policy. Thus, farmers living in areas with a larger proportion of agriculture are less supportive of the fallow policy. The survey results show that the main driver of this relation is that families with a greater proportion of agricultural labor in the family receive their main income from agriculture; these families worry that the government fallow subsidies will not be received in time and feel that their own planting will provide a more secure income.

In terms of the state of cultivated land, the three variables per capita area of cultivated land, use of machinery and farmland fragmentation had estimated coefficients at the 1%, 5%, and 5% significance levels, respectively (see Table 5). These results indicate that the per capita area of cultivated land, the use of machinery, farmland fragmentation and other cultivated land conditions significantly affect farmers' support for the fallow policy. The per capita arable land of farmers had a negative impact on support for the fallow policy, indicating that when farmers live in an area with more arable land per capita, they will have less support for fallow policy. The main cause of this relation is that when there is a greater per capita area of cultivated land, the degree of mechanization will be higher, farming becomes more convenient, work efficiency is high and farmers have more time to engaged in non-farm work, so the family income is higher. From a rational point of view, farmers will certainly choose to trust their own decisions regarding the use of arable land. The use of machinery also has a negative impact on support for the implementation of the government fallow policy. This result shows that farmers using machinery are less supportive of fallow policies; this is mainly because these farmers can engage in large-scale mechanized production, thereby reducing their production costs and achieving a higher net income from agricultural products. For them, planting winter

wheat can bring some profit, and support for the fallow policy is low. The degree of fragmentation of cultivated land has a significant impact on farmers' support for the fallow policy. In general, when farmland fragmentation is greater, farming becomes more inconvenient and higher cost; as the beneficiaries of ecological compensation, farmers will naturally hope that the government implements the winter wheat fallow policy.

3.2.3. Analysis of the Factors Affecting Farmers' Satisfaction with Fallow Policy Compensation

Table 6 shows the regression results from the ordered logistic model for satisfaction with the winter wheat fallow policy compensation in the groundwater funnel area. Based on the reference index for the fitness of the model, it can be seen that the variance is at an acceptable level; thus, the original hypothesis is rejected. From Table 5, the significance level is 0.0013, and the pseudo $R^2 = 0.1002$, showing that the farmer's satisfaction with the winter wheat fallowing system is expected to be satisfactory.

Table 6 Ordered logistic model of the farmers' degree of satisfaction with the winter wheat fallow policy in the underground funnel area

Level-One Variables	Level-Two Variables	Coefficient	Std. Error	z-Statistic	Prob.
Characteristics of farm decision-makers	Total population of the family	1.0051	0.6877	1.46	0.144
	Age	1.6948*	0.9943	1.7	0.088
	Gender	-0.9944**	0.4281	-2.32	0.020
	Education level	0.3521	0.2222	1.58	0.113
Family production and management characteristics	Farmers' occupation	2.0943**	0.9081	2.31	0.021
	Per capita non-farm income	-0.2239**	0.1008	-2.22	0.026
	Proportion of agriculture	-0.9272	1.0217	-0.91	0.364
	Per capita area of cultivated land	0.167	0.2651	0.63	0.529
Cultivated land status	Use of machinery	-1.8181**	0.8873	-2.05	0.040
	The total area of family cultivated land	-0.1743**	0.071	-2.45	0.014
	Cultivated land quality	-0.7411	0.7245	-1.02	0.306
Number of obs = 138					
Pseudo R^2 = 0.1002					
Prob>chi2 = 0.0013					

Note: *, **, *** represent the 10%, 5%, 1% significance levels, respectively.

In terms of the farm decision-makers' characteristics, as seen in Table 6, the estimated coefficients of the age and gender variables reached 10% and 5% significance levels, respectively. These results suggest that age and gender have a significant impact on farmers' satisfaction with the amount of compensation for the fallow policy. The age of the head of household has a significant positive impact on satisfaction with the amount of ecological compensation; the survey results show that farmers are satisfied with the amount of compensation. In particular, among farmers over 50 years of age, 100% are very satisfied with the amount of fallow compensation. This result is consistent with the findings of Chen et al. (2011) . This high level of satisfaction is mainly because as farmers age and physically decline, it becomes more difficult to engage in agricultural activities; further, the government's compensation for the fallow policy is fairly close to the net income of cultivated land, so older farmers are more satisfied with the amount of subsidy from the state. The gender of the farmer has a significant negative impact on satisfaction with the amount of fallow

compensation; this result is consistent with the findings of Shi et al. (2014). According to the survey results, 90.83% of the male heads of household are satisfied with the amount of compensation, while 75.86% of the female heads of household are satisfied. This result shows that women are less satisfied with the amount of fallow compensation; male participation in the fallow policy is higher than that of women, and so their satisfaction with the amount of ecological compensation is also higher.

In terms of the cultivated land state, as seen in Table 5, the estimated coefficients for the use of machinery and the total area of family cultivated land reached a significance level of 5%, showing that both of these variables have a significant effect on the response to the fallow policy compensation. The use of machinery has a negative impact on satisfaction with the amount of fallow policy compensation, indicating that the higher the degree of mechanization is, the lower the farmers' satisfaction with the amount of fallow compensation. The main reason is that the farmer can obtain high profits by using mechanized tillage, so the amount of fallow compensation becomes unsatisfactory. The total area of family cultivated land also negatively affected satisfaction with the amount of fallow compensation; the author's research finds that among the very satisfied farmers, 40% have 1-10 acres, 60% have 10- 15 acres, and 0% have 15 acres or more. It can be seen that there is lower satisfaction among farmers with a greater total area of family cultivated land. The main driver of this result is that farmers with a greater total area of family cultivated land invest more time and energy into farming, generating greater agricultural income, so they are less satisfied with the amount of fallow compensation.

3.3. Marginal effect analysis

Although the estimated coefficients in Table 4, Table 5, and Table 6 reflect the effects of different factors, they cannot fully and accurately reflect the degree of impact of different factors. Therefore, this paper uses a marginal effect analysis to further study the subject in more depth. In this paper, the marginal effects of the different influencing factors are calculated using the critical point and the correlation coefficient. In general, the conventional method of calculating the marginal effect of a continuous variable is not suitable for calculating that for dummy variables (Greene, 2003). Therefore, in this paper, when calculating the marginal effect of a single dummy variable, the other variables are normalized to zero, and the effect is calculated according to formula (5) (Carlevaro, 2003) to analyze the degree of

influence of the independent variable on the probability of the dependent variable. The calculation results for the marginal effect of x on y are in Table 7.

Table 7 Marginal effect of the independent variables on different models

	The model for understanding the fallow policy			The model for supporting the fallow policy				The model for satisfaction with the compensation amount for the fallow policy				
	Y=1	Y=2	Y=3	Y=1	Y=2	Y=3	Y=4	Y=1	Y=2	Y=3	Y=4	Y=5
Total population of the family	-	-	-	0.0289	0.0922	0.0135	-0.1346	-0.0071	-0.0884	-0.1110	0.1732	0.0334
Age	-0.0972	-0.0016	0.0989	-0.0164	-0.0523	-0.0077	0.0764	-0.0120	-0.1491	-0.1872	0.2920	0.0563
Gender	-0.0926	-0.0016	0.0941	-0.0269	-0.0856	-0.0126	0.1251	0.0070	0.0875	0.1099	-0.1713	-0.0330
Education level	-0.2142	-0.0036	0.2178	0.0002	0.0007	0.0001	-0.0010	-0.0025	-0.0310	-0.0389	0.0607	0.0117
Farmers' occupation	-0.2994	-0.0050	0.3045	0.0002	0.0007	0.0001	-0.0011	-0.0148	-0.1842	-0.2314	0.3608	0.0696
Dependency ratio	-	-	-	-0.0401	-0.1277	-0.0187	0.1866	-	-	-	-	-
The total number of agricultural laborers	-0.0463	-0.0008	0.0471	-	-	-	-	-	-	-	-	-
Per capita non-farm income	0.0190	0.0003	-0.0194	-	-	-	-	0.0016	0.0197	0.0247	-0.0386	-0.0074
Proportion of agriculture	0.2073	0.0035	-0.2108	0.0526	0.1674	0.0245	-0.2445	0.0066	0.0815	0.1024	-0.1597	-0.0308
Per capita area of cultivated land	-0.0503	-0.0008	0.0512	0.0125	0.0399	0.0059	-0.0583	-0.0012	-0.0147	-0.0184	0.0288	0.0055
Use of machinery	-	-	-	0.0631	0.2010	0.0295	-0.2936	0.0129	0.1599	0.2009	-0.3132	-0.0604
Farmland fragmentation	-0.0726	-0.0012	0.0739	-0.0377	-0.1202	-0.0176	0.1755	-	-	-	-	-
The total area of family cultivated land	0.0151	0.0003	-0.0153	-	-	-	-	0.0012	0.0153	0.0193	-0.0300	-0.0058
Cultivated land quality	-	-	-	-	-	-	-	0.0052	0.0652	0.0819	-0.1277	-0.0246

From Table 7, we find that in the model for farmers' understanding the fallow

policy, the marginal effect is greater than zero of the four variables of education, farmer occupation, total number of family laborers and per capita arable land when understand well. In the absence of other conditions, it is shown that the likelihood of farmers' understanding the fallow policy increases as these variables increase. The marginal effects of the four sets of variables are significant and negative when the dependent variable Y = 1 or Y = 2; as these variables increase, this suggests that the possibility of farmers' understanding the fallow policy is reduced. When Y = 1 or Y = 2, the marginal effect of the number of land blocks is positive. When the number of peasants increases, the probability of farmers understanding the fallow policy increases. In the model of farmers' support for the fallow policy, the total number of households, the proportion of farmers, the per capita area of cultivated land, and the use of machinery represent the four independent variables; for values of Y = 1, Y = 2, Y = 3, their marginal effect is positive; as these variables increase, farmers are more likely to support the fallow policy. The marginal efficiency of gender and dependency ratio is negative when Y = 1, Y = 2, Y = 3; as the value of these variables increases, farmers become less likely to support the fallow policy.

4. Conclusion and Discussion

4.1. Conclusion

Based on the questionnaires circulated in the Hengshui area, this paper constructs an ordered logistic model to explore the factors influencing farmers' response to the fallow policy in the Hengshui area, Hebei Province. The results are as follows:

In terms of the respondents' understanding of the fallow policy, 79% "somewhat understand" or "understand well". In terms of support for the implementation of the fallow policy, 84.1% offered "more support" or "high support". In the case of farmers' satisfaction with the amount of compensation, 87.7% are at least "somewhat satisfied". Farmers have a positive overall response to the fallow policy.

farmer's education, occupation, the total number of agricultural laborers in the family, and the per capita area of cultivated land all have a significant effect on the farmer's understanding of the fallow policy; While the total area of family cultivated land has a significant negative impact on understanding of the fallow policy.

The total population within the household, the ratio of farming households, the per capita area of cultivated land and the use of machinery all have a negative impact on support for the fallow policy. Farmer's gender, the dependency ratio and farmland

fragmentation all have a significant positive impact on support for the fallow policy.

4.2. Discussion

Based on the above results, the government should solve the problem of the surplus labor force appropriately among poor farmers. Addressing this problem of extensive labor surplus is of great importance to the fallow policy. Creating more non-agricultural employment opportunities can fundamentally solve the future livelihood problems of participating farmers.

Region's economy, transportation, and education services have a great effect on fallow policy. Most of the farmers in the sample area have a low educational level, relatively few employment channels and the income of farmers in the underground water funnel is unstable. Therefore, it is urgent to improve education among residents of the underground funnel area and further promote the fallow policy efforts. Additionally, farmers characteristics also have a great important affect their attitude and response to the fallow policy. Based on the characteristics of different types of farmers, different ways of implementing the fallow policy can be developed to fully mobilize the enthusiasm of farmers to participate in the fallow policy and achieve the best results. At the same time, the central government should increase its supervision of local governments implementing compensation for the fallow policy and strengthen farmers' support on the government

References

Bremer, L.L., Farley, K.A., Lopez-Carr, D., 2014. What factors influence participation in payment for ecosystem services programs? An evaluation of Ecuador's Socio Páramo program. Land Use Policy 36:122-133

Carlevaro, F., Sénégas, M.A., 2003. Simplified Maiginal Effects in Discete Choice Models: A correction. Economics Letters 92(1):44-46.

Chang, H.H., Chen, Y.H., 2011. Are participators in the land retirement program likely to grow energy crops? Applied Energy 88: 3183-3188.

Chen, Y., Chen, Y.R., Ma, W.B., 2011. Intention of Land Circulation in Reservoirs Resettlements Based on the Logistic Model: An Investigation into Sichuan, Hunan and Hubei Provinces. Resources Science 06:1178-1185.

Duesberg, S., Bogue, P., Renwick, A., 2017. Retirement farming or sustainable growth land transfer choices for farmers without a successor. Land Use Policy 61:526-535.

Vogelsang, D.L., Dunbar, J.O., 1963. A Method for Analyzing the Effects of Voluntary Land-Retirement Programs .Journal of Farm Economics 45(4): 789-796.

Greene,W.H., 2003. Econometric Analysis (4, edition)New Jersey: Prentice Hall.

Khanna, M., Yang, W., Farnsworth, R., Önal, H., 2003. Cost-Effective Targeting of Land Retirement to Improve Water Quality with Endogenous Sediment Deposition Coefficients. American Journal of Agricultural Economics.85(3)：538-553.

Li, P., Xiao, C.W., Feng Z.M., Jiang, L.G., Liu, Y., 2015. Household decision behavior in rice cropping systems in the major rice-producing area of Poyang Lake Plain, China. Geographical research 34(12):2257-2267.

Li, Z., Yan, J., Hua, X, Xin, L., Li, X., 2014. Factors influencing the cultivated land abandonment of households of different types:A case study of 12 typical villages in Chongqing Municipality. Geographical research 33(4):721-734.

Li, Z., Yang, J., 2015. Fallow willingness of rural households in Poyang Lake main grain-producing areas and its influencing factors. Guangdong Agricultural Sciences 42(22):162-167.

Liu, C.W., Huang, L.M., 2015. The changes of farmers' behavior in land use and its impacts on the food production during the process of marginalization of arable land. Geographical research (12):2268-2282.

Liang, Z.F., Xiao, X.C., Ni, J.P., 2014. Attitudes and Policy Responses of Farmers to Agricultural Non-point Source Pollution Control in the Three Gorges Reservoir Area——Based on the questionnaire of farmers in NanTuo Town, Fuling District, Chongqing City. Rural Economy 07: 92-97.

Luo, B., Li, J.B., Huang, G.H, Li, H.L., 2006. A simulation-based interval two-stage stochastic model for agricultural nonpoint source pollution control through land retirement. Science of The Total Environment, 361 (1-3) 38.

Meng, S.H., Fei, Y.H., Zhang, Z.J., Qian, Y., Li, Y.S., 2011. Groundwater vulnerability assessment of North China Plain. Geology in china 06:1607-1613.

Ribaudo, M.O., Osborn, C.T., Konyar, K., 1994. Land Retirement as a Tool for Reducing Agricultural Nonpoint Source Pollution. Land Economics 70(1) : 77-87.

Shi, C.X., Guo, X.H., Zhu, X.Q., Chen, J.J., Li, Y., 2014. Based on CVM Agro-ecological Compensation in Upstream of Erhai Lake Basin. Journal of Agro-Environment Science 33(4):730-736.

Shi, P., Yu, J., 2013. Study on ecological migration willingness and its influencing factors: A case of Ankang，Shaanxi. Journal of China Agricultural University 18(1):218-228.

Tian, M., Yan, L.D., Deng, Y.J., Yuan, H., 2012. Research on influencing factors of residents'willingness to pay for green agro-ecological compensation--A case from Wuhan in Hubei Province. Journal of southern agriculture 43(11):1789-1792.

Wang, C.H., Cui, L.J., Mao, X.F., Wen, Y., 2012. Comparative studies on the farmers willingness to accept eco-ompensation in wetlands nature reserve. Acta Ecologica sinica 32(17):5345-5354.

Wang, X., Li, X.B., Xin, L.J., 2013. Impact of the shrinking winter wheat sowing area on agricultural water consumption in the Hebei Plain. Acta geographica sinica (05):694-707.

Wang, X., Li, X.B., Xin, L.J., Tan, M.H., Li, S.F., Wang, R.J., 2016. Ecological compensation for winter wheat abandonment in groundwater over-exploited areas in the North China Plain. Acta Ecologica Sinica 71(5):829-839.

Wu, A.M., Li, C.C., Xu, Y.Z., Liu, J.G., Luo, G.Z., 2010. Key Issues Influencing Sustainable Groundwater Utilization and Its Countermeasures in North China Plain. South-to-North Water Transfers and Water Science& Technology 08(6):110-113.

Wu, Q., Xie, H.L., 2017. A Review and Implication of land fallow system research. Journal of Resources and Ecology 8(3): 223–231.

Xie, H.L., Cheng, L.J., Lv, T.G., 2007. Factors Influencing Farmer Willingness to Fallow Winter Wheat and Ecological Compensation Standards in a Groundwater Funnel Area in Hengshui, Hebei Province, China. Sustainability. 9(5), 839.

Xin, L.J., Li, X.B., Zhu, H.Y., Liu, X.J., Tan, H.M., Tian, Y.J., 2009. Validation of the inverse farm size-productivity relationship and its explanations: A case study of

Jilin Province. Geographical research 28(05):1276-1284.

Xie, X., Xie, H., Shu, C., Wu, Q., Lu, H., 2017. Estimation of Ecological Compensation Standards for Fallow Heavy Metal-polluted Farmland in China Based on Farmer Willingness to Accept. Sustainability 9(10), 1859.

Yin, K.，Xiao, Y., 2015. Empirical Research on Household Willingness and Its Caused Factors for Economic Compensation of Eco-fallow in the Water-level Fluctuation Zone of the Three Gorges Reservoir Area. Scientia Geographica Sinica 35(09):1123-1129.

Zhong, X.L.， Li, J.T., Feng, Y.F., Li, J.G., Liu, H.H., 2013. Farmland Transfer Willingness and Behavior in the Perspective of Farm Household Cognition in Guangdong Province. Resources Science 35(10):2082-2093.