Analysis of factors affecting small-scale farmland water conservancy construction based on the perspective of farmers' subdivision

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Abstract. This paper uses the survey data of Baoying and Shuyang counties in Jiangsu Province to analyze the investment intentions and behavioral orientations of different types of farmers on the construction of small-scale farmland water conservancy facilities, and constructs a Logit measurement model to explain the factors affecting the farmers' willingness to invest. The results show that: Farmers' willingness to invest is positively correlated with whether they are village cadres or not, household agricultural income, block arable land area, demand for farmland water conservancy facilities, evaluation of village cadres, comparison with surrounding village water conservancy facilities, and whether there are government involvement projects. It is also negatively related to the age of the farmer, the proportion of the working population, and whether or not he/she participated in the investment.

1. Introduction

Strengthening the construction of small-scale farmland water conservancy facilities and improving its supply level is one of the important contents of modern agricultural construction, which is directly related to national food security and farmers' increased production and income. However, farmers have lost the motivation and enthusiasm for investing in activities, making the construction of small-scale farmland water conservancy more difficult, and the problems of insufficient investment, poor management, and backward management are becoming more and more serious[1,2]. Governments at all levels, rural collectives and farmers have played games their respective interests in the construction and management of small-scale farmland water conservancy projects. The participating entities will actively participate in the construction and management of the project based on their own interests, thus helping to improve the governance status and mode of the project, and to effectively promote the reform of the property rights system of small farmland water conservancy projects[3]. In order to improve the conditions of small-scale farmland water conservancy facilities, in addition to vigorously increasing capital investment, the government also needs to pay attention to the status of farmers in the construction of small-scale farmland water conservancy projects, especially the large-scale outflow of rural labor, changes in income structure, and serious aging of farmers. Under the situation, it is the key to improve the supply mechanism of small farmland water conservancy construction by taking effective measures to guide farmers to actively participate in the construction of farmland water conservancy.

There have been many studies at home and abroad on the issues related to the participation of farmers in the construction of small-scale farmland water conservancy facilities. Rosegrant concludes
with a discussion of the potential for water policy reform and demand management to minimize adverse impacts when water is reallocated from agriculture [4]. Sarker and Itoh pointed out that investment in small-scale farmland water conservancy facilities should be shared by beneficiary farmers and the government [5]. At the end of the 19th century, In India, Australia and other countries, the government was a major investor in large-scale irrigation facilities: the Chinese government has long been a major investor in irrigation facilities, and after entering the 20th century, China's investment in irrigation facilities has increased significantly, and then showing a steady decline after reaching its peak in 1979 [6]. Gheblawli believed that government departments should, through effective measures, hand over part of the government's farmland water conservancy investment and management responsibilities to farmers [7]. Domestically, some researchers pointed out that the investment attitude of most farmer households is positive, but the proportion of willing investment is low [8]. The scale of farmers as basic irrigation units is too small, and due to the quasi-public goods attributes of small farmland water conservancy facilities, farmers’ self-supply of small farmland water conservancy is easy to fall into the “prisoner's dilemma” [9,10]. Some scholars have conducted in-depth research on the willingness of farmers to invest in small-scale farmland water conservancy construction. Zhu Honggen et al. and Liu Hui analyzed the willingness of farmers to participate in farmland water conservancy construction from the theoretical and empirical levels by using game theory and logistic model [11,12].

The above analysis conclusions provide a good inspiration for this study. However, most existing researches regard farmers as a whole, and farmers are no longer a highly homogeneous group, which is in the construction of small farmland water conservancy infrastructure. The willingness and behavioral orientation are also different. In addition, the forms of farmer households participating in small-scale farmland water conservancy construction are divided into investment and labor, and their willingness to invest is also different. Then what factors affect the choice of farmers’ input methods and input levels? This paper will draw on the existing research results, and use the survey data of farmers in Baoying and Shuyang counties in Jiangsu Province to analyze the willingness and behavior of participating in the construction of small farmland water conservancy facilities on the basis of subdividing the farmers.

2. Data sources and basic characteristics

The data used in this paper is from the field survey of small farmland water conservancy facilities in Baoying County and Shuyang County of Jiangsu Province in May 2012. Both counties were the first batch of small farmland water conservancy construction counties established in Jiangsu Province in 2009, so they are typical. The survey was conducted in the form of questionnaires. The contents of the questionnaire mainly included the basic characteristics of individual households and families, the degree of demand for small-scale farmland water conservancy facilities, the willingness to invest, and the financing intensity. In May 2012, our research team distributed 600 questionnaires in Baoying and Shuyang by random sampling. 542 valid questionnaires were collected, the effective recovery rate was 90.33%. The specific operation is to select five townships (towns) in each county, then three villages in each township (towns), and then select 20 farmers randomly in each village for investigation.

The survey targets are mainly farmers engaged in agricultural production. The basic characteristics of sample farmers are as follows: First, the agricultural population is aging. The average age of the surveyed households is around 55, which is the largest group in the survey sample, and the education level of the farmers is mostly below junior high school, Generally speaking, their educational level is low. Second, the farmers “do not live on agriculture” and the agricultural income is deputy. In terms of household income composition, more than 76% of farmers’ agricultural income accounts for less than 50% of their total household income, indicating that due to low agricultural income, for most farmers, agricultural income is not the main source of income for households. Third, farmers "Do not focus on agriculture", and agricultural production is concurrent. In the survey sample, the average labor force per household was 2.99, while the number of migrant workers per household went to 1.34. The farmers lacked attention to agricultural production activities.
3. Willingness of different farmers to invest in small-scale farmland water conservancy facilities

3.1. Subdivision of farmer types

According to the characteristics of “aging”, “sideline” and “commercialization” of farmers in the above analysis, we consider the land area owned by farmers, the proportion of agricultural income and age, and then divide them into four categories: large grain farmers, low part-time farmers, high part-time farmers and elderly farmers (table 1). This paper defines large grain-growing households as farmers who manage more than 25 acres of cultivated land. Most of them manage the scale by contracting land, accounting for 5.53% of the total sample, and the average cultivated land area is 37 acres. Their agricultural income accounts for 50% to 80% of the total household income. The elderly farmers refer to farmers over 60 years old, accounting for 34.42% of the total sample. In addition to the above two types of farmers, we classify the surplus farmers into low-level farmers and high-level farmers according to their degree of part-time operation. The former refers to farmers with agricultural income greater than 50%, accounting for 19.93% of the total; the latter refers to farmers with agricultural income less than 50%, accounting for more than 40% of the total sample.

Table 1. Statistics and characteristics of different types of farmers.

| Farmer type                        | Number of samples (unit) | ratio(%) | Average farmland per household (ma) | Average household income (ten thousand Yuan) | Agricultural income share (%) |
|------------------------------------|--------------------------|----------|-------------------------------------|--------------------------------------------|-----------------------------|
| Large grain growers                | 30                       | 5.53     | 37.34                               | 4.68                                       | 50%~80%                     |
| Elderly farmers                    | 186                      | 34.32    | 7.43                                | 5.06                                       | <30%                        |
| Farmers with low level of employment | 108                      | 19.93    | 9.42                                | 1.98                                       | >50%                        |
| Farmers with high levels of employment | 218                      | 40.22    | 5.94                                | 3.96                                       | <50%                        |

3.2. Farmers' willingness to invest in small-scale farmland water conservancy facilities

According to the survey data, 75.64% of the sample farmers believe that the investment in small-scale farmland water conservancy facilities is the responsibility of the farmers. It can be seen that most farmers' investment attitude towards small-scale farmland water conservancy facilities is relatively positive. Farmers' willingness to invest includes not only whether they are willing to invest, but also the way they invest when they participate in the investment. Therefore, in the course of the investigation, we set up several options in the questionnaire, “neither investment nor labor input, only investment but no labor input, only labor input but no investment, both investment and labor input”, to examine the willingness and manner of investment of farmers. The survey results (table 2) show that the proportion of farmers who choose not to invest is: large grain farmers (6.67%), low-level farmers (20.37%), high-level farmers (27.52%), and the elderly farmers (25.81%).

Table 2. Willingness of different types of farmers to invest in small-scale farmland water conservancy facilities.

| Input method                      | Large grain growers Household (unit) | Ratio (%) | Farmers with low level of employment Household (unit) | Ratio (%) | Farmers with high levels of employment Household (unit) | Ratio (%) | Elderly farmers Household (unit) | Ratio (%) |
|-----------------------------------|--------------------------------------|-----------|-------------------------------------------------------|-----------|-------------------------------------------------------|-----------|-------------------------------|-----------|
| Only investment but no labor input| 8                                    | 26.67     | 16                                                    | 14.81     | 94                                                    | 43.12     | 72                            | 38.71     |
| Only labor input but no investment| 4                                    | 13.33     | 42                                                    | 38.89     | 36                                                    | 16.51     | 36                            | 19.35     |
| Both investment                   | 16                                   | 53.33     | 28                                                    | 25.93     | 28                                                    | 12.84     | 30                            | 16.13     |
Neither investment nor labor input

| Willingness to bear | Large grain growers | Farmers with low level of employment | Farmers with high levels of employment | Elderly farmers |
|---------------------|---------------------|--------------------------------------|----------------------------------------|----------------|
|                     | Household (unit)   | Ratio (%)                           | Household (unit)                        | Ratio (%)       |
| 0                   | 2                   | 6.67                                | 22                                     | 20.37          | 60             | 27.52          | 48             | 25.81          |
| 1%~10%              | 6                   | 20                                  | 40                                     | 37.04          | 44             | 20.18          | 84             | 45.16          |
| 11%~30%             | 6                   | 20                                  | 30                                     | 27.78          | 66             | 30.28          | 38             | 20.43          |
| 31%~50%             | 10                  | 33.33                               | 14                                     | 12.96          | 26             | 11.93          | 14             | 7.53           |
| 51%~70%             | 4                   | 13.33                               | 2                                      | 1.85           | 18             | 8.26           | 2              | 1.08           |
| >70%                | 2                   | 6.67                                | 0                                      | 0              | 4              | 1.83           | 0              | 0.00           |

4. Farmers' willingness to invest and its influencing factors

4.1. Model setting

According to the above analysis, in the process of participating in the construction of small-scale farmland water conservancy facilities, farmers should consider the mode of investment on the one hand and the degree of investment on the other. The mode of investment can reflect whether farmers want to participate in investment and the expected way of investment. Based on this, we establish the farmer's input mode willingness model. The explanatory variable in the model is the probability that the farmer chooses one of the four input methods (neither investment nor labor input, only investment but no labor input, only labor input but no investment, both investment and labor input), which is a multi-categorized, interpretative variable that does not have an incremental or declining relationship with each other, can be fitted by multi-type Logistic models.

\[
\log \left( \frac{p(y = 1)}{p(y = 0)} \right) = \beta_0 + \beta_{11}x_{11} + \beta_{12}x_{12} + \cdots + \beta_{1n}x_{1n}
\]

This paper regards farmers who neither investment nor labor input as the basic group. In the process of regression estimation, “neither investment nor labor input=0, only investment but no labor input=1, only labor input but no investment =2, both investment and labor input=3”.

The degree of investment uses the proportion of input cost that farmers with willingness to invest to reflect the investment degree of farmers. The proportion of investment that farmers are willing to bear is as follows: “1=1%~10%, 2=11%~30%, 3=31% to 50%, 4=51% to 70%,” the interpretative variables with such hierarchical relationship can be estimated by fitting the Ordinal Logistic model.

4.2. Variable description

The proportion of farmers' willingness to invest in the construction of small-scale farmland water conservancy facilities is affected by many factors, among which the three aspects of family
characteristics, household characteristics and village characteristics have the most important influence on farmers' investment willingness [13,14]. Based on the existing research and combined with the actual investigation, this paper divides the factors that affect farmers' willingness to invest in small-scale farmland water conservancy infrastructure construction into four categories, i.e., individual characteristics of farmers, household characteristics, farmers' perception and behavior characteristics, as shown in table 4.

Table 4. Variable definition and descriptive analysis of factors affecting farmer input.

| Variable                                      | Symbol | Definition                                                                 | Mean    | Standard Deviation |
|-----------------------------------------------|--------|---------------------------------------------------------------------------|---------|--------------------|
| Farmer's personal characteristics            |        |                                                                           |         |                    |
| age                                           | X₃     | 1=20~30 2=31~40 3=41~50 4=51~60 5=>60                                   | 3.9042  | 0.9893             |
| Whether the village cadre                      | X₄     | 1=Y 0=N                                                                   | 1.9760  | 0.9311             |
| Educational level                             | X₅     | 1=Primary school 2=Junior high school 3=High school or technical school 4=High school or above | 0.4012  | 0.4916             |
| Farmer family characteristics                 |        |                                                                           |         |                    |
| The proportion of working population          | X₆     | Household working population/total number of household labor              | 0.5080  | 0.3735             |
| Agricultural income share                     | X₇     | Family farming income/total household income                              | 1.8922  | 0.8645             |
| Block area of cultivated land                 | X₈     | Total area of cultivated land/total number of plots                      | 3.4576  | 3.2457             |
| Farmers' perception and behavior characteristics|        |                                                                           |         |                    |
| Demand for farmland water conservancy facilities| X₉     | 1=very need 2=comparison needs 3=less need 4=no need                     | 1.5090  | 0.6574             |
| Evaluation of the status of existing water conservancy facilities| X₁₀   | 1=Unmanned maintenance, serious damage 2=Maintenance, partial damage 3=Good maintenance | 2.3413  | 0.6835             |
| Evaluation of village cadres                  | X₁₁   | 1=very satisfied 2=satisfied 3=general 4=not satisfied 5=very dissatisfied| 2.4731  | 0.8699             |
| Has it participated in the investment in farmland water conservancy construction in the past three years? | X₁₂   | 0=N 1=Y                                                                   | 0.5758  | 0.4957             |
| Community characteristics of farmers living   |        |                                                                           |         |                    |
| Comparison of the level of water conservancy facilities in the village with the surrounding villages | X₁₃   | 1=better 2=medium level 3=poor                                            | 1.8563  | 0.6139             |
| Is there any government involvement in new projects in the past three years? | X₁₄   | 0=N 1=Y                                                                   | 0.8563  | 0.5296             |
| Regional dummy variable                       | D      | 0=ShuYang 1=BaoYing                                                       | 0.5868  | 0.4939             |

4.3. Model estimation results and analysis
Using the survey data, this paper uses SPSS 16.0 statistical software to carry out Logistic regression analysis on the influencing factors of farmers' willingness to participate in small-scale farmland water conservancy construction. The regression results are shown in Table 5. According to the regression results of the model, in terms of goodness of fit, the chi-square test values of the two decision models are 288.059 and 212.273, respectively, both of which are significant at the significant level of 5%, and the values of R2 are 0.573 and 0.482, respectively. It is reasonable to say that the overall fit of the two models is better.

### Table 5. Model regression results of farmers' willingness to participate in small farmland water conservancy facilities.

| Variable | Willingness to invest (OLogistic) | Intention analysis (MLogistic) |
|----------|-----------------------------------|-----------------------------|
|          | Investment does not work | Do not invest | Investment | Intention |
|          | B       | Wald  | B       | Wald  | B       | Wald  |
| **Farmer's personal characteristics** | | | | | | |
| X1       | -0.107  | 1.141 | -0.529** | 4.376  | -0.250 | 0.911  | -0.059** | 3.101 |
| X2       | 1.638** | 4.803 | 1.475**  | 3.703  | 1.236  | 2.637  | 0.318**  | 2.293 |
| X3       | 1.032   | 1.702 | 0.230    | 1.098  | 0.601  | 1.688  | 0.284    | 1.440 |
| **Farmer family characteristics** | | | | | | |
| X4       | -0.083** | 4.657 | -0.476** | 2.756  | -0.354** | 3.763  | -0.165** | 3.074 |
| X5       | 0.406   | 1.459 | 0.150*   | 2.786  | 1.736**  | 11.531 | -0.146   | 1.477 |
| X6       | 0.202   | 3.342 | 0.033    | 0.228  | 0.169*  | 3.184  | 0.099*   | 2.725 |
| **Farmers' perception and behavior characteristics** | | | | | | |
| X7       | 0.510   | 3.067 | 0.370    | 1.660  | 0.136**  | 4.352  | 0.092    | 1.132 |
| X8       | 0.709   | 1.305 | -0.505   | 1.360  | -1.164  | 0.937  | 0.233    | 0.864 |
| X9       | 0.497** | 3.705 | 0.292**  | 0.823  | 0.190**  | 3.378  | 0.210*   | 2.507 |
| X10      | -0.270** | 3.266 | -0.870** | 2.914  | -0.384*  | 2.653  | -0.153*  | 2.972 |
| **Community characteristics of farmers living** | | | | | | |
| X11      | 0.802   | 3.118 | 0.777*   | 3.037  | 1.203*** | 7.854  | 0.130    | 3.282 |
| X12      | 0.526   | 3.060 | 0.914**  | 3.953  | 0.379*  | 2.998  | 0.579*   | 3.420 |
| D        | 0.174   | 0.686 | 0.124    | 1.021  | 0.047   | 1.235  | 0.132    | 1.125 |
| **Constant** | 2.516  | 3.266 | -0.576   | 0.698  | 3.439*  | 2.701  | ---      | ---   |

-2log likelihood: 288.059** 312.273**
R2: 0.573 0.452

- The impact of the individual characteristics of farmers on their willingness to invest in small-scale farmland water conservancy construction. From the model estimation results, the age of farmers has a significant negative impact on their willingness to invest. In terms of the willingness to invest, the higher the age of farmers, the worse their willingness to work, and the lower the proportion of water conservancy construction costs they are willing to share. This is consistent with the results of the previous statistical analysis; whether the village cadres have shown greater enthusiasm in the investment of small-scale farmland water conservancy facilities than the ordinary villagers: The educational level of farmers has no significant impact on their willingness to participate, probably because the educational level of sample farmers is mostly concentrated below junior high school.
- The influence of farmer household characteristics on their willingness to invest in small-scale farmland water conservancy construction. The results show that the proportion of migrant workers has a significant negative impact on the two decision-making models, that is, the higher the proportion of the total number of laborers in the household working population, the lower the willingness of farmers to invest, and the lower the proportion of willingness to invest. For families with more migrant workers, the demand for farmland water conservancy facilities is not strong; the proportion of agricultural income has a significant positive impact.
on the willingness to invest, and the greater the proportion of agricultural income in farm households, the more inclined it is to small The construction of farmland water conservancy facilities is invested; the area of cultivated land per block reflects the degree of fragmentation of cultivated land. From the estimation results, the larger the area of cultivated land per block, the stronger the willingness of farmers to invest.

- The influence of farmers' perception and behavioral characteristics on their willingness to invest in small-scale farmland water conservancy construction. According to the estimation results, the stronger the demand for small-scale farmland water conservancy facilities is, the more they are willing to invest or input labor in the construction of the project; the evaluation of the village cadres has a significant positive effect on the two decision models. The impact indicates that the higher the satisfaction of farmers with village cadres, the stronger their willingness to participate in the investment, and the higher the proportion of willingness to invest; The relevant result of whether farmers have participated in the investment in the construction of farmland water conservancy facilities in the past three years is unexpected. The main reason is that the farmers in this group have been forced to raise funds in the past, and the amount of funds they have been “invested” or invested far exceeds expectations, which leads to a decline in their enthusiasm for continued participation, and an expectation to bear a smaller proportion of costs in the investment.

- The influence of the characteristics of the community inhabited by farmers on their willingness to invest in small-scale farmland water conservancy construction. Compared with the level of farmland water conservancy facilities in the surrounding villages, it has a significant positive impact on the input mode willingness model, indicating that the poorer the level of facilities in the village compared with the surrounding villages, the stronger the willingness and motivation of farmers to participate in the investment. The new project invested by the government has a positive estimation coefficient for both decision models. When there is a small farmland water conservancy project invested by the government in the village, it will increase the enthusiasm of farmers to participate in the investment and the proportion of input costs they are willing to bear. Indicating that the government has a certain financial guidance role.

5. Conclusions and policy implications
Taking 542 rural households in Baoying County and Shuyang County as examples, this paper uses the econometric model to explain the main factors affecting farmers' willingness to invest on the basis of subdividing farmers. The research results show that farmers are building small farmland water conservancy facilities. The willingness to invest is influenced by the basic characteristics of farmers, the characteristics of farmers' households, the perceptions and behaviors of farmers, and the characteristics of rural residents' communities. The specific conclusions are as follows: Farmers' willingness to invest is positively correlated with whether they are village cadres or not, household agricultural income, block arable land area, demand for farmland water conservancy facilities, evaluation of village cadres, comparison with surrounding village water conservancy facilities, and whether there are government involvement projects. It is also negatively related to the age of the farmer, the proportion of the working population, and whether or not he/she participated in the investment.

Based on the above research conclusions, the following policy inspirations can be drawn: First, since farmers are not a highly homogenous group, they should adopt the method of “adapted to local conditions and vary from person to person” when designing a fund-raising system for farmers. Second, large grain growers have a high enthusiasm and ability to invest in small-scale farmland water conservancy construction. Therefore, improving China's land transfer system can effectively increase farmers' enthusiasm for participating in investment. Third, while emphasizing the dominant position of the government, it will further strengthen the guiding role of the government's small farmland water conservancy investment funds. Fourth, the campaign system for village cadres should be improved to
improve the satisfaction of farmers.

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References
[1] Cao P Y 2009 Investigation on the construction of small-scale farmland water conservancy facilities in the new period of rural reform-taking Henan Province as an example Iss. Agric. Econo. 9 83-8 (in Chinese)
[2] Song H Y and Wu Z B Profit 2009 Social resource intervention and property rights system reform: A study based on the construction and management of small-scale farmland water conservancy facilities China Rural Econ. 3 4-13 (in Chinese)
[3] Xia L, Shi X P, Feng S Y et al 2013 Analysis of the influence of agriculture-related enterprises on the participation of farmers in the investment of small-scale farmland water conservancy facilities J. Nanjing Agri. Univ. (Soc. Sci. Ed.) 13 54-61 (in Chinese)
[4] Rosegrant M W and Ringler C 2000 Impact on food security and rural development of transferring water out of agriculture Water Policy 8 34-36
[5] Sarker A and Itoh T 2001 The development of group farming in post-war Japanese agriculture J. Rural Coope. 1 24-28
[6] Thoni C, Tyran J R and Wengstrm E 2012 Microfoundations of social capital J. Public Econo. 96 635-43
[7] Gheblawi M S 2004 Estimating the value of stochastic irrigation water deliveries in southern Alberta: A discrete sequential stochastic programming approach (Canada: University of Alberta)
[8] Tan X Y and Liu L 2007 Analysis of the input mechanism of small-scale farmland water conservancy construction in main grain producing areas Iss. Agric. Econo. 4 41-46+111 (in Chinese)
[9] He X F and Guo L 2010 The interests of farmland water conservancy and its cost-benefit analysis-based on the survey of farmland water conservancy in Shayang County, Hubei Province Manag. World 7 86-97+187 (in Chinese)
[10] Lv J 2012 Supply mechanism for small-scale farmland water conservancy facilities: Based on government hierarchical differences Reform 3 59-65 (in Chinese)
[11] Zhu H G and Weng Y L 2010 Theoretical and empirical analysis of factors affecting farmers' willingness to participate in farmland water conservancy construction-based on micro survey data of 619 large grain producers in Jiangxi Province J. Nat. Resour. 25 539-46 (in Chinese)
[12] Liu H and Chen S Y 2012 An empirical analysis of factors affecting farmers' willingness to participate in small-scale farmland water conservancy construction-based on a survey of 475 farmers in major grain producing areas in Hunan Province China Rural Watch 2 54-66 (in Chinese)
[13] Liu L and Tan X Y 2006 Analysis of investment willingness of county and township governments and farmers in small-scale farmland water conservancy facilities in main grain producing areas China Rural Econ. 12 32-36+54 (in Chinese)
[14] Wang G S, Wu X X and Liaoy X M 2010 Farmers' willingness to invest in farmland water conservancy construction and its influencing factors-based on a survey of 303 farmers in Guangdong Water Conserv. Econ. 2 50-4 (in Chinese)