Influencing Factors of Water-saving Irrigation Technology Used by Vegetable Growers from the Perspective of Cost-benefit

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Abstract
This research uses 142 household survey data from 9 counties in Hebei Province and binary logistic model to analyze the influencing factors of farmers’ willingness to adopt water-saving irrigation technology. The results of this research include: Farmers’ educational level, awareness of water-saving technology to improve vegetable yield or quality, and government subsidies are positively correlated with farmers’ willingness to adopt water-saving irrigation technology. Age and cost perception of water-saving technologies are negatively correlated. Suggestions are put forward accordingly: Adopting corresponding incentive and support policies to stimulate farmers' enthusiasm for adopting new technologies; Fostering large-scale agricultural production, using enterprises and new business entities to drive ordinary farmers to adopt water-saving irrigation technologies; Establishing and improving the extension system of agricultural water-saving technology, and actively play the guiding and driving role of younger farmers with high cultural level.

Key words: water-saving irrigation; influencing factors; cost-benefit; vegetable growers

1. Introduction
Water is an indispensable part of human life and a strategic economic resource. Agricultural water use accounts for about 70% of the total water consumption in the world, and its proportion is increasing year by year. Its irrational irrigation methods cause a lot of water resources waste, which further aggravates the water shortage. As a large agricultural country, China is also plagued by the contradiction between agricultural development and water shortage. According to the statistics of the Ministry of Water Resources, in 2017, the total annual water consumption in China was 604.3 billion cubic meters, while agricultural water consumption accounted for about 60%, and the effective utilization rate was only 0.53, which meant that nearly half of the water resources were wasted in the irrigation process. The development of water-saving irrigation has become an effective way to alleviate the shortage of agricultural water resources and ensure the sustainable development of agriculture and other aspects.

Farmers are the main body of agricultural production and management in China and the ultimate implementation of water-saving irrigation. Under the background of the increasing shortage of water resources, it has become a hot topic in academia to analyze the influencing factors and mechanism of farmers' water-saving irrigation technology adoption behavior, and to induce farmers to use water-saving irrigation. China is the largest vegetable consumer and producer in the world. In 2017, the sown area of vegetables in China was 19.981 million hectares, accounting for 12.01% of the total sown area of crops in that year. Vegetable production has gradually become a pillar industry of rural economic development. It plays an increasingly important role in China's agricultural and rural economic development and has become an important source of economic development for rural and farmers in China. With the rapid development of vegetable industry, vegetable production has become an important factor to aggravate the contradiction of water resources. Based on the analysis of the purpose and demand of water-saving irrigation for vegetable growers, this paper studies the influencing factors of water-saving irrigation technology for vegetable growers in order to provide basis for inducing farmers to adopt water-saving irrigation technology and implementing water-saving irrigation.

2. Research Framework
2.1. Theoretical Basis of Research
Decision-making of water-saving technology has the general characteristics of decision-making behavior. From the perspective of cognitive psychology, decision-maker behavior choice is affected by both internal and external factors in the process of information processing, which is essentially the result of farmers' water-saving demand, motivation, goal and other factors. The theoretical basis of this study is as follows:
2.1.1. Behavioral Basis -- "Natural Person" and "Social Person"

According to Maslow's hierarchy of demand theory, farmers are "natural persons" first, and the goal they pursue is the realization of personal value. Therefore, the characteristics of farmers' irrigation behavior are first manifested as human instinct behavior, reflecting the role of "natural persons" of farmers. At the same time, peasant households are also "social people". Their needs include not only the self-needs of "natural persons", but also the social public needs. The main characteristic of "social people" is the purpose and consciousness of human activities, and human social activities are the behavioral process of pursuing the desired goals.

2.1.2. The Basis of Economics -- "Rational Economic Man" and "Limited Rational Economic Man"

Classical economics assumes that people's thinking and behavior are objective rational, and the goal pursued by irrigation behavior of farmers is to maximize profits, that is, "rational economic man". From the point of view of modern economics, due to the incompleteness of information acquired by man and the limitation of man's ability to understand the environment, man is in a state of "bounded rationality" between complete rationality and irrationality. Limited by production cost, risk, market environment, information and other factors, people are "bounded rational economic man", whose behavior decision-making is to maximize profits under the dual conditions of pursuing production cost and risk constraints.

Based on the above theoretical basis, vegetable planting behavior as the investment behavior of farmers, driven by the maximization of benefits, irrigation decision-making behavior of farmers is affected by production costs, expected returns, etc. While considering the current interests, they will also consider the long-term future development, while considering economic interests, they will also consider the ecological environment, social impact and other issues.

2.2 Research Hypothesis

Using the existing research results for references [2]- [9], this paper puts forward the hypothesis of influencing factors of willingness of vegetable growers to adopt water-saving technology from the perspective of cost-benefit, from the characteristics of farmers, input costs, current benefits, future benefits and water-saving irrigation environment.

(1) The characteristics of farmers affect the adoption of water-saving irrigation technology. The age, gender and educational level of the head of household were selected as variables.

(2) As a short-term investment behavior of farmers, the cost of vegetable production must be considered. The variable of farmers' perception of the cost of water-saving irrigation technology should be selected.

(3) Irrigation mode has an impact on farmers' income. Growers must consider the quality of their products when they sell their products to obtain economic benefits. Choose the variable of farmers' acceptance of water-saving irrigation to improve vegetable yield or quality.

(4) For peasant households, while considering their own production, they will also consider the issues of social responsibility and social needs. Two variables were selected: the degree of attention paid by growers to the problem of water shortage and the awareness of water resources conservation.

(5) Irrigation environment. If farmers can get government subsidies for water-saving technology, the cost of water-saving technology will be reduced and their enthusiasm for water-saving technology will be improved. The propaganda and training of the government and related departments can play a guiding role in the adoption of water-saving technology for vegetable growers and enhance the enthusiasm of water-saving and water-accumulation. Choose whether there is water-saving subsidy and water-saving technology training two variables.

3. Empirical Analysis

3.1 Model Selection

The binary logistic regression analysis can be used when the dependent variable is a binary classification variable. Let the dependent variable be Y. When an event occurs, Y takes 1, and Y takes 0 when an event does not occur. The m independent variables affecting the value of dependent variable Y are recorded as X_1, X_2, X_m. The following Logistic regression model can be obtained by recording the conditional probability P_i of event occurrence:

\[ \ln \left( \frac{P_i}{1-P_i} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_m X_m \]

\[ i = 1, 2, \ldots, m \]

The advantage of Logistic model is that it transforms the range of the target probability in the range of (0,1)
coefficient was negative, that is, the younger the farmers were, the greater the possibility of adopting

3.3.2 Result Analysis

The results are shown in Table 2.

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Variable description</th>
<th>mean value</th>
<th>standard deviation</th>
<th>Expected relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Virtual Variables: Whether to Use Water-saving Irrigation Technology</td>
<td>0.55</td>
<td>0.499</td>
<td></td>
</tr>
<tr>
<td>X1</td>
<td>Real variable: age of head of household</td>
<td>48.14</td>
<td>11.259</td>
<td></td>
</tr>
<tr>
<td>X2</td>
<td>Virtual Variables: Gender of head of household</td>
<td>0.78</td>
<td>0.415</td>
<td>+</td>
</tr>
<tr>
<td>X3</td>
<td>Virtual Variables: Educational level of head of household</td>
<td>2.72</td>
<td>1.068</td>
<td>+</td>
</tr>
<tr>
<td>X4</td>
<td>Virtual Variables: Perception of Technical Cost of Water-saving Irrigation</td>
<td>2.90</td>
<td>1.113</td>
<td>-</td>
</tr>
<tr>
<td>X5</td>
<td>Virtual Variables: Attention to the shortage of water resources</td>
<td>3.54</td>
<td>1.089</td>
<td>+</td>
</tr>
<tr>
<td>X6</td>
<td>Virtual Variables: Awareness of Water Resources Conservation</td>
<td>3.55</td>
<td>1.127</td>
<td>+</td>
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<tr>
<td>X7</td>
<td>Virtual Variables: Recognition of water-saving irrigation for improving vegetable yields or quality</td>
<td>2.88</td>
<td>0.971</td>
<td>+</td>
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<tr>
<td>X8</td>
<td>Virtual Variables: Are there water-saving subsidies</td>
<td>0.18</td>
<td>0.388</td>
<td>+</td>
</tr>
<tr>
<td>X9</td>
<td>Virtual Variables: Are there any water-saving technical training</td>
<td>0.26</td>
<td>0.440</td>
<td>+</td>
</tr>
</tbody>
</table>

3.2 Data Sources

In 2017, the vegetable sown area of Hebei Province was 1.233 million hectares, accounting for 14.71% of the total crop sown area of the province in that year. The total vegetable output was 82.598 million tons, ranking second in the national vegetable output for many consecutive years. This paper investigates the vegetable growers in the form of random interviews in villages in nine counties where vegetable production is the focus of Hebei Province. Likert scale was used to measure some items. A total of 163 households were interviewed, and 142 questionnaires were valid, with an effective rate of 87.12%.

Table 1. Explanatory variables and descriptions entered into the model

3.3 Model Estimation Results and Analysis

3.3.1 Model Estimation

The measurement model is estimated by SPSS 19.0 software, and all explanatory variables are calculated. The results are shown in Table 2. The whole model is remarkable. The Chi-square is 92.642, Sig. is 0.000, Cox & Snell R Square is 0.479, Nagelkerke R Square is 0.641.

<table>
<thead>
<tr>
<th>Parameter estimation results of model</th>
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<tr>
<td>B</td>
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<tr>
<td>X1</td>
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<td>X2</td>
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<td>X4</td>
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<td>X8</td>
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<td>X9</td>
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<td>β0</td>
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</table>

3.3.2 Result Analysis

(1) The age variable of vegetable growers passed the significance test of 1% statistical level and the coefficient was negative, that is, the younger the farmers were, the greater the possibility of adopting
water-saving irrigation technology. Vegetables, as high-value cash crops, require higher labor and technology. Young growers have more advantages than middle-aged and old growers in technology learning and application ability.

(2) Vegetable growers' educational level has passed the significant test of 1% statistical level and the coefficient is positive, that is, the higher the educational level of farmers, the greater the possibility of adopting water-saving irrigation technology. The higher the education level, the stronger the ability of information acquisition, and the better the ability of understanding and accepting new technology. Water-saving irrigation technology is a kind of agricultural technology, farmers' education level is improved, and the probability of using water-saving irrigation technology is increased.

(3) Vegetable growers have passed the significant test of 1% statistical level on the cost perception variable of water-saving technology, and the coefficient is negative. Irrigation input is an important part of the input of means of production. Farmers hope that the less input, the better. The more reasonable they feel about the input of water-saving technology, the more input they will increase.

(4) Vegetable growers' awareness of water-saving technology to improve vegetable yield or quality has passed the significance test of 1% statistical level and the coefficients are positive. As a rational economic man, farmers will invest limited labor force in production with less risk and higher return. Farmers' demand for water-saving irrigation technology is closely related to their own perception, while positive attitude towards the perception of technological effects induces farmers' demand for and choice of technology.

(5) The government subsidy has passed the significance test of 5% statistical level and the coefficient is positive. The subsidy of the government reduces the input cost of farmers and encourages them to adopt water-saving irrigation technology to a large extent. In the case of low prices of agricultural products, the increased benefits of water-saving irrigation technology can not compensate for the increase in costs, and government support is necessary.


4.1 conclusion

Through the research, it is found that farmers' educational level, awareness of water-saving technology to improve vegetable yield or quality and government subsidies are positively correlated with their willingness to adopt water-saving irrigation technology, while farmers' age and cost perception of water-saving technology are negatively correlated with them.

4.2 Policy Recommendations

(1) The government adopts corresponding incentive and support policies to stimulate the enthusiasm of farmers to adopt new technologies. Farmers who adopt water-saving irrigation technology can be subsidized by material subsidies or financial incentives, and the ratio of farmers to adopt technology can be improved by reducing their investment in water-saving irrigation technology, which is particularly important in the early stage of popularization of water-saving irrigation technology.

(2) Cultivate large-scale agricultural production and implement intensive management. On the basis of small-scale peasant economy with family as unit, we should actively expand the scale of production and promote the adoption of water-saving irrigation technology in the way that enterprises and new business entities drive ordinary peasant households to follow closely.

(3) Establish and improve the extension system of agricultural water-saving technology. In the promotion of water-saving technology, timely and accurate information and necessary technical support and services should be provided to grass-roots and farmers. In the training, younger and more educated farmers should play an active role in guiding and driving. Through demonstration, the pace of transformation from traditional irrigation mode to water-saving irrigation mode should be accelerated.

Acknowledgements

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References


