

A Review on Social Interaction Effects of Farmers' Water-saving Production Behavior in Grain

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Abstract: This paper systematically combs through the relevant literature on the social interaction effects of water-saving production behavior of grain farmers, and puts forward the shortcomings. The existing related literature mainly includes research on social interaction and its evaluation system, research on the driving factors of water-saving production, research on the effects of water-saving production, and research on the enhancement path of water-saving production. The shortcomings of the existing studies mainly include the insufficient research on the influence of social interaction of water-saving production behavior of grain, the social interaction path of the spillover effects of water-saving production of grain has to be tested, and the research on the incentive mechanism of water-saving production of grain has to be improved.

Keywords: Grain; Water-saving production; Social interaction; Farmers; Review.

1. Introduction

The report of the 20th Party Congress points out that it is necessary to consolidate the foundation of food security in all aspects, and grain production is one of the main links of fresh water consumption, and reasonable and efficient water resource utilization is crucial to guarantee food security and comprehensively promote rural revitalization. The "National Water Saving Action Program" puts forward agricultural water saving and efficiency actions, vigorously promoting water-saving irrigation and optimizing the crop planting structure of the two key tasks of water saving, and the implementation of these measures urgently needs to promote the development of water-suitable agriculture in China, and to promote the efficient water saving of grain. The "2023 Central Document No. 1" further points out that it supports key regions to carry out comprehensive management of groundwater over-mining, pushes forward the depth of water saving and control of agriculture in the Yellow River Basin, and develops efficient water saving and control of agriculture in arid and semi-arid areas. Arid and semi-arid areas to develop highly efficient water-saving dry farming, coordinate the promotion of highly efficient water-saving irrigation, and improve the long-term management and care mechanism. Through expanding the sowing area of low-water-consuming crops, improving irrigation methods and adopting water-saving technologies to build a sustainable utilization system for agricultural water resources. Water-saving production behavior emphasizes saving irrigation water consumption and alleviating agricultural water shortage, and plays a role in improving the water efficiency of grain irrigation through the adoption of water-saving technology and optimization of grain planting structure.

As the contradiction between supply and demand of water resources for grain production becomes increasingly severe, the problem of inefficient grain irrigation water use is highlighted. Due to factors such as aging and dilapidation of water-saving irrigation equipment, imperfect means of water use metering, dispersal of land plots, and complex planting structure, the degree of water-saving production of grain is low and weak in continuity. In the vernacular society, farmers

are not completely independent decision-making units, and the decision-making of grain water-saving production behavior is deeply influenced by social factors. In the process of agricultural production, the majority of farmers spontaneously form the same group, the decision-making behaviors of different individual farmers influence each other, and the materialized or non-materialized knowledge such as the business philosophy of water-saving production is transmitted and diffused among groups of farmers, and it is of great practical significance to analyze the driving mechanism of water-saving production behavior of grain with the social interactions as the entry point.

This paper takes water-saving production of grain as the research object, and reviews the related literature on the social interaction effects of farmers' water-saving production behavior of grain and their optimization strategy, which has a distinct demand-oriented feature, and is of great and far-reaching significance for breaking through the constraints of water resources, accelerating grain water-saving production, and realizing increased grain production, increased agricultural efficiency, and increased income for farmers.

2. Relevant Literature Review

2.1. Research on Social Interaction and Its Evaluation System

Social interaction is widely used in economics, with a variety of measurement methods. Therefore, how to define and measure social interaction in water saving production of grain is the key issue. The existing studies can divide the social interaction effects into three types: endogenous interaction effects, contextual effects, and correlation effects (Manski, 1993) [1], which are measured separately and downgraded by factor analysis. For the endogenous interaction effects, the index system is constructed from five aspects: direction, frequency, breadth, intensity and depth, with direction referring to the closeness of farmers' interpersonal relationship; depth referring to the degree of farmers' interdependence; frequency referring to the degree of exchange and learning of water-saving technologies among farmers; intensity referring to the degree of farmers' interest

and emotional investment; and breadth referring to the field and scope of farmers' social interaction (Gao and Lu, 2021) [2]. For contextual effects, the indicator system is constructed from average village personal characteristics and average village household characteristics. For association effects, measurements are made from a series of village fixed effects.

2.2. Research on Influencing Factors of Water-saving Production

Research on the driving factors of water-saving planting restructuring mainly focuses on agricultural water pricing policies. When the cost of irrigation water increases, farmers will increase the proportion of low-water-consuming crops, and the response of large-scale households to the rising cost of water prices is more sensitive (Xu and Wang, 2021) [3], where the water rights trading water price is more likely to motivate farmers to choose more water-saving crops. Yi et al. (2019) argued that only when the level of the unit price of agricultural irrigation water continues to rise to a certain height, farmers are likely to adjust the planting structure of crops [4]. Yao and Li (2023) found that whether farmers reduce the proportion of high-water-consuming crops depends on whether the marginal benefits that farmers expect to realize from selling water savings and planting low-water-consuming crops are greater than the marginal benefits of planting high-water-consuming crops [5].

Research on the drivers of water-saving technology adoption by farmers. Social network has significant positive effects on the adoption of water-saving irrigation technology, showing a typical inverted U-shaped relationship, from the different dimensions of social network, network reciprocity has positive effects relationship on the adoption of technology by farmers, while network learning, network trust and network interaction show an inverted U-shape relationship with the adoption of technology by farmers (Wang and Lu, 2015) [6]. The mechanism of social networks on water-saving irrigation technology adoption includes both direct and indirect paths and is dominated by direct impacts, while the indirect paths include broadening farmers' access to information, mitigating the inhibitory effects of external shocks, improving the effectiveness of extension services, and mitigating the inhibitory effects of technological uncertainty on the risk of adopting water-saving irrigation technology (He et al., 2018) [7].

Regarding other influencing factors of water-saving technology adoption by farmers, Cui et al. (2021) analyzed the impact of the well-drilling control pilot policy on water-saving technology adoption by farmers, and the study concluded that the well-drilling control policy has a significant role in promoting water-saving technology adoption by farmers, among which the impact of the well-drilling control pilot policy on the adoption of water-saving technology is more significant for the farmers who enjoy the ownership of irrigation wells. At the same time, the cultivation of irrigation water trading market and the popularization of knowledge related to water-saving technology can enhance the effects of well-drilling control policy on the adoption of water-saving technology by farmers [8]. Ma et al. (2021) analyzed the impacts of water use right registration policy and water withdrawal permit management policy on potato farmers' adoption of water-saving technologies, and concluded that the water use right registration policy can help farmers' adoption of water-saving technologies by clarifying water and well rights, while the

water withdrawal management policy can have a significant impact on farmers' adoption of water-saving technologies by controlling the expansion of the number of irrigation wells [9]. Xing et al. (2022) based on conservation motivation theory showed that high perceived severity, perceived vulnerability, self-efficacy, and response efficacy in farmers' cognition had facilitating effects on farmers' water saving technology adoption intention, and that payoff factor and response cost had significant negative effects on farmers' water saving technology adoption intention [10]. Qian et al. (2022) analyzed the impact of land right stability on the adoption of water saving technology by farmers, and concluded that compared with farmers who did not obtain the confirmation of rights and certificates, the probability of adoption of water saving technology by farmers with contracting right certificates can be increased by 7.2%, and land right stability can help the adoption of water-saving technology by farmers through the reinforcement of the willingness to operate in a contiguous area [11]. Jia and Lu (2017) analyzed the impact of credit constraints on the adoption of water-saving technologies, and found that the three dimensions of credit constraints such as amount constraints, interest rate constraints and term constraints significantly inhibit the adoption of water-saving technologies by farmers, and that there is a buffer role for social capital in the impacts of the amount constraints and interest rate constraints on the adoption of water-saving technologies [12].

2.3. Research on the Effects of Water-saving Production

The research related to the effects of water-saving production mainly focuses on the economic effects of water-saving technology adoption, including cost saving, yield increase, income increase and other aspects. Lv et al. (2016) based on farmers' corn production research data, empirical research found that the adoption of water-saving technology in irrigation costs, fertilizer costs, seed costs, pesticide costs and operating costs, etc., have saved farmers' production inputs, and the effects of yield increase can reach an average of 10 kg/mu [13]. Zhu et al. (2011) compared different types of water-saving irrigation techniques and concluded that sprinkler irrigation can increase wheat yield by 4.19%, which is higher than other water-saving irrigation techniques [14]. Hu and Lu (2018) analyzed the impact of water-saving irrigation technologies on poverty reduction among farmers, and concluded that for every 1% increase in the willingness to adopt water-saving technologies, the current poverty incidence and future poverty incidence among farmers will decrease by 10.5% and 2.6%, respectively [15]. Zhang et al. (2018) reached a similar conclusion from the perspective of water-saving project implementation that sprinkler and micro-irrigation can save 5% of land, which is equivalent to an 8% increase in mu yield, compared to traditional irrigation [16].

2.4. Research on the Enhancement Path of Water-saving Production

Existing studies have mainly centered on two aspects: crop rotation and fallow and water-saving technology adoption. Crop rotation and fallow is an important measure for the management of groundwater overexploitation in North China, and an important measure for realizing the strategic measure of "storing grain in the ground and storing grain in technology", which is of great significance for realizing the

sustainable development of agriculture (Long et al., 2017) [17]. Its main goal is to fallow high water-consuming winter wheat and develop a farming system of “one season of fallow and one season of rain-fed”, so as to reduce the consumption of groundwater and repair the groundwater environment. Considering that crop rotation and fallow will cause economic losses to farmers who rely on agricultural production as a source of livelihood, it is necessary to provide reasonable compensation to farmers. Wang et al. (2016) suggested that the compensation standard for fallow should be formulated based on specific objectives in a period of time, and the initial compensation standard with groundwater recovery and environmental restoration as the main objective should be 350 yuan/mu, and the later compensation standard with the main objective of maintaining the balance of groundwater extraction and replenishment can be adjusted to 280 yuan/mu [18].

In terms of water saving technology subsidies, Liu et al. (2011) measured the water saving technology subsidy standard based on farmers’ willingness to be compensated based on the principle of Hicks’ compensatory variance and equivalent variance, and obtained that the amount of subsidy in line with the Pareto improvement should be greater than or equal to the cost of adoption of water saving technology by farmers [19]. Xu et al. (2018) used the choice experiment method to construct the external benefit evaluation index system of water-saving technology adoption, and obtained that the reasonable compensation standard for farmers of membrane drip irrigation technology in Minqin County, downstream of the Shiyang River, should be about 789.15 yuan/ha [20]. In addition, for the welfare perspective of technology subsidies, Feng et al. (2013) used the EDM policy evaluation model to analyze the impacts of water-saving technology inputs on producer, consumer, and social welfare, and concluded that water-saving technology inputs in agriculture increased producer surplus, consumer surplus, and total social surplus, and that a decrease in the price of agricultural commodities increased consumer welfare, and the quantity of agricultural supply increased producer welfare [21].

3. Literature Commentary

In summary, the established studies provide a solid research foundation, but there are the following shortcomings in the research on the influence mechanism of social interaction on farmers’ water-saving production behavior of grain.

Firstly, there is insufficient research on the influence of social interaction on farmers’ water-saving production behavior of grain. Treating farm households as independent decision-making units and ignoring the influence of water-saving production decisions from others does not explain water-saving production behavior well. Farmers’ water-saving production behavior is affected by the water-saving production behavior decisions of other farmers in the same group, i.e., social interaction effects, which needs to be systematically theoretically analyzed and empirically tested from the perspective of social interaction on water-saving production behavior.

Secondly, the social interaction path of the spillover effects of water-saving production of grain needs to be tested. Water-saving production behavior has obvious spatial dependence characteristics, and the positive impact of water-saving production on grain irrigation water use efficiency has

demonstration effects or spatial spillover characteristics to adjacent areas. Existing studies have rarely analyzed the spillover effects, i.e., social interaction effects, on the impact of water-saving production on irrigation water use efficiency, which needs to be further deepened.

Thirdly, the research on the incentive mechanism of water-saving grain production by farmers needs to be improved. There is a “free-rider” behavior in the process of water-saving production, resulting in insufficient endogenous motivation for water-saving production. It is urgent to explore from the theoretical level to make reasonable and accurate compensation for the externalities of water-saving production, and put forward optimization strategies and countermeasures to promote water-saving grain production.

4. Future Research Directions

4.1. Analysis of the Current Situation of the Social Interaction Effects of Water-saving Production in Grain

With the continuous development of water-suitable agriculture in China, water-saving production of grain presents obvious regional differences, and its changing trend needs to be grasped from both time and space dimensions. This includes the supply and demand damping of water resources for grain production, the spatial and temporal distribution characteristics of water-saving technologies, the evolution of the water footprint of grain cultivation structure, the characteristics of the rebound effects of grain water-saving production, as well as the social interactions of the sample farmers in the research, so as to sort out the current situation and the changing trends of the social interactions between grain water-saving production and the farmers in several aspects, and to condense the scientific issues, so as to provide the reality basis for the follow-up research. The subsequent research can use the combination of normative analysis and descriptive statistics, on the one hand, through the literature study of domestic and foreign research on water-saving production to sort out the dynamics of related research, on the other hand, combined with the field research, the use of questionnaires for the collection of micro-survey data, and the construction of an indicator system to measure endogenous interaction effects, contextual effects, and correlation effects.

4.2. Mechanism Analysis of the Impact of Social Interaction on Water-saving Production Behavior

Based on social learning theory and farmers’ behavior theory, analyze the interaction mechanism between social interaction effects and farmers’ water-saving production behavior. Farmers’ water-saving production behaviors include the adoption of water-saving technologies and the optimization of grain cultivation structure, which reduces irrigation water consumption per unit area by improving grain irrigation water use efficiency. Among them, the adoption of water-saving technologies by farmers can realize water saving per unit area of grain production, and the optimization of planting structure through the selection of grain crops and crop rotation can reduce the proportion of high water-consuming crops planted, thus realizing the saving of total irrigation water consumption. Social interaction can be information dissemination mechanism, role model

mechanism, social norms mechanism, reduce the probability of farmers' water-saving production behavior and willingness to deviate, to achieve farmers' water-saving production behavior response. Water-saving production behavior not only promotes the water use efficiency of grain irrigation in the region, but also promotes the water use efficiency of grain irrigation in neighboring regions, i.e., spatial social interaction effects. Based on this, the subsequent research can analyze three aspects: to clarify the mechanism of social interaction on the response of water-saving production behavior; to clarify the path of social interaction on the impact of water-saving production behavior on water use efficiency of grain irrigation; to construct the utility function model of farmers, and based on the mathematical and theoretical model derivation, to clarify the mechanism of the impact of social interaction on the water-saving production behavior of farmers, and to test the social interaction effects of water-saving production behavior.

4.3. Analysis of Optimization Strategies and Countermeasures of Water-saving Production Behavior based on Social Interaction

The traditional crude irrigation method of grain production for a long time has low water use efficiency, resulting in the path-dependent dilemma of water resource utilization. And water-saving production behavior is naturally characterized by positive externalities, the private benefits of farmers' water-saving production are smaller than the social benefits of ecological improvement, which leads to market failure and "free-rider" behavior, and the endogenous motivation of farmers' water-saving production is insufficient. Based on this, a reasonable and accurate compensation for the externalities of water-saving production can achieve the organic unity of the farmer's goal of maximizing benefits and the social goal of sustainable use of water resources and guaranteeing food security. The follow-up study can be based on the research data, use case analysis methods to test the existence of "free-rider" behavior in the process of water-saving production; construct an evolutionary game model to analyze the logic of collective action in water-saving production; use the mechanism design theory, based on the principle of incentive-compatible construction of the compensation mechanism for water-saving production of farmers, taking into account the individual goal of maximizing the effectiveness and the principle of economic development. The individual goal of maximizing utility and the social goals of economic development and environmental protection are taken into account. Based on this, the subsequent research can analyze three issues: analyze the "free-rider" behavior in the process of water-saving production; use the evolutionary game model and mechanism design theory to analyze how to reasonably and accurately compensate for the externality of water-saving production from the perspective of collective action; and put forward optimization strategies and countermeasures to promote water-saving production of grain.

5. Conclusions

This paper has systematically sorted out the research related to the social interaction effects of farmers' grain water-saving production behavior, given the shortcomings of existing research, and proposed the direction of the future research.

Firstly, the existing studies mainly include the study of social interaction and its evaluation system, the study of the driving factors of water-saving production, the study of the impact of water-saving production, and the study of the enhancement path of water-saving production.

Secondly, the existing studies have the following shortcomings. (1) There is insufficient research on the impact of social interaction on water-saving production behavior of grain, which requires systematic theoretical analysis and empirical testing of water-saving production behavior from the perspective of social interaction. (2) Existing studies have less analyzed whether there is spillover effects, i.e., social interaction effects, on the impact of water-saving production on water irrigation efficiency, which needs to be further deepened. (3) The research on incentives for water-saving grain production needs to be improved. There is an urgent need to explore the reasonable and accurate compensation for the externality part of water-saving production from the theoretical level.

Thirdly, the directions for further research in the future include the following. (1) The analysis of the current situation of the social interaction effects of grain water-saving production. (2) The analysis of the impact of social interaction on water-saving production behavior. (3) The analysis of optimization strategies and countermeasures of water-saving production behavior based on social interaction.

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References

- [1] Manski C F. Identification of endogenous social effects: The reflection problem[J]. *The Review of Economic Studies*, 1993(3): 531-542.
- [2] Gao Tianzhi, Lu Qian. Social interaction for soil and water conservation in farming households [J]. Does social interaction promote the adoption of soil and water-saving technologies by farmers? [J]. *Resources and Environment in the Yangtze Basin*, 2021, 30(12): 3004-3016.
- [3] Xu Lang, Wang Ning. Impact of agricultural water price on water saving behavior of farmers with different planting scales: A study based on a survey in Shijin Irrigation District[J]. *Journal of Arid Land Resources and Environment*, 2021, 35(11): 81-88.
- [4] Yi Fujin, Xiao Rong, Wang Jinxia. Metered water pricing, quota management or per mu charge: An exploration of agricultural water use policies in the Haihe River Basin[J]. *China Rural Survey*, 2019, 145(1): 33-50.
- [5] Yao Peng, Li Huizhao. Can agricultural water rights trading promote green agricultural development[J]. *China Rural Economy*, 2023, 458(2): 17-40.
- [6] Wang Geling, Lu Qian. A study on the path of social network influencing farmers' technology adoption: Taking Minqin water-saving irrigation as an example[J]. *Journal of Huazhong*

- University of Science and Technology (Social Science Edition), 2016, 30(5): 83-91.
- [7] He Zhiwu, Lei Yun, Lu Qian. Impacts of technological uncertainty and social network on farmers' adoption of water-saving irrigation technologies: A case study of Zhangye City, Gansu Province[J]. *Journal of Arid Land Resources and Environment*, 2018, 32(5): 59-63.
- [8] Cui Yi, Ma Jiujie, Kong Xiangzhi et al. Water saving effects of irrigation well ownership and well-drilling control policies: An analysis based on potato grower survey data[J]. *China Rural Economy*, 2021(2):82-105.
- [9] Ma Jiujie, Cui Yi, Kong Xiangzhi et al. Water right system, water abstraction license management and farmers' adoption of water saving technologies: An empirical study on the water saving effects of water right reform based on differential modeling[J]. *Statistical Research*, 2021, 38(4): 116-130.
- [10] Xing Xia, Xiu Changbai, Yan Ye. Influencing factors of agricultural water saving technology adoption behavior: Based on conservation motivation theory and cross-theoretical model[J]. *Journal of China Agricultural University*, 2022, 27(1): 274-286.
- [11] Qian Long, Rao Qingling, Liu Tongshan. The effects of land rights stability on farmers' adoption behavior of water-saving irrigation technologies-Empirical evidence from the Huanghuaihai agricultural area [J]. *Journal of Nanjing Agricultural University (Social Science Edition)*, 2022, 22(2): 135-146.
- [12] Jia Rui, Lu Qian. Credit constraints, social capital and adoption of water-saving irrigation technology: A case study of Zhangye, Gansu[J]. *China Population, Resources and Environment*, 2017, 27(5): 54-62.
- [13] Lv Jie, Jin Xue, Han Xiaoyan. Research on economic and technical evaluation of farmers' adoption of water-saving irrigation: An example of corn production in Tongliao City[J]. *Journal of Arid Land Resources and Environment*, 2016, 30(10): 151-157.
- [14] Zhu Lijuan, Xiang Huijuan. Analysis of farmers' willingness to adopt water-saving irrigation in major grain producing areas[J]. *Chinese Journal of Agricultural Resources and Regional Planning*, 2011, 32(6): 17-21.
- [15] Hu Lun, Lu Qian. Poverty reduction effects of water-saving irrigation technology adoption under drought risk shocks: A case study of Zhangye City, Gansu Province[J]. *Resources Science*, 2018, 40(2): 417-426.
- [16] Zhang Baozhong, Peng Zhigong, Lei Bo, Du Lijuan, Wang Lei, Liu Yu. Water use characteristics of typical crops and modern agricultural irrigation technology model in China[J]. *Strategic Study of CAE*, 2018, 20(5): 77-83.
- [17] Long Yuqin, Wang Cheng, Dang Chun et al. Cultivated land fallow willingness of different types of farmers in groundwater leakage area and its influencing factors: Based on a survey of 598 farmers in Xingtai City[J]. *Resources Science*, 2017, 39(10): 1834-1843.
- [18] Wang Xue, Li Xiubin, Xin Liangjie et al. Discussion on ecological compensation for winter wheat fallow in groundwater over-mining area of North China[J]. *Acta Geographica Sinica*, 2016, 71(5): 829-839.
- [19] Liu Jundi, Huo Xuexi, Huang Yuxiang, Han Ting. Research on water-saving irrigation subsidy standard based on farmers' willingness to be paid[J]. *Journal of Agrotechnical Economics*, 2012(11): 29-40.
- [20] Xu Tao, Zhao Minjuan, Qiao Dan, Shi Hengtong. Accounting for the compensation standard of water-saving irrigation technology under the perspective of externality: Based on the selection experiment method[J]. *Journal of Natural Resources*, 2018, 33(7): 1116-1128.
- [21] Feng Ying, Yao Shunbo, Li Sheng. Agricultural water saving technology compensation based on EDM[J]. *Journal of Natural Resources*, 2013, 28(4): 705-712.