

# Mechanistic Analysis of the Impact of Multidimensional Relationship Networks on Farmers' Behavior of Carbon Emission Reduction

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**Abstract.** Agricultural carbon emission reduction is indispensable to the achievement of the "double carbon" goal, and the multidimensional relationship network has become the key to the decision-making of farmers' carbon emission reduction behaviour. Based on the perspective of heterogeneous relationship subjects, this paper divides the relationship network into three dimensions: market relationship, government relationship, and social relationship network, and explores the theoretical analysis of the influence of multidimensional relationship network on the decision-making of carbon emission reduction behaviours of farmers, and analyses the mechanism of relationship network influencing the carbon emission reduction behaviours of farmers from the three aspects of information flow, demonstration effect, and factor guarantee based on the social capital theory to lay a solid theoretical foundation for the later empirical analyses. It lays a solid theoretical foundation for the later empirical analysis.

## 1 Introduction

As one of the important sources of greenhouse gas (GHG) emissions, carbon emission reduction in the agricultural production system is attracting much attention, and the Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC) points out that agricultural GHG emissions account for about 13.5% of the total anthropogenic emissions, and have become the second largest source of GHG emissions, and in China, this proportion has been close to 17%, with an upward trend, Among them, fertiliser is the top carbon source, with a proportion of nearly 60%<sup>[1]</sup>. In the context of the "double carbon" goal, how to realize the transformation and upgrading from high-carbon agriculture to low-carbon agriculture, and reduce agricultural carbon emissions has become a new direction for the development of modern agriculture. Carbon mitigation technologies are technologies included in the agricultural production process that have a carbon reduction contribution and may have the effect of reducing means of production and increasing agricultural productivity, while the means of achieving emission reductions in agriculture are mainly means of production reductions and technology adoption. However, the adoption rate of carbon emission reduction technologies in rural areas of China is still low. Since farmers are both micro-entrepreneurs of agricultural production and adopters of carbon-reducing technologies, the study of the mechanism of low carbon emission reduction technology adoption from the perspective of farmers is

the basis for the establishment of micro incentive mechanism for the promotion of carbon emission reduction technology, which is the key issue to be solved in the agricultural field under the goal of "dual-carbon".

Currently, there are not many studies on agricultural carbon emission reduction at the micro level, but there have been studies related to carbon emission reduction behaviors, such as green technology adoption, ecological production behaviors, etc., which explain the factors that may influence the behaviors of farmers from the perspectives of basic characteristics of farmers and household resources<sup>[2]</sup>. In addition to the above influencing factors, more scholars have paid attention to the micro influence of relationship networks in the diffusion of new agricultural technologies<sup>[3]</sup>. Farmer relationship networks is a relatively stable system of relationships gradually formed through the interactions among individual members, and the embeddedness theory suggests that actors are not completely independent in making relevant decisions, and their relationship networks have an impact on their behavioral decisions<sup>[4]</sup>. Based on the limited knowledge theory, Zhu <sup>[5]</sup> found that the farmers' relationship network can significantly promote the adoption of resource-saving technologies. Yang <sup>[6]</sup> found that both clannish and friendship networks have a significant impact on the degree of adoption of green production technologies. Li <sup>[7]</sup> found that heterogeneous relationships have a more significant effect on technology adoption than homogeneous relationships.

In summary, the existing literature has a certain foundation for the study of relationship networks

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affecting farmers' behavior, but there are still aspects worth studying: first, in the literature on relationship networks, existing studies have focused on the impact of relational networks on farmers' behavior, but there is not much literature focusing on the heterogeneity of relational subjects. Secondly, the existing literature pays more attention to the mediating role of the actors' own characteristics in the relationship network's influence on farmers' behavior, while ignoring the resourcefulness of the relationship network. Based on the social capital theory, this paper explores the mechanism of the multidimensional relationship network's influence on farmers' behavior from the three perspectives of the flow of information, demonstration effect, and the guarantee of factors.

## 2 Mechanistic Analysis

### 2.1 Influence of multidimensional relational networks on farmers' carbon emission reduction behavioral decisions

Research findings have indicated that the relationship network has a positive effect on technology adoption behavior, however, due to the differences in the relationship network, actors have different access to resources, forming differentiated carbon emission reduction behavioral decisions, so it is necessary to clarify the relationship network embedded in the farm household. China's rural areas are a relatively typical relationship-oriented society, the relationship network had the characteristics of high closeness, strong convergence, and low heterogeneity, therefore, the influence of the relationship network on the behavioral decisions of the farmers showed the following characteristics "The one who is close to Zhu is red, and the one who is close to ink is black". Whereas carbon emission reduction technology has significant positive externalities, farmers lack the initiative to adopt it, and the initial promotion of its use requires strong support from the government, At present, in China's important agricultural service system, agricultural suppliers and agricultural technicians, etc. are the main bodies that have the most direct contact with farmers, so their influence on the decision-making of farmers' carbon emission reduction behavior is increasingly significant [8]. Drawing on existing research, this paper classifies the farmers' relationship network into three categories based on the different subjects involved in farmers' behavioral decision-making: (1) social relationship network with farmers linked to relatives, friends, and townspeople, etc. (2) market relationship network with farmers linked to agribusiness merchants, retailers of agricultural production materials, etc. (3) government relationship network with farmers linked to governmental departments, village cadres, and agricultural technology departments.

From the viewpoint of governmental relationship network, the strong connection relationship implies that farmers have access to more comprehensive and scientific technical information, and have greater chances

of obtaining technical guidance, financial subsidies and other resources, which positively promotes the decision-making of farmers' carbon emission reduction behavior. The first step in decision-making is to know the technology, which is the biggest obstacle for farmers with limited information, while driven by the pursuit of maximizing the combined economic, social and environmental benefits, the government will take the initiative to improve scientific and comprehensive technical information for farmers, which is conducive to deepening the understanding of farmers on carbon emission reduction technology, and the government will form the farmers' value recognition of carbon reduction technology through the value guidance mechanism, which becomes an internal incentive to guide the adoption of carbon emission reduction technology by farmers. However, the costs and benefits of new technologies are the key factors influencing farmers' willingness to transform into behavioral decisions, and the government's loan subsidies and guarantee fee subsidies can effectively reduce the financial costs of farmers' adoption of carbon emission reduction technologies, especially in the case of "scarcity of resources", and the allocation of resources in the network of relationships can help farmers to obtain these scarce resources in order to support carbon emission reduction behavioral decisions.

In terms of the network of market relationships, strong connectivity implies that farmers have more access to technological information, and that it is easier to allocate market resources such as technology and its accompanying service guidance to promote the adoption of new technologies by farmers. On the one hand, at the initial stage of purchasing new agricultural materials, farmers have less technical information, but in order to promote agricultural products, retailers with resource advantages will provide farmers with detailed knowledge on the use of agricultural products, and voluntarily pay for publicity to organise activities such as visits to experimental plots, technical training, etc., which will help farmers make decisions on carbon emission reduction behaviour. On the other hand, frequent interactions create a cooperative atmosphere of mutual help and friendliness, and agricultural suppliers are more likely to provide credit trial promotion, which to some extent alleviates the financial constraints of farmers in adopting new technologies.

In terms of social relationship networks, dense network connections can shorten the information transmission distance and are characterized by high trust and reciprocal motives, which help farmers adopt new technologies. Firstly, the social relationship network linked by blood and geography is the innate relationship network, so the network members are familiar with each other and have a high degree of trust, which can significantly increase the willingness of farmers to share information and the reliability of information, which is conducive to the transmission of tacit information, and the strong motivation of reciprocity among the network members can help to alleviate the resource constraints encountered in the adoption of technology. Second, the "neighborhood effect" based on social networks can

significantly promote the adoption of technology by farmers.

## **2.2 Pathways of multidimensional relational networks affecting farmers' carbon emission reduction behavioral decision-making**

Social capital theory suggests that the relationship network, as a carrier of social capital, can provide various resources for the actors, thus promoting farmers' technology adoption behaviour. Scholars have already found that information availability, demonstration effect, and factor flow are the key factors that promote the adoption behavior of new technologies by farmers<sup>[9-10]</sup>, and important resources such as capital, technology, and information are embedded in the flow of the relational network, which in turn plays an important supportive role for the diffusion of agricultural technology<sup>[11]</sup>. In summary, the flow of information, the demonstration of technology, and the guarantee of elements play an important role in the multidimensional relational network influencing farmers' carbon emission reduction behavioral decision-making.

The technological information held by farmers is incomplete, while the relational network can promote information flow, alleviate information asymmetry and revise technology perceptions, which affects carbon emission reduction behavioral decisions. Interactive communication among members of the network can effectively promote the dissemination of information on new agricultural technologies. On the one hand, knowing more carbon emission reduction technologies, it is more likely to select and implement the technologies that match their own endowments and needs, breaking the impact of information barriers on the decision-making of farmers' behaviors, and on the other hand, the flow of information can improve the farmers' technological cognition, which can be used to increase crop yields and yields. On the other hand, the flow of information can improve farmers' technological awareness and more comprehensive understanding of the role of new technologies in increasing crop yields and returns, protecting the ecological environment, etc., to improve the response level of farmers' carbon emission reduction behaviors.

By providing high-quality resources, the relational network increases the learning opportunities of farmers, which in turn creates a "demonstration effect" that influences the decision-making of carbon emission reduction behaviors. Due to the limitations of their own knowledge level and judgment ability, farmers embedded in the relational network will imitate the behaviors of the more successful ones in the relational network, showing obvious demonstration effects and forming the convergence of technology adoption behaviors. On the one hand, many agricultural technological knowledge is acquired through "learning by doing", which has the characteristic of "tacit", and the interaction with the successful ones promotes the transmission of tacit knowledge, and the guidance and accumulation of technological knowledge reduces the technological

complexity cognition of farmers and realizes the demonstration effect of technology. On the other hand, the application effect of carbon emission reduction technology is uncertain, and the successful demonstration brings them a clear and visible benefit prospect, which reduces the farmers' perception of technological risk, and then influences the technology preference and adoption behavior decision.

The adoption of new technologies often implies the input of new productive factors, and farmers can obtain capital, labor and other factors through the relationship network, which significantly reduces the cost pressure of farmers' technology transformation and effectively promotes the adoption of carbon emission reduction technologies. Among the many productive factors, capital is a key element in the adoption of new technologies, and the existence of credit constraints weakens the enthusiasm of farmers in adopting technologies, leading to farmers abandoning the selection of new technologies due to the lack of capital, while the relational network can alleviate the problem of credit constraints, which can help farmers to obtain both formal lending and private lending. On the one hand, farmers embedded in strong relational networks are more likely to form informal institutional arrangements of mutual benefit and cooperation and sharing, which effectively reduces the cost of access to finance and alleviates the negative impact of resource constraints on behavioral decisions. on the other hand, the adoption of new technologies has a greater degree of uncertainty, while rural areas lack appropriate financing guarantee institutions, and relational networks as a traditional "invisible guarantee mechanism", which can make it easier for farmers to obtain borrowing and promote carbon emission reduction behavioral decisions.

## **3 Conclusions**

This paper finds that the relationship network can improve the adoption rate of carbon emission reduction technology of farmers, in which the government relationship network is a key factor influencing the decision-making of carbon emission reduction behavior of farmers, and the information, technical guidance, financial subsidies and other resources provided by the government can effectively guide farmers to form the value of carbon emission reduction technology and reduce the cost of adopting the technology, and the market relationship network and the social network can provide the corresponding technical guidance according to the real needs of farmers. The market relationship network and social relationship network can provide corresponding technical guidance according to the real needs of farmers, which reduces the complexity and risk perception of farmers on carbon emission reduction technology. Meanwhile, the high closeness and high trust of the social relationship network promote the reciprocal effect among network members, which in turn promotes the decision-making of farmers' carbon emission reduction behavior to different degrees. In order to further sort out the role of various resources in the

multidimensional relationship network in influencing farmers' carbon emission reduction behavioral decision-making, this paper summarizes the important resources flowing in the relationship network based on the social capital theory as three kinds of information flow, demonstration effect, and elemental security, and finds that the relationship network can promote the flow of information, alleviate the asymmetry of information and modify the technical cognition, increase the learning opportunities of farmers by providing high-quality resources, and form the demonstration effect. The demonstration effect contributes to the accumulation of tacit knowledge and the formation of benefit prospects, and at the same time reduces the adoption cost of technology through the provision of capital and other factor guarantees, which in turn promotes the decision-making of carbon emission reduction behavior of farmers. Based on social network theory and social capital theory, this paper provides an in-depth analysis of the mechanism of multi-dimensional relationship network affecting carbon emission reduction decision-making, which helps to further empirically analyse the micro-decision-making mechanism of the diffusion of carbon emission reduction technology, and provides an important reference for the promotion of agricultural carbon emission reduction technology and the realization of agricultural low carbon development and dual carbon goals in China.

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