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To cite this version:

Hang Chen, Guifen Chen, Ying Zhang, Hongjun Gu. Research on Agricultural Scientific and Technological Information Dissemination System Based on Complex Network Technology. 11th International Conference on Computer and Computing Technologies in Agriculture (CCTA), Aug 2017, Jilin, China. pp.432-439, 10.1007/978-3-030-06179-1_43 . hal-02111562

HAL Id: hal-02111562

https://inria.hal.science/hal-02111562v1

Submitted on 26 Apr 2019

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Research on Agricultural Scientific and Technological Information Dissemination System Based on Complex Network Technology

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Abstract. In view of the complexity of information dissemination in agriculture and the uncertainty of farmers' demand for scientific and technological information, this paper makes a comprehensive and accurate analysis for the dissemination network of scientific and technological information of agriculture based on complex network technology. Firstly, this paper researches the characteristics of the peak degree distribution, average path length and clustering coefficient of a complex network established by the agricultural information dissemination network. Through the research on the three basic characteristics, this paper confirms that the agriculture information dissemination network has the characteristics of scale-free network and small-world network. The method of node research is analyzed by using a complex network. That is that this paper makes a comprehensive analysis for the information propagation speed, scope, analysis and application of dissemination network of agricultural scientific and technological information from degree centrality, betweenness centrality and relationship strength theory. The research results show that the degree centrality can accelerate the information dissemination and be conducive to the accuracy of the information; the betweenness centrality can quickly expand the information dissemination and accurately grasp the degree of control for information resources; the relationship strength theory can reduce the cost of information dissemination and improve the degree of information adoption. This conclusion proves that the application of the analysis method of complex network can effectively improve the speed and quality of agricultural information dissemination network and better serve the agricultural production and farmers' life.

Keywords: Complex network; Dissemination of scientific and technological information; Centrality; Relationship strength.

1 Introduction

In the study of the dissemination of information content, people frequently discussed the spread of infectious viruses in the crowd, the spread of computer viruses in the network and viral marketing activities. China is a big agricultural country, but the study of information dissemination in agriculture is comparatively scarce [1]. The basic position of agriculture in the development of our national economy can not be ignored. It is the source of people's food and clothing and the basis condition for survival. In real life, the majority of the population in China is in the rural areas [2-4]. The development of agriculture is directly related to the improvement of the living standards of farmers and the stability of the rural society. Every year, our country will accumulate a large amount of agricultural information. The specific agricultural information data include crop emergence information, soil information, fertilizer information, irrigation information, insects information, weather information, various disaster information, etc [5]. However, in rural areas, the information is often blocked and the farmers can't understand various information timely, which will seriously restrict the development of rural social economy [6]. Therefore, now people should urgently study and solve the problems that how to improve the farmers' ability to obtain information and how to quickly and locally transmit the information to farmers to promote the rapid development of agriculture.

2 The Complex Network Characteristic of the Dissemination of Scientific and Technological Information of Agriculture

2.1 Distribution of the Degree of Network

The degree distribution of network nodes is one of the important statistical characteristics of complex networks. The degree of a node is usually defined as the number of adjacent nodes and the number of edges connected to the node. The average degree of a network refers to the average value of the degree of all nodes in the whole network, which is usually referred to as <K>. When the nodes with the same degree are counted separately, a distribution diagram of the degree of network nodes can be obtained. We can use the distribution function P(k) to describe the distribution situation of the degree [7]. It represents that when any node was selected in network, the degree of it is exactly the probability of K. Through the practice of a large number of researchers, it is proved that many networks in real life have power-law distribution, such as Internet network, scientific collaboration networks, protein interaction networks, etc. Such networks usually have the scale-free properties, also known as scale-free networks.

Researches show that the interpersonal relationship network has two statistical characteristics in real life, namely small world characteristics and scale-free characteristics. In rural areas, the rural information dissemination network also has scale-free network characteristics like the complex network [8].

2.2 The average path length

The average path length is the another important statistical characteristic in a complex network. The distance between two nodes in a network has many different definitions. The most commonly used statistical method is to compute the number of edges in the shortest path that connects the two nodes. As shown in Fig. 1, the node A is directly connected to the node B and the distance between the node A and B is 1. As shown in Fig. 2, if node A wants to connect to the node B, it must pass through the node C, and the distance between node A and B is 2. As shown in Fig. 3, there are two paths A-C-B and A-C-D-B to connect node A and node B. If we want to calculate the distance between node A and B, we should adopt the path of A-C-B, so the distance between the node A and B is 2. Network diameter is defined as the maximum distance between two selected nodes in the network. The average path length of a network is defined as the average minimum distance between all node pairs in a network. The average path length and diameter measure the transmission performance and efficiency of the network. In different network structures, the average path length is given different meanings. For example, in urban traffic network, the average path length is often defined as the distance between traffic stations.

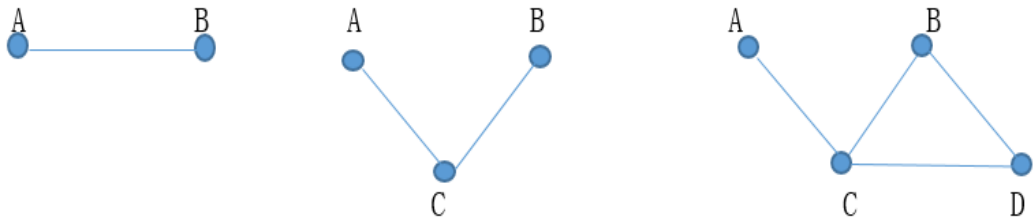

Fig. 1. Direct connection **Fig. 2.** Connection with a midpoint **Fig. 3.** Multipath connection

2.3 Clustering Coefficient

In a complex network, the clustering coefficient of a node is defined as the ratio between the number of edges between all nodes which are adjacent to this node and the maximum number of edges between these adjacent nodes. Suppose that there is a node i, and there are Ki nodes connected with it, then the clustering coefficient of the node(i) is:

$$C = \frac{2Ei}{ki(ki-1)}, \quad i = 1, \ 2, \ \cdots, \ N \tag{1}$$

In the formula, Ei is the actual number of edges that exist between the ki nodes. The average clustering coefficient of a network is defined as the average value of the clustering coefficients of all nodes contained in the network. In the case of (1), the maximum number of connected edges between ki nodes is ki (Ki-1) /2, then the average clustering coefficient of the network is

$$C = \frac{1}{N}\sum_{I=1}^{N} Ci \tag{2}$$

The average clustering coefficient of the network reflects the aggregation of the network. For example, in a friend relationship network, a person's two friends are likely to be friends with each other. The aggregation coefficient of a network is essentially the study of the probability that the two adjacent nodes of the same node are still the adjacent nodes in the network. It clearly reflects the local characteristics of the complex network.

3 The Role of Complex Network Technology in the Dissemination of Scientific and Technological Information of Agriculture

3.1 Degree centrality

For a node, the more the number of nodes which are directly associated with it, the stronger the central position of it, the higher the degree centrality of it. In complex networks, most of the nodes which are less directly related to other nodes are in the edge position. Such nodes have very little informal power and influence in the network. The behavior of such actors is usually limited by the actors in the central position [9].

Survey shows that rural big-specialized-households of crop and animal productions have the strongest demand for information resources, followed by the intermediary organization, marketing businesses, wholesale market personnel, agricultural entrepreneurs. The general farmers have the lowest demand for information. People such as the big-specialized-households of crop and animal productions and marketing businesses have higher knowledge level than the general farmers, and can accurately interpret and apply the acquired information. In general, ordinary villagers will have a process to re-read the information they receive. The information transmitted by the mass media is broad and the dissemination content lacks the pertinence, moreover has the strong specialty. For the ordinary farmers in low cultural level, it is difficult to achieve the understanding of the same level. Therefore, these big-specialized-households of crop and animal productions in high cultural level play a crucial role, they can translate the information they receive into the language that ordinary farmers can understand.

They have a high educational level, have a strong ability to receive and acquire information and their horizon is broadened, so they can deliver valuable information to ordinary farmers. Therefore, they have high prestige among the farmers. They can be regarded as “opinion leaders” in the eyes of ordinary farmers, and have a high influence on the attitude and behavior of farmers to accept information. In rural areas, people who can be regarded as “opinion leaders” are locally recognized as the people who have a high cultural level and have a certain prestige among the masses.

In the rural information dissemination network, the general farmers and “opinion leaders” are regarded as nodes in the network, the connection between the general farmers and general farmers, between the general farmers and “opinion leaders” and between the “opinion leaders” and “opinion leaders” are the edges between nodes in the network. In this complex network, the majority of farmers occupy the marginal position, but the “opinion leaders” occupy the central position. The opinion leaders have a high degree centrality in the whole complex network. Therefore, in the process of information dissemination, new information can be first transmitted to the local “opinion leaders” and then transmitted by “opinion leaders” to the ordinary farmers affected by them. By using this transmission mode from the node with a high degree centrality to the node with a low degree centrality, the speed of information dissemination can be accelerated and the scope of information dissemination also can be increased. It is also conducive to the accurate interpretation and application of information.

3.2 Betweenness Centrality

In a complex network, the degree centrality of nodes refers to the degree of difficulty and ease of the resource from one node to another. The betweenness centrality of nodes measures the control degree of this node for the resource in the network. The betweenness centrality means that in a network, if the two nodes want to have an association, they must establish a connection through another node. If a node is on the shortest path between the two nodes, then the node is considered to have a high betweenness centrality. The actor with high betweenness centrality can use more opportunities to speed up the dissemination of information. He has a strong ability to control the flow of information. This also shows that he has an important position in the network, because he decides whether or not the other two actors could communicate with each other and also affects whether information resources in the network can spread a large area. Therefore, nodes with high betweenness centrality have the obvious media role in the network transmission.

The rural interpersonal network is a common phenomenon. Fig. 4 shows a typical model of rural interpersonal network. Through the connection among nodes, we can analyze the characteristics of information dissemination in rural areas and the path of information dissemination. According to the nodes and the content of connection, the network can be divided into several different sub networks, such as the village head network, well-informed man network and home core personnel network. The dotted portion in Fig. 4 is a small network combined by four nodes which are connected with each

other. The people in this network usually have the common interests and hobbies and share information with each other. In this typical rural interpersonal network, it can be expanded according to the blood relationship, geographical relationship and occupation relationship to form a more complicated rural interpersonal interaction network.

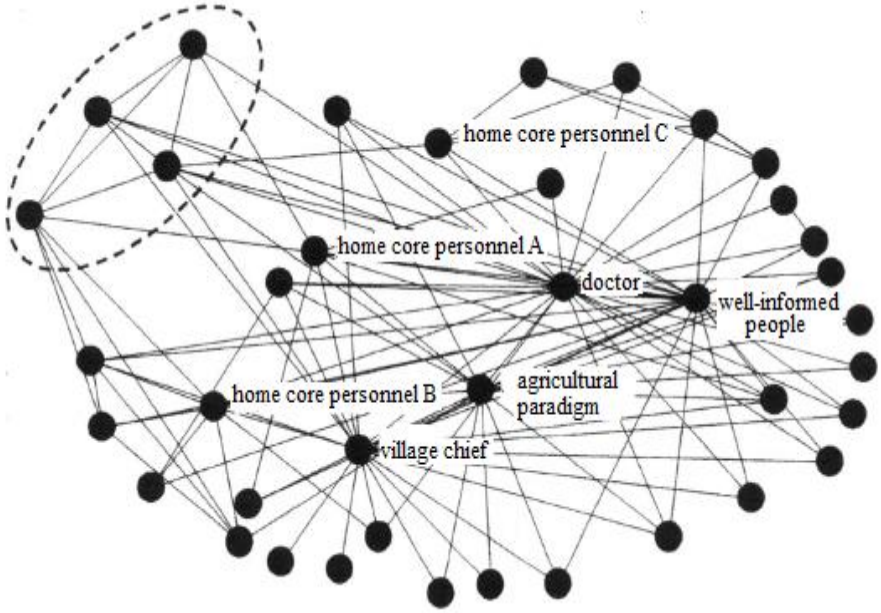

Fig. 4. Rural interpersonal network model

The people who promote the expansion of the network may be the village chief, well-informed people, agricultural demonstration households, or the general villagers in the network. In the network, he may be at the center or on the edge. Such villagers are very important, because they have an important place in the information dissemination network. Such nodes are called the intermediate nodes in complex networks because they directly affect the change of network size. The villagers who are similar to intermediary nodes should be paid enough attention in the process of information dissemination. The approval degree of such villagers for information and their willingly attitude of transmitting information directly determine the stability and scale of the information dissemination network. In the rural information dissemination network, the higher the betweenness centrality of farmers, the more important his position, the greater the impact on the scope of information dissemination. Therefore, the application of the analysis strategy of betweenness centrality of a complex network in the information dissemination of farmers can better control the diffusion range and accurately master the degree of control of information resources.

3.3 Relationship Strength

Strong relationship and weak relationship have different functions in the process of formation and operation of an information dissemination network [10]. Strong relationship will usually form a closed ring in the information dissemination network. The members in the ring network generally contact with each other directly. The information obtained by them is often what they have already known. In that way, information will be transmitted repeatedly and shared deeply. The weak relationship will form a non-closed linear relation. The redundancy of information and the cohesiveness of the structure in such network are very low. Therefore, the main role of the strong relationship is to maintain the stability of information dissemination network, improve the cohesion within the organization and deepen the trust and sense of belonging of the organization members to the organization. The weak relationship exists among the people with different interests, so the information shared among them can't be repeated. Therefore, the weak relationship plays a "bridge" role in the dissemination of information in the network. It can transfer the information resources to another person who is not familiar with this information resources group.

As a ubiquitous group phenomenon, relationship strength theory also exists in the complex network of rural information dissemination. Due to the specific rural blood relationship, geographical relationship and occupation relationship, a small closed group with strong relationship will be formed easily among villagers. They have a common recognition, high sense of understanding and comply with the arrangement of the same system. Under the guidance of the high cohesion and behavior coordination of villagers, the cost of information dissemination can be reduced to a greater extent. Through the loose indirect contact, weak connection can integrate more villagers in other groups into

the relationship network that it exists. In that way, it can not only be conductive to the villagers to acquire the information with high quality and low repetition rate in a larger scope, but also expand the scope of the dissemination of information.

The relationship strength theory should be applied to the rural information dissemination network. The villagers in strong relationship group should contact new villagers to form the weak relationship, and in this relationship, they should increase interaction frequency, deepen the emotion and enhance the intimacy, so as to strengthen the weak relationship and transform it into the strong relationship. Farmers are busy in spring and autumn. In summer and winter, they are mostly idle, so they have more leisure time to participate in various activities, create the opportunities to communicate with each other and deepen their feelings. Because of the unique lifestyle in rural areas, it is very beneficial to develop new relationships, and the cycle of transforming the weak relationship into the strong ones is also very short. Therefore, the application of the analysis method of relationship strength theory in rural information dissemination network can reduce the cost of information dissemination, accelerate the speed of information dissemination, expand the scope of information dissemination and improve the degree of information adoption.

4 Conclusion

From the original agriculture to the ancient traditional agriculture, and then to the modern agriculture today, the agricultural development of our country has lasted for thousands of years. Rural information dissemination involves the information flow at different levels and in many fields, such as agriculture, farmers and rural areas. According to the above research results, we can analyze that:

The first one is that because of the rural special geographical relationship, blood relationship and occupation relationship, rural information dissemination network has a small average path length and a large clustering coefficient. The information dissemination network of agriculture has scale-free network characteristics and small world network characteristics.

The second one is that the application of degree centrality theory in rural information dissemination network, the attention of “opinion leaders” effect and the adoption of mode of information dissemination from the villagers with high degree centrality to the villagers with low degree centrality can accelerate the speed of information dissemination, and be conducive to the accurate interpretation and application for the information.

The third one is that the analysis theory of betweenness centrality should be applied to the rural information dissemination network to analyze the villagers with intermediary nature. These villagers should be paid highly attention, their recognition for the information should be enhanced and their enthusiasm of information dissemination should be mobilized. In that way, the scope of information dissemination can be expanded quickly.

The fourth one is that by using the theory of relationship strength, the relationship between villagers can be divided into strong relationship and weak relationship. The strong relation can be used to develop new relation, that is the weak relation, and then the weak relation can be transformed into the strong relation. Because of the unique work and rest rules in rural areas, this transformation can be completed quickly. The application of relationship strength theory can reduce the cost of information dissemination cost, accelerate the speed of information dissemination, expand the scope of information dissemination and improve the adoption of information.

Acknowledgements. The authors wish to express their gratitude to the national spark program project: Precise operation technology integration and demonstration of corn (No. 2015GA660004) for its generous support of this work.

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