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Analysis of Farmers' Social Interactions to Apply Principles of Conservation Agriculture in Iran: Application of Social Network Analysis

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ABSTRACT

Implementation of Conservation Agriculture (CA) project is a process of multi-participation that involves actors from agricultural researchers and scientists, extension agents, private consulting firms, pioneer farmers, rural cooperatives, family members, peer farmers, etc. The social interactions between farmers and actors drive the CA development. Therefore, this study analyzes the social network structures and characteristics of various actors by social network analysis in seven processes of applying CA in Iran. The research sample was composed of farmers who participated in the CA project in three provinces of Fars, Golestan, and Khuzestan (n= 133). The research instrument was a questionnaire that was designed as a matrix. The findings showed that pioneer farmers, CA farmers, and family members were the main actors in the farmers' social network. It can be concluded that these actors were the main social power in applying CA principles by farmers and they constituted the main centrality of the farmers' social network. It means that farmers are more likely to interact with local actors, and they interact less with the government and the actors outside the rural community. Therefore, it can be recommended that social power should be identified and project management should be organized through them in attempts to implement CA.

Keywords: Extension planners, Pioneer farmers, Social power and influence, Sustainable agriculture.

INTRODUCTION

Conservation Agriculture (CA) is a sustainable package that alleviates soil erosion and greenhouse gases, enhances soil fertility and productivity, and many other benefits. Generally, CA is a triple approach for agriculture that includes maintaining a permanent cover on the soil by crop residuals, practicing no-tillage to reduce soil disturbance and dispersion, and using crop rotation to cut off the cycle of pests and improve soil fertility (Choudhary *et al*., 2018; Dhar *et al*., 2018; Ward *et al*., 2018; Das *et al*., 2018; Sun *et al*., 2018). At the global level, CA is planned with respect to the ecological and sustainable agriculture principles that contribute to the use of farms and environment (Wassmann 2009; Behera *et al*., 2010; Lal, 2013; Izadi and Hayati, 2014; Abdulai and Abdulai, 2017). In other words, CA is an approach to manage agricultural ecosystems that achieve a sustainable agriculture by minimizing soil disturbance and soil erosion, maintaining crop residues and diversifying the crops (Powlson *et al*., 2016; Tirol-Padre *et al*., 2016).

Mafongoya *et al*. (2016) hold that the benefits of CA depend on the level of farm management including planting time, the use of herbicides, pesticides, and fertilizers, and adequate training about the use of agriculture implements. However, an important point that should be considered is the social interaction among farmers. More extensive social interactions of farmers improve their understanding of the

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benefits of CA. Meanwhile, scholars have recommended that the communication between all actors (farmers, extension agents, researchers, and others) should be increased to improve CA's productivity and adoption. Findings from research farms are used to enhance the understanding of CA's benefits, such as reducing evaporation from the soil surface, and soil compaction, moderating soil temperature, etc. (Reed *et al*., 2014). This interaction should be aimed to develop tools and machines that facilitate CA implementation in different conditions (Carmona *et al*., 2015). Therefore, increasing farmers' social interactions will contribute to applying the CA principles more effectively. In other words, farmers establish social interactions with different people to apply CA principles and to acquire and share CA information and knowledge. Therefore, it can be inferred that the study of farmers' social interactions to implement CA principles can form the basis for sustainable agriculture development.

Farmers' social interactions occur within social networks. Farmers use various information sources to carry out agricultural activities and form a social network. Recognizing farmers' social network has helped agriculture authorities and extension planners to identify their communication channels and to use these channels to convey the cropping recommendation to farmers. Social networks improve the managerial capacity of farmers (Hoang *et al*., 2006; Isaac *et al*., 2007) and play an essential role in farmers' decision in innovation process (Matuschke and Qaim, 2009; Tatlonghari *et al*., 2012) so that recognizing the ways by which experiences and knowledge are shared and exchanged among farmers is one of the essential issues about the farmers' social community (Seeniang and Thaipakdee, 2013). Unfortunately, the officials in the agricultural sector in Iran have exploited few channels to convey research findings to farmers, and they have poor knowledge of farmers' social network. This slows down the process of agricultural development. Accordingly, this research was carried out to analyze farmers' social network in implementing the CA principles.

Various studies have been conducted on farmers' information sources and their social networks. Nonetheless, less research has focused on farmers' social networks in applying CA principles.

It has been shown that farmers use different sources to obtain information. For example, Ransom *et al*. (2003) suggested that farmers connected to extension agents for information about improved maize varieties in Nepal. Solano *et al*. (2003) identified family members and technical advisors as the most important actors in the Costa Rican farmers' social network. Safi Cis *et al*. (2014) expressed opinion leaders, extension agents, and family members as the most important information sources among Iranian farmers' social interactions. Rehman *et al*. (2013) argue that social interactions among farmers, pioneer farmers, extension agents, and government organizations are conducive to information transfer. Hedjazi and Veisi (2007) determined that farmers' social network consisted of extension agents, researchers, and peer farmers. Azizi Khalkhili and Zamani (2009) and Ahmadi *et al*. (2017) identified the Agricultural Extension Service Center as the main source of information transfer in farmers' social interactions. Peng (2002), Li *et al*. (2003), and Tang *et al*. (2004) have pointed out that opinion leaders, expert peers, and family members have the most social interactions in China.

Pratiwi and Suzuki (2017) concluded that peer farmers played a major role in farmers 'social networks. Farmers' social networks consisted of friends, peers, and extension agents. Ramirez-Sanchez and Pinkerton (2009) and Salpeteur *et al*. (2016) found that social networks play a flexible and key role among local communities in natural resource management so that farmers' social networks have a positive effect on farmers' social capital (Bao *et al*. 2018). The social interactions of farmers can play a role in preventing the degradation of natural resources as a change factor in farmers' knowledge, perception, and attitudes (Blackstock *et al*., 2010). Especially talking, social networks can motivate the participation of farmers in the development and adoption of innovation (Lamb *et al*. 2016). Other results also identified the social network of villagers consisted of local leaders, family members, NGOs, the private sector and the government (Ramirez *et al*., 2014; Utaranakorn and Yasunobu, 2016) trainers and extension agencies (Faulkner *et al*., 2014; Bowe

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and der Horst, 2015). A summary of other studies is presented in Table 1.

According to the literature review, it can be concluded that various actors are involved in the social networks of farmers and villagers as information sources. These actors are trustworthy among farmers and they have more knowledge sharing among farmers. In general, these actors can include researchers of Jihad-e Agricultural Research Centers, extension agencies, private consulting firms, pioneer farmers, rural cooperatives, family members, and peer farmers.

In Iran, CA was for the first time practiced in four provinces of Khouzestan, Fars, Golestan, and Khorasan, in an area of 150 hectares in 2007 and, then, it expanded to the other provinces. In 2014, a comprehensive organization was established with the formation of the Supreme Headquarters of CA in the Ministry of Agriculture and Technical Committee at ministerial level, provincial agricultural organization and management of the townships/counties. National Headquarters of Department of CA is under the authority of Ministry of Agriculture. The Supreme Headquarters of CA is responsible for macroeconomic policies in support of CA's technology development in interaction with intra and inter-organizational sectors. National Headquarters of CA is responsible for issues related to the design, development, approval and notification of programs, projects, guidelines and other activities related to the development and promotion of CA. CA Technical Committee is responsible for the operating procedures of the programs and projects, development or revision

Table 1. Some studies in field of the farmers' social network.

Authors	Research topic	Results
Navarro-Navarro *et al*. (2017)	Social networks for management of water scarcity	Farmers' social network in water management consisted of family members, friends, peer farmers and local government.
Raya (2016)	The influence of social network structure on the farmer group participation	Participation of farmer groups will increase, if the social network structure is stronger.
Utanarakorn and Yasunobu (2016)	The mutual influence of managerial ability and social networks of farmers on participation in an organic vegetable group	Farmers with a larger social network have more opportunities to evaluate information and exchange knowledge.
Manning (2013)	A knowledge exchange and diffusion of innovation model for primary production	Extension staff, local leaders, and peer farmers are main sources of exchanging knowledge.
Miller and Mobarak (2015)	Learning about new technologies through social networks	Peer and opinion leaders are played a key role in the social network of villagers.
Opara (2008)	Agricultural information sources used by farmers	Extension agencies are considered as the most important source of information for farmers.
Mengistie *et al*. (2015)	Information, motivation and resources: the missing elements in agricultural pesticide policy implementation	Farmers have more interaction with the private sector for using pesticides.
Golbaz *et al*. (2015)	Information sources influencing soil testing innovation adoption	Farmers' interactions with pioneer farmers lead to adoption of innovations by farmers.
Heidari Sarban, and Roknoddin Eftekhari (2011)	Effective factors in farmer's membership in rural production cooperatives	Jihad-e Agricultural Centers of Iran and rural cooperatives played an important role to information transfer in the farmers' social network.
Mirzayee *et al*. (2011)	Effects of extension tools and informational sources on participations of farmers in water users cooperatives	Extension agents, peer farmers and pioneer farmers as the three pillars of the farmers' social network
Ochieng *et al*. (2012)	Determinants of adoption of management interventions in indigenous chicken production	Farmers' organizations as one of the main channels of innovation transfer
Alfred and Fagbenro (2006)	Perception of Tilapia farmers on information sources in the coastal region	Extension institutions have a strong role in the farmers' social network.

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of operating instructions, identification of equipment list and allocation of funds for each project. At provincial level, the CA Technical Committee tracks issues related to the implementation of programs with provincial and national guidelines, identifies provincial priorities, and is responsible for the implementation, extension and education, compares the results of research projects with field conditions within the CA-based Applied Research and Delivery model farms framework (HUB), and aggregates the results and evaluates the implementation of the plan. According to this plan, CA-based Applied Research and Delivery (HUB) have been established in all provinces. Also, development of technical guidelines for irrigated and rainfed lands and holding workshops and CA educational courses for experts and farmers are also some key activities of this project. Every year, the Ministry of Agriculture Jihad and agricultural organizations of the provinces implement more than 100 extension and education courses and other programs for the development of CA. At present, more than 745,000 hectares of lands in Iran are under residue management, crop rotation and low tillage and more than 112,000 hectares are under no tillage.

However, each CA system has its own problems and obstacles that complicate the relationship between farmers and actors. For example, the infrastructure-institutional and bureaucratic challenges slow down the establishment of a link between extension agents and farmers. On the other hand, the economic challenges limit farmers' access to CA equipment whereas to get the equipment, farmers should make a connection with the private sector and mechanization service companies. Thus, if the farmers are in poor economic status, private firms cannot be strong and influential actors in farmers' social network. Also, the inconsistency of CA principles with conventional agriculture principles sometimes inhibits the establishment of a connection between farmers and the extension agents and researchers. For instance, according to conventional agriculture practices, farmers used to collect plant residue from the farm to make other uses of it. But, CA says that the residue should be left on the soil surface. When farmers do not agree with this practice, it is impossible to build a strong relationship between them and agents/researchers. This weakens the social influence of these actors in the farmers' community. Other researchers (e.g. Wall, 2007; Sims *et al*., 2012; Jat *et al*., 2014; Singh *et al*., 2015) have also stressed out this challenge.

MATERIALS AND METHODS

Social Network Analysis (SNA)

The study was a sociometric research. In this study, SNA was applied to investigate farmers' social interaction in a CA project. SNA was presented in the 1930s as a new sociological approach (Borgatti *et al*., 2009). It was developed through the integration of various disciplines such as psychology, sociology, anthropology, mathematics, statistics, etc. A social network is a set of actors and the relations among them. In other words, networks are composed of nodes (actors) connected through "ties" that are represented graphically in a sociogram as points and lines (Borgatti *et al*. 2009). Valente (2010) stated that SNA is a statistical method that investigates who interacts with whom for a given purpose. SNA focuses on modeling the relations of actors, describing the structure of relations, and studying the impact of the structure on the whole network and individual components (Scott, 2017). SNA provides a framework to study and model different aspects of agricultural innovation and applying sustainability principles (Spielman *et al*., 2011; Lubell *et al*., 2014). SNA can enable a better understanding of the complexity and multi-dimensionality of multi-stakeholder innovation processes (Beers and Geerling-Eiff, 2014). The main indexes of SNA used in this research include two aspects: (1) Description of the actors' characteristics, such as degree of centrality, betweenness centrality, and closeness centrality (see below); and (2) Description of the network characteristics, such as density, network degree centralization, and betweenness centralization. These indexes are described below.

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Degree centrality*:* Refers to the number of farmers who are connected directly to the actors. In the actors' network of a CA project. If an actor has the highest degree of centrality, it could be the center of the network and might have the greatest power. This actor can be seen as the leader of the CA project.

Betweenness centrality*:* Refers to the proportion of total ties to farmers that pertain to an actor. It measures the potential of an actor that can be a mediator to control other actors. In the actor's network of a CA project, if an actor attracts more other actors to knowledge sharing in the CA project, it has higher betweenness centrality. This actor can be seen as a bridge connecting others.

Closeness centrality*:* Is the sum of an actor's shortest distances with other actors. In the actor's network, if an actor is close to many other actors in the network, it has higher closeness centrality. This actor could communicate well with others and play an important role in the CA project.

Sample and Data Collection

The social boundary of the research was confined to three provinces of Fars, Golestan, and Khuzestan in Iran (Figure 1). These provinces are considered as pioneers in a CA project implemented in 32 provinces of Iran. The research sample was composed of farmers participated in the CA project in these provinces (49 farmers in Fars Province; 42 farmers in Golestan Province, and 42 farmers in Khuzestan Province). We used a questionnaire designed as a matrix consisting of seven basic CA principles that farmers should implement in their farms. These principles include crop rotation (crop pattern), crop residue management, no-tillage/low tillage, irrigation method, seed variety, pest, weed and disease control methods, and equipment/machinery use for CA. The main actors in the farmers' Social network consisted of researchers at the Agricultural Research Centers (Sc), Extension agents (Ex), Private consulting services experts (Pr), Pioneer farmers (Pi), rural Cooperative (Co), Family members (Fa), and the farmers who participated in the Conservation Agriculture project (CA). Therefore, according to the social network of actors in the process of applying principles of CA, the SNA indexes were calculated by using the SNA and software UCINET$_{6.528}$.

RESULTS AND DISCUSSION

Appropriate crop rotation is one of the primary principles of CA. Crop rotation and cropping pattern may be different based on climate conditions. Therefore, farmers collect information and knowledge to choose appropriate crop rotation from various sources. The results are shown in (Table 2 and Figure 2-a). It is seen that the pioneer farmers and CA project farmers have played the most important roles in knowledge and information dissemination about crop rotation among farmers. Based on the results, the pioneer farmers were the leader in selecting cropping pattern. The centrality, betweenness, and closeness degree of the pioneer farmers were the highest among all actors. The family members were the third main driver of crop rotation. The centrality, betweenness, and closeness degree of the family members were 23.48, 11.28, and 10.27, respectively. Also, the rural cooperatives had been referred to the least as a source of information by farmers. These results are consistent with the results of Solano *et al*. (2003), Hedjazi and Veisi (2007), Rehman *et al*. (2013), and Safi Cis *et al*. (2014). They stated that

Figure 1. Map of Iran showing the research provinces.

pioneer farmers, family members, and peer

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farmers are the main core to exchange information within farmers' social networks.

CA farmers should manage and conserve crop residues on the soil. Therefore, they need to use valid sources of information for crop residues management and degree of crop residues on the soil. Farmers' SNA showed that in the process of crop residues management, the pioneer farmers were central resource and their degree centrality, betweenness, and closeness were 58.33, 18.35, and 53.02, respectively. Most farmers followed the pioneer farmers to manage the residue. Also, the CA farmers and scientists of Agricultural Research Centers (ARCs) were ranked the second and third, respectively. Furthermore, numbers of farmers' referrals to the pioneer farmers, the CA farmers, and scientists of ARC were 96, 55, and 32 times, respectively. This finding shows that the retention of plant residue or its burning by farmers depends on pioneer farmers and CA farmers. It can be concluded that they believe pioneer farmers and CA farmers work correctly and they can follow them. On the other hand, when leaving plant residue on the soil surface, farmers may be concerned about the loss of their crop yield in which case researchers at the ARC are a reliable scientific source for them. Farmers believe that researchers at the ARC have enough knowledge to convey to farmers, whereas extension agents are the link between researchers at the ARC and farmers and they should bridge them to one another. However, the results revealed that these agents perform poorly in encouraging the farmers to keep plant residue. It can be inferred that farmers do not trust extension agents adequately and the educational-extension strategies and programs have not been so thriving. Based on (Figure 2-b), private advisory services experts and rural cooperatives had a weak role in the process of residues management. Other researchers (Hedjazi and Veisi 2007; Mirzayee *et al*. 2011; Ataei and Zamani Miandashti 2014; Golbaz *et al*. 2015; Miller and Mobarak 2015) have confirmed that pioneer farmers, peer farmers, and agricultural scientists have played an important role to transfer knowledge among farmers.

No-tillage is one of the most important principles of CA. Farmers' fields should undergo the lowest soil disturbance because one of the dangers threatening agricultural sector has always been soil erosion (Abbasian *et al*., 2017). The findings indicated that the pioneer farmers and the CA farmers were more effective in motivating farmers to use no-tillage (Figure 2-c). Farmers take the pioneer farmers and the CA farmers as their behavioral patterns to do no-tillage/low tillage. Farmers follow the behaviors of people who have strong social authority in rural communities. Social authority is the result of several factors, such as high social status, prosperity, creativity, general satisfaction, social trust, technical competences, and so on. Individuals intend to perform a behavior when they feel that the people who are important for them confirm that behavior (Shin and Hancer, 2016). These actors are referred by 72 and 70 farmers, respectively. It means that they are social powers to apply no-tillage by farmers and have high authority in the farmers' social network. Thus, it can be claimed that actors have different strategies to influence the decisions of farmers. This means that the farming strategies of pioneer farmers and CA farmers are more influential on the adoption of CA practices by farmers than extension agents, researchers at the ARC, and the private advisory services experts. Rural actors mostly apply social strategies and close interactions. However, extension agents, researchers at the ARC, and the private advisory services experts mostly adhere to technical and scientific strategies. Nonetheless, application of social strategies and higher social interactions influence the adoption of innovations by social communities more strongly. Technical and scientific strategies take longer time for adoption by farmers, and they need to be integrated with social interactions within social communities. Their degree centrality was 56.06 and 52.27, respectively. Family members, extension agents, scientists of ARC, private consulting service experts, and rural cooperatives were the next priorities as source of information for farmers, respectively. The study findings are consistent with the results of Solano *et al*. (2003), Manning (2013), Ramirez *et al*. (2014), and Navarro-Navarro *et al*. (2017). They argued that the pioneer farmers and the main farmers who participated in the projects have social authority in rural areas.

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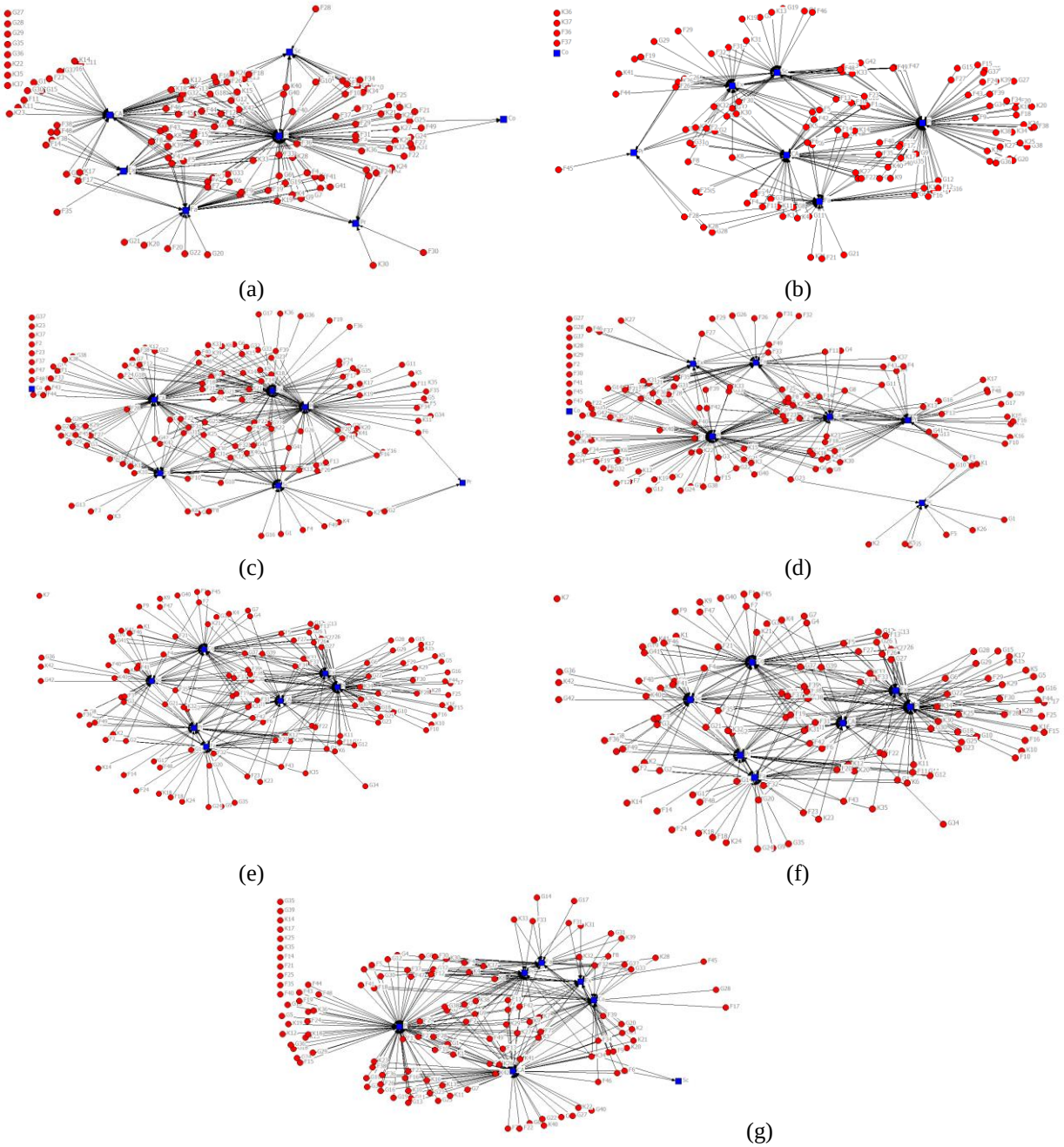

Figure 2. Farmers' social network in (a) crop rotation process, (b) crop residue management, and (c) applying no-tillage/low tillage, (d) choosing irrigation methods. (e) choosing seeds variety (improved varieties), (f) pest, weed, and diseases control, (g) using CA equipment and machinery.

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Farmers applied irrigation methods with various levels of efficiency. Experts recommended that farmers should use pressurized irrigation methods (such as drip and sprinkle irrigations) with high efficiency in sustainable agriculture, especially in CA (Cetin and Bilgel, 2002; Afzalinia *et al*., 2016). The findings indicated that in farmers' social network, pioneer farmers played the main role in using proper irrigation methods by farmers. As is evident in (Figure 2-d), private consulting service experts were the second most important source of information and knowledge for farmers. Specialists of the private sector in rural communities always employ competitive strategies to compete with the public sector and extension agents so as to establish commercial links with farmers. The higher the influence of the private sector in rural communities is, the stronger the social relations are between farmers and experts in the private sector. Powerful social relations, in turn, will create mutual trust between them and, consequently, their innovations and technical and scientific recommendations will be accepted more easily by farmers. New irrigation methods also require modern tools and facilities. These tools and implements are provided by the private advisory services experts. Therefore, it can be concluded that the private advisory services experts play a key role in building social networks of farmers for the adoption of new irrigation techniques, although the public sector is the provider of financial facilities, such as loans, as well as consultation. But, the main consultation and guidelines to adopt new irrigation techniques come from experts in the private sector. So, it can be said that other actors have performed poorly in this competition. Therefore, most farmers referred to pioneer farmers and private consulting service experts to apply irrigation method in the CA project and they are known as valid and reliable source of information. Numbers of farmers' referrals to the pioneer farmers and private consulting service experts were 79 and 45 times, respectively. Also, rural cooperatives, scientists of ARC and extension agents had the least referrals by farmers. Other researchers (Ramirez *et al*. 2014; Mengistie *et al*. 2015; Utaranakorn and Yasunobu 2016) believed that pioneer farmers and private consulting service centers can share specialized information in the farmers' social network.

The process of choosing seed variety by farmers resulted from multiple forms of actors. In this stage, pioneer farmers, rural cooperatives, and family members were the three main sources of information of the farmers' social network; their degree centrality, betweenness, and closeness were higher than those of other actors. In this stage, rural cooperatives were the main factor facilitating the use of seeds by farmers. Rural cooperatives in Iran provide seeds (improved varieties) for villagers. Therefore, rural cooperatives are considered important actor to offer seeds. Furthermore, these actors will have more social influence and control power on the use of improved varieties by farmers in social network. Others actors (scientists of ARC, extension agents, private consulting service experts and farmers participated in the CA project) had approximately the same role and effect in knowledge and information transfer about improved varieties (Table 2 and Figure 2-e). Heidari Sarban and Roknoddin Eftekhari (2011), Ochieng *et al*. (2012), and Navarro-Navarro *et al*. (2017) mentioned that rural cooperatives and family members are valid sources of information for farmers. Cooperatives and particularly agricultural cooperatives do play a major role in production, primary processing, and marketing of agricultural and livestock commodities among farmers (Mohammed and Wan Lee, 2014; Ataei *et al*., 2016).

The complex nature of the farmers' social network in pest, weed, and disease control stage is depicted in (Figure 2-f). The analysis of the actors revealed a large number of influential actors from public, private, and local institutions. The private consulting service experts were rated the first most important actor, a group that consists of most experts in the field of plant protection that provided services related to pest, weed, and disease control for farmers. Its betweenness, closeness, and degree centrality was high at this stage. According to degree centrality, it is found that the private consulting service experts were linked more by farmers in social network. Therefore, this actor has more authority and was considered a key actor or social power in farmers' social network. The second and third most influential groups of actors at the local and public levels were the

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pioneer farmers and extension agents, respectively. Rural cooperatives gained the lowest betweenness centrality. The farmers had less contact with rural cooperatives than with any actors. The findings of the study are consistent with the results of Peng (2002), Solano *et al.* (2003), Alfred and Fagbenro (2006), and Mengistie *et al.* (2015). Also, Faure *et al.* (2017) mentioned the importance of improving and regulating the private consulting services and strengthening the coordination of consulting activities of private actors for an efficient agricultural advisory system.

To implement a CA project, it is imperative to use some new equipment and machineries. So, farmers need to know how they should be used in their farms. As depicted in (Figure 2-g), the farmers' social network analysis revealed that the pioneer farmers and CA farmers are the most important source of information and knowledge, respectively. It means that pioneer farmers and CA farmers are connected to maximum number of actors to use equipment and machinery of CA by farmers. The pioneer farmers and CA farmers are key actors with social power in using the equipment and machinery of CA by farmers and have high authority in the farmers' social network. It can be concluded that pioneer farmers and CA farmers enjoy strong social capital amongst farmers. This means that these two actors possess high social trust, participation, and solidarity in social communities so that they are actively involved in social activities of the village and participate in most important local decision-making. Hence, villagers have a deep trust in them in the use of CA machinery. Also, scientists of ARC were the less important actors for farmers in using CA equipment and machinery. Based on centrality indexes, this actor had low social power in farmers' network and it cannot be considered an effective actor. The research results of Manning (2013), Miller and Mobarak (2015), Ataei and Zamani (2015), and Navarro-Navarro *et al.* (2017) confirm our findings. They believed that pioneer farmers and peer farmers have social power and influence in rural areas and they can change other farmers' mindset. Key functions, key actors, and their main results are presented in Table 3.

CONCLUSIONS

Farmers' social interactions always improve the trust and participation among social actors. Development of social interactions will create a social network. The transfer and sharing of knowledge and information between farmers and actors is facilitated by a social network. In the social network, most farmers communicate with actors who are trustworthy. Farmers communicate with actors who have more social influence. Therefore, recognizing key actors in rural society can play an important role in agricultural development. The principles of sustainable agriculture can be transferred to the farmers faster by recognizing key actors. This study was conducted to analyze the social interactions of farmers in implementing CA in Iran. In general, the findings showed that pioneer farmers were the main actors in the farmers' social network. Meanwhile, farmers referred to the pioneer farmers to implement six CA activities (from seven activities). In other words, pioneer farmers had the main social power in applying CA principles by farmers and they were the main centrality of the farmers' social network. Therefore, it can be concluded that pioneer farmers are able to influence the flow of information resources among other actors because they have a variety of information sources through out-group links.

The CA farmers were the second source of information on farmers' social network. Farmers referred to the CA farmers to apply four CA activities (crop rotation, crop residue management, no-tillage/low tillage and using the equipment and machinery of CA). It can be concluded that the farmers who participated in CA project had high reputation and authority. They take power on the farmers' social network based on the number of relationships they receive from or send to other people on the network and they grasp the control of other farmers. The family members were the third active actor in using CA principles in the farmers' social network. Finally, it can be concluded that pioneer farmers, farmers who participated in CA project, and family members formed the main three vertices of the farmers' social network in the CA project. These actors are the main source of exchange and transfer of knowledge and information to farmers and they

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Table 3. Key functions and actors and their main results.

No.	Key function	Key actors	Main results
1	Crop rotation	- Pioneer Farmers - CA Farmers - Family Members	- Leader in selection of appropriate cropping pattern.
2	Crop residue management	- Pioneer Farmers - CA Farmers - Scientists of ARC	- Maintain crop residue on the soil surface - Avoiding the burning of crop residue
3	No-tillage/ low tillage	- Pioneer Farmers - CA Farmers - Family Members	- Reducing soil disturbance and erosion - Traffic control for agricultural machinery - Reduction soil compaction
4	Choosing irrigation methods	- Pioneer Farmers - Private Advisory Services Experts - Family Members	- Using new irrigation methods by farmers - Using wide ridge
5	Applying seeds	- Pioneer Farmers - Rural Cooperative - Family Members	- Using improved varieties in their farms
6	Pest, weed and diseases control	- Private Advisory Services Experts - Pioneer Farmers - Extension Agents	- Controlling pest, weed and diseases by applying integrated pest and weed management and crop rotation - Using the green manure
7	Using equipment and machinery	- Pioneer Farmers - CA Farmers - Family Members	- Providing equipment and machinery of CA system - Choosing suitable machinery for applying CA principles

are considered by the farmers as reliable sources of information. It means that they have high social power and strong social influence among farmers. Therefore, it can be concluded that farmers are more likely to interact with local actors, and they interact less with government and actors outside the rural community (extension agents, scientists of Jihad-e agricultural research centers and private consulting service experts). However, extension agents are the executive arm of the government in rural areas and are considered to be the bridge between farmers and the government and should interact with farmers to a greater extent to exchange new information and knowledge. It was found that social interactions to use more CA principles are mostly established by social communities and that actors outside the village have minor roles. It can be argued that the external actors lack the solidarity in farmers' social network for the adoption of CA principles. Thus, the information of the external actors is not shared easily and its dissemination is hindered by such obstacles as unsuccessful experience in conducting agricultural plans in the villages, poor educational-extension programs, unavailability of technical infrastructure, poor social capital between local communities and institutions, low diversity in the use of information transfer methods, etc. Therefore, it is recommended that public and private sector actors (such as extension agents and private consulting service experts) get involved more in various projects to build trust in rural communities. Increasing trust among farmers will increase the social influence of actors and it will facilitate the sharing of information and knowledge in the farmers' social network.

In general, to implement CA, social powers should be identified first and project management be organized through them. Social network analysis is one way to identify the key actors. Only social powers are among the farmers who can organize the network between farmers. Social powers and local leaders are key elements for the development of sustainable agriculture and CA adoption. The central power of social network will contribute to decisions to

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apply the principles of sustainability, and farmers' compatibility capacity will be strengthened. In addition to local social powers, public and private actors will strengthen farmers' trust.

REFERENCES

1. Abbasian, A. R., Chizari, M. and Bijani, M. 2017. Farmers' Views on the Factors Inhibiting the Implementation of Soil Conservation Practices (The Case of Koohdasht Township, Iran). *J. Agri. Sci. Tech*, **19(4):** 797-807.
2. Abdulai, A. -N. and Abdulai, A. 2017. Examining the Impact of Conservation Agriculture on Environmental Efficiency among Maize Farmers in Zambia. *Envir. Dev. Econ.*, **22(2)**: 177-201. doi:10.1017/S1355770X16000309
3. Afzalinia, S., Ziaee, A., Dehghanian, S. E. and Alavimanesh, S.M. 2016. Effect of Conservation Tillage and Irrigation Methods on Water Productivity and Wheat Yield in Rotation with Cotton (Case Study in Fars Province). *Eng. Res. Agri. Mecha. Sys.*, **17(66):** 57-70. doi:10.22092/erams.2016.106421
4. Ahmadi, F., Heidari, G. and Shafiee, F. 2017. An Analysis of the Factors Affecting the Use of Information Resources and Communication Channels by ranchers to participate in rangelands rehabilitation and restoration projects (Dehgolan Township). *J. Range Watershed Manag.*, **70(1)**: 31-41. doi:10.22059/jrwm.2017.61964 (In Persian).
5. Alfred Y. and Fagbenro, A. 2006. Perception of Tilapia Farmers on Information Sources in the Coastal Region of Ondo State, Nigeria. In: "*Tilapia: Sustainable Aquaculture from the New Millennium*", (Eds.): Wilfrido, M. and Alfred, Y. *Proceeding of 7th International Symposium on Tilapia in Aquaculture (ISTA) Boca del Rio*. Veracruz, Mexico, **2:** 274- 279.
6. Ataei, P. and Zamani Miandashti, N. 2014. Investigation of Factors Influencing the Implementation of the Recommendations of Research Finding Diffusion-Push Plans by Farmers' Fars Province. *J. Agri. Econ. Dev. Res.*, **45(1)**: 93-106. (in Persian)
7. Ataei, P. and Zamani, N. 2015. Determinants of the Transfer of Sustainability Learning in Agriculture Sector of Iran. *J. Agri. Sci. Tech*, **17(6):** 1437-1447.
8. Ataei, P., Izadi, N. and Yaghoubi Farani, A. 2016. Documentation of Managerial Experiences of Successful Production Cooperatives in Hamedan Province. *Co-Operation Agri.*, **5(18):** 1-28. (in Persian).
9. Azizi Khalkheili, T. and Zamani, G.H. 2009. Farmer Participation in Irrigation Management: The Case of Doroodzan Dam Irrigation Network, Iran. *Agri. Water Manag.*, **96(5)**: 859-865. doi:https://doi.org/10.1016/j.agwat.2008.11.008
10. Bao, H., Zhu, X., Cen, Y., Peng, Y. and Xue, J. 2018. Effects of Social Network on Human Capital of Land-Lost Farmers: A Study in Zhejiang Province. *Soc. Indicators Res.*, **137(1)**, 167-187. doi:10.1007/s11205-017-1592-6
11. Beers, P. J. and Geerling-Eiff, F. 2014. Networks as Policy Instruments for Innovation. *J. Agri. Edu. Ext.*, **20(4)**: 363-379. doi:10.1080/1389224X.2013.846870
12. Behera, U. K., Amgain, L. P. and Sharma, A. R. 2010. *Conservation Agriculture: Principles, Practices and Environmental Benefits*. In: (Eds.): "*Conservation Agriculture"* Behera, U. K., Das, T. K. and Sharma, A. R. Division of Agronomy, Indian Agricultural Research Institute, New Delhi– 110012, PP. 28-41.
13. Blackstock, K. L., Ingram, J., Burton, R., Brown, K. M. and Slee, B. 2010. Understanding and Influencing Behaviour Change by Farmers to Improve Water Quality. *Sci. Total Envir.*, **408(23)**: 5631-5638. doi:https://doi.org/10.1016/j.scitotenv.2009.04.029
14. Borgatti, S. P., Mehra, A., Brass, D. J., and Labianca, G. 2009. Network Analysis in the Social Sciences. *Science*, **323(5916)**: 892–895. doi:10.1126/science.1165821
15. Bowe, C., and der Horst, D. V. 2015. Positive Externalities, Knowledge Exchange and Corporate Farm Extension Services: A Case Study on Creating Shared Value in a Water Scarce Area. *Ecosys. Services*, **15**: 1-10. doi:10.1016/j.ecoser.2015.05.009
16. Carmona, I., Griffith, D. M., Soriano, M. -A., Murillo, J. M., Madejón, E. and Gómez-Macpherson, H. 2015. What do Farmers Mean When They Say They Practice Conservation Agriculture? A Comprehensive Case Study from Southern Spain. *Agri. Ecosys. Envir.*, **213(Suppl. C)**: 164-177. doi:https://doi.org/10.1016/j.agee.2015.07.028
17. Cetin, O. and Bilgel, L. 2002. Effects of Different Irrigation Methods on Shedding and Yield of Cotton. *Agri. Water Manage.*, **54**: 1-15.
18. Choudhary, M., Datta, A., Jat, H. S., Yadav, A. K., Gathala, M. K., Sapkota, T. B. Das, A. K.,

[DOR: 20.1001.1.16807073.2019.21.7.13.4]

Sharma, P. C., Jat M. L., Singh, R. and Ladha, J. K. 2018. Changes in Soil Biology under Conservation Agriculture Based Sustainable Intensification of Cereal Systems in Indo-Gangetic Plains. *Geoderma*, **313**: 193-204. doi:10.1016/j.geoderma.2017.10.041

19. Das, T. K., Saharawat, Y. S., Bhattacharyya, R., Sudhishri, S., Bandyopadhyay, K. K., Sharma, A. R. and Jat, M. L. 2018. Conservation Agriculture Effects on Crop and Water Productivity, Profitability and Soil Organic Carbon Accumulation under a Maize-Wheat Cropping System in the North-Western Indo-Gangetic Plains. *Field Crops Res.*, **215**: 222-231. doi:10.1016/j.fcr.2017.10.021
20. Dhar, A. R., Islam, M. M., Jannat, A. and Ahmed, J. U. 2018. Adoption Prospects and Implication Problems of Practicing Conservation Agriculture in Bangladesh: A Socioeconomic Diagnosis. *Soil Till. Res.,* **176**: 77-84. doi:10.1016/j.still.2017.11.003
21. Faulkner, P. E., Owooh, B. and Idassi, J. 2014. Assessment of the Adoption of Agroforestry Technologies by Limited-Resource Farmers in North Carolina. *J. Ext.,* **52(5)**.
22. Faure, G., Huamanyauri, M. K., Salazar, I., Gómez, C., de Nys, E. and Dulcire, M. 2017. Privatisation of Agricultural Advisory Services and Consequences for the Dairy Farmers in the Mantaro Valley, Peru. *J. Agri. Edu. Ext.*, **23(3)**: 197-211. doi:10.1080/1389224X.2017.1320639
23. Golbaz, S. S., Karamidehkordi, E. and Mojaradi, G. 2015. Information Sources Influencing Soil Testing Innovation Adoption by Grape Farmers in the Khorramdarreh Township. *J. Rur. Dev. Strategies,* **2(2)**: 81-100. doi:10.22048/rdsj.2015.13412 (In Persian).
24. Hedjazi, Y. and Veisi, H. 2007. Contribution of Communication Channels and Information Sources to the Adoption. Fish Farming Innovation in Iran. *J. Ext. Syst.*, **1:** 42-54.
25. Heidari Sarban, V. and Roknoddin Eftekhari, A. 2011. Investigating the Effective Factors in Farmer's Membership in Rural Production Cooperatives in the Form of an Integrated Model of Innovation Dissemination: Case Study of Ardabil Province. *Community Dev. (Rural and Urban Communities)*, **3(1**): 149-168. (in Persian)
26. Hoang, L. A., Castella, J. -C. and Novosad, P. 2006. Social Networks and Information Access: Implications for Agricultural Extension in a Rice Farming Community in Northern Vietnam. *Agri. Hum. Values*, **23(4)**: 513-527. doi:10.1007/s10460-006-9013-5
27. Isaac, M. E., Erickson, B. H., Quashie-Sam, S. J. and Timmer, V. R. 2007. Transfer of Knowledge on Agroforestry Management Practices: The Structure of Farmer Advice Networks. *Ecol. Soc.*, **12(2)**.
28. Izadi, N. and Hayati, D. 2014. Appraising Iranian Maize Growers' Ecological Behavior: Application of Path Analysis. *J. Agri. Sci. Tech*, **16(5):** 993-1003.
29. Jat, R. A., Sahrawat, K. L., Kassam, A. H. and Friedrich, T. 2014. Conservation Agriculture for Sustainable and Resilient Agriculture: Global Status, Prospects and Challenges. In: "*Conservation Agriculture: Global Prospects and Challenges",* (Eds.): Jat, R. A., Sahrawat, K. L. and A. H. Kassam, A. H. CAB International, PP. 1-25.
30. Lal, R. 2013. Climate-Resilient Agriculture and Soil Organic Carbon. *Indian J. Agron.*, **58(4)**: 440-450.
31. Lamb, J. N., Moore, K. M., Norton, J., Omondi, E. C., Laker-Ojok, R., Sikuku, D. N., . . . Odera, J. 2016. A Social Networks Approach for Strengthening Participation in Technology Innovation: Lessons Learnt from the Mount Elgon Region of Kenya and Uganda. *Int. J. Agri. Sust.*, **14(1)**: 65-81. doi:10.1080/14735903.2015.1025479
32. Li, N., Wang, L., Ruan, L., Chen, W. and Wang, N. 2003. Farmers' Attitude Towards Two Communication Channels. *Manag. Agri. Sci. Tech.*, **2**: 19-22.
33. Lubell, M., Niles, M. and Hoffman, M. 2014. Extension 3.0: Managing Agricultural Knowledge Systems in the Network Age. *Soc. Nat. Resour.*, **27(10)**: 1089-1103. doi:10.1080/08941920.2014.933496
34. Mafongoya, P., Rusinamhodzi, L., Siziba, S., Thierfelder, C., Mvumi, B. M., Nhau, B. Hove, L., and Chivenge, P. 2016. Maize Productivity and Profitability in Conservation Agriculture Systems across Agro-Ecological Regions in Zimbabwe: A Review of Knowledge and Practice. *Agri. Ecosys. Envir.,* **220(Suppl. C)**: 211-225. doi:https://doi.org/10.1016/j.agee.2016.01.017
35. Manning, L. 2013. A Knowledge Exchange and Diffusion of Innovation (KEDI) Model for Primary Production. *British Food J.,* **115(4)**: 614-631. doi:10.1108/00070701311317883
36. Matuschke, I. and Qaim, M. 2009. The Impact of Social Networks on Hybrid Seed Adoption in India. *Agri. Econ.,* **40(5)**: 493-505. doi:10.1111/j.1574-0862.2009.00393.x

[DOR: 20.1001.1.16807073.2019.21.7.13.4]

37. Mengistie, B. T., Mol, A. P. J., Oosterveer, P. and Simane, B. 2015. Information, Motivation and Resources: The Missing Elements in Agricultural Pesticide Policy Implementation in Ethiopia. *Int. J. Agri. Sust.,* **13(3)**: 240-256. doi:10.1080/14735903.2014.959330
38. Miller, G. and Mobarak, A. M. 2015. Learning about New Technologies through Social Networks: Experimental Evidence on Nontraditional Stoves in Bangladesh. *Mark. Sci.* **34(4):** 480-499. doi:10.1287/mksc.2014.0845
39. Mirzayee, A., Mirdamadi, S. M., Hosseini, S. M. and Sajadi, A. 2011. Effects of Extension Tools and Informational Sources on Participations of Farmers of Golestan Province in Water Users Cooperatives. *Co-Operation Agri.,* **22(5):** 127-145.
40. Mohammed, N., and Lee, B. W. 2014. Role of Cooperatives in Rural Development: The Case of South Nations Nationalities and People Region, Ethiopia. *Dev. Country Stud.,* **4(19):** 32-39.
41. Navarro-Navarro, L. A., Moreno-Vazquez, J. L. and Scott, C. A. 2017. Social Networks for Management of Water Scarcity: Evidence from the San Miguel Watershed, Sonora, Mexico. *Water Alternatives,* **10(1):** 41-64.
42. Ochieng, J., Owuor, G. and Bebe, B. O. 2012. Determinants of Adoption of Management Interventions in Indigenous Chicken Production in Kenya. *Afri. J. Agri. Resour. Econ.,* **7(1):** 39-50.
43. Opara, U. N. 2008. Agricultural Information Sources Used by Farmers in Imo State, Nigeria. *Info. Dev.* **24(4):** 289-295. doi:10.1177/0266666908098073
44. Peng, G. 2002. The Role of Mass Media in the Diffusion of Agricultural Technologies. *Sci. Tech. Progress Policy*, **8:** 84-85.
45. Powlson, D. S., Stirling, C. M., Thierfelder, C., White, R. P. and Jat, M. L. 2016. Does Conservation Agriculture Deliver Climate Change Mitigation through Soil Carbon Sequestration in Tropical Agro-Ecosystems? *Agri. Ecosys. Envir.,* **220(Suppl. C):** 164-174. doi:https://doi.org/10.1016/j.agee.2016.01.005
46. Pratiwi, A. and Suzuki, A. 2017. Effects of Farmers' Social Networks on Knowledge Acquisition: Lessons from Agricultural Training in Rural Indonesia. *J. Econ. Structures,* **6(1):** 8. doi:10.1186/s40008-017-0069-8
47. Ramirez, S., Dwivedi, P., Ghilardi, A. and Bailis, R. 2014. Diffusion of Non-Traditional Cookstoves across Western Honduras: A Social Network Analysis. *Ener. Policy,* **66(Suppl. C):** 379-389. doi:https://doi.org/10.1016/j.enpol.2013.11.008
48. Ramirez-Sanchez, S. and Pinkerton, E. 2009. The Impact of Resource Scarcity on Bonding and Bridging Social Capital: The Case of Fishers' Information-Sharing Networks in Loreto, BCS, Mexico. *Eco. Soc.,* **14(1):** 22.
49. Ransom, J. K., Paudyal, K. and Adhikari, K. 2003. Adoption of Improved Maize Varieties in the Hills of Nepal. *Agri. Econ.,* **29(3):** 299-305. doi:https://doi.org/10.1016/S0169-5150(03)00057-4
50. Raya, A. B. 2016. The Influence of Social Network Structure on the Farmer Group Participation in Indonesia. *Asian Soc. Sci.,* **12(3):** 119-129. doi:10.5539/ass.v12n3p119
51. Reed, B., Chan-Halbrendt, C., Tamang, B. B. and Chaudhary, N. 2014. Analysis of Conservation Agriculture Preferences for Researchers, Extension Agents, and Tribal Farmers in Nepal Using Analytic Hierarchy Process. *Agri. Syst.,* **127(Suppl. C):** 90-96. doi:https://doi.org/10.1016/j.agsy.2014.01.007
52. Rehman, F., Muhammad, S., Ashraf, I., Mahmood, K., Ruby, T. and Bibi, I. 2013. Effect of Farmers' Socioeconomic Characteristics on Access to Agricultural Information: Empirical Evidence from Pakistan. *J. Anim. Plant Sci.,* **23(1):** 324-329.
53. Safi Cis, Y., Karamidehkordi, E. and Hosseini, S. M. 2014. Analyzing the Social Capital of Actors and Information Sources of Agricultural Innovation Systems in Adopting Innovations by Farmers: An investigation in the Shabestar Township of the East Azarbayejan Province. *Agri. Ext. Edu. Res., 7***(26):** 35-50. (in Persian)
54. Salpeteur, M., Patel, H. H. R., Molina, J. L., Balbo, A. L., Rubio-Campillo, X., Reyes-García, V. and Madella, M. 2016. Comigrants and Friends: Informal Networks and the Transmission of Traditional Ecological Knowledge among Seminomadic Pastoralists of Gujarat, India. *Eco. Soc.,* **21(2).** doi:10.5751/ES-08332-210220
55. Scott, J. 2017. *Social Network Analysis: A Handbook.* Fourth Edition, SAGE Publications, London.
56. Seeniang, P. and Thaipakdee, S. 2013. Key Success Factors and Constraints of Organic Vegetable Production Systems in Thailand: Lessons Learned from Selected Cases of Best Practices. *Kasetsart J. Soc. Sci.,* **34(1):** 162-170.
57. Shin, Y. H. and Hancer, M. 2016. The Role of Attitude, Subjective Norm, Perceived Behavioral Control, and Moral Norm in the

[DOR: 20.1001.1.16807073.2019.21.7.13.4]

Intention to Purchase Local Food Products. *J. Foodservice Bus. Res.*, **19(4):** 338-351.
58. Sims, B. G., Thierfelder, C., Kienzle, J., Friedrich, T. and Kassam, A. 2012. Development of the Conservation Agriculture Equipment Industry in Sub-Saharan Africa. *Appl. Eng. Agri.*, **28(6):** 1-11. doi:https://doi.org/10.13031/2013.42472
59. Singh, V. P., Barman, K. K., Singh, R. and Sharma, A. R. 2015. Weed Management in Conservation Agriculture Systems. In: "*Conservation Agriculture"*, (Eds.): Farooq, M. and Siddique, K. H. M. Springer International Publishing, Cham, PP. 39-77.
60. Solano, C., León, H., Pérez, E. and Herrero, M. 2003. The Role of Personal Information Sources on the Decision-Making Process of Costa Rican Dairy Farmers. *Agri. Syst.*, **76(1):** 3-18. doi:https://doi.org/10.1016/S0308-521X(02)00074-4
61. Spielman, D. J., Davis, K., Negash, M. and Ayele, G. 2011. Rural Innovation Systems and Networks: Findings from a Study of Ethiopian Smallholders. *Agri. Hum. Values*, **28(2):** 195-212. doi:10.1007/s10460-010-9273-y
62. Sun, L., Wang, S., Zhang, Y., Li, J., Wang, X., Wang, R., Lyu, W. Chen N. and Wang, Q. 2018. Conservation Agriculture Based on Crop Rotation and Tillage in the Semi-Arid Loess Plateau, China: Effects on Crop Yield and Soil Water Use. *Agri. Ecosys. Envir.*, **251:** 67-77. doi:10.1016/j.agee.2017.09.011
63. Tang, Y., Wang, D. and Xie, W. 2004. A Study of Farmers' Preference for Information Channels in Impoverished Areas of China. *J. Agri. Tech. Econ.*, **2:** 28-33.
64. Tatlonghari, G., Paris, T., Siliphouthone, I. and Suhaeti, R. 2012. Seed and Information Exchange through Social Networks: The Case of Rice Farmers of Indonesia and Lao PDR. *Soc. Mind*, **2(2):** 169-176.
65. Tirol-Padre, A., Rai, M., Kumar, V., Gathala, M., Sharma, P. C., Sharma, S., Nagar, R. K., Deshwal, S. Singh, L. K., Jat, H. S., Sharma, D. K., Wassmann, R., and Ladha, J. 2016. Quantifying Changes to the Global Warming Potential of Rice Wheat Systems with the Adoption of Conservation Agriculture in Northwestern India. *Agri. Ecosys. Envir.*, **219(Suppl.C):** 125-137. doi:https://doi.org/10.1016/j.agee.2015.12.020
66. Utaranakorn, P. and Yasunobu, K. 2016. The Mutual Influence of Managerial Ability and Social Networks of Farmers on Participation in an Organic Vegetable Group in Khon Kaen Province, Thailand. *Kasetsart J. Soc. Sci.* **37(3):** 127-131. doi:10.1016/j.kjss.2016.08.001
67. Valente, T. W. 2010. *Social Networks and Health: Models, Methods and Applications*. Oxford University Press, Oxford, UK.
68. Wall, P. C. 2007. Tailoring Conservation Agriculture to the Needs of Small Farmers in Developing Countries. *J. Crop Improvement*, **19(1-2):** 137-155. doi:10.1300/J411v19n01_07
69. Ward, P. S., Bell, A. R., Droppelmann, K. and Benton, T. G. 2018. Early Adoption of Conservation Agriculture Practices: Understanding Partial Compliance in Programs with Multiple Adoption Decisions. *Land Use Policy*, **70:** 27-37. doi:10.1016/j.landusepol.2017.10.001
70. Wassmann, R., Jagadish, S. V. K., Sumfleth, K., Pathak, H., Howell, G., Ismail, A., Serraj, R., Redona, E., Singh, R. K., and Heuer, S., 2009. Chapter 3 Regional Vulnerability of Climate Change Impacts on Asian Rice Production and Scope for Adaptation. *Adv. Agron.*, **(102):** 91-133.

[DOR: 20.1001.1.16807073.2019.21.7.13.4]

تحلیل تعاملات اجتماعی کشاورزان برای به‌کارگیری اصول کشاورزی حفاظتی در ایران (کاربرد تحلیل شبکه اجتماعی)

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چکیده

اجرای طرح کشاورزی حفاظتی یک فرآیند مشارکتی چندگانه است که کنشگرانی از محققان کشاورزی، مروجان، شرکت‌های مشاوره‌ای خصوصی، کشاورزان پیشرو، تعاونی‌های روستایی، اعضای خانواده، سایر کشاورزان و غیره در آن درگیر هستند. تعاملات اجتماعی بین کشاورزان و کنشگران منجر به توسعه کشاورزی حفاظتی می‌شود. بنابراین، این پژوهش به تحلیل ساختار شبکه اجتماعی و ویژگی‌های کنشگران گوناگون با استفاده از تحلیل شبکه اجتماعی در هفت مرحله به‌کارگیری کشاورزی حفاظتی در ایران پرداخته است. نمونه تحقیق از کشاورزان مشارکت‌کننده در طرح کشاورزی حفاظتی در سه استان فارس، گلستان و خوزستان تشکیل شده بود (n= ۱۳۳). ابزار پژوهش، پرسشنامه‌ای بود که به‌صورت ماتریکس طراحی گردید. یافته‌ها نشان داد که کشاورزان پیشرو، کشاورزان مشارکت‌کننده در طرح کشاورزی حفاظتی و اعضای خانواده کنشگران اصلی در شبکه اجتماعی کشاورزان بودند. می‌توان نتیجه گرفت که این کنشگران قدرت اجتماعی اصلی در به‌کارگیری اصول کشاورزی حفاظتی توسط کشاورزان و مرکزیت اصلی شبکه اجتماعی کشاورزان بودند. این بدان معناست که، کشاورزان بیش‌تر تمایل دارند با کنشگران محلی ارتباط برقرار کنند و تعامل کم‌تری با کنشگران دولتی و کنشگران خارج از جامعه روستایی دارند. بنابراین، می‌توان پیشنهاد داد که قدرت‌های اجتماعی بایستی شناخته شوند و مدیریت طرح‌ها از طریق آنها سازمان‌دهی گردد.

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