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Harvesting resilience: the role of social capital in driving adaptive behaviour among Iranian farmers

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ABSTRACT

Climate change is a global challenge affecting human health, livelihood, and food security, and poses a serious threat to agriculture. Adaptation measures are needed to mitigate climate change impacts. Social capital offers a perspective on differences in adaptation to climate change. Nevertheless, the fundamental role of social capital in agricultural adaptation isn't fully understood. Therefore, this study investigates how social networks, norms, participation, trust, solidarity, beliefs and risk perception affect adaptation among Iranian farmers. Survey data were collected from 250 farmers randomly selected in Susangerd city, Khuzestan Province, Iran. An integrated model combining social capital, beliefs, and risk perceptions is used. Structural equation modelling results show the model explained 69% of the variance in adaptation behaviour and 66% and 40% of the variances in risk perception and climate beliefs, respectively. Such results demonstrate the robustness of the model in predicting adaptation strategies. Based on the findings, social solidarity and climate beliefs were the most effective predictors of risk perception, while farmers' social networks were the most important predictors of behaviour. This study, by confirming the importance of social capital on the farmers' beliefs, risk understanding and adaptation behaviour, offers suggestions for fostering and implementing more practical adaptation strategies.

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Adaptation strategies; participation; social solidarity; social network; social trust; climate adaptation/or climate change

Highlights

- Introduces a comprehensive model intertwining social capital, climate change beliefs and risk perceptions to predict adaptive behaviours
- Reveals that strong social solidarity and networks significantly boost adaptive actions
- Demonstrates how beliefs in climate change and heightened risk perceptions drive proactive adaptation
- Surprisingly finds that social trust, while important, does not directly influence adaptation behaviours.

1. Introduction

Climate change is a crucial ecological and social challenge in the twenty-first century and beyond, and has already caused severe and irreversible damage to development (Wang et al., 2020). The agriculture sector is one of the first systems to be influenced by climate change due to its direct dependence on climatic conditions such as temperature and precipitation (Ali et al., 2017; Mendelsohn, 2014; Pakmehr et al., 2021). It is predicted that by 2080, global agricultural production will decrease between 3 and 16 per cent due to climate change effects, and there will be an average of 10–25 per cent reduction in agricultural productivity in developing countries (IPCC, 2014). In addition, climate change through increasing production costs, loss of farmers' income and an increase in the seasonal unemployment rate, affects socio-economic conditions and the livelihood of people and communities that are dependent on agriculture (Chenani et al., 2021;Islam et al., 2014), and on a large scale, can have multiple devastating effects, including an increase of destitution and hunger, food insecurity and conflict risks, thus representing a great threat to humans and the environment (Leonard, 2022).

Adaptation to climate change and its effects is a complementary response to reducing vulnerability, in particular, in agriculture-based economies (Assefa & Haile, 2021). Some adaptation strategies of farmers include applying highly resistant cultivars, protecting soils, modifying planting schedules, integrating trees on property, increasing fertilization, ensuring agricultural products, and improving field irrigation (Belay &

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Fekadu, 2021; Delfiyan et al., 2021). However, farmers encounter many problems in selecting the best-fitting strategies for their lands (Clar & Steurer, 2019) because the choice of adaptation behaviours is influenced by a multifaceted set of subjective and objective factors. Such factors take the shape of (i) demographic and economic drivers (Dang et al., 2019; Pauw, 2013; Shiferaw, 2014), (ii) resources, services and technologies drivers (Antwi-Agyei et al., 2015; Dang et al., 2019), (iii) institutional and political drivers (Dang et al., 2019; Shiferaw, 2014), (iv) socio-cultural drivers (Dang et al., 2019; Jones & Boyd, 2011; Nielsen & Reenberg, 2010) and finally (v) cognitive and psychological drivers (Boazar et al., 2019; Kuehne, 2014;Truelove et al., 2015). As Greene (2018) contends, most research on adaptation strategies tends to focus on objective drivers, including personal characteristics and economic, resource and technology and formal and political drivers. As a result, subjective drivers such as cognitive and psychological factors (Dang et al., 2019; Zobeidi et al., 2021) and socio-cultural values in adapting to climate variabilities are more often neglected. Extant findings (Nguyen et al., 2016; Wuepper et al., 2020) have demonstrated that adaptive behaviour is a process involving value and belief systems, attitudes and perceptions, personalities, people's motivations, goals and culture and without considering socio-psychological variables, studies will not be able to identify farmers' behaviours about climate change.

Amongst psychological drivers, beliefs about climate change and risk perceptions are identified in the literature as a basis for predicting the formation of individual behaviours and adaptation (Arbuckle et al., 2015; Mase et al., 2017). This makes it critically essential to study beliefs about climate change and risk perception as two fundamental constructs in the context of climate change adaptation. One important socio-cultural driver is social capital. As researchers (see Belay & Fekadu, 2021; Fletcher et al., 2020; Saptutyningsih et al., 2020) have noted, social capital has played a pivotal role in farmers' selection of climate change adaptation strategies. In the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2014), social capital was explicitly introduced as an asset that enhances adaptation capacity. Social capital facilitates collective actions and consequently is assumed as a significant supporter for challenges beyond an individual's capacity (Paul et al., 2016). Social capital provides psychological support in crisis contexts (Panahi & Moayerian, 2025). Furthermore, social capital is tremendously effective in rural communities, where formal support is either provided at a distance or is completely absent; subsequently, neighbours often rely upon one another (Buck-McFadyen et al., 2019).

The notion of social capital is vital in understanding common resources (Ballet et al., 2007). Social capital is associated with diverse aspects such as economic development and growth, health, policy and environmental management (Tiwari et al., 2019; Wu & Liu, 2020). For instance, Wu and Liu (2020) demonstrated that in ecological protection projects, social capital can help land management and not only promote rural living standards and income levels, but also improve ecosystem services and attract foreign investments as well as urban tourists. Likewise, Michelini (2013) research states that apart from social benefits and the importance of social capital in creating suitable organizational performance, social capital is also key to economic performance, reduction of costs, improvement in the flow of information and resolution of conflicts, an increase in other forms of capital and the development of interest in work and innovation. In this regard, social capital is considered an indicator of society's communication and social norms that also affect people's environmental behaviour (Miller & Buys, 2004).

Social norms and standards are considered important components of social capital. Norms can often have either a negative or positive effect on individuals' environmental behaviours. In fact, social norms are crucial in shaping behaviour. In rural societies, social capital is not only about collective tasks like repairing barns, harvesting crops or building bridges, but also about fostering values that hold the community together, such as mutual trust and willingness to collaborate and community solidarity against external problems (Fletcher et al., 2020). Therefore, it is vitally important to pay attention to social capital to increase farmers' adaptability to climate change (Wang et al., 2021). Generally, it is essential to enhance knowledge on the variety of drivers that determine the success of adaptation strategies to improve their success and to facilitate better planning of inventions in agricultural extension and development and improving adaptation policies (Wuepper et al., 2020). Nonetheless, the role of social capital as a determinant of successful behaviour adaptation is still understudied (Thamaga-Chitja & Tamako, 2017).

It is noteworthy that climate change has had a wide impact on agriculture in Khuzestan Province, Iran. It has contributed to reduced yields of strategic crops such as wheat, rice, and dates (Baninaimeh, 2024) as well as a decrease in economic profit (Karimifard et al., 2018). People in this province, and particularly the city of Susangerd, have demonstrated an acceptable level of social capital (Abiyat Jomee, 2019). The question is whether social capital could affect farmers' adaptation behaviour in this city using an integrated model encompassing beliefs and risk perception. To the best of the authors' knowledge, no research has been conducted investigating this issue in this region. Therefore, this study aims to address the identified gaps by analysing the impacts of social capital on farmers' adaptation behaviour using an integrated model encompassing beliefs and risk perception in the city of Susangerd, Khuzestan Province, Iran.

This study has the potential to contribute valuable insights into the role of social capital for improved future design of adaptation policy with effective and sustainable performance, because dealing effectively with the impacts of climate change requires collaboration between the public, experts and governments to develop and implement appropriate policy responses. This study is a reference for formulating and implementing adaptation behaviours more effectively for vulnerable agrarian communities in developing countries and shall help to foster the design of agricultural extension and educational interventions.

2. Theoretical framework

A widely used approach to explain individual behaviour in the field of economic psychology is the Theory of Planned Behavior (TPB) introduced by Ajzen in 1985. TPB suggests that the

intention of a behaviour plays as a mediator role of attitude (individual beliefs with respect to the outcome of behaviour), subjective norms (individual perception of social pressure), and perceived control (an individual's opinion about their ability to carry out a particular behaviour). Applying in agricultural studies, the literature has highlighted some of its shortcomings because it only focuses on cognitive constructs, excluding the effect of the farmers' environment and their interaction with the community (Yazdanpanah et al., 2022a, 2022b; Yazdanpanah et al., 2024). To fill this gap, in this study, beliefs, risk perception and adaptation behaviour were used as parts of the researchers' modified TPB mixing with social capital as a predictor of adoption behaviour (Figure 1). In the following, after defining social capital and its aspects, the relationship between social capital, beliefs, risk perception and adaptation behaviour is explained. Consequently, the hypotheses and research framework are presented in this section. Social capital is a characteristic based on the interaction between individuals and groups, which encompasses trust, mutual relations, collective identity, cooperation and a sense of partnership between individuals, which aids in contributing to the performance of a specific behaviour. Whilst definitions of social capital vary, three primary dimensions can be identified as common components: (i) social networks, (ii) trust and participation and (iii) belief systems, values and norms that enable cooperation and coordination of people to attain anticipated objectives and joint benefits (Yazdanpanah et al., 2022a, 2022b). It can be used to increase livelihoods or track shared objectives (Valenzuela et al., 2020). Accordingly, social capital is a relationship enabling individuals to acquire shared values and norms, as well as trust, information, knowledge and resources, through social networks are for people (Savari et al., 2023). Acter et al. (2020) have also examined new dimensions of social capital, namely social solidarity in their study. Therefore, to widely investigate the effect of social capital on adaptation strategies, in this research, five components, including social networks, social trust, social norms, social participation and social solidarity, are integrated within our research framework.

Social networks are the basis of social capital and one of the main drivers of individual thought and performance (Bian et al., 2018). According to Dapilah et al. (2020), these networks are defined as a group of people or organizations that form a set of relationships, which, in turn, are defined by patterns of horizontal and vertical relationships. Social networks consist of formal and informal networks (Bian et al., 2018). Formal networks are typically established through connections between individuals and members of social groups, voluntary associations and non-governmental organizations, which can be measured by group relations (Wang et al., 2021). Informal networks reflect interactions between people and their communities, including friendships, kinships and neighbourhood interactions (Ma, 2015).

In recent years, the role of social networks has absorbed more attention in climate change research. Indeed, social networks not only improve the capability of farmers to adjust to climate change but also provide opportunities for underprivileged or marginalized people to find new ways to deal with climate change (Dapilah et al., 2020; MacGillivray, 2018; Wang et al., 2021). Through social networks, people can share their knowledge, skills and experience and then spread perceived risks and claim reciprocity in times of crisis. The better social networks households have, the more opportunities they must participate in various activities (Zigale, 2021).

Research has also demonstrated that social networks influence risk perception during disasters. In fact, the social network can act as a platform for group information exchange and can scatter information concerning disaster dangers employing reliable sources, and consequently the performance of campaigns, seeking to effectively communicate risks (Babcicky & Seebauer, 2017; Islam & Walkerden, 2015; Wan & Du, 2022).

Studies have also revealed that these significant sources of information (e.g. social networks) affect individuals' beliefs about climate change by increasing access to information (Leiserowitz, 2006). Jooste et al. (2018) point out that risk is an internal feeling and a bottom-up approach. These internal feelings can be thought of as individuals' true beliefs. Since social networks reflect interactions among people, the belief in the existence of risks such as climate change risk also occurs when it is created in a social network. Research by Ni et al. (2021) shows that social networks can have positive effects on people's beliefs about carrying out the right thing. Therefore, the first three hypotheses of the study include the following:

H1: Social networks have a positive effect on farmers' beliefs in climate change.

H2: Social networks among farmers have a positive effect on risk perception of climate change.

H3: Social networks have a positive effect on the adaptation behavior of farmers to climate change.

Social trust is another fundamental and key component of social capital (Bouma et al., 2008). Trust relies on common norms and values, resulting in expectations of common behaviour in a society (Svendsen & Svendsen, 2000). Accordingly, social trust is defined as a belief on which people trust in other members of society (Bakker & Dekker, 2012). It also refers to following and obeying with calmness and assurance from others in relation to something beyond one's knowledge and ability (Dutcher, 2015). Social trust is considered a precondition for persons to cope with social problems and take cooperative action to accomplish commonly advantageous outcomes (MacGillivray, 2018). It is an integral part of social life because it is the foundation of a dynamic society, social participation, effective governance, economic productivity and risk management, which cannot be realized without trust among participating members (Lee, 2013).

Relating to climate change adaptation, previous research shows that in societies with high levels of trust, people's pro-environmental behaviours have a greater impact on other societal members compared to societies with lower trust levels. Social trust can help each side confirm the correctness and rationality of environmentally friendly behaviours, remove barriers to information exchange and cooperation between people, improve individual understanding of environmental knowledge and risks and deepen public understanding of

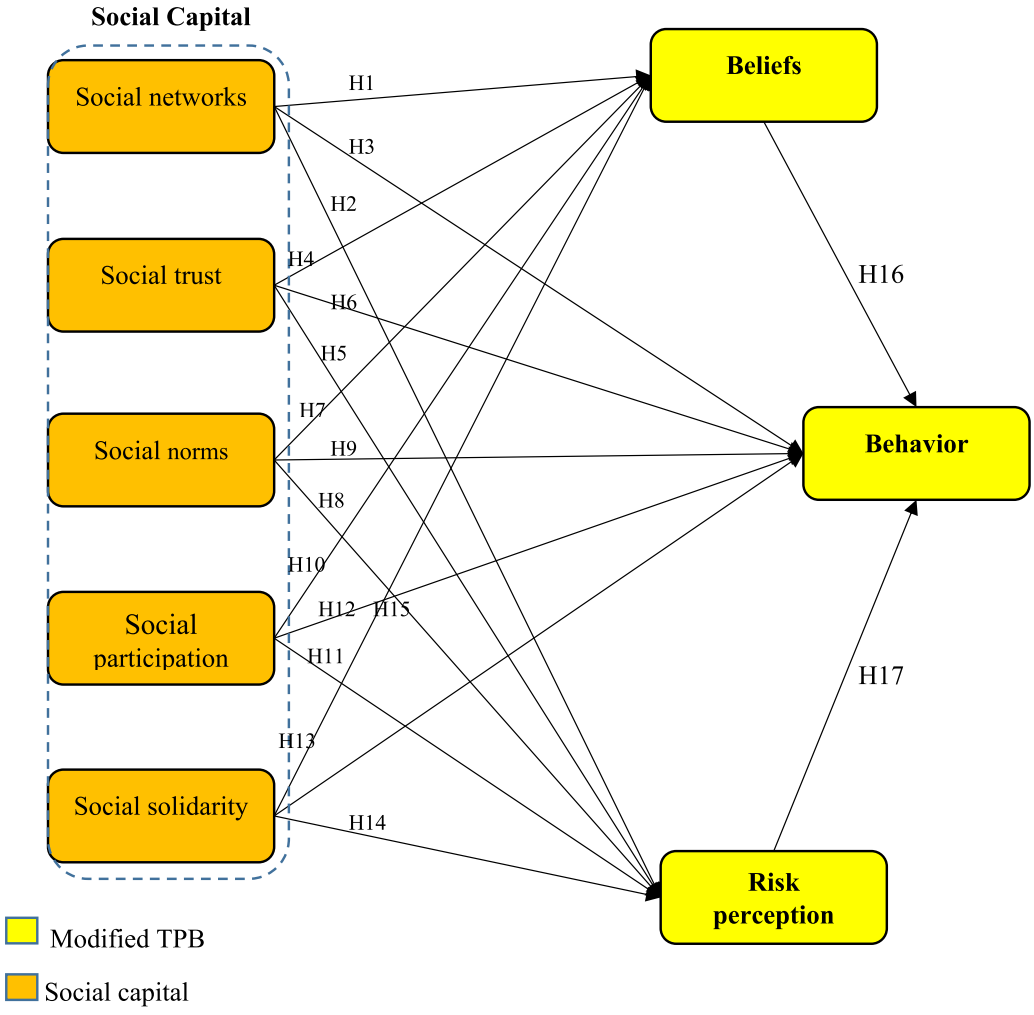

Figure 1. Research Framework: Integrating the Theory of Planned Behavior (TPB) and social capital.

pro-environmental behaviours (Wan & Du, 2022). Therefore, social trust can play an effective role on climate change adaptation behaviour (Gong et al., 2018; Saptutyningsih et al., 2020; Wang et al., 2021) and risk perceptions among farmers (Babcicky & Seebauer, 2017; Gong et al., 2018; Wang et al., 2021). A high correlation between social trust and people's beliefs in climate change has also been observed (Singh, 2015). Research indicates that farmers with a high level of trust in their information sources about climate change have stronger beliefs in the occurrence of climate change and that the primary cause of climate change is human-induced (Arbuckle et al.,2015). Therefore, it is expected that:

H4: Social trust has a positive effect on farmers' beliefs in climate change.

H5: Social trust has a positive effect on farmers' risk perception of climate change.

H6: Social trust has a positive effect on farmers' adaptation behaviours

Social norms are another core component of social capital created in a specific context over time, by the general understanding of mandatory, permitted and prohibited behaviours (Neef et al., 2018). It refers to social contracts that are shaped through the collaboration of fellows living in a network of associations. Social norms can successfully limit and regulate the behaviour of individuals or groups, improve social trust and mutual collaboration (Tiwari et al., 2019). While there is still no single definition for social norm, Wang et al. (2021) consider social norm to be based on the social culture of behavioural codes or customary principles and rules that influence people's behaviours and attitudes (Saptutyningsih et al., 2020).

In various studies, the importance of using social norms to encourage pro-environmental behaviour has been highlighted (Farrow et al., 2017; Nisa et al., 2019; Wolske et al., 2020). Social norms among farmers are considered important for the implementation of conservation methods and technologies (Mase et al., 2017; Morton, 2008; Reimer et al., 2014). Also, the effect of social norms on risk perception regarding climate change has been evaluated positively (Abrahamse & Steg, 2013; Yu et al., 2019). As an example, a survey in Australia revealed that social norms can lead to behaviours of flood mitigation. In other words, Lo (2013) showed that social norms with both direct and indirect effects through the perceived risks can propel adaptation behaviours.

Van der Linden (2015) demonstrated that the effect of social norms on the risk perception of climate change is very strong. This research showed that the greater one perceives

that their social referents (i.e. friends and family) consider climate change as a risk, the more they themselves will perceive the threats of climate change and its effects. This is supported by the work of Goldberg et al. (2020), who investigated the role of social norms in one's close social group, such as family and friends. The results of their research indicated that those who think that most of their friends and family believe in climate change, most likely believe in climate change and adapt their behaviours to mitigate climate change. Therefore, it is expected that:

H7: Social norms have a positive effect on farmers' beliefs in climate change.

H8: Social norms have a positive effect on farmers' risk perception.

H9: Social norms have a positive effect on farmers' adaptation behaviours to climate change.

Social participation is an organized process undertaken by community members that leads to the creation of a spirit of empathy and cooperation between individuals. It can also advance development processes (Nummela et al., 2008). Different degrees of participation are possible, ranging from pseudo-participation, information, and consultation to ownership (Arnstein, 1969; Collins & Ison, 2009). Participation is a key component for analysing and designing development interventions. Furthermore, overall participation allows people to interact, create networks to disseminate information and provide a place to build trust among group members (Witvorapong et al., 2015). Torres et al. (2020) acknowledge that moving towards higher degrees of participation is necessary when planning for climate change. As some researchers (e.g. Saptutyningsih et al., 2020; Su et al., 2021) have demonstrated, social participation has a positive and significant effect on the behaviour of adapting to climate change. Improving social participation can also affect individuals' beliefs about pro-environmental behaviour, enable them to influence social interactions, strengthen the perception of environmental risks and simultaneously foster pro-environmental behaviours by promoting their sense of responsibility and cultivating their mental awareness (Wan & Du, 2022). Therefore, it is hypothesized that:

H10: Social participation has a positive effect on farmers' beliefs in climate change.

H11: Social participation has a positive effect on farmers' risk perception.

H12: Social participation has a positive effect on farmers' adaptation behaviours to climate change.

Solidarity is another element of social capital (Acter et al., 2020). In its most basic form, it may be defined as individuals' willingness to participate and cooperate with their peers (Nguyen, 2020). As Woosnam (2013) contends, outpouring from solidarity is the sentiment of 'we togetherness.' In other words, the construct can be considered the characteristics that protect the society against disintegration (Cloete, 2015) and refer to the vertical and horizontal relationships between the members of the society (Koehler, 2021).

Solidarity is created by spending time, effort and money to develop and strengthen collective action to achieve a better result for a particular group (Acter et al., 2020). Social solidarity is a complex and dynamic process (Nguyen, 2020) that includes strong social relationships, shared values, a sense of identity and a sense of belonging to a particular community (Koehler, 2021). In relation to climate change, social solidarity has been found to be a tool that can foster more sustainable actions and unity in a fight against a crisis (Hereth, 2022). As Acter et al. (2020) revealed, the ability of societies to adapt to climate change depends on the cooperation among the members of that society (Acter et al., 2020). Therefore, social solidarity is a critical factor for climate change adaptation. This is supported by Stoner (2018), who advocates strengthening social solidarity as a solution for transnational cooperation to deal with climate change. Researchers (see Below et al., 2012; Mertz et al., 2009; Okonya et al., 2013) confirmed that social solidarity was integral in engaging in entrepreneurial behaviour (as a form of adaptive behaviour to climate change). Social solidarity also influences the risk perception of people in society. According to van der Veen (2011), social solidarity is based on the degree of individuals' willingness to share information about risks, and their understanding of such risks can be effective in adaptation.

H13: Social solidarity has a positive effect on farmers' beliefs in climate change.

H14: Social solidarity has a positive effect on farmers' risk perception.

H15: Social solidarity has a positive effect on farmers' adaptation behaviours to climate change.

Belief in climate change is a key construct and a vital prerequisite for adapting to climate change, (Dang et al., 2019; Hoogendoorn et al., 2020; Prokopy et al., 2015). Such a belief refers to people's acceptance of the occurrence and impact of climate change (Le Dang et al., 2014), or their consciousness of climate change-related phenomena (Hyland et al., 2016). To take any action to adapt to climate change, farmers must have a consideration of climate change and believe in its existence (Le Dang et al., 2014). Most behavioural models, including Fishbein's (1963) value-expectancy model, Ajzen's (1985) theory of planned behaviour and Stern's (2000) value-belief-norm theory, have also emphasized the fundamental role of belief in predicting people's behaviour (Arbuckle et al., 2015). As noted previously, in this study, beliefs, risk perception and adaptation behaviour were used as parts of the modified TPB, incorporating social capital as a predictor of adoption behaviour. People's beliefs about climate change affect their adaptive behaviour (Li et al., 2017). Huang (2016) finds that people with strong beliefs about environmental changes are more interested in obtaining environmental information and taking environmental protection strategies. Therefore, it is hypothesized:

H16: Farmers' beliefs in climate change have a positive effect on their adaptation behaviour to climate change.

Research on farmers' risk perceptions towards climate change is increasing (Li et al., 2017). Risk perception is a mental construct (Sjöberg, 2000) about the perceived probability of occurrence of a risk, amount, time or consequences of effects of that risk by an individual, group or society (Reser et al., 2012;

Table 1. Constructs and corresponding items with sources constructs and items sources.

	Constructs and items	Sources
Social capita	**Social networks (CR = 0.74, AVE = 0.49, α =0.55)**	
	Local institutions solve the problems of local communities during climate change.	Wang et al. (2021)
	There is good communication between local institutions and regional and national organizations on climate change.	
	Local and regional institutions are looking for cooperation with villagers to deal with climate change.	
	The private sector, government and local institutions have a very good relationship to deal with climate change.	
	Communication between families, relatives and acquaintances is very close among farmers.	
	Social trust (CR = 0.91, AVE = 0.74, α = 0.88)	
	During the change status, people have complete trust in each other.	Wheeler et al. (2017), Yazdanpanah et al. (2022a, 2022b), Savari et al. (2023)
	Rural social institutions have carried out basic activities for rural development during the drought (supplying loans, seeds or equipment).	
	At the time of climate change, living with the people and villagers gives a sense of peace and security.	
	I have complete trust in the villagers for lending and financial aid during climate change.	
	If other villagers need agricultural implements, I will provide them.	
	Social participation (CR = 0.91, AVE = 0.59, α = 0.86)	
	I try to take an active part in the affairs of the village.	Oshio and Kan (2019), Savari et al. (2023)
	I try to give financial and intellectual help during the implementation of the plans to deal with climate change.	
	I interact closely with the council and government institutions to deal with climate change.	
	Participating in solving the problems of the villagers during climate change is enjoyable for me.	
	I always try to mobilize local communities to deal with climate change.	
	Social norms (CR = 0.85, AVE = 0.59, α = 0.76)	
	The social status of people among villagers does not fade during climate change.	Wang et al. (2021)
	Villagers adhere to their traditional and original values during climate change.	
	During climate change, the people of the village do not accept the lack of ethics and philanthropy from others.	
	During the time of climate change, if any problem occurs, the village people will resolve it peacefully.	
	Social solidarity (CR = 0.88, AVE = 0.65, α = 0.81)	
	During current times of climate change, there are more quarrels and conflicts *(Reverse-coded item)*.[a]	Larsen et al. (2020), Savari et al. (2023)
	People voluntarily help each other deal with climate change.	
	During climate change, I feel that the village people do not hesitate to help each other as much as possible.	
	During climate change, I don't need to consult for adaptation strategies (Lack of need in others(*(Reverse-coded item)*.[a]	
	There is no cooperation among residents in choosing strategies to deal with climate change *(Reverse-coded item)*.[a]	
	All the villagers are empathetic towards the development of the region in the conditions of climate change.	
Modified TPB	**Beliefs (CR = 0.84, AVE = 0.65, α = 0.73)**	
	Scattered rains have increased.	Arbuckle et al. (2015)
	I believe we have hotter summers than in the past.	
	I believe that climate change is happening.	
	Risk perception (CR = 0.92, AVE = 0.89, α = 0.73)	
	Climate change has a negative effect on my farm.	Arbuckle et al. (2015), Zobeidi et al. (2021)
	I believe that due to climate change, the harvest of my farm's products will decrease.	
	Climate change will reduce the yield of cereals (wheat, barley, corn, rice).	
	I believe that climate change will reduce fodder and destroy livestock.	
	Behaviour (CR = 0.80, AVE = 0.56, α = 0.80)	
	The use of adapted *crops* and *varieties*	Okonya et al. (2013), Tesfahun and Chawla (2019), Zobeidi et al. (2021)
	No tillage-low tillage	
	The usse of organic fertilizer	
	Crop diversification	
	Changing agricultural operations (planting, holding and harvesting)	

[a]A reverse-coded item is presented on a 5-point Likert scale of agreement; 1 = very much; 5 = very little.

Sjöberg et al., 2004). Studies have demonstrated that risk perception of climate change is a necessary prelude to adopting adaptation strategies (Esham & Garforth, 2013;; Frondel et al., 2017; Li et al., 2017; Mase et al., 2017; Mercado, 2016; Nguyen et al., 2016). Esham and Garforth (2013) investigated the impact of farmers' risk perception on adaptation measures in Sri Lanka and concluded that when farmers understand climate change and consider its effects on their lives, they are more likely to engage in adaptive strategies. Other studies (see Higginbotham et al., 2014; Mase et al., 2017; O'Connor et al., 2005) also revealed that understanding the risks caused by climate change plays a key role in farmers' willingness to include climate information in arriving at decisions. Therefore, it is hypothesized:

H17: Farmers' risk perception has a positive effect on their adaptation behaviours to climate change.

3. Methodology

3.1. Survey procedures and participants

This cross-sectional, survey-based research was undertaken in the city of Susangerd (Dasht-e Azadegan County, Khuzestan Province), in southwestern Iran. This province, with a cultivated area of 1.2 million hectares, annually produces about 13.5% of the total agricultural products of Iran. Khuzestan is one of the most important agricultural hubs in Iran, producing more than 138 types of agricultural products (Agriculture Organization of Khuzestan, 2017). Also, the city of Susangerd is the capital of Dasht-e Azadegan County. It has a hot, dry climate. The economy of this county is mainly based on agriculture and animal husbandry. The fertile soil and abundant water have made this region one of the agricultural poles of the province, providing products such as wheat, barley, rice, corn, sugarcane, and dates. As a result, Khuzestan province (in general) and Susangerd (in particular) have important positions in terms of agriculture and food security. Nevertheless, the province has encountered numerous droughts and a reduction of water resources in recent years due to climate change. Unless farmers adjust their behaviours to adapt to climate change, agricultural output will be jeopardized soon (Yazdanpanah et al., 2024).

The statistical population consisted of 2400 farmers in Susangerd city. Based on the Krejcie and Morgan table, 250 farmers were selected as the sample, applying a random sampling method. Data was collected in July of 2021, asking the farmers to complete a questionnaire … In terms of demographics, farmers were approximately 45 years old on average, ranging from 24 to 73 years. Their average agricultural work experience was roughly 16 years. As far as their level of education was concerned, farmers varied from being illiterate to possessing a master's degree, with an average of seven years of schooling. It is important to note that informed consent for participation in this study was obtained from all participants. Consent was provided verbally by which participants were fully informed about the purpose of the study, their participation was voluntary and they could refuse to continue at any time without penalty.

3.2. Survey instrument

An on-site, self-administered questionnaire was used to collect data and ultimately test research hypotheses. Questions were designed based on existing literature about farmers' adaptation behaviour, farmers' beliefs in climate change, perceived risk and social capital variables. The items in the questionnaire, along with their sources, are shown in Table 1. The content validity of the questionnaire was evaluated using the opinions of a group of experts in environmental sciences, agriculture and hydrology. The reliability and internal homogeneity of the questionnaire were determined using Cronbach's alpha coefficient. As indicated in Table 1, Cronbach's alpha for all constructs revealed acceptable reliability ($\alpha = 0.55$-0.88). It is worth noting that the value of alpha under 0.50 is unacceptable (Schrepp, 2020). Although Cronbach's alpha for social network items was poor (0.55) according to the classification noted by George and Mallery (2003), it could be acceptable as it is over 0.50. Furthermore, Nunnally (1978) states that in the early stages of research, reliabilities ranging from 0.50 to 0.60 are sufficient. The questionnaire contained 37 items (presented on 5-point Likert scales of agreement; 1 = very little; 5 = very much) across eight constructs.

3.3 Data analysis

To evaluate the effects of social capital on the adaptation behaviour of farmers to climate change, the data were analysed using SPSS24 and SmartPLS software. Since research topics in behavioural and social studies tend to involve numerous variables, the multivariate analysis method should be used (Afkhami et al., 2021). Third-generation PLS is a structural equation modelling (SEM) software that is used to examine relations among latent factors measured by observed items. Investigators use this software for its universality and inclusiveness in testing proposed conceptual models (Hair et al., 2014). Further, the software is ideal to use when data (at nominal, ordinal, and interval levels of measurement) are non-normally distributed (Wang et al., 2014). Therefore, the use of PLS is growing in popularity (Hair et al., 2014). SEM allows the investigator to examine a set of regression equations concurrently. SEM includes factor analysis, ordinary correlation analysis, and multivariate regression (Ullman & Bentler, 2012) and is a comprehensive approach for testing hypotheses about relations among latent factors and observable items (Bowen & Guo, 2011).

3.4 Evaluation of measurement model

To determine convergent validity, the calculated average variance extracted (AVE) and composite reliability (CR) should exceed 0.50 and 0.70, respectively. AVE values for each construct except social networks were greater than 0.5. However, according to Fornell and Larcker (1981), if factor composite reliabilities are more than 0.6, AVE values less than 0.5 are acceptable. All CR values were higher than 0.7. In general, the instrument has good convergent validity (Table 2).

Discriminant validity indicates that each construct measures a unique and distinct phenomenon. The Fornell-

Table 2. Discriminant analysis and convergent validity results of Fornell-Larcker.

Constructs	Social network	Social trust	Social norm	Social participation	Social solidarity	Risk perception	Belief	Behaviour
Social network	**0.630**[a]							
Social trust	0.247**	**0.858**[a]						
Social norm	0.552**	0.261**	**0.769**[a]					
Social participation	0.528**	0.255**	0.558**	**0.885**[a]				
Social solidarity	0.553**	0.339**	0.726**	0.389**	**0.810**[a]			
Risk perception	0.540**	0.432**	0.693**	0.598**	0.702**	**0.871**[a]		
Belief	0.502**	0.335**	0.480**	0.473**	0.480**	0.640**	**0.806**[a]	
Behaviur	0.695**	0.326**	0.524**	0.575**	0.582**	0.675**	0.704**	**0.753**[a]

[a]Indicates the square root of AVE for each construct.
**Correlation is significant at the $p < 0.01$ level.

Larcker criterion was used to evaluate discriminant validity for all model constructs. According to this index, discriminant validity exists when construct variances are less than the common variance of each construct (Fornell & Bookstein, 1982). Discriminant validity was examined by calculating the square root of each AVE and then comparing that to the correlation between that construct and other model constructs (Sánchez-Prieto et al., 2017). As shown in Table 2, all model constructs demonstrated discriminant validity according to the Fornell-Larcker criterion.

4. Results

After confirming the reliability and validity of the measurement model, a structural model was conducted to evaluate the predicted variance of the behaviour and the effect sizes for each outcome construct. Structural model estimation results are presented in Table 3.

The initial analysis results revealed that the model has good fit indicators and that the model predicted 69.2% of the change in growers' adaptation behaviour to climate change. In addition, the model predicted 66.5% of the change in risk perception and 40.1% of the variance of beliefs.

Table 3. Structural path analysis results.

Hypothesis	Path coefficient (β)	*t* statistics	
H1: Social network → Belief	0.287	4.256	Supported
H2: Social network → Risk Perception	0.089	1.225	Rejected
H3: Social network → Adaptation Behaviour	0.354	5.805	Supported
H4: Social trust → Belief	0.150	3.003	Supported
H5: Social trust → Risk Perception	0.171	4.804	Supported
H6: Social trust → Adaptation Behaviour	0.000	0.011	Rejected
H7: Social norm → Belief	0.055	0.637	Rejected
H8: Social norm → Risk Perception	0.191	2.656	Supported
H9: Social norm → Adaptation Behaviour	0.150	2.146	Supported
H10: Social participation → Belief	0.192	3.003	Supported
H11: Social participation → Risk Perception	0.267	3.918	Supported
H12: Social participation → Adaptation Behaviour	0.152	2.680	Supported
H13: Social solidarity → Belief	0.154	2.091	Supported
H14: Social solidarity → Risk Perception	0.354	5.290	Supported
H15: Social solidarity → Adaptation Behaviour	0.159	3.084	Supported
H16: Belief → Adaptation Behaviour	0.336	4.737	Supported
H17: Risk Perception → Adaptation Behaviour	0.151	2.300	Supported

Findings demonstrate that social network, with the highest path coefficient, is the strongest predictor of farmers' adaptation behaviour (β = 0.354, $t = 5.805$). These networks also have a significant effect on people's beliefs (β = 0.287, $t = 4.256$) but do not affect farmers' risk perception (β = 0.089, $t = 1.255$). Furthermore, social trust has no direct effect on adaptive behaviour (β = 0.00, $t = 0.011$). This construct has a positive and significant effect on risk perception (β = 0.171, $t = 4.804$) and beliefs about climate change (β = 0.150, $t = 2.003$). It is noteworthy that each aspect of social capital has direct and indirect effects on adaptive behaviour. The direct effect is the path between the aspect of social capital and adaptive behaviour. The indirect effect is the path between the aspect of social capital, beliefs/risk perception and adaptive behaviour.

Social norms have a positive effect on risk perception of farmers (β = 0.191, $t = 2.656$) and adaptation behaviour (β = 0.150, $t = 2.146$) while it has no effect on their beliefs (β = 0.055, $t = 0.637$). At the same time, social participation has a direct effect on risk perception (β = 0.267, $t = 3.918$), beliefs (β = 0.192, $t = 3.003$) and adaptive behaviour (β = 0.152, $t = 2.680$). Examining the effect of social solidarity showed that this construct has a positive effect on risk perception (β = 0.354, $t = 5.290$), beliefs (β = 0.154, $t = 2.091$) and adaptive behaviour (β = 0.159, $t = 3.084$). Ultimately, both beliefs (β = 0.336, $t = 4.737$) and risk perception (β = 0.151, $t = 2.300$) directly affect adaptive behaviour.

The acquired structural model with standardized path coefficients is demonstrated in Figure 2. The supported paths are shown by the black arrows, whereas the rejected ones are depicted by the red dotted arrows.

5. Discussion

The present study aimed to examine the effect of social capital on farmers' adaptation behaviour to climate change variability. To achieve this, a comprehensive and integrated model including modified TPB mixing with social capital was designed and tested to predict adaptive behaviour.

The proposed model explained 69.2% of the variance in adaptation behaviour, indicating its soundness. Further, the model explained 66.5% of the variance in risk perception and 40.1% of the variance in the belief in climate change. Such results highlight the value in considering social capital constructs and risk perceptions and beliefs in explaining farmers' behaviour.

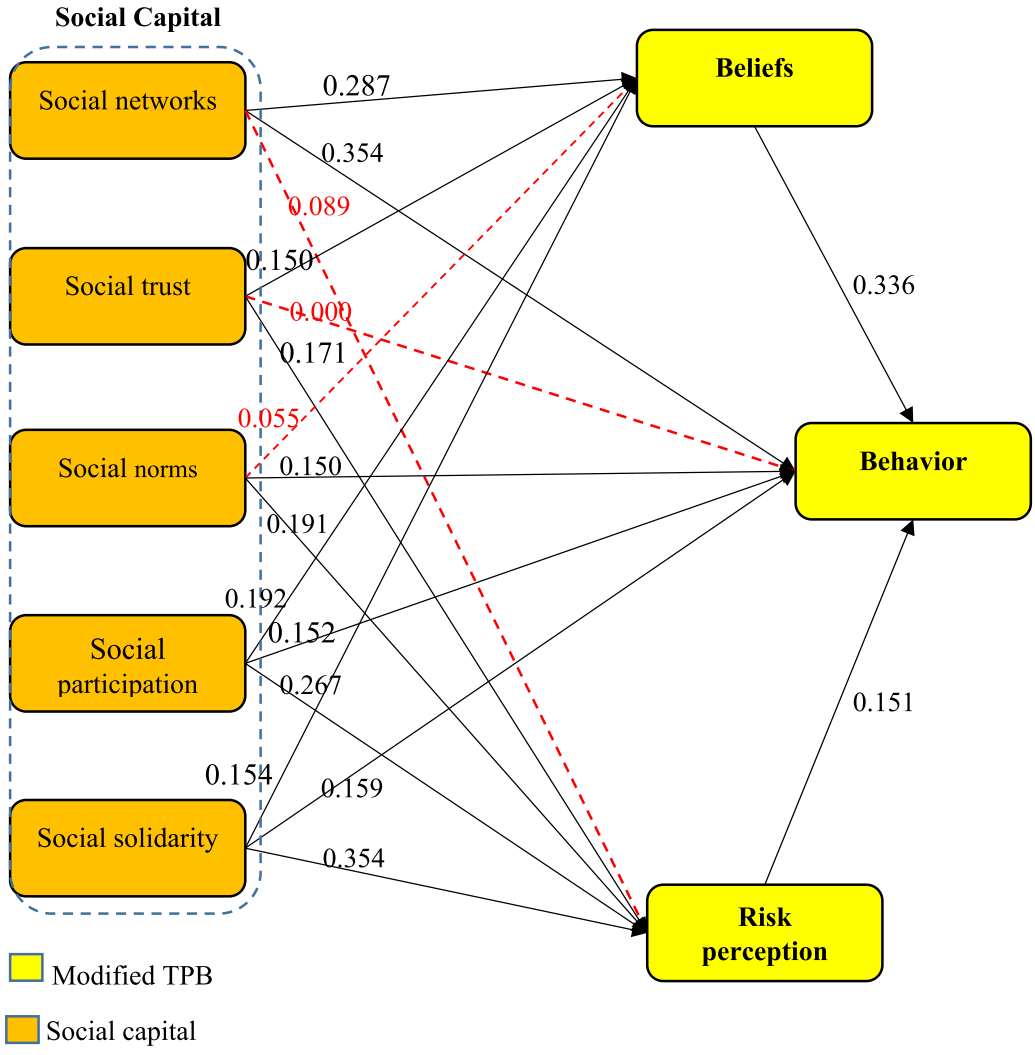

Figure 2. The acquired structural model with standardized path coefficients.

The results indicated the positive effect of all social capital constructs except social trust on climate change adaptation behaviour. Aguilar et al. (2022) also noted that the connection between social capital and climate adaptability could be even more pronounced among smallholder farmers. Nevertheless, this study revealed that social trust had no significant effect on adaptation behaviour. It is worth noting that Roknodin Eftekhari et al. (2016) pointed out the lack of people's trust in each other, managers, and authorities in the city of Susangerd. In the current study, farmers have no/little trust in each other to lend loans or share agricultural implements. In addition, rural social institutions may not provide them with loans, seeds or equipment during the drought. Nevertheless, social trust had positive effect on both beliefs and risk perception in this research which is in line with others' research findings (e.g. Babcicky & Seebauer, 2017; Mase et al., 2015; Singh, 2015; Wang et al., 2021). It could be deduced that the level of social trust among people in this city could be effective on their beliefs and risk perception, but it is not strong enough to influence their adaptive behaviour. According to Panahi and Moayerian (2025), building trust could encourage greater integration of individuals' initiatives into disaster management strategies.

Social networks were the most effective predictor of adaptive behaviour. Similar findings were demonstrated through the works of Dapilah et al. (2020) and Wang et al. (2021). Social networks have also been shown to have a strong effect on individuals' beliefs in climate change, which is consistent with the research undertaken by Ni et al. (2021). In fact, Cunningham et al. (2016 found that social networks can contribute to a stronger belief in climate change among farmers, increasing adaptive behaviour. This makes sense because social networks increase one's access to information. However, our findings showed that social networks did not affect farmers' risk perception of climate change. Researchers and agricultural agents who are responsible for the creation and expansion of adaptation have the potential to alter farmers' beliefs by increasing information and creating warnings about climate change and its effects on farmers' livelihoods.

Social solidarity was another powerful variable in explaining farmers' adaptive behaviour. This variable, directly and indirectly, has a positive and significant effect on risk perception and beliefs on adaptive behaviour. Studies (e.g. Below et al., 2012; Mertz et al., 2009; Okonya et al., 2013) have also revealed that social solidarity affects adaptive behaviour. Fitzsimmons (2019) found conflicting results, which show some

people in society deny these changes due to the social solidarity in society. In other words, the more interdependent farmers perceive they are in terms of development and adaptation to climate change, the more they perceive climate change exists, the more understanding they have of climate change risks, and the more adaptation behaviours in which they engage. Therefore, social solidarity has been one of the most critical factors influencing performance.

Social participation also positively influenced beliefs, understanding of risk, and adaptive behaviour. These results are consistent with Saptutyningsih et al. (2020), Su et al. (2021), and Dupdal et al. (2022). To put it another way, the extent of farmers' participation in intellectual and financial activities to mitigate climate change issues and cooperation with rural councils and institutions, impacts their perceptions about beliefs in and risks of climate change as well as adaptation behaviours. Khanal et al. (2018) also emphasized that special attention should be paid to farmers' participation in the development of national programs focused on adaptation strategies.

Though social norms were shown to influence risk perceptions and adaptation behaviour in our study, such norms did not have a significant influence on individuals' beliefs in climate change. Other works (e.g. Abrahamse & Steg, 2013; Farrow et al., 2017; Nisa et al., 2019; Saptutyningsih et al., 2020; Wolske et al., 2020) have demonstrated the significantly positive effect that social norms have on adaptation behaviour.

Our research findings further demonstrate the strong influence of the belief in climate change on adaptation behaviour, which is consistent with what others have found (Arbuckle et al., 2015; Hoogendoorn et al., 2020). Therefore, paying attention to this factor can create a valuable solution for adapting to climate change among farmers. Li et al. (2017) also state that the increase in individuals' beliefs around the dangers of climate change is due to their increased awareness of extreme weather events, and adaptive behaviour depends on their level of awareness and belief. By increasing farmers' awareness of climate change examples, it is possible to facilitate favourable changes in their beliefs to adopt adaptive behaviour. Our work revealed that risk perception has a positive effect on adaptive behaviour. This effect is confirmed by scholars, such as see Arbuckle et al., 2015; Li et al., 2017; Mase et al., 2017; Mercado, 2016; Nguyen et al., 2016). Farmers who understand the negative effects of climate change on their farms, financial situations, health, and other related issues will engage in adaptive behaviour to avoid or neutralize these effects. By creating appropriate content and training farmers, agricultural extension agents and experts can create educational material to show the benefits of adapting their farming practices based on climate change.

6. Conclusion

Choosing adaptation tactics has become a significant strategy for farmers to reduce environmental threats, decrease the susceptibility of the socio-ecological system, and accomplish development aims. Adaptation to climate change is a dynamic social process (Adger, 2001). In addition to objective drivers, such as socio-demographic characteristics, location conditions and access to politics, the previous research showed that the selection of climate change adaptation strategies for farmers is also influenced by objective drivers, especially social capital. Therefore, in this research, the effect of social capital on the adaptation behaviour of farmers to climate change was investigated. According to a proposed model, the effect of social capital variables on risk perception and belief in climate change and adaptation behaviour of farmers was investigated. Adaptation and natural resource management can be effective by improving the level of trust and mutual relations, creating a common context and a common understanding and providing various solutions. If the community is defined as the solidarity of people who have high social interactions or are highly emotional, then people can manage natural resources when they are involved in collective action. The findings showed that the model supports social capital as a strong predictor of behaviour. The variance explained in the model was very suitable ($R^2 = 69.2$). Therefore, social capital, risk perception and belief in climate change predict climate change adaptation behaviour. This research showed that social networks are the most important predictors of behaviour. Social networks increase the awareness of farmers and increase their willingness to carry out adaptation strategies (Cunningham et al., 2016). Therefore, social networks can be considered a positive feature in encouraging rural development. In addition, a good social network is a vital station for farmers to gain information that is crucial in modern agricultural production, such as technical information relating to machines or inputs. In addition, it can inspire farmers to use innovative technologies in agriculture and animal husbandry.

The findings of this study offer insights into the link between social capital and adaptive behaviour mediating beliefs and risk perception. Furthermore, the results have the potential to contribute to the design of more effective, pertinent policies for farmers in addressing climate change.

7. Policy implications and limitations

This research provides strong evidence for politicians and planners in developing appropriate plans to help facilitate farmers' adaptation behaviour to climate change, especially within rural regions of Iran and comparable contexts.

As beliefs were effective in explaining adaptive behaviour, it is suggested that politicians and government planners use social networks to enhance farmers' awareness of the harmful consequences of climate change and educate residents about appropriate methods to consider in adapting behaviours in response to climate change.

In addition, risk perception had an influence on adaptive behaviour. Thus, it is recommended that extension agents hold classes and workshops for farmers to train them about the potential effects of climate change in the region.

As social network was the strongest predictor of farmers' adaptation behaviour, it should be taken into considerable account. Since social networks had no effect on farmers' risk perception, it is suggested that collaborative social networks of farmers and institutions form to exchange knowledge and experience about the probable risk of climate change in the region.

Admittedly, the success of implementing adaptation policies and management strategies depends on the farmers' participation in different activities offered by rural institutions. It is possible to stimulate participation in local communities through social networks and make these policies operational, and increase the acceptance and adherence to these policies. Therefore, creating networks and increasing farmers' awareness through them, and expanding people's participation in government programs should be considered by agricultural agents and experts. However, increasing the density of social networks depends on improving trust, facilitating information and increasing participation in a social network (Afkhami et al., 2021).

More interaction between agricultural planners and developers with farmers also causes the expansion of social networks and, as a result, more participation of farmers, which is effective in carrying out adaptive behaviour. This participation can have a positive effect on social solidarity among farmers. However, social participation without improving social trust is not possible (Reshadi, 2020). In other words, trust can encourage individuals to be involved in cooperative and collaborative activities (Savari et al., 2024). According to the results, it is vitally important to build trust not only among the farmers and the rural social institutions in the region, but also among the farmers themselves. Rural social institutions should provide support for climate change by supplying loans, seeds, or equipment. In addition, the capacity of local elders and trustees can be utilized to increase trust among farmers.

All these cases indicate the importance of paying attention to the educational and advisory role of agricultural promoters and experts in the implementation of adaptive behaviours to climate change. If government agencies and agricultural extension experts' actions to increase social capital (e.g. social participation, solidarity, networks and norms) of farmers are properly guided and supported (Thamaga-Chitja & Tamako, 2017), achieving strategies for behavioural adaptation to climate change will be possible. Governments should improve and strengthen the infrastructure and platforms used by agricultural services by formulating appropriate policies. They should focus on improving the social capital of farmers, strengthening communication between farmers through consolidation of civic culture, expanding communication networks and inspiring entertaining actions. Therefore, this research can be an important step in implementing policies and promoting climate change adaptation programs in these regions. Like all research, this study also has limitations. The first is the cross-sectional nature of our study. Such an approach limits the ability to make causal inferences (Mase et al., 2017). The second limitation is related to the nature of using questionnaires; we collected self-reported behavioural data and not observed behavioural data. In addition, there is a risk of bias in answering the survey questions, for example, the construct of trust (Goldstein et al., 2008) states that survey respondents tend to underreport their level of trust in their neighbors, because this type of *informal social influence* may be outside of an individual's conscious awareness, or a respondent may indicate in a survey that he/she do not trust their neighbor about climate change solutions, whereas they would if a communication effort occurred (Sleeth-Keppler et al., 2017). Therefore, to enrich the research and policy implications, future researchers should consider utilizing a mixed method of both quantitative and qualitative research approaches to triangulate findings best. Also, future studies could explore farmers' vulnerability and resilience to climate change.

Ethical approval statement

All procedures performed in studies involving human participants followed the ethical standards of the institutional and/or national research committee, along with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Author contributions statement

Masoud Yazdanpanah: conception and design, analysis and interpretation of the data; the drafting of the paper; revising it critically for intellectual content; and the final approval of the version to be published; Tahereh Zobeidi: analysis and interpretation of the data; the drafting of the paper; Bahar Homayoon: analysis and interpretation of the data; the drafting of the paper. Nadejda Komendantova: revising it critically for intellectual content, and the final approval of the version to be published. Alexa Lamm: revising it critically for intellectual content, and the final approval of the version to be published. Kevan Lamm: revising it critically for intellectual content, and the final approval of the version to be published and Kyle Maurice Woosnam: revising it critically for intellectual content, and the final approval of the version to be published.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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