


Resilience Behavior of Farmers to Climate Change and Effects on Food Security in Iran

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Original Research

Received:

24 February 2025

Revised:

31 March 2025

Accepted:

13 April 2025

Published online:

30 June 2025

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Abstract:

The Khuzestan province is among the main production areas of wheat, one of Iran's most important strategic products. In recent years, this province has faced severe environmental problems, including climate change. Therefore, it is necessary to pay attention to resilience behavior of farmers in this region to deal with the negative effects of climate change and its effect on food security. This cross-sectional survey study was conducted from June 2022 to January 2024. The population consisted of wheat farmers in the Khuzestan province, Iran (N=22500). The sample size was determined based on Morgan table (n=378). For analyzing food security level, the 18-item USDA Household Food Security (HFS) questionnaire, which contains questions that underlie the 12-month food security scale in survey-instrument form, was used. Based on the results, about one-third of households (36.43%) were experienced HFS and 63.57% were insecure. To analyze livelihood resilience to climate change, the LRCC model of farmers, which includes three components of self-organization, capacity of learning and buffer capacity, was used. Also, based on the Average Variance Extracted (0.514<AVE<0.711) and Composite Reliability (0.801<CR<0.923), the questionnaire had a convergent validity and appropriate reliability. SPSS16 and Smart PLS software were used to analyze the data. Results of research showed that LRCC had a significant impact on the HFS. According to the results, it is recommended that, by careful planning, sufficient benefits be gained from the potential of LRCC model in the future development policies of HFS, so that an effective step can be taken toward rural development.

Keywords: Food Security, Agricultural productivity, Environment, Structural equation model, Khuzestan

Cite this article: Asadi, S., Noorivandi, A. N., Ommani, A. R., & Sabour, M. S. (2025). Resilience Behavior of Farmers to Climate Change and Effects on Food Security in Iran. *Agricultural Marketing and Commercialization*, 9(1), 11–23.

Introduction

Climate change endangers the livelihood of farmers in different ways (Lu et al., 2019). Climate change has worrisome effects on reducing crop yields (Sinnarong et al., 2019), reducing product quality (Benyoussef Bisbis et al., 2018), changing water resources (Sukanya & Sabu, 2023; Lu et al., 2019), reducing income (Dhakal et al., 2022), reducing productivity (Coderoni & Pagliacci, 2023; Dasgupta et al., 2021), and reducing efficiency

(Guo et al., 2022). Climate change affects the yield and production of agricultural products through the increase in temperature and change in precipitation patterns, as well as through changes during the plant growth period and crop cycle (Shah et al., 2018). As the results of recent studies and evaluations show that if no action is taken to deal with the warming of the earth's temperature, the global production of agricultural products will decrease by 16 percent by 2080. Achieving sustainable food security as well as resilience against climate change is of unique

importance among the priorities of development goals in every country (Savari & Zhooldideh, 2021; Beyene et al., 2023). The results of conducted research suggest that risked household livelihood and climate change is strongly related to food security in different area and that the level of food security provided by those two factors is reduced (Shah and Dulal, 2015). Butler and McFarlane (2018) believe that climate change affects food security in two ways: changes in agricultural productivity and changes in the economy of society, which lead to a decrease in people's purchasing power. Also, Wheeler and von Braun (2013) stated that climate change can quickly affect the four main dimensions of food security. That is, climate change causes a threat to healthy food, available food, usable food and stable food. The risk of reducing food security due to climate change is one of the most important and fundamental challenges that is expanding in the 21st century. This risk affects different countries over time (Lobell et al., 2011). In fact, climate changes have the capacity to turn into horrible and devastating events for human communities and the environment in the absence of risk reduction systems (Li et al., 2021; Wen et al., 2023). Climate change places at risk many of the basic things people need to be healthy and to live dignified lives (Zhao et al., 2022). For example, a 2°C rise in temperature is to cause changing rainfall patterns, more intense extreme events, changes in ecosystems, reduction of water resources and changes in food systems (Hoegh-Guldberg et al., 2018). Human, animal and environmental losses caused by climate change are likely through a wide range of direct consequences (such as more intense heat waves, floods and storms), indirect consequences (such as reduced water quantity and quality, food shortages, desertification) and socio-economic problems (such as unemployment, migration, poverty and income reduction) to occur (Calleja-Agius et al., 2021). Climate change has caused adverse effects on water resources and production elements in different regions of the world, including Iran, so farmers need better adaptation to climate change to ensure their sustainable livelihood. The results of economic models show that under the conditions of climate change, the cultivated area will decrease between 26 and 36 percent (Kalbali et al., 2021). There is large uncertainty about the future of agricultural sector of Iran in the context of climate change. The existing studies show that Iran's total crop yield is projected to decrease in all scenarios. It is predicted that climate change will contribute to reducing water resources in various regions of Iran. Moreover, reduction in precipitation and rising temperatures can greatly increase the irrigation water requirement. Economic studies reveal that as water availability declines, the welfare of farm families will also reduce (Karimi et al., 2018). In Iran, where the agricultural sector is an important part of the country's economy, this issue is of great importance. Although there have been many studies on climate change, little research has been done in Iran on the adaptation of farmers in different

agricultural systems to climate change (Abdollahzadeh et al., 2023). Undoubtedly, the occurrence of climate change in Iran is inevitable. More than 85% of the parts of Iran are in the dry geographical belt and desert strip. This country is one of the least rainy regions in the world. It is predicted that by 2050, Iran will face a climate crisis with a 20-25% decrease in average rainfall and a 2.6°C increase in temperature. Therefore, it will experience various climatic crises such as droughts and severe and prolonged floods and temperature increase (Goli et al., 2023). Considering that climate changes are generally characterized by low rainfall and high temperature, this event may be more challenging for Iran because it is located in the arid and semi-arid region of the earth and the annual rainfall is less than one third of the world (Farajzadeh et al., 2022). Climate change has had severe effects on the agricultural sector of the southwest region of Iran (Khuzestan province), which is mainly dryland, and smallholder farmers are struggling with minimal livelihood options (Abdollahzadeh et al., 2023). According to the mentioned researches, the critical situation of climatic changes is increasing in the southwest of Iran, especially in Khuzestan province (Chenani et al., 2021). The severe effects of climate change on agriculture have made food security uncertain. Due to the mentioned effects, it is necessary to take advantage of resilience requirements for climate change management to achieve food security (Farajzadeh et al., 2022; Seppelt et al., 2022).

Theoretical foundation for extracting dimensions and components of research constructs

Conceptual framework Household Food Security (HFS)

Food security has various dimensions that include global, regional, national, local, household and individual levels. Several factors affect food security at different levels. Food security is a multidimensional phenomenon that includes quantitative and qualitative dimensions, including climate change, internal conflicts, natural disasters, and social norms (Abdullah et al., 2019). The different international organizations used different of food security indicators (e.g. USDA: HFS; World Food Programme: FCS; USAID: HFIAS; FAO: POU and FIES; and EIU: GFSI) (Manikas et al., 2023). The multidimensional nature of food security complicates the evaluation and measurement process. Several factors influence the selection of evaluation dimensions. In this regard, the budget, economic, social, and political and security situation has an impact (Vaitla et al., 2017). To better understand food security indicators, one of the frameworks that can comprehensively explain it is the HFS that explained by United States Department of Agriculture. The food security scale is based on answers to 18 questions. It examines the questions of household food supply from quantitative and qualitative dimensions. It also measures the psychological and behavioral aspects of family members. The four types of situations are (Kehinde et al., 2021; Foster et al., 2019; USDA, 2012):

- The first situation: 2 questions that include concern for

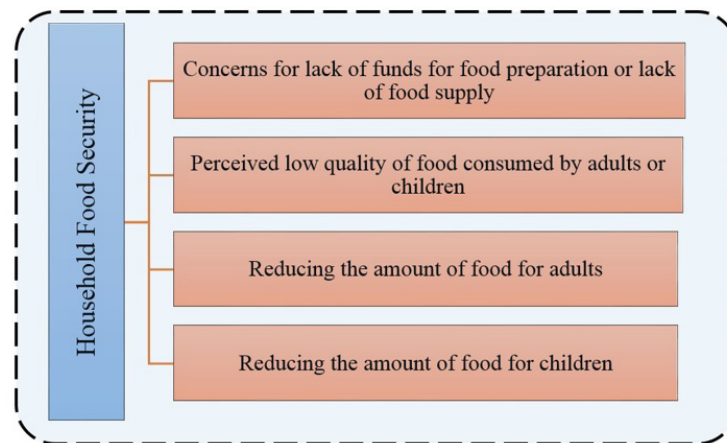


Figure 1. A conceptual framework to analyze HFS (Kehinde et al., 2021; Foster et al., 2019; USDA, 2012)

lack of funds for food preparation or lack of food supply.

- The second situation: 3 questions that include perceived low quality of food consumed by adults or children.
- The third situation: 7 questions that include reducing the amount of food for adults.
- The fourth situation: 6 questions that include reducing the amount of food for children.

Considering the definition of food security, this situation refers to a situation in which all people always have access to food in quantitative and qualitative dimensions to live a healthy life (Bahiru et al., 2023). In order to formulate a conceptual framework regarding HFS in this research, 4 dimensions that were proposed in the United States module have been considered (Fig. 1)

Conceptual framework Livelihood Resilience to Climate Change (LRCC)

It was shown in several studies that the reduction of food production and production productivity and efficiency due to climate change is inevitable (Dasgupta et al., 2021; Sheng & Xu, 2019; Guo et al., 2022). Therefore, the challenge of weather and climate change increases the risk of reducing crop productivity related to temperature changes and drought stress. The negative effects on the average yield of crops and pastures will probably be clearly visible in the coming years when climate change is expected to increase (Kalbali et al., 2021). Climate changes in the national and global arenas cause a series of environmental, social, ecological and economic issues that endanger human development and progress. The effects of climate change even affect national income (Dell et al., 2009) and economic growth (Hsiang and Solow, 2010). In order to deal with climate change and its management, various researchers raised the resilience of livelihood as a vital issue (Quandt, 2018). The idea of resilient livelihoods implies resilience and sustainable management in both livelihoods and socio-ecological dynamics. A new understanding of the nature and application of the resources and importance of resilience in livelihoods,

enables the identification of indicators of resilience of livelihoods to changes, emphasizes resources that were previously overlooked, and provides new issues for appropriate and sustainable use of the available resources despite climate changes (Lecegui et al., 2022). It should be noted that today, from the point of view of various researchers, resilience is considered as an important and vital component of sustainable livelihood, which largely expresses the ability to deal with external tensions and shocks (Feldmeyer et al., 2020). Also, resilience is defined as the ability of a system to reduce disturbances in order to maintain and improve performance and prevent the reduction of resource productivity (Douxchamps et al., 2017). Identifying and understanding the factors that create livelihood resilience against climate and weather changes is very important and vital because livelihood systems must be compatible with global and local changes (Quandt et al., 2017). The concept of resilience is used for sustainable resource management towards ecosystem functioning, human development and well-being (Lecegui et al., 2022). One of the basic and important points is that livelihood resilience is explicitly and coherently defined in line with the United Nations Sustainable Development Goals for the 2030 horizon (Nasrnia & Ashktorab, 2021). Improving the capacity of rural households to resilience to climate change has become one of the most important strategies facing international and national institutions. Nasrnia & Ashktorab (2021) concluded in their research that the review of livelihood resilience models showed that depending on the amount of resilience in each model should use a different method and procedure to improve resilience during drought. Several frameworks have been presented for resilience against climate change. In this research, according to the conceptual frameworks of Liu et al. (2020) and other researches that were in this direction, LRCC dimensions were extracted. In the extractive model, the relationship between dimensions of livelihood capitals has been considered with the approach of resilience as an important function to deal with external changes. The

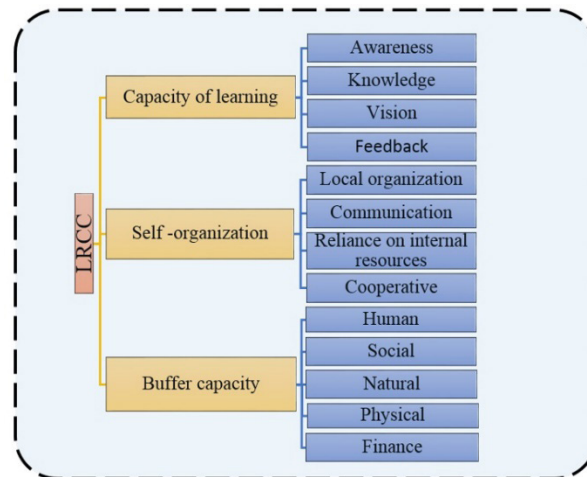


Figure 2. A conceptual framework to analyze LRCC (Liu et al., 2020; Shariatzadeh et al., 2021).

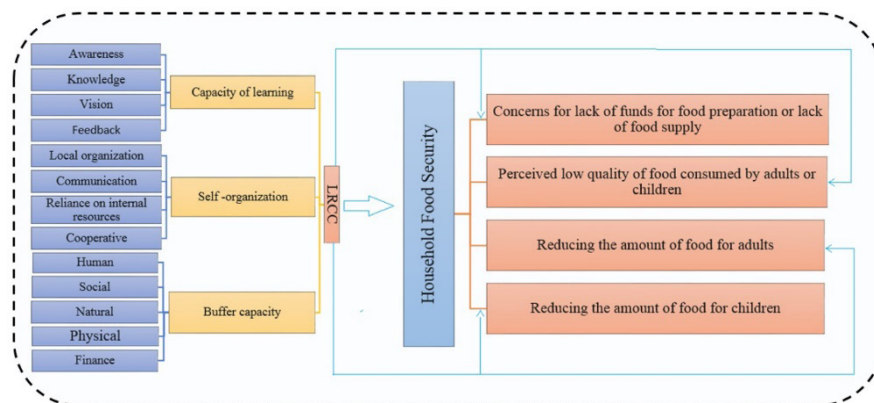


Figure 3. A Conceptual Framework Effect of LRCC on the HFS (Egamberdiev et al., 2023; Kehinde et al., 2021; Foster et al., 2019).

LRCC model creates new insights and concepts to provide opportunities to control environmental factors. Regarding resilience against climate change, several frameworks have been presented. But in this research, the framework was considered to be appropriate to the social, economic and political structure of the studied region and was compiled based on a qualitative research and with the opinion of Iranian experts.

Conceptual framework effect of LRCC on the HFS

Despite paying a lot of attention to agricultural development models in recent years in rural areas, the issues of rural poverty and widespread climate change have created many challenges and crises. Climate change and the spread of food insecurity have a direct relationship (Connolly-Boutin et al., 2016; Esham et al., 2018; Dhraief et al., 2019). Cunsolo and Ellis (2018) believe that climate change affects people's mental health and social and welfare variables, and this can negatively affect their ability to participate in economic, productive and social activities. Several studies have confirmed that climate change reduces food security. This decrease exists in many countries of the world, especially in developing countries. Climate change reduces food production in several ways. Direct

effects such as changes in rainfall and drought and indirect effects such as changes in product prices, changes in the supply chain and reduction of assets can be mentioned (Amoah and Simatele, 2021). Resilience is an important element in planning and managing climate change and implementing interventions in humanitarian activities, reducing the risk of changes, adapting to climate change and improving food security (Doran & Fingleton, 2016). Resilience is defined from the sociological and ecological dimensions as the capacity of socio-economic systems (for example, local organizations, tribes and families) to cope with shocks through absorption, adaptation and change (Folke et al., 2010). Smallholder farmers who have few resources are more likely to face the severe negative effects of climate change and among this group, the food security of households is seriously affected. The necessity of resilience to climate change and success in doing this depends on the capacity to adapt. It was found in various studies that households that were vulnerable to climate change had high levels of food insecurity. The decrease in the price of agricultural products, the increase in the costs of production and agricultural inputs, and the occurrence of crop and livestock diseases aggravated household food

Table 1. Coding survey responses for the food security scale

Question Number	Question	Negative Responses (Code = 0)	Affirmative Responses (Code = 1)	Missing Data (Code = 2)
Q ₁	Worried food would run out	Never true	Often true; Sometimes true	Refused; Don't know
Q ₂	Food bought just didn't last	Never true	Often true; Sometimes true	Refused; Don't know
Q ₃	Couldn't afford to eat balanced meals	Never true	Often true; Sometimes true	Refused; Don't know
Q ₄	Few kinds of low-cost food for children	Never true	Often true; Sometimes true	Refused; Don't know (or No children)
Q ₅	Couldn't feed children a balanced meal	Never true	Often true; Sometimes true	Refused; Don't know (or No children)
Q ₆	Children were not eating enough	Never true	Often true; Sometimes true	Refused; Don't know (or No children)
Q ₇	Adult(s) cut or skipped meals	Never true	Yes	Refused; Don't know
Q _{7a}	Adult(s) cut or skipped meals, 3+ months	Only 1 or 2 months	Almost every month; Some months but not every month	Refused; Don't know
Q ₈	You ate less than felt you should	No	Yes	Refused; Don't know
Q ₉	You were hungry but didn't eat	No	Yes	Refused; Don't know
Q ₁₀	You lost weight because not enough food	No	Yes	Refused; Don't know
Q ₁₁	Adult(s) not eat for whole day	No	Yes	Refused; Don't know
Q _{11a}	Adult(s) not eat for whole day, 3+ months	Only 1 or 2 months	Almost every month; Some months but not every month	Refused; Don't know
Q ₁₂	Cut size of children's meals	No	Yes	Refused;
Q ₁₃	Children ever skip meals	No	Yes	Don't know
Q _{13a}	Children skip meals, 3+ months	Only 1 or 2 months	Almost every month; Some months but not every month	Refused; Don't know (or No children)
Q ₁₄	Children ever hungry	No	Yes	Refused; Don't know (or No children)
Q ₁₅	Children not eat for whole day	No	Yes	Refused; Don't know (or No children)

Reference: (USDA, 2012; Noorollah Noorivandi, 2018).

obtained by measurement is represented by scale points from zero to eighteen (Noorollah Noorivandi, 2018).

To analyze livelihood resilience to climate change, the LRCC model of farmers was used. The dimensions and components of the LRCC model have been extracted in various researches. This model consists of 3 dimensions: 1- Buffer capacity, which includes the sum of subsistence capital including human, physical, financial, natural and social capital. 2- Self-organization, which includes the ability to form flexible networks to deal with unbalanced

conditions and environmental, economic and social challenges (Liu et al., 2020). 3- Learning capacity, which includes acquiring knowledge and skills to form a resilient structure (Liu et al., 2020).

The novelty of this research, in addition to focusing on the dimensions of the food security scale and the LRCC model, this issue has measured the role of the dimensions of the LRCC model on HFS with a structural equation model (SEM). There is scattered research in this regard. However, there is no structured way to provide researchers

and planners with the evidence and relationships between the different dimensions of these two important constructs in rural development. Structured analysis of LRCC and HFS relationships can be very useful for them to make informed decisions and plan carefully.

Study area

Khuzestan province is located in the southwest of Iran and it is the fifth province in terms of size (Figure 4). Khuzestan is located in a very strategic and transit position. Khuzestan, after Tehran province, has the highest gross domestic product among the provinces of Iran. Historically, Khuzestan is considered one of the oldest inhabited areas of the Iranian plateau, where the history of human settlement goes back to 2,700 years before Christ and the formation of the Elam civilization in the third millennium before Christ. Khuzestan has a privileged position in the country with an input volume of more than 33 billion cubic meters of water per year and having 3 billion cubic meters of water stored in underground aquifers. With only 4% of the country's area, Khuzestan contains more than 30% of the country's surface water.

Data analysis

After collecting and categorizing the data, the descriptive and inferential statistics were used. For analyzing of data SPSS16 software and Smart PLS software were used to extract Structural Equation model. In this research, because of the two constructs of LRCC and HFS, which were of reflective type of first rate and second order combination, each of their dimensions were evaluated reflectively by questions. Therefore, due to the combined variables in the structural model of the research, partial least square - based software such as PLS has the ability to perform such calculations (Fathi et al, 2019; Kiani et al., 2021). In addition, PLS is a very suitable method when researchers

want to measure causal relationships (Hair et al., 2019). The PLS, unlike Lisrel, can provide an appropriate approach for researchers due to less dependency of sample size, variables level, and normal distribution (Fathi et al, 2019). Therefore, for the mentioned reasons in this study, Smart PLS 2 software was used to analyze the data. Validity and Reliability of Measurement Content validity of the questionnaire was confirmed by experts' opinions. Also, based on the average variance extracted ($0.514 < AVE < 0.711$) and composite reliability ($0.801 < CR < 0.923$), the questionnaire had a convergent validity and appropriate reliability.

Results and discussion

Demographic and socio-economic characteristics of respondents in this study are summarized in Table 2. The mean of years old was 43. The respondents consisted of 358 men (92.51%) and 29 women (7.49%). The results showed that about (51%) of the sample had high school level and higher of education. The mean annually income was 2150 million rial. Near the 50% of the respondents had ownership exploitation system in agriculture.

Based on the results, about one-third of households (36.43%) were experienced HFS and 63.57% were insecure (total of the three groups of food insecurity). About one-fourth of the respondents (27.91%) experienced food insecurity without hunger, also less than one-fourth of the respondents (22.48%) suffered food insecurity with mild hunger and one-fifth of the respondents (13.44%) experienced food insecurity with intense hunger. These results are illustrated in Table 3.

The dimensions and components of LRCC introduced in the different researches which is designed according to Iran and introduced in the form of a conceptual framework, were the criteria for measuring LRCC in this research. This model has three main dimensions that are presented

Table 2. Demographic and socio-economic characteristics of respondents

Variables	Level	Frequency	percent	Cum percent	Mean or mod
Age(year)	20-30	54	13.95	13.95	Mean=43
	31-40	121	31.27	45.22	
	41-50	134	34.63	79.84	
	50 <	78	20.16	100	
Level of education	Reading and writing	36	9.30	9.30	Mod= High school
	Primary	59	15.25	24.55	
	Guidance school	92	23.77	48.32	
	High school	102	26.36	74.68	
	Diploma and higher	98	25.32	100	
Income (annually) Million Rial	≤1000	59	15.25	15.25	Mean=2150
	1001-2000	154	39.79	55.04	
	2001-3000	91	23.51	78.55	
	3001-4000	58	14.99	93.54	
	4000<	25	6.46	100	
Exploitation system	Rental	87	22.48	22.48	Mod= Ownership
	Ownership	189	48.84	71.32	
	Share	56	14.47	85.79	
	Mixed	54	13.95	99.74	
Gender	Men	358	92.51	92.51	
	Women	29	7.49	100	

Table 3. Frequency distribution of HFS

HFS Status	Frequency	Percent	Cumulative Percent
secure	141	36.43	36.43
insecure without hunger	108	27.91	64.34
insecure with mild hunger	87	22.48	86.82
insecure with intense hunger	52	13.44	100
Total	150	100.00	

Table 4. Status of LRCC dimensions

Dimensions	Components	Elements	Mean	sd	CV
Buffer capacity	Financial capital	Current asset	2.87	0.85	0.296
		Cash	2.92	0.94	0.322
		Bank account	2.58	0.82	0.318
		Income	3.01	0.79	0.262
	Social capital	Access to loans	3.28	0.82	0.250
		Social Trust	3.28	0.86	0.262
		Social Coherence	3.09	0.87	0.282
	Physical capital	Social participation	3.21	0.89	0.277
		Communication and transportation infrastructure	2.98	0.98	0.329
		Agricultural tools and machinery	2.87	0.94	0.328
		Water supply channel	3.05	1.02	0.334
		Quantity and quality of housing	2.95	0.88	0.298
		Technical knowledge	3.29	0.92	0.280
		Skill	3.12	0.94	0.301
Human capital	Innovation	2.28	0.83	0.364	
	Land	3.06	1.06	0.346	
Natural capital	Water	3.87	0.95	0.245	
	Ecosystem	3.56	0.92	0.258	
Self-organization	Local institutions	Local networks	3.25	0.95	0.292
		Village council	2.52	0.82	0.325
	Cooperation and communication	Popular mobilization	3.04	0.79	0.260
		Ethnic and tribal relations	3.22	0.84	0.261
		Cooperation between neighbors	3.28	0.85	0.259
	Communication structures	Effective exchange of information between local groups and networks	3.01	0.85	0.282
		Effective exchange of information between farmers	3.41	0.82	0.240
	Reliance on internal resources	Effective exchange of information between extension agents and farmers	2.85	0.95	0.333
		Internal human resources	2.84	0.97	0.342
		Internal sources of finance	3.01	1.04	0.346
		Internal physical and natural resources	2.92	0.81	0.277
Awareness of threat and opportunity	Awareness of threat	3.54	0.92	0.260	
	Awareness of opportunity	3.14	0.94	0.299	
	Transmission of information about resilience in local group	2.25	0.81	0.360	
Shared social vision	Transmission of information about resilience in larger scale	3.07	1.01	0.329	
	Ability to matching knowledge	Encourage learning	3.81	0.92	0.241
Encourage creativity		3.51	0.91	0.259	
Encourage knowledge transfer		3.01	1.04	0.346	
Feedback mechanism	Knowledge transfer feedback	2.92	0.81	0.277	
	Experience transfer feedback	3.25	0.98	0.302	
Ability to share knowledge and information	Farmers gives his information to others	2.98	0.94	0.315	
	Farmers gives his knowledge to others	3.05	0.92	0.302	

Table 5. The summary of the obtained results of the fitting of the research measurement model

Main factor	Latent variable	Observed variable	Symbol	Factor Load	
LCRR	Buffer capacity	Financial capital	B1	0.689	
		Social capital	B2	0.602	
		Physical capital	B3	0.701	
		Human capital	B4	0.512	
		Natural capital	B5	0.651	
	AVE= 0.652, CR=0.845, Cronbach Alpha= = 0.852				
	Self-organization	Local institutions	S1	0.611	
		Cooperation and communication	S2	0.652	
		Communication structures	S3	0.705	
		Reliance on internal resources	S4	0.650	
		AVE= 0.611, CR=0.895, Cronbach Alpha= = 0.887			
	Capacity of learning	Awareness of threat and opportunity	C1	0.812	
		Shared social vision	C2	0.609	
		Ability to matching knowledge	C3	0.719	
		Feedback mechanism	C4	0.651	
Ability to share knowledge and information		C5	0.511		
AVE= 0.632, CR=0.901, Cronbach Alpha= = 0.924					
HFS	HFS1	I worried whether our food would run out before we got money to buy more.	Q1	0.708	
		The food that we bought just didn't last, and we didn't have money to get more.	Q2	0.601	
		AVE= 0.521, CR=0.801, Cronbach Alpha= = 0.792			
	HFS2	We couldn't afford to eat balanced meals."	Q3	0.615	
		We relied on only a few kinds of low-cost food to feed the children because we were running out of money to buy food.	Q4	0.852	
		We couldn't feed the children a balanced meal because we couldn't afford that.	Q5	0.582	
	AVE= 0.711, CR=0.922, Cronbach Alpha= = 0.801				
	HFS3	Did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?	Q ₇	0.612	
		How often did this happen — almost every month, some months but not every month, or in only one or two months?	Q _{7a}	0.609	
		Did you ever eat less than you felt you should because there wasn't enough money to buy food?	Q ₈	0.811	
		Were you ever hungry but didn't eat because you couldn't afford enough food?	Q ₉	0.606	
		In the last 12 months, did you lose weight because there wasn't enough food?	Q ₁₀	0.719	
		Did you or other adults in your household ever not eat for a whole day because there wasn't enough money for food?	Q ₁₁	0.623	
		How often did this happen — almost every month, some months but not every month, or in only one or two months?	Q _{11a}	0.651	
		AVE= 0.641, CR=0.923, Cronbach Alpha= = 0.935			
HFS4		The <i>children were not eating enough</i> because we just couldn't afford enough Food.	Q ₆	0.618	
	Did you ever <i>cut the size of any of the children's meals</i> because there wasn't enough money for food?	Q ₁₂	0.724		
	Did any of the <i>children ever skip meals</i> because there wasn't enough money for food?	Q ₁₃	0.529		
	How often did this happen — almost every month, some months but not every month, or in only one or two months?	Q _{13a}	0.605		
	Were the <i>children ever hungry</i> but you just couldn't afford more food?	Q ₁₄	0.608		
	Did any of the <i>children ever not eat for a whole day</i> because there wasn't enough money for food?	Q ₁₅	0.749		
AVE= 0.608, CR=0.815, Cronbach Alpha= = 0.892					

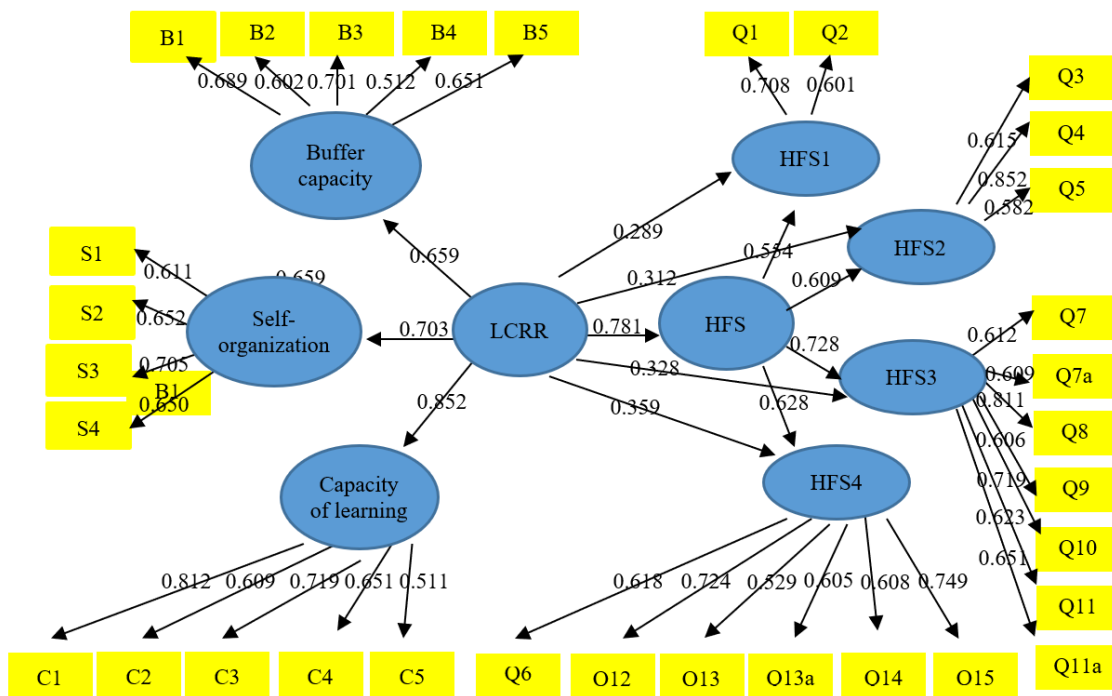


Figure 5. The final model of the effect of LRCC on the HFS.¹

Table 6. The path coefficient and *T* values of the research components.

Variable relationships	Path coefficient	<i>T</i> value
LCRR → HFS	0.781	9.128
LCRR → HFS1	0.289	2.895
LCRR → HFS2	0.312	3.012
LCRR → HFS3	0.328	3.125
LCRR → HFS4	0.359	3.421
LCRR → Buffer capacity	0.659	7.981
LCRR → Self-organization	0.703	8.125
LCRR → Capacity of learning	0.852	11.285
HFS → HFS1	0.554	6.248
HFS → HFS2	0.609	6.854
HFS → HFS3	0.728	8.587
HFS → HFS4	0.628	7.289

Table 7. The CV-Communality of the latent variables of the structural research model.

Factor	<i>SSO</i>	<i>SSE</i>	<i>1-SSE/SSO</i>
Buffer capacity	5680	2584.124	0.545
Self-organization	4800	2354.811	0.509
Capacity of learning	3500	1658.325	0.526
HFS1	4300	2435.354	0.434
HFS2	1520	859.845	0.434
HFS3	3570	1985.458	0.444
HFS4	2150	1589.124	0.261

in Figure 2. Also, table 4 shows the status of LRCC dimensions.

With the aim of checking the convergent validity and reliability of the research tool and measuring the linear relationship between the observed and latent variables, the factor loading of each statement was determined (Table 5).

Cronbach’s alpha and Composite Reliability (CR) indices were used to test internal consistency and one-dimensional reliability. The acceptable level of Cronbach’s alpha should be higher than 0.7 in order to evaluate the reliability as homogeneous and one-dimensional (Lance et al., 2006). Hair et al. (2009, p. 619) noted that CR values of 0.7 or

¹ • HFS1: Concern for lack of funds for food preparation or lack of food supply (Q1, Q2).

• HFS2: Perceived low quality of food consumed by adults or children (Q3, Q4, Q5).

• HFS3: Reducing the amount of food for adults (Q7, Q7a, Q8, Q9, Q10, Q11, Q11a).

• HFS4: Reducing the amount of food for children (Q6, Q12, Q13, Q13a, Q14, Q15).

higher denote good reliability. Therefore, according to Table 3, all reflecting factors of the structural model of this study had a satisfactory internal consistency. Meanwhile, the obtained values for the Average Variance Extracted (AVE) indicated the convergent validity of the components, so that the minimum value of the AVE in the convergent validity, should be 0.5. AVE is a measure of the amount of variance that is captured by a construct in relation to the amount of variance due to measurement error (Lee, 2017). Figure 5 shows the final model of the effect of LRCC on HFS. Based on the results, the capacity of learning, had the greatest effect on the LCRR. Statement B3 from the buffer capacity, S3 from the self-organization dimension and C1 from the capacity of learning dimension had the highest importance in the dimensions of LCRR. The HFS3 and HFS4 had the greatest importance on the HFS, respectively. Statements Q1, Q4, Q8 and Q15 had the highest effect in HFS1, HFS2, HFS3 and HFS4, respectively.

Based on the results in Table 6, LCRR had a significant impact on HFS and its dimensions. As the results show, the HFS3 and capacity of learning dimensions had the highest importance in the HFS as well as the LCRR members, respectively. Table 7 shows the results of testing the quality of the measurement model. This index measures the ability of the model to predict observed variables by their respective latent variable values. Based on the results, the value of SSO represents the Sum of Squares Observed for each latent block, SSE represents the Sum of Squares the predicted Error for each latent variable block, and the SSE/SSO represents the CV-Communality. If the CV-Communality is positive for the latent variables, the model has a good quality measurement, so, the obtained values confirm the quality of the model.

Conclusion

Based on the results of various researches, it was determined that the majority of smallholder farmers, especially in developing countries, who are responsible for providing the food needs of the people, are fragile in the face of climate change and their food security is greatly threatened. Considering the spread of climate change and its adverse effects on food security, the current research was conducted with the aim of designing a model with a resilience approach in farmers' livelihoods to deal with climate change in order to ensure household food security (LRCC/FSH) and tried to create a framework be presented comprehensively to achieve this goal. In this research, the elements of FSH and LRCC were analyzed and the relationships between these elements were presented in order to identify a comprehensive perspective in order to increase the capacity of adaptation, reduce vulnerability and finally increase the stability in the food security of households. Considering the conditions of climate change crisis and food security in Iran and especially Khuzestan province, it is necessary to make policies in the agricultural sector and food security in this province based on the presented model. Paying attention to the social, economic, environmental, institutional and technical dimensions in increasing the resilience of farmers against climate changes

and creating suitable psychological, social and economic conditions for food security provides the necessary ground for sustainable agricultural development. The findings of this study have brought to attention the unknown relationships between LRCC and FSH components and a better understanding of these relationships that have been neglected or less understood so far. Considering the characteristics of smallholders, who mainly produce crops and livestock for households use, increasing the productivity and efficiency of production helps to increase food security. Therefore, we can conclude that successful adaptation to climate change and climate variability and increasing resilience will significantly increase food security in Iran. The findings of this study can help to understand how climate change leads to the vulnerability of households through threats to food security. The results can contribute to effective policy responses. This study provides realistic information and aims to improve the status of food security indicators by identifying and analyzing the relationships between resilience against climate change.

Availability of Data and Materials:

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Conflict of Interest:

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors' Contributions:

Sharareh Asadi: Writing – original draft, Formal analysis. Azadeh Noorollah Noorivandi: Writing – original draft, Writing – review and editing, project administration. Ahmad Reza Ommani: Validation, Methodology, conceptualization. Mohammad Sadegh Sabour: visualization, analysis.

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