Journal of Systems Thinking in Practice
JSTINP, *QUARTERLY*
Homepage: jstinp.um.ac.ir
Online ISSN: 2821-1669
Research Article
DOI: 10.22067/JSTINP.2022.78935.1022
JSTINP 2022; Vol. 1, No. 3

Designing a Sustainable Entrepreneurship Development Model for Iran's Agriculture: Application of Interpretive-Structural Model (ISM)

Marzieh Samadi-Foroushani[a*], Farideh Ranjbar[b], Mohammad Javad Keyhanpour[c]

[a] *Department of Industrial Management, Faculty of Management, University of Tehran, Tehran, Iran.*
[b] *Department of Business Administration, Faculty of Management and Accounting, Allameh Tabatabai University, Tehran, Iran.*
[c] *Department of Management and Engineering of Water Resources, Faculty of Civil Engineering, Islamic Azad University, Tehran, Iran.*

How to cite this article

Samadi-Foroushani, M., Ranjbar, F., and Keyhanpour, M.J., 2022. Designing a Sustainable Entrepreneurship Development Model for Iran's Agriculture: Application of Interpretive-Structural Model (ISM). *Journal of Systems Thinking in Practice*, *1*(3), pp.109-125. doi: 10.22067/JSTINP.2022.78935.1022.
URL: https://jstinp.um.ac.ir/article_43140.html.

ABSTRACT

Due to the lack of attractiveness of agricultural entrepreneurship, a significant part of Iran's agricultural capacities has not been properly utilized. This study focused on identifying and analysing the obstacles to developing sustainable agricultural entrepreneurship in Iran. To this end, identifying barriers was conducted using the Fuzzy Delphi method and data were gathered through interviews and questionnaires. In the following, the obstacles were analysed using the ISM approach and with the participation of a group of 8 experts. An interrelationship diagram of the obstacles was designed at five levels. At the fifth level, the fundamental obstacles included a lack of sustainable agricultural entrepreneurship development strategies in the country's macro development plans, the dependence of financial resources of the agricultural sector on the government banking system and government subsidies, lack of sustainable agricultural entrepreneurship consulting services, insufficient attention to research and low participation on the part of universities and research institutes. This indicates the immense impact of such barriers on the trajectory toward the realization of sustainable agricultural entrepreneurship. At the fourth level, lack of binding laws to assure compliance with environmental standards lack of formal training; At the third level: Lack of incentive policies to increase private sector involvement in providing capital for owners of entrepreneurship ideas, a lack of recognition of opportunities in line with the region's climate, lack of distribution channels in the target markets of sustainable agricultural entrepreneurship opportunities, and lack of social development toward creating values and establishing innovative and creative sustainable agricultural businesses; At the second level, lack of knowledge on agricultural entrepreneurship opportunities in optimizing cultivation and water consumption patterns, lack of product pricing systems, and inappropriate marketing; and at the first level, lack of investment in knowledge-based and technological opportunities have been identified as the most susceptible obstacles in realizing sustainable agricultural entrepreneurship.

Keywords

Sustainable Development, Sustainable Entrepreneurship, Agricultural Entrepreneurship Obstacles, Interpretive Structural Modelling (ISM).

Article history

Received: 2022-09-24
Accepted: 2022-11-28
Published (Online): 2022-11-28

Number of Figures: 2 **Number of Tables: 9** **Number of Pages: 17** **Number of References: 31**

***Corresponding author**
Email: samadi.m@ut.ac.ir

1. Introduction

Sustainable development conceptually stems from the promotion of sustainable use of natural resources. Sustainability concerns have gained increasing significance among organizations and their stakeholders worldwide. In this regard, adaptation to the environment has become an instrument for the transition to sustainable development. Sustainable development does not aim to preserve the status quo but considers the transition of resources to future generations. On the other hand, in recent years, there has been a growing interest in exploiting entrepreneurial competencies to solve problems and foster improvements in the components of sustainable development, which include social, environmental and economic dimensions (Davies and Chambers, 2018). Sustainable entrepreneurs focus on identifying new business opportunities that lead to developing products or processes that are more sustainable than what is currently available (Schaltegger et al., 2016). Lüdeke-Freund and Dembek (2017) define this entrepreneurship as a voluntary commitment to creating social and environmental value beyond ordinary business occupations while creating economic value. Sustainable entrepreneurs observe environmental considerations through every stage of creating and developing their business and play a greater role in improving resource utilisation efficiency, mitigating environmental risks and hazards, reducing waste and ensuring cultural and social quality. Sustainable entrepreneurship is closely connected with social responsibility and environmental development, for it reflects the involvement of entrepreneurs in various social and environmental dimensions (Spence et al., 2011).

Agriculture has become the basis of development in many countries, and this sector is also critical in Iran. FAO reports rank Iran among the world's top 7 countries in agricultural production (FAO, 2017). Enjoying different weather conditions and diversity in terms of topography, Iran has various agricultural products. This sector can play a major role in economic prosperity. However, investigations reveal that despite all the efforts made in the agriculture sector in recent years, this sector is facing bottlenecks regarding development due to structural problems. Despite all the potential and actual talents and abilities, Iran's agriculture sector is allocated only a 5-10% share of the country's gross domestic product. According to the Agricultural Research Education and Extention Organization (AREEO) announcement, the number of farmers drops by an average of 50 thousand people yearly due to the lack of facilities and attractions in the agriculture sector (OECD-FAO, 2019). Statistics show that a significant part of Iran's agricultural capacities has not undergone proper

exploitation. However, FAO has announced that Iran's natural resources have the potential to supply the countries in the Persian Gulf region in addition to its own food supply. Given that the paradigm of entrepreneurship is concentrated on creating new value by taking advantage of opportunities, Iran's agricultural sector is facing many obstacles and complications in developing sustainable entrepreneurship. This study intends to identify obstacles to sustainable entrepreneurship development in Iran's agriculture sector by reviewing the studies and using experts' opinions. The design of the sustainable agricultural entrepreneurship development model based on analysing the critical sustainability obstacles is research innovation.

2. Literature review

According to the current research problem, after reviewing the relevant literature, the background of the research conducted on sustainable agricultural development, sustainable entrepreneurship and agriculture entrepreneurship was analysed, and an attempt was made to take into consideration the obstacles to the development of sustainable agricultural entrepreneurship and to summarize these obstacles by using the literature review.

The concepts and a number of studies are presented as follows. Sustainable agriculture is considered an approach to ensure economic, social and ecological sustainability. Applying entrepreneurial ability to address sustainable development is called sustainable entrepreneurship in sustainable entrepreneurship literature (Schaltgger and Wagner, 2011). Sustainable entrepreneurs focus on identifying new business opportunities that lead to developing products or processes that are more sustainable than what is currently available (Schaltegger et al., 2016). The literature was analysed regarding agricultural sustainability development, sustainable entrepreneurship and agricultural entrepreneurship. In general, studies conducted in the field of agricultural development are of great interest, and most emphasize the productivity of factors of production.

Hosseinzadeh et al. (2022) identified the dynamic complexities and development points of the entrepreneurial ecosystem (EE) in Iran's agricultural sector to improve the productivity of production factors, including arable land, water resources and human resources capital. Keyhanpour et al. (2021) modeled the water-food-energy nexus, showed that food resources security in Iran would be in jeopardy in the future, and proposed policies for improving water resources and land productivity and managing the supply and demand of water, food and energy resources. Richardson et al. (2020) suggested in a study that investment in

infrastructure development to improve agricultural productivity potentially plays a key role in the development of the agriculture sector. Mesgari et al. (2017) designed the dynamics of the agricultural development system in Iran and proposed policies for the productivity of water and land resources, considering the increase in demand and economic development in the future. There are also studies in agricultural entrepreneurship that focus on value creation and business creation in the agriculture sector.

After reviewing the agricultural development in Iran, Rezaei et al. (2018) emphasized entrepreneurial agriculture and recommended agricultural education oriented toward entrepreneurial goals and the generation of a non-traditional view. Rezaei and Izadi (2019) researched entrepreneurship obstacles in small agricultural quick-impact enterprises in Iran. Based on the results, management skills, knowledge management, business environment, self-managed training, and government policies predict changes in entrepreneurship development in quick-impact enterprises. Additionally, factor analysis indicated five obstacles in developing entrepreneurship in quick-impact enterprises, including financial problems, market orientation, weakness of information, poor and inappropriate business environment and weakness in supportive government policies. Kumar et al. (2021) identified sustainability and circular economy adoption barriers in the agriculture supply chain. The study indicates that lack of government support and incentives and lack of policies and protocols are significant obstacles .Yaghoubi et al. (2018) examined the effect of virtual social networks on the entrepreneurial behavior of agriculture students in Iran and emphasized the potential of virtual social networks in promoting the development of agricultural entrepreneurship in that country.

Zhu et al. (2019) addressed sustainable agriculture considering the development of entrepreneurship in China, and their findings indicated the substantial role of entrepreneurship in agricultural production in emerging economies. They also emphasized the role of financial incentives, information provision and technical support in developing entrepreneurship and proved the role of entrepreneurship in transforming government initiatives to improve the agriculture sector's economic and sustainable performance.

Wilkinson et al. (2017) investigated the organic agriculture policy as a context of institutional dynamics of entrepreneurship and considered the relationship between the structure and the concepts of entrepreneurship to develop organic agriculture policies and identify the areas of competition and distinct paths of institutional change under the influence of the interaction of entrepreneurship and institutional structural dynamics. Esiobu and Ibe

(2015) analyzed the development of entrepreneurship in agriculture among farmers in Nigeria and discussed poor access to entrepreneurial information, insufficient seed capital and the long distance between farms and local markets as the main challenges of entrepreneurship development and called for support from the government and the private sector in order to develop agricultural entrepreneurship. Table 1 summarises a few studies conducted on sustainable entrepreneurship in Iran's agriculture sector.

Table 1. Literature on sustainable entrepreneurship in iran's agriculture sector

Researchers	Title	Findings
Najafabadi et al. (2021)	Water resources productivity and agricultural entrepreneurship development	Using water storage technologies and new irrigation technologies results in the development of entrepreneurship in the agriculture sector.
Heshmati et al. (2019)	Factors affecting sustainable development of agricultural entrepreneurship	The Ministry of Agriculture Jihad must pay more attention to the special role of its promotion and development forces to provide consulting and support services to farmers in order to develop agricultural businesses.
Hamidi et al. (2018)	Urban agriculture: A strategy for developing employment and entrepreneurship	Urban agriculture can attract a wide range of entrepreneurial employment opportunities in the production and agricultural services sector for the employment of agriculture graduates, which should be noted by employment and development authorities.
Ehsanifar et al. (2019)	Evaluation of the level of sustainability in agricultural entrepreneurial activities	Entrepreneurship units maintain a relatively stable state by observing indicators such as attention to natural resources, use of indigenous knowledge, use of low toxic chemicals, involvement and cooperation, communication with consulting centers, dependence on government support and subsidy, and the buyers' lack of awareness of the products.
Ahmadi et al. (2018)	Sustainable agricultural entrepreneurship of rural women	Social, marketing, policy-making, individual, psychological and technical components account for approximately 62% of changes in the variable of agricultural entrepreneurship capability.
Mirzaei and Sepah Panah (2018)	The effect of entrepreneurial characteristics of agricultural consulting services on entrepreneurial spirit	There is a significant relationship between the entrepreneurial spirit and a number of traits relevant to entrepreneurship, such as self-confidence, courage at work, teamwork, motivation and innovation, competitiveness, the rule of law and order, self-help, risk-taking, and job interest.
Sharifi et al. (2019)	Identification of sustainable agricultural development challenges	Protection-support, research-promotional, market-based and product-based factors were introduced as the most important obstacles and challenges on the path to sustainable agricultural development.
Moridsadat and Eftekhari (2018)	Evaluation of sustainable agricultural development status with an entrepreneurial approach	The current status of sustainable agriculture with an entrepreneurial approach in Khuzestan is unfavorable, and the environmental dimension and the Mediterranean region are in worse conditions. Focusing on developing the environmental dimension and creating regional balance are emphasized.
Rasekhi et al. (2017)	Factors affecting the success of urban and rural agricultural entrepreneurs	There is a significant difference between urban and rural entrepreneurs in terms of individual resources, economic resources, political support and socio-cultural support, and the resources for the success of entrepreneurs in urban areas are more abundant than those in rural areas.
Rezaei et al. (2018)	Development of green entrepreneurship in line	This study considered a simultaneous application of precision agriculture, organic agriculture and the production of healthy

Researchers	Title	Findings
	with promoting sustainable development	crops for reducing the use of chemicals, enhancing performance, increasing economic productivity and reducing adverse environmental effects.
Fallah Haghighi and Mirtorabi (2018)	Issues of knowledge-based agriculture companies located in the scientific and industrial research organization	Lack of trust in the market of knowledge-based agricultural products, lack of facilities and financial support from knowledge-based agriculture companies, poor administrative and legal structure in the establishment of knowledge-based agriculture companies, and inadequacy of supporting and commercializing policies and laws in the field of agricultural research.
Pay Khasteh et al. (2017)	Investigation of the competencies needed for the development of sustainable entrepreneurship	There are seven key dimensions involved in the formation of sustainable entrepreneurship development: Systems thinking, an integrated view of diversification and interdisciplinary thinking, insightful and normative thinking, interpersonal actions and strategic management

3. Methodology

According to the purpose of the research, the combined methodology of the fuzzy Delphi method and interpretive structural modeling (ISM) has been chosen. Key obstacles to sustainable agricultural entrepreneurship were identified in the first stage using a two-stage fuzzy Delphi. Table 2 presents the characteristics of the set of triangular fuzzy numbers, verbal expressions of the degree of influence and the used center of gravity de-fuzzification method.

Table 2. Fuzzy number set and the corresponding verbal expression and defuzzification method

Center of gravity	Rectangular fuzzy digits	Real number	Effectiveness rating
XM1 = (L1+M1+U1) / 3	X1 = (L1, M1, U1) = (0, 0, 0.25)	0	No effect
XM2 = (L2+2M2+U2) / 4	X2 = (L2, M2, U2) = (0, 0.25, 0.5)	1	Slight effect
XM3 = (L3+4M3+U3) / 6	X3 = (L3, M3, U3) = (0.25, 0.5, 0.75)	2	Low effect
Z* =MAX (XM1, MM2, MM2)	X4 = (L4, M4, U4) = (0.5, 0.75, 1)	3	High effect
X=((L1+L2+L3)/3, (M1+M2+M3)/3, (U1+U2+U3)/3)	X5 = (L5, M5, U5) = (0.75, 1, 1)	4	Very high effect

In the following, the matrix of effectiveness and effectiveness of key obstacles was compiled in the form of a questionnaire, and with the participation of experts, a structural self-interaction matrix was obtained. In the following, by forming the final matrix, the determination of relationships and leveling between obstacles was done, and finally, the network of interactions was designed as an interpretive structural model. Figure 1 presents the implementation process of the present research. The research participants were a combination of experts in sustainable agricultural development and entrepreneurship and management of active agricultural businesses in Iran. Table 3 shows the characteristics of the participants of this research.

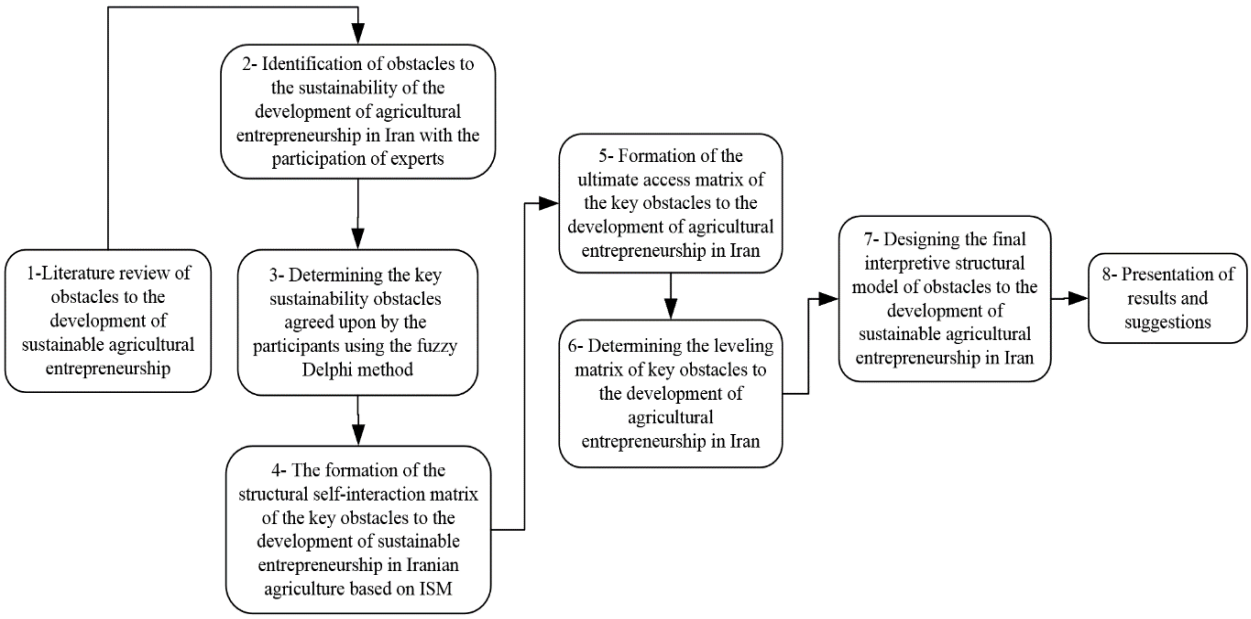

Figure 1. The implementation process of modeling the development of sustainable agricultural entrepreneurship in Iran

Table 3. Characteristics of research participants

Area of Expertise	Experience (year)	Field	Education
Entrepreneurial management	10<	Entrepreneurship	PhD
Investors of knowledge-based companies	15>	MBA Management	Masters
SME investor	20<	MBA Management	Masters
Agricultural development management	15<	Agricultural innovation and entrepreneurship	Masters
Entrepreneurial management	20<	Entrepreneurship	Masters
Agricultural entrepreneur	15<	Industrial Management	PhD
development of agricultural entrepreneurship	15<	Agricultural Engineering	PhD
Agricultural development planning	10<	agricultural development	PhD

4. Findings

According to the implementation process of the research, after reviewing the literature in the field of sustainable entrepreneurship in the agricultural industry and conducting semi-structured interviews with experts, a list of obstacles to the development of sustainable agricultural entrepreneurship was identified. As seen in Table 4, 41 obstacles, including 20 economic obstacles, 11 environmental obstacles and 10 social obstacles for developing agricultural entrepreneurship in Iran, were identified.

Table 4. Obstacles to sustainable entrepreneurship development in the agriculture sector

Sustainable dimensions	Symbol	Obstacles to sustainable entrepreneurship development in the agriculture sector	Reference
Economic (E)	E_1	Lack of sustainable entrepreneurship development strategies of the agriculture sector in the country's macro development plans	Experts' opinion
	E_2	Lack of investment in knowledge-based and technological entrepreneurship opportunities in the agriculture sector	Hosseinzadeh et al. (2022); Nguyen et al. (2021); Esiobu and Ibe (2015)
	E_3	Financing the agriculture sector dependent on the government banking system and government subsidies	Hosseinzadeh et al. (2022) Rezaei & Izadi (2019)
	E_4	Policymakers' lack of attention to sustainable management and development of agricultural entrepreneurship in line with environmental changes	Experts' opinion
	E_5	Failure to apply business consultants in identifying sustainable entrepreneurial opportunities in the agriculture sector	Hosseinzadeh et al. (2022); Nguyen et al. (2021); Heshmati et al. (2019)
	E_6	Incapacity of the administrative and legal structure in establishing knowledge-based companies in the field of agriculture and insufficiency of the policies and laws supporting and commercializing in the field of agricultural research.	Fallah Haghighi and Mirtorabi (2018)
	E_7	Shortage of loans and financial support for agricultural knowledge-based companies	Hosseinzadeh et al. (2022)
	E_8	Failure to formulate support policies for the emergence and commercialization of novel ideas in the agriculture sector	Hosseinzadeh et al. (2022); Zhu et al. (2019)
	E_9	Frustrating administrative bureaucracy for registering and confirming knowledge-based companies in the agriculture sector	Zhu et al. (2019)
	E_{10}	Absence of incentive policies to increase private sector involvement in providing capital to owners of sustainable entrepreneurial ideas in the agriculture sector	Hosseinzadeh et al. (2022); Rasekhi et al. (2017); Esiobu and Ibe (2015)
	E_{11}	Strict state regulations in approving agricultural knowledge-based products	Fallah Haghighi and Mirtorabi (2018)
	E_{12}	Failure to offer government loans to sustainable entrepreneurship in the agriculture sector to reduce investment risk	Hosseinzadeh et al. (2022); Zhu et al. (2019); Rasekhi et al. (2017)
	E_{13}	Failure to support the production-to-consumption chain and encourage sustainable entrepreneurship to improve the agriculture supply chain	Hamidi et al. (2018)
	E_{14}	High rate of bank interest for innovative agricultural plans	Fallah Haghighi and Mirtorabi (2018)
	E_{15}	Failure to consider the employment potential of the agriculture sector through sustainable entrepreneurship	Hamidi et al. (2018)
	E_{16}	Lack of product pricing systems, improper marketing, presence of brokers and consequently low profit for agricultural entrepreneurs	Hosseinzadeh et al. (2022); Sharifi et al. (2019)
	E_{17}	Absence or monopoly of distribution channels in the target markets of sustainable agricultural entrepreneurial opportunities	Hosseinzadeh et al. (2022); Nguyen et al. (2021)
	E_{18}	Failure to develop infrastructure suited to sustainable entrepreneurship opportunities in the agriculture sector	Richardson et al. (2020); Ehsanifar et al. (2018)

Sustainable dimensions	Symbol	Obstacles to sustainable entrepreneurship development in the agriculture sector	Reference
	E_{19}	Lack of proper agricultural support services offered by the Ministry of Agriculture Jihad to sustainable entrepreneurship in the agriculture sector	Heshmati et al. (2019)
	E_{20}	Failure to adopt appropriate policies to prevent smuggling and imports of similar products	Experts' opinion
Environmental (B)	B_1	Lack of knowledge about agricultural entrepreneurship opportunities in the optimization of cropping patterns and water consumption	Hosseinzadeh et al. (2022)
	B_2	Failure to consider entrepreneurship opportunities to develop infrastructural technologies of optimized water consumption in agriculture	Hosseinzadeh et al. (2022)
	B_3	Lack of knowledge about regional resources and opportunities for sustainable entrepreneurship of products suitable for the region's climate	Keyhanpour et al. (2021)
	B_4	Lack of knowledge relevant to using plant remains	Ehsanifar et al. (2019)
	B_5	Absence of binding laws to assure compliance with environmental standards in the agriculture sector	Experts' opinion
	B_6	Lack of development of new agricultural patterns, such as greenhouse cultivation	Keyhanpour et al. (2021)
	B_7	Failure to consider entrepreneurial opportunities of producing fertilizers based on compost to replace chemical fertilizers and other manure	Rezaei et al. (2018)
	B_8	Neglecting entrepreneurial opportunities in the area of packaging and post-harvest technologies and producing healthy products with few additives	Rezaei et al. (2018)
	B_9	Lack of knowledge about sustainable entrepreneurship opportunities to establish modern pressure irrigation technologies and the technology of GIS and remote sensing	Najafabadi et al. (2021)
	B_{10}	Neglecting entrepreneurial opportunities in the field of technologies and application of modern irrigation technologies	Najafabadi et al. (2021)
	B_{11}	Lack of knowledge about sustainable agricultural entrepreneurship in line with the climate of each region	Experts' opinion
Social (S)	S_1	Absence of formal education and creation of specialized knowledge for the development of sustainable entrepreneurship in the agriculture sector	Hosseinzadeh et al. (2022); Heshmati et al. (2019); Rezaei et al. (2018)
	S_2	Failure to promote society to create value and set up sustainable creative, and innovative businesses in the agriculture sector	Heshmati et al. (2019); Mirzaei and Sepah Panah (2018)
	S_3	Shortage of specialized consulting services in the area of sustainable entrepreneurship in the agriculture sector	Nguyen et al. (2021); Heshmati et al. (2019); Ehsanifar et al. (2019)
	S_4	Absence of trade unions and cooperatives in start-up and entrepreneurial businesses in the agriculture sector	Hosseinzadeh et al. (2022)
	S_5	Insufficient consideration of entrepreneurial R&D and little involvement of universities and research centers in research, training and promotion of sustainable agriculture	Hosseinzadeh et al. (2022)
	S_6	Failure to review and analyze successful international projects of sustainable entrepreneurship in the agriculture sector	Experts' opinion
	S_7	The low level of society's attention to the social responsibility of businesses	Experts' opinion
	S_8	The dominance of rural attitude in managing villages	Rezaei et al. (2018)
	S_9	Failure to cultivate entrepreneurial sustainable development competencies in the agriculture sector	Mirzaei and Sepah Panah (2018)
	S_{10}	Mistrust in the market of knowledge-based agricultural products	Fallah Haghighi and Mirtorabi (2018)

Then, based on the fuzzy Delphi method, the experts were asked to determine the effectiveness of obstacles in developing agricultural entrepreneurship by designing a questionnaire. After analyzing the data, as seen in Table 5, the expert group agreed upon 14 key obstacles, including 6 economic obstacles, 3 environmental obstacles and 5 social obstacles.

Table 5. Key obstacles to sustainable entrepreneurship development in the agriculture sector

Symbol	Key Obstacles of sustainable entrepreneurship development	Rate
E_1	Lack of sustainable entrepreneurship development strategies of the agriculture sector in the country's macro development plans	1
E_2	Lack of investment in knowledge-based and technological entrepreneurship opportunities in the agriculture sector	2
E_3	Financing the agriculture sector dependent on the government banking system and government subsidies	1
E_{10}	Absence of incentive policies to increase private sector involvement in providing capital to owners of sustainable entrepreneurial ideas in the agriculture sector	2
E_{16}	Lack of product pricing systems, improper marketing, presence of brokers and consequently low profit for agricultural entrepreneurs	7
E_{17}	Absence or monopoly of distribution channels in the target markets of sustainable agricultural entrepreneurial opportunities	6
B_1	Lack of knowledge about agricultural entrepreneurship opportunities in the optimization of cropping patterns and water consumption	4
B_5	Absence of binding laws to assure compliance with environmental standards in the agriculture sector	9
B_{11}	Lack of knowledge about sustainable agricultural entrepreneurship in line with the climate of each region	8
S_1	Absence of formal education and creation of specialized knowledge for the development of sustainable entrepreneurship in the agriculture sector	3
S_2	Failure to promote society to create value and set up sustainable creative, and innovative businesses in the agriculture sector	4
S_3	Shortage of specialized consulting services in the area of sustainable entrepreneurship in the agriculture sector	5
S_4	Absence of trade unions and cooperatives in start-up and entrepreneurial businesses in the agriculture sector	10
S_5	Insufficient consideration of entrepreneurial R&D and little involvement of universities and research centers in research, training and promotion of sustainable agriculture	3

According to the interpretative structural methodology, the experts were invited to study the effective barriers in pairs using the symbols below.

V: One-way communication from i to j
A: One-way communication from j to i
X: Two-way communication between i and j
O: There is no connection between i and j

Based on this comparison, the structural self-interaction matrix was set (Table 6), and in the next step, the reachability matrix was obtained (Table 7). The adapted reachability matrix was obtained in the following, taking into account transferability in the relationships of the variables (Table 8).

Table 6. The structural self-interaction matrix (SSIM)

	S_5	S_4	S_3	S_2	S_1	B_{11}	B_5	B_1	E_{17}	E_{16}	E_{10}	E_3	E_2	E_1
E_1	X	O	O	O	V	V	V	V	O	O	V	V	V	
E_2	A	A	A	A	A	A	A	A	A	A	A	A		
E_3	X	V	X	V	V	V	V	V	V	V	V			
E_{10}	A	A	A	A	X	X	X	V	V	0				
E_{16}	A	A	A	A	A	O	O	O	O					
E_{17}	A	A	A	A	O	X	O	O						
B_1	A	O	A	A	A	A	A							
B_5	V	V	V	V	V	V								
B_{11}	A	A	A	X	A									
S_1	A	O	A	X										
S_2	A	A	A											
S_3	V	A												
S_4	V													
S_5														

Table 7. The reachability matrix

	S_5	S_4	S_3	S_2	S_1	B_{11}	B_5	B_1	E_{17}	E_{16}	E_{10}	E_3	E_2	E_1
E_1	1	0	0	0	1	1	1	1	0	0	1	1	1	1
E_2	0	0	0	0	0	0	0	0	0	0	0	0	1	0
E_3	1	1	1	1	1	1	1	1	1	1	1	1	1	0
E_{10}	0	0	0	0	1	1	1	1	1	0	1	0	1	0
E_{16}	0	0	0	0	0	0	0	0	0	1	0	0	1	0
E_{17}	0	0	0	0	0	1	0	0	1	0	0	0	1	0
B_1	0	0	0	0	0	0	0	1	0	0	0	0	1	0
B_5	1	1	1	1	1	1	1	1	0	0	1	0	1	0
B_{11}	0	0	0	1	0	1	0	1	1	0	1	0	1	0
S_1	0	0	0	1	1	1	0	1	0	1	1	0	1	0
S_2	0	0	0	1	1	1	0	1	1	1	1	0	1	0
S_3	1	0	1	1	1	1	0	1	1	1	1	1	1	0
S_4	1	1	1	1	0	1	0	0	1	1	1	0	1	0
S_5	1	0	0	1	1	1	0	1	1	1	1	1	1	1

Table 8. The adapted matrix

		S_5	S_4	S_3	S_2	S_1	B_{11}	B_5	B_1	E_{17}	E_{16}	E_{10}	E_3	E_2	E_1	
		14	13	12	11	10	9	8	7	6	5	4	3	2	1	Σ
E_1	1	1	0	0	0	1	1	1	1	0	0	1	1	1	1	9
E_2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
E_3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1*	14
E_{10}	4	1*	0	0	0	1	1	1	1	1	0	1	0	1	0	8
E_{16}	5	0	0	0	0	0	0	0	0	1*	1	0	0	1	0	3
E_{17}	6	1*	0	0	1*	0	1	0	1*	1	1*	1*	0	1	0	8
B_1	7	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2
B_5	8	1	1	1	1	1	1	1	1	0	0	1	1*	1	1*	12
B_{11}	9	0	0	0	1	1*	1	1*	1	1	0	1	0	1	0	6
S_1	10	0	0	0	1	1	1	0	1	0	1	1	0	1	0	7
S_2	11	0	0	0	1	1	1	0	1	1	1	1	0	1	0	8
S_3	12	1	0	1	1	1	1	0	1	1	1	1	1	1	0	11
S_4	13	1	1	1	1	0	1	1*	0	1	1	1	0	1	0	10
S_5	14	1	1*	1*	1	1	1	0	1	1	1	1	1	1	1	13
	Σ	8	4	5	9	9	11	6	11	9	8	11	5	14	4	

The input and output sets of each variable were obtained with the help of the matrix. The variables whose output and common sets were completely similar were placed at the highest

level of the interpretive structural mode hierarchy. This operation was repeated until the components of the subjects of all levels were determined. Table 9 provides the ratings of the barriers to sustainable entrepreneurship development in the agriculture sector.

Table 9. The rating matrix of the barriers to sustainable entrepreneurship development in the agriculture sector

Barriers	Input Set	Output Set	Common Set	Level
E_1	1,3,8,10,14	1,2,3,4,7,8,9,10,14	1,3,8,10,14	Level 5
E_2	1,2,3,4,5,6,7,8,9,10,11,12,13,14	2	2	Level 1
E_3	1,3,8,10,12,14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	3,8,10,12,14	Level 5
E_{10}	1,3,4,6,8,9,10,11,12,13,14	2,4,6,7,8,9,10,14	4,6,8,9,10,14	Level 3
E_{16}	3,5,6,10,11,12,13,14	2,5,6	5,6	Level 2
E_{17}	3,4,5,6,9,11,12,13,14	2,4,5,6,7,9,11,14	2,4,5,6,9,11,14	Level 3
B_1	1,3,4,6,7,8,9,10,11,12,14	2,7	7	Level 2
B_5	1,3,4,8	2,4,7,8,9,10,11,12,13,14	4,8	Level 4
B_{11}	1,3,4,6,8,9,10,11,12,13,14	2,4,6,7,8,9,10,11,12	4,6,8,9,10,11,12	Level 3
S_1	1,3,4,8,10,11,12,14	2,4,5,7,9,10,11	4,10,11	Level 4
S_2	3,6,8,9,10,11,12,13,14	2,4,5,6,7,9,10,11	6,8,9,10,11	Level 3
S_3	3,8,9,12,13,14	2,3,4,5,6,7,9,10,11,12,14	3,8,9,12,14	Level 5
S_4	3,8,13,14	2,4,5,6,8,9,11,12,13,14	8,13,14	Level 5
S_5	1,3,4,6,8,12,13,14	1,2,3,4,5,6,7,8,9,10,11,12,13,14	1,3,4,6,8,12,13,14	Level 5

Finally, a preliminary model was drawn according to the variables' levels and the final researchability matrix. As illustrated in Figure 2, the final model of the interpretive structure was drawn by removing transferability in the preliminary model.

It can be seen that the barriers to sustainable entrepreneurship development in the agriculture sector have been identified. At the fifth level, the absence of strategies for sustainable entrepreneurship development in the agriculture sector in the country's macro development plans, the dependence of the financing of the agricultural sector on the government banking system and government subsidies, lack of specialized consultants in the area of sustainable entrepreneurship in the agriculture sector, lack of trade unions and cooperatives in start-up and entrepreneurial businesses in the agriculture sector, insufficient consideration of entrepreneurial R&D and little involvement of universities and research centers in research, training and promotion of sustainable agriculture were identified. This indicates the high impact of these barriers on the path toward the realization of sustainable entrepreneurship in the agriculture sector. At the fourth level, the absence of binding regulations to assure compliance with environmental standards in the agriculture sector and the lack of formal education and creation of specialized knowledge for the development of sustainable entrepreneurship in the agriculture sector were considered to affect the factors of the third level, namely absence of incentive policies to increase private sector involvement in providing capital to owners of sustainable entrepreneurial ideas in the agriculture sector, lack of knowledge about sustainable agricultural entrepreneurship in line with the climate of each

region, absence of distribution channels in the target markets of sustainable agricultural entrepreneurial opportunities and monopoly of distribution units, as well as failure to promote the society to create value and start sustainable, innovative businesses in the agriculture sector. Moreover, at the second level lies the lack of knowledge about agricultural entrepreneurship opportunities in optimizing cropping patterns and water consumption, lack of product pricing systems, improper marketing, presence of brokers and consequently low profit for agricultural entrepreneurs. At the first level, lack of investment in knowledge-based and technological entrepreneurship opportunities in the agriculture sector was identified as the most susceptible barrier to the realization of sustainable entrepreneurship in the agriculture sector.

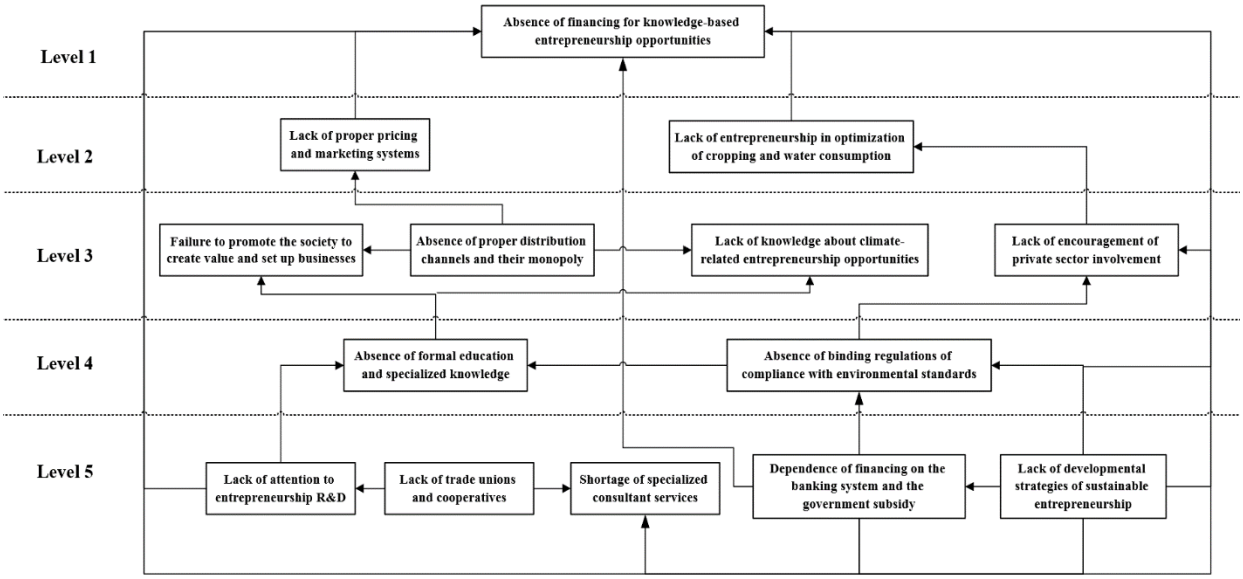

Figure 2. The interpretive structural model of the barriers to sustainable entrepreneurship development in the agriculture sector

5. Discussion and conclusion

Sustainable agriculture, as the central axis of sustainable development, has been known as an appropriate approach toward economic sustainability and attention to the lives of a significant third-world population. Sustainable agricultural development rests on the notion that agricultural methods not only at the level of food production but also, to a large extent, at the level of environmental conditions influence the capacity of agriculture in sustainable use of varied ecosystem services. Sustainable agriculture is considered an approach to ensure economic, social and ecological sustainability. Given the capacities of developing agriculture entrepreneurship in Iran, it is vital to use the entrepreneurship capability to address sustainable development. This is named sustainable entrepreneurship. Sustainable entrepreneurs focus on identifying new business opportunities that lead to developing products or processes that are

more sustainable than currently available in the market. After reviewing the literature and consulting the experts in entrepreneurship development and sustainable agricultural development, this study proposed an interpretive structural model to identify the barriers to developing Iran's sustainable agricultural entrepreneurship. Based on the model's findings, an interrelationship diagram of the obstacles to sustainable agricultural entrepreneurship development was designed at five levels. At the fifth level, the fundamental obstacles include a lack of sustainable agricultural entrepreneurship development strategies in the country's macro development plans, the dependence of the financial resources of the agricultural sector on the government banking system and government subsidies, shortage of sustainable agricultural entrepreneurship consulting services, and insufficient attention to research and development and little participation on the part of universities and research and education institutes toward the promotion of sustainable agriculture. This is indicative of the immense impact of such obstacles on the trajectory to the realization of sustainable agricultural entrepreneurship. At the fourth level, there is a lack of binding laws to assure compliance with environmental standards and a lack of formal training and specialised knowledge creation. The third level includes a lack of incentive policies to increase private sector involvement in providing capital for owners of sustainable agricultural entrepreneurship ideas, a lack of recognition of sustainable agricultural entrepreneurship opportunities in line with the region's climate, a lack of distribution channels in the target markets of sustainable agricultural entrepreneurship opportunities, and lack of social development toward creating values and establishing innovative and creative sustainable agricultural businesses. At the second level, there is a lack of knowledge on agricultural entrepreneurship opportunities in optimizing cultivation and water consumption patterns, a lack of product pricing systems, and improper marketing. Eventually, at the first level, a lack of investment in knowledge-based and technological entrepreneurship opportunities in the agricultural sector has been identified as the most susceptible obstacle to realizing sustainable agricultural entrepreneurship. Analysis of the barriers to development was an attempt to enhance the understanding and cognition of agricultural sustainable entrepreneurship development policy-makers and planning for developing sustainable agricultural entrepreneurship.

In future research, it is suggested that the causes and factors affecting Iran's sustainable agricultural entrepreneurship ecosystem be analyzed based on the new theories in this field. It is also suggested that to remove the obstacles, each obstacle's main actors and stakeholders should be identified, and the system solutions agreed upon by the stakeholders should be

extracted using soft systems methodology. The design of the system dynamics model is also suggested in future research to identify sustainable entrepreneurship development policies in Iran's agriculture.

Disclosure statement

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

References

Ahmadi, S., Kohestani, H., Yadavar, H., Shabanali Femi, H., 2018. Designing a sustainable agricultural entrepreneurship development model among rural women (Kurdistan province case study). *Agricultural science and sustainable production*, *29*(3), pp.237-251. [in Persian].

Davies, I., Chambers, L., 2018. Integrating Hybridity and Business Model Theory in Sustainable Entrepreneurship. *Journal of Cleaner Production*, *177*, pp.377-386. https://doi.org/10.1016/j.jclepro.2017.12.196.

Ehsani-far, T., Rostami, F., Naderi, N., Khosh-khoi, S., 2019. Measuring the level of sustainability in agricultural entrepreneurial activities in Kermanshah province. *Environmental Science and Technology*. *21*(6), pp.244-256. [in Persian]. https://doi.org/10.22034/JEST.2019.25946.3489.

Esiobu, N. S., & Ibe, G. O. G., 2015. Analysis of entrepreneurship development in agriculture among arable crop farmers in Imo State, Nigeria. *International Journal of African and Asian Studies*, *7*(3), pp.92-99. https://iiste.org/Journals/index.php/JAAS/article/view/19578.

FAO, 2017. The future of food and agriculture: Trends and challenges (Food and Agriculture Organization of the United Nations). *Rome*.

Fallah Haghighi, N., Mirtrabi, M., 2018. The problems of knowledge-based agricultural companies located in the Scientific and Industrial Research Organization of Iran. *Journal of Entrepreneurship in Agriculture*, Volume 4, Number *4*, pp.79-97. [in Persian]. https://doi.org/10.22069/jead.2018.14803.1322.

Food and Agriculture Organization of the United Nations. Available at: www.fao.org/statistics.

Heshmati, Mohammad, Shihki Tash, M., Sardar Shahraki, A., 2019. Investigating the factors affecting the sustainable development of agricultural entrepreneurship in Boyer Ahmad city. unpublished thesis, University of Sistan and Baluchistan, Faculty of Management and Economics. [In Persian].

Hamidi, K., Yaqoubi, J., Ahdanjad Roshti, M., 2019. Urban agriculture: a strategy for the development of employment and entrepreneurship. *Journal of Studies in Entrepreneurship and Sustainable Agricultural Development*, *6*(1), pp.101-114. [In Persian] .https://doi.org/10.22069/jead.2020.18392.1428.

Hosseinzadeh, M., Samadi Foroushani, M. and Sadraei, R. 2022, Dynamic performance development of entrepreneurial ecosystem in the agricultural sector, *British Food Journal*, *124*(7), pp.2361-2395. https://doi.org/10.1108/BFJ-08-2021-0909.

Keyhanpour, M. J., Jahromi, S. H. M., & Ebrahimi, H., 2021. System dynamics model of sustainable water resources management using the Nexus Water-Food-Energy approach. *Ain Shams Engineering Journal*, *12*(2), pp.1267-1281. https://doi.org/10.1016/j.asej.2020.07.029.

Kumar, S., Raut, R. D., Nayal, K., Kraus, S., Yadav, V. S., & Narkhede, B. E. (2021). To identify industry 4.0 and circular economy adoption barriers in the agriculture supply chain by using ISM-ANP. *Journal of Cleaner Production*, *293*. https://doi.org/10.1016/j.jclepro.2021.126023.

Lüdeke-Freund, F., & Dembek, K., 2017. Sustainable business model research and practice: Emerging field or passing fancy? *Journal of Cleaner Production*, *168*, pp.1668-1678. https://doi.org/10.1016/j.jclepro.2017.08.093.

Mirzaei, Kh., and Sepahpanah, M., 2018. Analyzing the effect of entrepreneurial characteristics of members of agricultural consulting service companies on their entrepreneurial spirit (case study: Hamadan and Malair cities). *Entrepreneurial research approaches in agriculture*, *2*(2), pp.15-30. . [In Persian].

Moridsadat, P., Ruknuddin Eftekhari, A., 2018. Assessing the state of sustainable agricultural development with an entrepreneurial approach (case study: Khuzestan province). *The Journal of Spatial Planning*, *22*(3), pp.80-111. [In Persian]. http://hsmsp.modares.ac.ir/article-21-16197-fa.html.

Mesgari, I., Jabalameli, M. S., & Barzinpour, F., 2017. System dynamics modeling for national agricultural system with policy recommendations: application to Iran. *Pakistan Journal of Agricultural Sciences*, *54*(2), pp.457-466. http://pakjas.com.pk/papers/2723.pdf.

Najafabadi, A., Ain Ali Vernos Fadrani, D., 2021. How to properly use the available water resources to deal with the water shortage crisis and develop agricultural entrepreneurship. *The second national conference of agricultural industry and commercialization*. Khuzestan University of Agricultural Sciences and Natural Resources, May 2021. [In Persian].

Nguyen, T. T., Shahreki, J., Van Hong, P., & Van Tung, N., 2021. Rural Entrepreneurship in Vietnam: Identification of Facilitators and Barriers. *In Rural Entrepreneurship and Innovation in the Digital Era*, pp.159-178. https://doi.org/10.4018/978-1-7998-4942-1.ch009.

OECD-FAO Agricultural Outlook 2019-2028, Available at: https://www.oecd.org/agriculture/oecd-fao-agricultural-outlook-2019/.

Pay Khasteh, P., and Alam Beigi, A., and Batahai, S., 2017. Examining the competences required for the development of sustainable entrepreneurship in higher agricultural education. *Agricultural Administration management research*, *2*(40), pp.32-43. [In Persian]. https://doi.org/10.22092/jaear.2017.107329.1271.

Rasekhi, B., Ghanbari Movahed, R., Alibaygi, A., 2017. Comparative analysis of agricultural entrepreneurship in rural and urban areas of Kermanshah province. *Rural Research, 9*(35), pp.346-359. [In Persian]. https://doi.org/10.22059/jrur.2017.228470.1071.

Rezaei, Bijan, Naderi, Nader, Rostami, Sahar., 2018. Development of green entrepreneurship in the direction of promoting sustainable development (relying on organic agriculture, healthy products and precision agriculture). *Journal of Studies in Entrepreneurship and Sustainable Agricultural Development*, *5*(2), pp.1-15. [In Persian]. https://doi.org/10.22069/JEAD.2018.14808.1323.

Rezaei-Moghaddam, K., & Izadi, H. (2019). Entrepreneurship in small agricultural quick-impact enterprises in Iran: Development of an index, effective factors and obstacles. *Journal of Global Entrepreneurship Research*, *9*(1), pp.1-21. https://doi.org/10.1186/s40497-018-0133-3.

Edeme, R.K., Nkalu, N.C., Idenyi, J.C. and Arazu, W.O., 2020. Infrastructural development, sustainable agricultural output and employment in ECOWAS countries. *Sustainable Futures*, *2*. https://doi.org/10.1016/j.sftr.2020.100010.

Schaltegger, S., Hansen, E. G., & Lüdeke-Freund, F., 2016. Business models for sustainability: Origins, present research, and future avenues. *Organization & Environment*, *29*(1), pp.3-10. https://doi.org/10.1177/1086026615599806.

Schaltegger, S., Wagner M, 2011. Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Business strategy and the environment*. *20*(4), pp.222-237. https://doi.org/10.1002/bse.682.

Sharifi, A., and Afzali Goroh, A., and Babaei, M., 2019. Identifying the challenges of sustainable agricultural development in the south of Kerman province. *Geography and Environmental Sustainability*, *9*(30), pp.91-106. [In Persian]. https://doi.org/10.22126/ges.2019.1065.

Spence, M., Gherib, J.B.B., and Biwolé, V.O., 2011. Sustainable Entrepreneurship: Is Entrepreneurial Will Enough? A North-South Comparison. *Journal of Business Ethics*, *99*(3), pp.335-367. https://doi.org/10.1007/s10551-010-0656-1.

Wilkinson, J., Hooda, P. S., Barker, J., Barton, S., & Swinden, J., 2017. Occurrence, fate and transformation of emerging contaminants in water: An overarching review of the field. *Environmental Pollution*, *231*, pp.954-970. https://doi.org/10.1016/j.envpol.2017.08.032.

Yaghoubi Farani, A., Karimi, S., Izadi, N., & Ataei, P., 2019. Effect of virtual social networks on entrepreneurial behaviour of agriculture students in Iran. *Applied Economics*, *51*(21), pp.2326-2335. https://doi.org/10.1080/00036846.2018.1543940.

Zhu, Q., Jia, R., & Lin, X., 2019. Building sustainable circular agriculture in China: economic viability and entrepreneurship. *Management Decision*, *57*(4), pp.1108-1122. https://doi.org/10.1108/MD-06-2018-0639.