



Challenges and obstacles of healthy vegetable production in greenhouses of Fars province, Iran

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Original Article

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Citation: Aliyari, V., Nooripoor, M. and Sharifi, Z. 2024. Challenges and obstacles of healthy vegetable production in greenhouses of Fars province, Iran. Greenhouse Plant Production Journal, 1(3): 45-67.

<https://10.61186/gppi.1.3.45>

KEYWORDS

Fars province
Greenhouse
Grounded theory
Healthy vegetables

ABSTRACT

Agriculture in a controlled environment, especially in greenhouses contributes to meet the demand of the growing population and stabilize the food supply. The residual amount of pesticides in raw agricultural crops consumed freshly is of paramount importance compared with other crops and the control of these substances is significant to maintain the consumers' health. Therefore, this study aimed to identify challenges and obstacles of healthy vegetable production in greenhouses of Fars province, Iran. This study was a qualitative research in terms of methodology, and an applied one in terms of purpose using grounded theory. The participants consisted of vegetable greenhouse farmers of Fars province and experts and specialists of related institutions (Agricultural Jihad Organization). The samples were selected purposefully employing the snowball technique in which achieved theoretical saturation by interviewing 38 ones. Reviewing and summarizing the interviews, 285 primary codes were extracted identifying in 37 categories. Accordingly, the coding pattern of the main phenomenon (not producing healthy vegetables) obtained including causal conditions, contextual conditions, intervening conditions, strategies and consequences. The findings revealed that not producing healthy vegetables could lead to human-social, ecological-environmental and economic consequences. Finally, based on the results, some suggestions were recommended. The results can pave the way for policy makers and planners to adopt strategies to lead greenhouse farmers to produce healthy vegetables as well as facilitates the acceptance of such products.

ARTICLE

HISTORY

Received: 23 December 2024

Revised: 30 December 2024

Accepted: 07 January 2025

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Publisher: Arak University

1. Introduction

Agriculture is the largest industry in the world, which annually generates approximately 1.3 trillion dollars of food and more than one billion jobs (Naseem *et al.*, 2023). Population increase, which is expected to reach 9.7 billion ones by 2050 and 11 billion ones by 2100 (Barbosa Junior *et al.*, 2022; Babu *et al.*, 2022), leads to tension between human demand for food and resource depletion and other adverse environmental effects. Hence, changes to existing food production systems are required (Blom *et al.*, 2022; Zhou *et al.*, 2021). In this regard, agriculture in a controlled environment has emerged as a significant strategy for producing crops throughout the year and as a solution for better use of production resources, increasing the quality of products and productivity per unit area. Greenhouse is one of the important types of agriculture in a controlled environment (Iddio *et al.*, 2020; Asgharipour *et al.*, 2020). Greenhouse agriculture plays an important role in increasing agricultural productivity and separating production from land use (Stemmler and Meemken, 2023).

One of the most notable greenhouse products is vegetables. They can be considered as a low-cost and essential source of nutrition, whose production plays an important role in the regional and national economy of the agricultural sector (Bandgar *et al.*, 2021; Parvin and Sarker, 2021) guaranteeing considerable food independence for the world population (Rhioui *et al.*, 2023). Cultivating and harvesting of these crops are generally short-term and be grown several times throughout the year based on early, medium and late varieties (Bandgar *et al.*, 2021). Providing nutrients such as antioxidants, minerals and dietary fiber, and irreplaceable vitamins (Wang *et al.*, 2022), vegetables are widely recommended in people's daily diet of (Dong *et al.*, 2020).

In recent years in Iran, the production of greenhouse crops, especially vegetable crops (such as tomatoes and cucumbers), has been of paramount importance (Amerian, 2022). The high value of vegetable production encourages greenhouse farmers to widely apply synthetic pesticides, nitrogen, and other mineral and organic fertilizers to ensure high yield (Guan *et al.*, 2022; Padilla *et al.*, 2020; Kalkhajeh *et al.*, 2021; Gallardo *et al.*, 2020). Meanwhile, the conditions of the closed space of the greenhouses have affected the chemical inputs. Compared to open cultivation, chemicals have intensified the pollution of the environment and produced products with pesticide residues (Bagheri *et al.*, 2024). Therefore, the production of greenhouse crops is associated with adverse effects including soil, air, plants, nearby water sources pollution, environmental destruction, biodiversity disruption, increase in greenhouse gas emissions, etc. (Guan *et al.*, 2022; Barbosa Junior *et al.*, 2022; Gallardo *et al.*, 2020; Babu *et al.*, 2022; Dong and Liang, 2023; Kalkhajeh *et al.*, 2021; Hu *et al.*, 2021). Indiscriminate use of chemical fertilizers and pesticides in greenhouses (Faryabi *et al.*, 2017; Alipour *et al.*, 2018), early harvesting of the product after spraying and presenting it to the market seriously threatens the health of consumers as well as greenhouse owners (Faryabi *et al.*, 2017; Alipour *et al.*, 2018; Hooshmandan Moghaddam Fard and Shams, 2016). Physiological problems caused by pesticides include skin irritation, eye pain, dizziness, nausea, shortness of breath, thyroid dysfunction, and inhibition of reproduction, hormonal disorder and weakening of the immune system (Dewi *et al.*, 2022). This problem is critically important in relation to freshly consumed products (tomatoes, cucumbers and other vegetables) (Nikan and Morvati, 2019; Alipour *et al.*, 2017). Thus, in order to achieve sustainable agriculture, it is essential to reduce the consumption of chemicals in greenhouse production (Salem *et al.*, 2017).

Among various available solutions for these problems, two solutions presented in terms of the type of agricultural products namely the approach of organic agriculture and the production of healthy products.

Organic products are the ones produced without the use of chemicals, pesticides, food additives, hormones, radiation, fertilizers, antibiotics, flavorings and other artificial substances (Ghasemi Dakdare *et al.*, 2021; Ashaolu and Ashaolu, 2020). However, the term "healthy product" in the Executive Regulations, Section B, Article 61 of the Fourth Development Program Law, means a product that is free from toxic elements and compounds, pollutants, pesticides, elements and heavy metals, and mycotoxins or produced in compliance with the maximum allowed residue (MRLs) (Hatefi *et al.*, 2022; Faal Amand and Falsafian, 2022; Karami dehkordi and Rahmani Fard, 2022). Healthy products are produced under the control and application of agricultural standards and operations, certain methods such as good agricultural practices (GAP), integrated pest management (IPM) techniques, natural or organic products (Karami dehkordi and Rahmani Fard, 2022). Due to the high standard of organic products, the market and mass production of organic products are not very feasible for farmers, and also the high price of organic food makes these products available to a small percentage of customers (Xu *et al.*, 2020; Faal Amand and Falsafian, 2022); whereas the production of healthy agricultural products is relatively more possible and easier to access and a more acceptable solution (Faal Amand and Falsafian, 2022). In the production of such products, due to the application of organic fertilizers compatible with nature and the use of agricultural and biological control methods, environmental sustainability is guaranteed to an abundant extent; accordingly, a significant step has been taken towards sustainable agriculture (Pirozeh *et al.*, 2022). Increasing global sensitivities in this regard, it has been decided that by the end of 2011, only healthy and organic agricultural products will be able to reach the world markets (Haghjou *et al.*, 2011; Pirozeh *et al.*, 2022). This is despite the fact that in Iran, no significant measures have been taken to plan, guide and support this production method, and farmers and members of the society have been deprived of its benefits (Khodaverdizadeh, 2017). Therefore, this question arises that considering the need to produce healthy crops, especially in greenhouses, why has the production of these products not expanded significantly in Iran? Fars province has a special importance in the production of vegetables and is one of the most pioneering regions in the production of greenhouses vegetable. In 2019, this province ranked seventh in terms of the area under greenhouse cultivation (with 269 hectares) and ranked ninth in the country in terms of the production of these products with 50194 tons (Ministry of Jihad Agriculture, 2019). In 2020, there were 839 greenhouses with an area of 302 hectares in the province and ranked sixth with a share of 3% of the country's greenhouses. In fact, the number of greenhouses increased by 5.9 percent compared to the previous year (Statistical Center of Iran, 2020). Table 1 illustrates the status of greenhouses in Fars province in terms of the area under cultivation, production and yield of vegetable greenhouse crops.

Table 1- Area under cultivation, production, and yield of vegetable greenhouse crops

Crop	Province	Area Under Cultivation (Hectare)	Production (Tons)	Yield
Tomato	Country	2157.9	633072	293.4
	Fars Province	45	10126	225
Eggplant	Country	282.6	44248.1	156.6
	Fars Province	0	15	-
Pepper	Country	985.6	132969.4	134.9
	Fars Province	23	4980	216.5
Cucumber	Country	7413.8	1914304.7	258.2
	Fars Province	162	34125	210.6
Other vegetables	Country	416.6	37037.4	-
	Fars Province	39	948	-
Total	Country	11256.5	2761631.6	-
	Fars Province	269	50194	-

Source: Ministry of Agricultural Jihad, 2019

According to the amount of greenhouse vegetable production in Fars province, a significant percentage of these products are exported to other provinces and countries. The importance of the residual amount of pesticides in raw agricultural products consumed freshly is vitally important compared to other products (Yazdanpak *et al.*, 2019) and the control of these substances is significant to maintain the consumers' health (Sanjari *et al.*, 2021). On the other hand, the producer is like any economically active person, seeks to obtain financial benefits, and it is not possible to consider only the consumer with a one-sided point of view and expect that the production conditions will be beneficial for the producer. Therefore, an important challenge is raised here, and that is how to consider both the production of a healthy product and the producer gain benefits. Therefore, the current research seeks to identify and prioritize the challenges and obstacles of healthy vegetable production in greenhouses of Fars province.

Considering the significance of safe products, various studies have been conducted regarding the obstacles and limitations of healthy agriculture, some of which are referred in the following.

Salem *et al.* (2017) in a research concluded that the most important obstacles to organic greenhouse cucumber production in Yazd province included the high risk of organic product production, insufficient government support for organic agriculture, lack of a specific market, and insufficient information of producers in the field of organic agriculture and lack of production knowledge and skills.

Mangla *et al.* (2017) identified and prioritized the barriers to achieve sustainable consumption and production trends in supply chains. Having identified 30 barriers, the findings indicated that organizational barriers were considered as a key barrier in achieving sustainable consumption and production trends in supply chains and had the highest priority.

The challenges of integrated pest management for small-scale farms in developed economies were studied by Grasswitz (2019). Based on the findings, the lack of knowledge and appropriate research/technical support, availability of pest management inputs appropriate to the scale, ignoring and political factors were introduced as challenges of integrated pest management. Sharifi *et al.* (2019) identified the challenges of sustainable agricultural development in the south of Kerman Province revealing that five factors of supportive, research-extensional, input and product market, technical and technological and cultural-social ones could explain 70.90% of the total variance of the challenges of sustainable agricultural development in the south of Kerman province.

The results of Yazdanpanah *et al.* (2019) investigating the factors affecting avoiding the use of pesticides to greenhouse vegetables showed that the moral norm of greenhouse farmers is the main predictor of their intention to avoid the use of pesticides, followed variables of self-identity and attitude.

Evaluating barriers to implementing green supply chain management, Rahman *et al.* (2020) pointed out that insufficient knowledge and support, inadequate technology and infrastructure, financial and organizational limitations, lack of support and operational policies were the most important barriers to the implementation of green supply chain management practices. According to Xu *et al.* (2020), the main challenges of the green food industry included uneven development of green food, insufficient technological innovations, weak international competition, consumers' distrust, awareness and higher prices of green food products, and insufficient support.

The results of the study by Gupta *et al.* (2020) showed that the types of constraints faced by vegetable growers in adoption of integrated pest management technologies in the Bundelkhand region of Uttar Pradesh included the lack of knowledge about the integrated pest management technology, the lack of knowledge about pesticides and their application patterns, the lack of respondents' knowledge about biological pesticides or other alternatives.

The high cost of inputs (seeds, fertilizers, pesticides, labor, etc.) under the category of socio-economic constraints, the lack of proper marketing facilities under the category of institutional and infrastructural constraints and the insufficient number of demonstrations of new technologies under the category of extensional communication constraints were the major constraints perceived by the respondents.

Melkeri *et al.* (2020) studied the constraints experienced by farmers in adopting sustainable practices in Redgram-based farming system. The results indicated that high wages and unavailability of workers, high cost of chemical fertilizers, high cost of plant protection chemicals, lack of access to pheromone traps and biological agents, lack of access to credit on time, lack of beneficial prices and insufficient support by government organizations were the major constraints faced by farmers.

Kassem *et al.* (2021) investigated the barriers of smallholder orange farmers for compliance with Global Good Agricultural Practices standards. The findings showed that the farmers' adherence to the standards was average. Using factor analysis, the barriers to farmers' compliance with global standards of good agricultural practices were grouped into four categories including (personal and economic barriers, knowledge and awareness barriers, institutional support barriers, and infrastructural barriers). Based on the findings, institutional support barriers were considered the most important by farmers in their decisions to comply with standards, followed by personal and economic barriers.

Investigating the prospects and constraints experienced in organic farming by farmers, Ghanghas *et al.* (2021) found out that the farmers were facing very serious limitations; such as the lack of incentives or special reward policies by the government, the predominance of non-organic farmers in the area, the lack of mobilization of organic farmers, and the tendency to use chemical pesticides due to their high visual impact.

Ahmadi Firouzjaie *et al.* (2022) identified and prioritized the practical challenges and solutions of pro-environmental behavior of greenhouse cucumber growers in Tarand District. In this research, indiscriminate use of chemical fertilizers, pesticides and herbicides was introduced as the most important challenge of the environmental behavior of greenhouse farmers, and items such as the use of low-quality and disposable plastic covers, unsanitary disposal and improper recycling of production waste in the greenhouse, use of diesel for heating the greenhouse and air pollution, and lack of greenhouse farmers' knowledge about the adverse effects of using chemical fertilizers and pesticides were placed in the next rank, respectively.

Canwat and Onakuse (2022) studied the social, economic and environmental challenges of organic agriculture in a developing country, acknowledging limited information, market risk, and limited access to financial services and dependence on foreign markets and limited integration of policies as challenges in the organic sub-sector. Chinenye (2023) investigated socio-economic determinants of crop production strategies adopted by organic farmers in Onicha local government area of Ebonyi state, Nigeria. According to the findings, the four major limitations identified included economic/institutional, social, financial and technological limitations.

Kharel *et al.* (2023) assessed good agriculture practices for safe and sustainable vegetable production in mid-hills of Nepal. The results revealed that farmers faced many challenges in adopting agricultural operations. The difficulty of management was introduced as the most important challenge. After that, lack of insurance premium rate, knowledge, access to inputs and other risks were mentioned as the next most important challenges. The findings of this study indicated that the adoption of good agricultural practices contributed to reduce the use of agricultural chemicals and subsequently encouraged farmers to produce safe and sustainable vegetables.

Reviewing the previous studies indicated that, the most important challenges of healthy crop production include economic, managerial, technological, cultural-social, supportive, research-extension, marketing, institutional, personal and infrastructure challenges. However, not much research has been conducted in the field of examining the challenges and obstacles in the production of healthy vegetable and summer crops in the greenhouses of Fars province, especially with a qualitative approach and the grounded theory method. Hence, this study was carried out to fill this gap.

2. Materials and Methods

2.1. Study area

The studied area, Fars province, with an area of 122,608 square kilometers in the south of Iran, covers 8.1% of the country's area. It is located in the south east of Iran with latitudes from 27°03' to 31°42' N and longitudes from 50°36' to 55°35' E. The average annual rainfall in the study area is 388.5 mm (Massoudi *et al.*, 2023). Iran has 22447 greenhouses, of which 20632 are active while 1845 are inactive. In 2020, the area of greenhouses in the country was 9,856 hectares, and 3% of the area of greenhouses in the country was located in Fars province, and accordingly ranked sixth in the country (Statistical Center of Iran, 2020).

Table 2- The number of greenhouses in Fars province according to the activity status

Province	2019			2020		
	Active	Inactive	Total	Active	Inactive	Total
Total in country	20311	1483	21794	20632	1845	22477
Fars province	695	97	792	678	161	839

Source: Statistical Center of Iran, 2020

2.2. Method

This study was a qualitative in terms of approach, and an applied-developmental one in terms of purpose using grounded theory to investigate the challenges and obstacles of healthy vegetable production in greenhouses of Fars province. The participants of this research consisted of vegetable greenhouse farmers of Fars province and experts and specialists of related institutions (Agricultural Jihad Organization). The samples were selected purposefully employing the snowball technique. Analyzing the texts noted in the interviews, observations and document review, theoretical saturation was achieved by interviewing 38 key informants including greenhouse owners and experts of Agricultural Jihad of Fars province. In other word, the interviews continued until no new information was added and the points presented by the experts and greenhouse owners became repetitive. The manuscripts of the interviews were written and then approved by the participants. The interviews started with general and simple questions and progressed to more detailed questions. In order to increase and verify the reliability of the data, meticulous note-taking was used during data collection and feedback was received from the research participants. Furthermore, the repetition of contents and concepts by the participants in the research indicated the appropriate reliability of the collected data. According to the procedure of receiving feedback from the respondents, the results of the analysis were made available to the participants and they were requested to comment on the degree of congruence and appropriateness between their interpretations and their own experience. Such action provides a second opportunity for the primary respondents to comment more seriously and with more reflection on what they have already pointed out and also on the interpretations (Braun and Clarke, 2006). In grounded theory method, the data are divided and coded into constituent parts after being collected. Open coding is the process of analyzing, examining, comparing, conceptualizing and classifying data. In the process of open coding, the obtained concepts are grouped and converted into categories. Axial coding is a set of procedures by which, after open coding, the data are created in new ways by

establishing relationships between categories. This is done by linking codes to contexts, consequences, patterns of interaction and causes (Khezri *et al.*, 2015). In axial coding, the researcher selects a category in the open coding stage and considers it a central phenomenon. Then he relates other categories namely: causal conditions, strategies, contextual conditions, core category, intervening conditions and consequences. This step involves drawing a diagram called a coding pattern (Strauss and Corbin, 2011; Mohammadi *et al.*, 2021):

Causal conditions: Categories related to conditions that affect the central category; it includes events or incidents that directly affect the central phenomenon and cause its occurrence or development. In fact, it is the events that affect this phenomenon and lead to its occurrence. In the current research, causal conditions were assumed the reasons for not producing healthy vegetables in the greenhouses of Fars province.

Core category or main phenomenon: It is a mental form of a phenomenon that is considered the basis of the process. The main phenomenon always appears in the data and all other main categories are related to it. The main phenomenon is the central thought of the research, which in most cases results from the main question of the research. In this research, the main phenomenon is, not producing healthy vegetables in the greenhouses of Fars province.

Contextual conditions: They are special conditions that affect strategies. Contextual conditions are a set of specific characteristics related to the phenomenon and create situations in which people and organizations react under this situation. The strategy and measures under the contextual conditions deal with the management of the phenomenon. In this research, the contextual conditions leading to not producing healthy vegetables in the greenhouses of Fars province were taken into consideration.

Intervening conditions: They are general contextual conditions that affect strategies including factors that moderate the intensity of causal and contextual conditions on actions and interactions. To put it other words, it facilitates or interferes with the effect of causal and contextual conditions and plays the role of an obstacle. Hence, it facilitates or limits the strategy. In this research, the obstacles and limiters of producing healthy vegetables in greenhouses were considered.

Strategies: They are specific actions or interactions stemming from the central phenomenon. In an intervening or contextual condition, a certain set of actions, agents or possible measures are presented in line with the central phenomenon.

Consequences: They are the result of the output or action and reaction, and they are often identified by focusing on questions such as what would happen if and what would not happen if (Savari and Razmavar, 2022; Piramoon *et al.*, 2023). To interpret and announce the results, content analysis was performed by MAXQDA software version 30, an advanced software for qualitative data analysis which is used in the fields of humanities, social sciences, etc. for accuracy, ease and acceleration of research process (Sharifzadeh *et al.*, 2023).

3. Results

After reviewing the interviews, the manuscripts of the interviews were written down. Summarizing them, key terms and concepts about the research topic were extracted in the form of 285 primary codes. These concepts are the open coding which are conceptualized and regulated. Then, after several reviewing, common concepts were identified in 37 categories including consumers' false beliefs, greenhouse farmers' false beliefs, lack of greenhouse

farmers' social commitment, lack of consumers' trust, lack of greenhouse farmers' trust, weak communication, lack of greenhouse farmers' motivation, lack of greenhouse farmers' empowerment, lack of capital, lower profitability, poor livelihood, physical cost, time cost, financial cost, consumers' disruption in providing healthy crops, disruption in the sale of products, lack of cultural context, lack of supportive-policy, consumers' economic situation, consumption pattern, lack of greenhouse farmers' awareness about market requirements, lack of market monitoring, lack of technology-infrastructure, lack of greenhouse farmers' knowledge and managerial awareness. Moreover, strategies including culture building, improving the support structure, improving services, training healthy behavior in greenhouses, monitoring, amending laws, correct management, improving technical-technological conditions, strengthening greenhouse farmers' empowerment, advertising and trust building were classified. Concepts and categories are described in Table 3.

As noted by Strauss and Corbin, the identified categories are classified into the five categories of causal conditions, contextual conditions, intervening conditions, processes and interactions (strategies) and consequences. This stage is called axial coding (Strauss and Corbin, 2011; Hasanzadeh *et al.*, 2023).

A- Causal conditions: They are events and variables that affect the phenomenon and lead to its occurrence. The reasons for not producing healthy vegetables are as described in Table 3.

Table 3- Extracted categories and concepts, results of two stages of open and axial coding (causal conditions)

Concepts	Categories	Axial coding
Consumers' belief in the health of conventional greenhouse products after washing and disinfection	Consumers' false beliefs	Causal conditions
Belief in low or negligible chemical residues in conventional greenhouse products		
Considering conventional greenhouse products more economical to use		
Considering conventional products to be of higher quality (due to visual aspects) than safe products		
Considering all greenhouse products as nutritious and not distinguishing between safe and conventional products		
Consumers believe that all greenhouse products are safe		
Belief in the insignificant quality difference between safe and conventional products		
Underestimating the effect of safe products on the consumers' health		
Belief in the high cost of safe products, due to the lack of access and knowledge of their cost		
Greenhouse farmers' false beliefs about growing healthy crops		
Considering it difficult to comply with healthy crop production standards		
Belief in lagging behind the competition with other greenhouse farmers due to the lack of efficiency of growing healthy crops		
Belief in the importance of the quality of the produced crop in terms of visual aspect (proper appearance) and pay no attention to the taste, health and properties of the crop	Lack of greenhouse farmers' social commitment,	
Greenhouse farmers' poor conception of their social responsibilities due to crop production and lack of attention to consumers' health		
Greenhouse farmers' lack of attention to their workers' and employees' health due to the use of chemicals in crop production		
Greenhouse farmers' belief in achieving success through income and profit and not being concerned about the health of society and the environment		
Greenhouse farmers' priority to satisfy the customers' taste, and lack of attention to the effect of the crop on the customers' health		
Lack of concern due to indiscriminate use of fertilizers and chemical pesticides among greenhouse farmers and lack of attention to protect the		

environment		
Lack of consumers' trust in greenhouse units in terms of producing healthy crops	Lack of consumers' trust	
Lack of consumers' trust due to fraud in the market and the market the use of the title of healthy crop as a tool to sell products		
Little consumers' trust in the health of greenhouse crops (due to inappropriate packaging)		
Prevalence of mistrust among consumers and lack of confidence in the authenticity of health of greenhouse crops		
Consumers' distrust due to not having the proper brand to purchase healthy crops		
Consumers' uncertainty about the benefits of healthy crops for humans and the environment		
Lack of consumers' trust in the symbol of healthy crop production		
Lack of reliable information on the crop market		
Lack of trust and social cohesion among greenhouse farmers in the region		
Lack of greenhouse farmers in the relevant specialists and experts		
Greenhouse farmers' uncertainty about the yield of healthy crops		
Greenhouse farmers' uncertainty about receiving positive feedback from consumers after producing and presenting healthy crops		
Greenhouse farmers' uncertainty about receiving incentives and support from the relevant organizations		
Exchange of few experiences among the greenhouse-farmers of the region regarding healthy crop production	Weak communication	
Poor cooperation among vegetable greenhouse farmers in the region		
Greenhouse farmers' poor communication with consumers and lack of receiving respect for producing healthy crops		
Greenhouse farmers' limited participation in extensional programs and activities for healthy crop production		
Poor performance of experts and specialists in communicating with greenhouse farmers and encouraging them to produce healthy crops		
Lack of communication with the consultants of the relevant clinics to produce healthy crops		
Lack of close and continuous communication between experts and farmers		
Lack of effective communication between greenhouse farmers and distribution and sales networks (retail companies, etc.)		
Weak communication among research, extension and greenhouse farmer		
Low motivation of greenhouse farmers to produce healthy crops		
Greenhouse farmers rely on their previous habits and knowledge		
Considering impractical to produce safe vegetable greenhouse crops		
Tendency to swift and high income and higher yield and income than conventional agriculture		
Lack of tendency to change the conventional methods of growing greenhouse crops	Lack of greenhouse farmers' empowerment	
Lack of tendency to grow health crops in the greenhouse		
Using traditional methods of production and lack of familiarity with the methods of producing safe greenhouse products		
Using inexperienced and uninformed forces to produce healthy crops		
Lack of technical skills in managing proper operation of growing safe greenhouse crop		
Lack of knowledge to use the technologies needed to grow healthy crops	Lack of capital	
Lack of enough capital and savings to grow healthy crops		
The need for more capital to grow healthy crops		
Inability to take the risk of growing healthy crops due to lack of financial support	Lower profitability	
Insufficient capital of the greenhouse farmer		
Reduction in the yield of healthy crops compared to other crops during the early years (due to less use of pesticides and chemical fertilizers, etc.)		

Lack of visible profitability from growing safe greenhouse crops in the short term				
Lower income from growing healthy crops compared to the cost				
Lack of profitability of healthy crops in the short term				
Low selling price compared to initial costs				
Lack of differentiation of the market for safe and unhealthy crops				
Inability to provide livelihood in the early years of growing healthy crops	Poor livelihood			
Inability to sell healthy crops at a reasonable price and disruption of livelihood				
Instability of the financial situation of greenhouse farmers in terms of financial liquidity, capital and credits	Physical cost			
Increasing the physical measures of the greenhouse due to less consumption of chemical pesticides, such as mechanical and manual weeding				
Difficulty of preparing the fertilizers needed to grow safe greenhouse crops				
Difficulty of preparing biological insecticides compared to chemical insecticides				
Difficulty of biological methods of pest control				
The need for constant monitoring the activities of greenhouse workers	Time cost			
The need for constant presence in the greenhouse				
Lack of natural and biological fertilizers and the need to spend time to prepare them (the need for rotten manure, otherwise it contains weed seeds and disease-causing agents)				
Time-consuming nature of learning the principles of healthy crop production in the greenhouse (learning how to control pests, maintain soil fertility, etc.)				
Intensification of pests and detection of the proper time, place and amount of chemical pesticides in growing healthy crops				
The need to replace proper, principal and modern methods of irrigation				
Difficult access to biological materials compared to chemical fertilizers and pesticides				
High price of biological fertilizers compared to chemical fertilizers	Financial cost			
Cost of providing the inputs needed for growing healthy crops				
High cost of production (soil bed preparation, biological materials, workers, etc.)				
High cost of labor compared to the cost of using chemicals (the cost of labor to perform physical greenhouse activities such as weeding, mechanical pest control, etc.)				
High costs of maintaining and transporting healthy crops (shorter shelf life of healthy crops compared to chemical products, crop sensitivity, etc.)				
Being costly to implement experts' recommendations				
High initial cost to purchase the equipment needed to grow crops				
High cost of bank loan interest				
Small number of stores supplying healthy crops in the region			Consumers' disruption in providing healthy crops	
Lack of introducing stores supplying healthy crops to consumers				
Difficulty of paying for healthy crops due to lack of price transparency compared to other products				
Difficulty of choosing crops by consumers due to the less variety of healthy crops compared to conventional crops in the market				
Less supply of healthy crops than conventional crops				
Consumers' confusion in differentiating between healthy crops and other crops				
Less choice of healthy crops compared to conventional crops, due to the marketability of chemical crops				
Market fluctuation and inflation in vegetable greenhouse prices	Disruption in the sale of products			
Additional charge for transporting and packaging of healthy crops				
Different prices of healthy crops				
Perishability of agricultural crops on the way to the market (low crop durability)				
Poor infrastructure to sell healthy crops				

Lack of marketability of healthy crops (lack of attractiveness and taste of new foods)		
Lack of demand for healthy crops from consumers		
Inappropriate marketing for produced healthy crops		
Purchasing safe greenhouse crops by dealers at a lower price		
Determining the price of healthy crops by dealers		
Lack of credit and capital to carry out marketing measures		
Absence of agents to purchase crops		
Non-guaranteed purchase of produced crops		
Problems of packaging and labeling of produced crops		
Lack of issuing a certificate due to making the crop cheaper and selling it		
Not considering the price difference between healthy crops and conventional greenhouse crops		

B- Contextual conditions: As pointed out previously, they are special conditions that affect strategies. The contextual conditions of not producing healthy vegetables in greenhouses are as described in Table 4:

Table 4- Extracted categories and concepts, results of two stages of open and axial coding (contextual conditions)

Concepts	Category	Axial coding
Improper nutrition patterns in society and consumption of unsafe materials	Consumption pattern	Contextual conditions
The custom of consuming marketable vegetable crops with visual effects		
Inappropriate taste of consumers and their attention to appearance		
Consumers' inattention to the ingredients of the crops		
Consumers' Eating habits	Lack of greenhouse farmers' awareness about market requirements	
Lack of awareness about customers' needs in the target market		
Lack of awareness about the market situation of healthy crops		
Lack of awareness about the principles and standards of packaging healthy crops		
Lack of awareness about the correct way of storing healthy crops		
Lack of awareness about the correct way of transporting healthy crops		
Lack of awareness about the principles and standards of manufacturing healthy crops		
Lack of familiarity with the principles and regulations of healthy crops supply markets		
Lack of awareness about labeling and packaging of healthy crops		
Lack of knowledge about the proper place to supply healthy crops		
Lack of awareness about national and international standards for producing healthy crops		
Lack of identification of competitors and competitors' strategies in the field of selling healthy crops		
Lack of analyzing the feedback of customers' healthy crops		
Lack of knowledge about the market demand for healthy crops		
Lack of monitoring institutions of healthy crops production	Lack of market monitoring	
Inefficient and short-term monitoring periods		
Lack of monitoring of the crop segregation system in the market		
Lack of monitoring the packaging of healthy crops		
Lack of monitoring compliance with the necessary standards for crop export (non-standard weight, improper packaging, etc.)	Lack of technology-infrastructure	
Inadequacy of supply centers for the inputs needed by greenhouse farmers to produce healthy crops (such as biological pesticides, natural and biological fertilizers)		
Lack of a specific market to supply inputs and equipment needed to produce healthy crops		
Lack of markets dedicated to selling healthy crops in the region		
Lack of easy access to needed tools and equipment		
Lack of access to inputs		

Lack of proper storage and transportation facilities for healthy crops		
Lack of processing industries in the region		
Improper sorting and packaging facilities for healthy crops		
Lack of access to cooperatives of healthy crops		
Lack of associations related to the marketing of healthy crops		
Lack of access to required clinics and laboratories		
Lack of access to consulting service companies and institutions		
Lack of greenhouse farmers' proper access to financial resources such as loans and bank facilities		
Lack of access to skilled and experienced workforce		
Lack of access to information and new technologies in the field of producing healthy crops		
Lack of access to applied research regarding the marketing of healthy crops		
Lack of access to applied research regarding new technologies for producing healthy crops in greenhouses		
Lack of consumers' easy access to healthy crops due to the small number of centers supplying healthy crops		
Lack of local certification centers		
Lack of educational centers for producing healthy crops		
Using inappropriate greenhouse structures	Lack of greenhouse farmers' knowledge and managerial awareness	
Lack of knowledge of time, type, method and proper amount of using chemical pesticides		
Lack of knowledge of various methods for biological control of pests in producing healthy crops		
Lack of knowledge of soil management and correct techniques of soil bed preparation for growing safe greenhouse crops		
Lack of knowledge of water management and correct irrigation methods to produce healthy crops		
Lack of knowledge of the required technology, tools and equipment to produce healthy crops and how to use them		
Lack of knowledge of using inputs and organic and biological materials in producing healthy crops		
Lack of knowledge of evaluating methods for maximum chemical residues in greenhouse crops		

C- Intervening conditions: They are the conditions that affect the strategies and facilitate or limit the strategies which are as described in Table 5:

Table 5- Extracted categories and concepts, results of two stages of open and axial coding (Intervening conditions)

Concepts	Category	Axial coding
Unsuitable background of the society and lack of social acceptability to the importance of consumers' health (the focus of economic and income issues on the social class of people)	Lack of cultural context	Intervening conditions
Improper conventional consumption culture in the region		
Lack of encouraging greenhouse farmers to produce healthy crops		
Lack of consumption culture of safe greenhouse crops among people		
Lack of culture building to consume healthy crops		
Wrong culture of advertising unsafe products in the media for profit	Lack of supportive-policy	
Lack of organizations and institutions related to producers of healthy crops		
Lack of allocating subsidy facilities (biological facilities, energy, drip irrigation, etc.)		
Lack of agency to purchase healthy crops		
The existence of non-specialist extensional institutions and misleading of producers of healthy crops		
Lack of specific regulations and standards for crop control		
Not allocating export incentives for exporters of healthy crops		
Non-guaranteed purchase of safe greenhouse crops		

Lack of supporting financial institutions		Consumers' economic situation
Lack of government support policies for marketing safe greenhouse crops		
Lack of appropriate insurance coverage for producing healthy crops		
Government embargo and not entering quality and authorized production inputs		
Government embargoes and their effect on reducing exports and restricting access to international markets		
Reforming the structure of the administrative bureaucracy to remove restrictive rules for producing safe vegetable crops		
Effect of income and financial situations on the purchase of healthy crops		
Economic recession and inflation in the market of greenhouse crops		
Decrease in people's purchasing power		
Livelihood problems and attention to the crop quantity rather than its quality		

D- Strategies: They are a set of special features related to the phenomenon and create situations in which people and organizations react under this situation. The strategic conditions for healthy vegetable production are as described in Table 6:

Table 6- Extracted categories and concepts, results of two stages of open and axial coding (strategies)

Concepts	Category	Axial coding
Promoting the culture of consuming healthy crops through mass media	Culture building	Strategies
Culture building to improve people's nutrition patterns towards healthy crops through different ways such as influencers		
Culture building to improve the consumers' nutritional habits and attention to crop quality rather than priority to visual aspects		
Preventing the spread of unhealthy and fast-food consumption and spreading the culture of consuming safe and local crops in the region		
Patterning the healthy crop consumption through social networks and using society's acceptable people		
Supporting of organization and relevant institutions to spread the culture of healthy crop consumption	Improving the support structure	
Providing appropriate financial-support incentives for greenhouse farmers (providing income deficit by the government to healthy crop farmers, etc.)		
Creating government support programs related to healthy crops such as providing subsidies for inputs, facilities and credits		
Creating suitable insurance coverage in the field of greenhouse production and considering insurance discounts for producers of healthy crops		
Government's attention to provide alternative inputs for producing safe greenhouse crops, such as alternatives to chemical fertilizers and pesticides.		
Facilitating the access of greenhouse farmers to the necessary, quality and diverse inputs and facilities		
Providing credits and financial budgets for the producing healthy crops		
Facilitating the process of obtaining license, issuing certificates and monitoring		
Facilitating the access of greenhouse farmers to receive advice on producing healthy crops		
Creating programs to support the associations' activities to supply healthy crops		
Making appropriate and fair decisions in the field of pricing safe greenhouse crops	Improving services	
Guaranteed purchase of healthy crops from greenhouses		
Appropriate design of marketing system to increase the motivation of healthy crop producers		
Improving services provided by the Agricultural Jihad Organization and other related organizations		
Strengthening the distribution channel of healthy crops by eliminating dealers, strengthening greenhouse cooperatives and using the capacity of virtual networks.		

Creating specific locations to supply healthy crops and developing the number of specialized stores		
Holding a training course for sellers in the field of providing and selling healthy crops		
Appropriate design of labels for safe greenhouse crops		
Using the capacity of virtual networks and websites to sell healthy crops		
Compiling appropriate and native standards in the region for the type of greenhouse structure		
Designing a proper system for informing consumers about the benefits of healthy crops (presence of experts at festivals, places of supply, mass media, etc.)		
Teaching the use of biological pest control methods for vegetable greenhouse crops such as (parasitoid bees, ladybugs, <i>Chrysoprela carnea Stephens</i> , etc.)	Training healthy behavior in greenhouses	
Training on the use of agronomical pest control such as (weed control, planting resistant species adapted to the environment, timely irrigation, not using nitrogen fertilizer, etc.)		
Training on the appropriate design of the greenhouse structure to prevent the entry of pests (use of insect netting)		
Teaching the appropriate use of organic fertilizers to provide the needed nutrients for vegetables in the greenhouse		
Teaching the appropriate use of chemical fertilizers and pesticides in producing healthy crops		
Increasing awareness in the field of healthy crops through the use of educational-extensional publications		
Transferring experiences and exchanging opinions in the field of healthy crop production to other farmers	Monitoring	
Government monitoring on reducing the chemical consumption in greenhouses, in accordance with international standards		
Monitoring the healthy crop market to prevent the dealers' abuse		
Monitoring violations and preventing the sale of fake crops		
Monitoring and organizing the distribution of inputs needed to grow healthy crops		
Policy-making to create monitoring systems for producing healthy crops		
Monitoring and supporting of the government in promulgating and developing the growing safe greenhouse crops	Amending laws	
Monitoring and organizing healthy crop stores		
Modifying the licensing process, issuing certificates		
Expanding trade relations and developing global markets		
Integrating relevant units to facilitate the licensing and monitoring process		
Enacting laws to deal with the misuse of the title of healthy crops and fraud		
Allocating sufficient budget for implementing policies of producing healthy crops	Correct management	
Removing subsidies for preparing chemical inputs		
Compiling national and provincial perspectives for developing the consumer market and trading healthy crops		
Providing quantitative and annual goals based on perspectives and priorities		
Providing long-term plans to create a suitable environment for export		
Using skilled workers		
Facilitating the process of consulting services for the producing and distributing healthy crops	Improving technical-technological conditions	
Training skilled workforce in the field of producing healthy crops		
Providing tools and equipment needed for biological control		
Providing new tools and equipment to produce healthy crops		
Facilitating access to the laboratory to measure the residual amount of fertilizer and chemical pesticides		
Necessity to establish research centers and conduct applied research		
Creating a multidisciplinary team including researchers, experts, producers		
Researchers' attention to create new sustainable methods and cultivars,		

appropriate to the local conditions of the region	Strengthening greenhouse farmers' empowerment	
Providing technical and expert solutions and recommendations in the field of healthy crop production to greenhouse farmers		
Providing high quality raw materials and inputs		
Attempting to set up a suitable platform for direct sales of greenhouse crops		
Improving the greenhouse farmers' ability to provide the necessary capital for growing healthy crops		
Identifying the taste and consumption habits of greenhouse crops and producing healthy crops according to consumers' habits		
Providing training to greenhouse farmers to produce crops according to market needs		
Analyzing the feedback of consumers' healthy crops and correcting deficiencies		
Attention to the export of greenhouse crops and complying with the standards for the return of the crop		
Providing a support system to support greenhouse units such as production organizations and cooperatives		
Differentiating the healthy crop stalls in stores and providing brochures containing information and benefits of these crops for human health and the environment.	Advertising and trust building	
Developing communication between greenhouse farmers and consumers using social networks		
Holding safe greenhouse crop festival to supply crops, seasonal and permanent exhibitions, conferences, etc		
Identifying consumers' expectations and giving importance to their desires and expectations		
Ensuring the usefulness of healthy crops by providing information and scientific evidence, making and broadcasting documentaries, etc		
Encouraging consumers to purchase healthy crops by offering discounts and persuasive and motivational policies		
Providing the opportunity for the public to visit the process of producing safe greenhouse crops		
Using multiple sales channels and diversifying them for maximum access (online sales, etc.)		
Providing the conditions for dealing with consumer complaints, resolving violations and gaining their satisfaction		
Creating a distinction between the characteristics of healthy crops and other crops in advertisements		
Analyzing feedback and attempting to improve and build trust		
Showing concern for consumers' health and social responsibility		

E- Consequences: They are the output or results of actions and reactions are often identified by focusing on questions such as what would happen if and what would not happen if. The consequences of not implementing strategies are shown in Table 7:

Table 7- Extracted categories and concepts, results of two stages of open and axial coding (Consequences)

Concepts	Category	Axial coding
Causing illness for greenhouse workers (inflammation skin disease, spots and blisters, blurred vision and eye irritation, headache and dizziness, heart palpitations, coughing and sneezing, sweating and increased body temperature)	Human-social consequences	Consequences
Endangering the consumers' health by increasing the consumption of pesticides		
Causing illness for consumers (reduction of fertility, damage to the nervous system, reduction of the efficiency of the body's defense system, cancer, etc.)		
Poisoning of agricultural workers with pesticides (headache, dizziness, nausea and stomachache)		

Damage to the family, workers and employees of the greenhouse due to excessive consumption of chemicals		
Dependence on imported products		
Difficulty in accessing safe ingredients in the community		
Lack of safe production atmosphere for other greenhouses		
Destruction of beneficial insects due to spraying	Ecological-environmental consequences	
Outbreak of some pests in the greenhouse environment		
Resistance of pests to chemical pesticides		
Emergence of new pests in the greenhouse environment (due to the destruction of natural enemies)		
Damage to soil texture		
Air pollution		
Plant contamination		
Pollution of surface water adjacent to the greenhouse		
Soil pollution		
Groundwater pollution		
Effect on water quality		
Loss of biodiversity		
Contamination of products with chemicals	Economic consequences	
Increasing agricultural waste (as a result of indiscriminate use of fertilizers and chemical pesticides)		
Reducing yield and crop production in the long term		
Increasing healthcare costs and the need for treatment		
Reducing the productivity of greenhouse crops		
Problem of exporting to international markets (non-acceptance of the crop by foreign markets)		
Improper nutritional value due to the use of chemicals		

In the next stage of research, the main category is selected and other categories are related to it. After selecting the central category based on selective coding, in a systematic and objective manner, other categories are subordinated to it, and the central category is linked with other categories in a systematic way (Givkey *et al.*, 2023). According to the coding pattern (Figure 1), causal conditions including consumers' false beliefs, greenhouse farmers' false beliefs, lack of greenhouse farmers' social commitment, lack of consumers' trust, lack of greenhouse farmers' trust, weak communication, lack of greenhouse farmers' motivation, lack of greenhouse farmers' empowerment, lack of capital, lower profitability, poor livelihood, physical cost, time cost, financial cost, consumers' disruption in providing healthy crops, disruption in the sale of products affected the main category (not producing healthy vegetables), the contextual and intervening conditions and led to the occurrence or expansion of the phenomenon of not producing healthy vegetables. In interventional conditions lack of cultural context, lack of supportive-policy, consumers' economic situation affected the action and reaction strategies of the main phenomenon (not producing healthy vegetables). In addition, according to the model, the main obstacles that have provided the necessary context for the occurrence of the phenomenon included consumption pattern, lack of greenhouse farmers' awareness about market requirements, lack of market monitoring, lack of technology-infrastructure, lack of greenhouse farmers' knowledge and managerial awareness. Strategies such as culture building, improving the support structure, improving services, training healthy behavior in greenhouses, monitoring, amending laws, correct management, improving technical-technological conditions, strengthening greenhouse farmers' empowerment, advertising and trust building contribute to obviate the obstacles of healthy crop production. The outputs and consequences of the non-occurrence of the mentioned strategies include human-social, ecological-environmental and economic consequences.

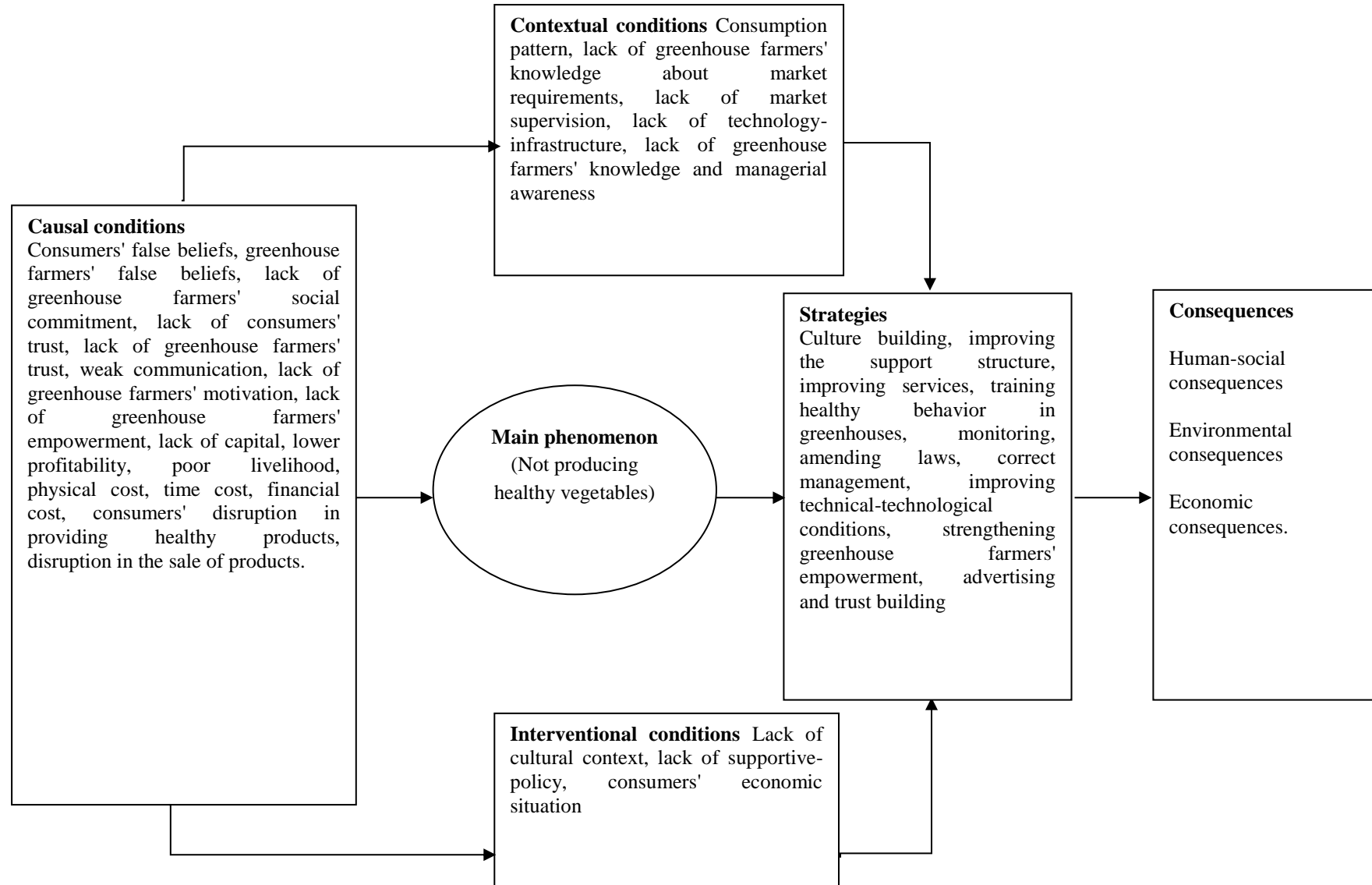


Figure 1. Obtained coding pattern of the research

4. Conclusion and suggestion

Agriculture in a controlled environment, especially in greenhouses, as one of the important strategies of crop production, contributes to meet the demand of the growing population and stabilize the food supply. The high value of vegetable production has encouraged the greenhouse owners to excessively use synthetic pesticides and chemicals, while the conditions of the closed space of the greenhouses have affected the chemical inputs disrupting the decomposition process, intensifying the contamination of crops with pesticide residues, which leads to manifold hazards. Therefore, expanding the production of healthy crops in greenhouses and solving its challenges and obstacles is vitally significant.

The findings of the research showed that the reasons for not producing safe vegetables in the greenhouses of Fars province include consumers' false beliefs, greenhouse farmers' false beliefs, lack of greenhouse farmers' social commitment, lack of consumers' trust, lack of greenhouse farmers' trust, weak communication, lack of greenhouse farmers' motivation, lack of greenhouse farmers' empowerment, lack of capital, lower profitability, poor livelihood, physical cost, time cost, financial cost, consumers' disruption in providing healthy crops, disruption in the sale of products. This finding is in line with the research by Adebisi *et al.* (2019), investigating the constraints to the adoption of organic leafy vegetable production in Nigeria pointed out the lack of trust, increased cost and the lack of visible benefits in organic vegetable cultivation. The production of healthy crops is more costly and less efficient compared to conventional cultivation leading to the ignorance of detrimental effects of conventional cultivation on humans and the surrounding environment. The high cost of producing such crops and the lack of consumers' trust were confirmed by Delangizan *et al.* (2020). The findings of Lal and Mazhar (2021) noted the cost of time and the lack of natural and biological fertilizers and the long process of its preparation. Furthermore, in this research, the financial cost and expensiveness of biological fertilizers are mentioned. Consistent with the findings of the present study, Thakur *et al.* (2022) pointed out the weak livelihood and unstable credibility in the organic cultivation system, and also the lack of knowledge to use the technologies required for cultivating healthy crops as a limiting factor for cultivating organic crops.

Eshraghi Samani *et al.* (2016) also noted the obstacle of lack of motivation and tendency to grow organic crops, which is agreement with the findings of the present study. In addition, the results are in line with the findings of Rashidpour (2020) pointing out the challenge of unwillingness to change habits and conventional methods to carry out organic cultivation and the results of Hoang (2021) relying on old habits and knowledge in using good agriculture practice, noting the need for more investment and spending to provide inputs and increase the labor force. Lack of consumers' trust is consistent with the results by Pooralijan *et al.* (2021).

According to the findings, in interventional conditions lack of cultural context, lack of supportive-policy, consumers' economic situation have affected the action and reaction strategies of the main phenomenon (not producing healthy vegetables). The lack of the cultural bed is in line with the findings by Hoang (2021).

Based on the results, the main obstacles providing the essential context for the occurrence of the phenomenon included consumption pattern, lack of greenhouse farmers' awareness about market requirements, lack of market monitoring, lack of technology-infrastructure, lack of greenhouse farmers' knowledge and managerial awareness. These findings are in agreement with Adebisi *et al.* (2019) mentioning the lack of vegetable growers' knowledge and awareness for organic cultivation as the constraints to the adoption of organic leafy vegetable production in Nigeria. It is also consistent with the results by Haneef *et al.* (2019) pointing out infrastructural

constraints for organic farming. In the research by Thakur *et al* (2022), the lack of facilities for transporting the product to the market in the organic cultivation system was also noted.

It is suggested to remove technological-infrastructure obstacles by creating an effective and coordinated distribution network of healthy crops, contribute to minimize the time of storage and transportation of products, and consequently, to reduce waste in the distribution path. It is feasible to improve transportation infrastructure of healthy crops using fast and optimal transportation ways, proper packaging, accurate route planning and proper timing, choosing strategic distribution locations, and coordination between manufacturers, suppliers, and retailers.

It is also suggested to hold workshops, seminars and educational advertisements about the benefits of consuming healthy crops, implement persuasive and motivational policies such as offering discounts, and holding tours of greenhouses for direct familiarization with the process of producing healthy crops and using the capacity of the media, including radio, television and social networks in order to improve the consumption pattern and increase public awareness and promulgate the consumption of healthy crops.

Strategies such as culture building, improving the support structure, improving services, training healthy behavior in greenhouses, monitoring, amending laws, correct management, improving technical-technological conditions, strengthening greenhouse farmers' empowerment, advertising and trust building make a contribution to surmount the obstacles of healthy crop production. The non-occurrence of these strategies would lead to consequences namely human-social, ecological-environmental and economic consequences.

Conflict of interest

The authors declares no conflict of interest.

Acknowledgments

The authors sincerely appreciate all the participants for their contributions without whom conducting this research would not have been possible.

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