Bridging the knowledge gap of apple growers: Transition from conventional to organic production pattern in Iran

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Abstract

Organic Agriculture (OA) is an ecological, economic and social system that has been in the spotlight to replace and reduce the adverse consequences of conventional agriculture (CA) and achieve sustainable agriculture. The future of OA depends heavily on the knowledge of producers. Accordingly, the current research is based on the Borich model and a survey method using a questionnaire, to examine the existing knowledge and needed by Damavand gardeners to produce organic apples. Thus, using Cochran's formula, a sample of 158 gardeners were selected and interviewed by simple random sampling method. The validity of the assessment tool was obtained through a panel of experts. Also, to evaluate the reliability of the designed items, a pilot study was conducted outside the main sample. The results showed that in the planting stage, most of the respondents had very poor and weak level of knowledge, in the growing stage and the harvest the less than needed average level of knowledge to produce organic apples. The study of gardeners' information-seeking behavior showed that they were initially more inclined to individual resources like other experienced and prominent gardeners, and then to agricultural experts and extension agents. The need to acquire knowledge for organic production increased with the increase in the age of gardeners. However, with increasing issues such as education level, use of information resources, cultivation level and work experience, the need to acquire knowledge decreases. Finally, based on the Borich model, priority educational issues were identified to bridge the knowledge gap in order to produce organic apples in the planting, growing and harvesting stages.

***Keywords**: Organic agriculture, Conventional agriculture, Training needs assessment, Borich model, Organic apple, Iran.*

1. Introduction

The ensuring food security has emerged as one of the serious challenges with increasing population. Thus, in recent decades, more emphasis has been placed on intensive agriculture through the increasing use of chemical inputs, especially fertilizers and chemical pesticides (Palis *et al.*, 2006). Although some success has been achieved, the indiscriminate use of these inputs has led to worrying consequences, including the instability of agricultural systems, the unauthorized chemical residues in food products, and the emergence of a variety of diseases and environmental hazards (Jensen and Blok, 2008; Yazdan-

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Table 1 - World: Organic agricultural land (including in-conversion areas) and regions' shares of the global organic agricultural land 2019.

Region	*Organic agricultural land (hectares)*	*Regions' shares of the global organic agricultural land*
Africa	2030830	2.8%
Asia	5911622	8.2%
Europe	16528677	22.9%
Latin America	8292139	11.5%
Northern America	3647623	5.0%
Oceania	35881053	49.6%
World	72285656	100.0%

Source: IFOAM, 2021.

panah *et al.*, 2015). Because CA is like a double-edged sword, which on the one hand has low cost and high yield and on the other hand has negative effects on humans and the environment (Lumpkin, 2003). In conventional agriculture, more than 300 types of hazardous chemical compounds such as pesticides, herbicides and chemical fertilizers are used to control pests, insects and provide the nutrients needed by the soil. In addition to polluting groundwater, the residues of these substances are absorbed by plants and trees and deposited in fruits and vegetables and transferred to the human body by consumption (Asgari and Hasani Moghaddam, 2011). Accordingly, industrial agriculture has caused the loss of biodiversity and habitats and has provided the conditions for the emergence of various diseases and the spread of viruses. Therefore, the need for sustainable and resilient food systems is very much felt (Luttikholt, 2020). Now, along with ensuring food security, the issue of food safety has become very important. Thus, OA has been introduced as a suitable alternative to CA (European Commission, 2016). OA is a type of agriculture that aims to create integrated, systematic and humane production systems that do not conflict with environmental, social and economic advantages. Different definitions of organic products emphasize the non-use of genetic modifications, toxins, chemical fertilizers, hormones and other chemicals. Because these products are the result of OA process (Basha *et al.*, 2015). Positive effects on the environment and improving the situation of villagers and rural society economically justifies OA and with its proper implementation can provide healthy and sustainable food. Today, the role of OA in achieving sustainable development goals is quite clear (Gabriel and Tscharntke, 2007; Luttikholt, 2020). OA can also help reduce climate change because it reduces greenhouse gases, especially nitrous oxide, by not using nitrogen fertilizers. By creating and consuming organic matter, it stores carbon in biomass and soil. Eliminating the energy required to produce fertilizers and chemical pesticides and using the farm's internal inputs reduces energy consumption by 30-70% per unit area, and as a result, the fuel used for transportation is reduced (IFOAM, 2020). OA is a production system that maintains the health of soil, ecosystems and people. This system emphasizes ecological processes, biodiversity and cycles adapted to local conditions. Thus, the expansion of OA has grown exponentially, especially after the intensification of sensitivities to agriculture climatic and environmental issues. These new ideas include more rational use of natural resources, environmental protection, high-efficiency low-input agricultural approach, food security, land return and sustainable agricultural development through systems such as organic, biological, biodynamic and natural systems with extensive relevant theoretical and applied studies (Regouin, 2003). In parallel with this development, the world organic food market has expanded by an average of 20% per year (Pino *et al.*, 2012). According to the latest global statistics (Table 1), the amount of land under cultivation of organic products in the world is 72.3 million hectares, which includes 1.5% of

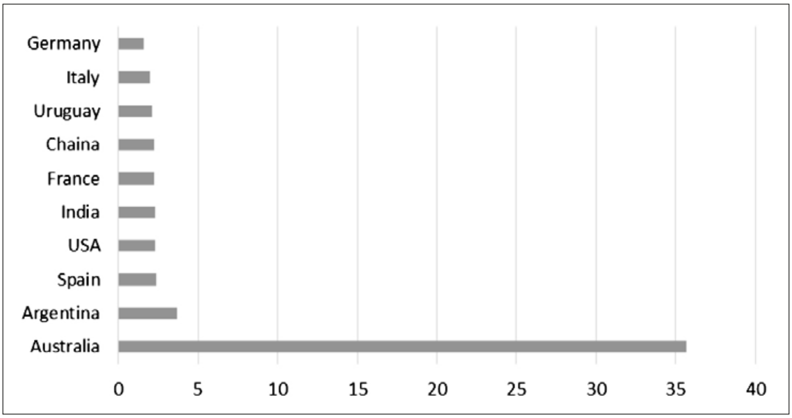

Figure 1 - World: The ten countries with the largest areas of organic agricultural land 2019.
Source: IFOAM, 2021.

the total land in the world. Asia, with an area of 5.9 million hectares, accounts for about 8.2% of the world's organic matter. Australia with 35.7 million hectares, Argentina with 3.7 million hectares and Spain with 2.4 million hectares, respectively, have the highest area under organic crops in the world (Figure 1). The number of producers of organic agricultural products in the world is 3.1 million, of which 1366226 belong to India, 210353 to Uganda and 203602 to Ethiopia (IFOAM, 2021). Despite the high growth of production and demand for organic products, but the share of production of these products is still small compared to conventional methods of agricultural production in the world. Therefore, in many countries, agricultural policies show a strong orientation towards friendship with nature.

In Iran, there is a greater tendency for intensive agriculture and high consumption of chemical inputs to achieve food security and increase production, so that the amount of chemical fertilizer consumption has increased from 2.5 to 3.5 million tons in the last 10 years, i.e., at the level of 12 million hectares, the amount of chemical fertilizer consumption is 1665588 tons with an average of 61 kg and pesticides 1800628 liters with an average of 0.4 liters per hectare (FAO, 2013). These conditions have made Iran rank 67th among 180 countries in terms of environmental performance index (EPI, 2020). Despite the increasing spread of OA in the world, in Iran this trend is slowly increasing. According to the latest global statistics, the amount of agricultural land under cultivation of organic crops is 11,916 hectares, which is about 0.03% of the total land of Iran and about 3879 people are working in this regard (IFOAM, 2021). In Iran, apples are the most important horticultural product, so that it is in the first rank of production (Ministry of Agriculture, 2020); besides, globally, apples are ranked third in terms of acreage after citrus and bananas (Choupannejad *et al.*, 2018). Iran has a special position in the world due to the favorable climatic conditions for the cultivation of apple (Naderi *et al.*, 2020). World apple production is about 90 million tons and that in terms of area under apple cultivation, Iran ranks third and in terms of production (3872000 tons), sixth in the world after China (54447793 tons), Poland (5649323 tons), Italy (4604271 tons), USA (3925828 tons) and Chile (3872000 tons) (FAO, 2020). According to the latest statistics, the Ministry of Agriculture (2020) announced the area under cultivation of Iranian apple orchards in 2020 as 296 thousand hectares with a production of 5.2 million tons and exports of 925 thousand tons. The average apple production in Iran is 16 tons per hectare and in Tehran province is 32 tons per hectare. There are about 12,000 hectares of apple orchards in Tehran province. Furthermore, the average yield of apple production belongs to Damavand city with about 85 tons per hectare. Damavand city with the area under cultivation of 5800 hectares and the production of 230 thousand tons of apples has the first rank in Tehran province. Damavand apple is one of the best and most famous apple brands in Iran. In recent decades, due to the indiscriminate use of pesticides and chemical fertilizers to increase crop production by Damavand gardeners, Malling apple trees have been damaged, which makes it difficult to control pests and plant diseases, production instability and reduced crop quality, susceptibility to environmental stress, natural resources pollution and endangerment of human health. Organic apples are higher in quality of nutrition and tastier than conventional apples because chemical inputs are not used in its production (Ministry of Agriculture, 2020).

The main role of gardeners in moving towards OA necessitates analysis of farmers' knowledge to move and change the paradigm from a CA model to organic agriculture. However, despite the prediction of increasing the production of organic products in the future, few practical and experimental studies have been conducted on the training needs of gardeners to produce organic products. Despite the advantages of producing and consuming organic produce, it is not possible to make the right decisions without sufficient information (Lind *et al.*, 2003). However, traditional farmers have emphasized the lack of knowledge and information as one of the main constraints to the transition to organic agriculture (Sadeghi *et al.*, 2012). Farmers' decision to produce organic produce can be influenced by several factors. One of the important factors for OA by farmers is their knowledge of the production of these products. Study Gostchi *et al.* (2007) showed that there is a positive and significant relationship between knowledge of OA and the general environmental attitude of farmers. The results of a study conducted in Canada showed that the lack of knowledge and skills required for organic farm management and the lack of marketing opportunities for organic products are the most important reasons for avoiding OA practices. Economic factors also had the greatest effect on the conversion of OA among conventional farmers. Pest control, diseases and insects, uncertainty of economic efficiency, complexity and difficulties of the conversion process were identified as the main obstacles to the use of OA operations (Khaledi *et al.*, 2007). An influencing factor in the acceptance of OA is knowledge and awareness of its advantages (Stobbelaar *et al.*, 2007). While high costs, uncertainty of certification, lack of marketing information, lack of information related to price, high cost of manpower, production problems and information insufficiency were expressed as the main obstacles in the process of producing organic products (Sterrett *et al.*, 2005). In study of Alhafi Alotaibi *et al.* (2021), they found that the sustainability of OA depends on farmers' experience, the quality of information provided, risk management, and compliance with related regulations. Organic farmers and the OA Organization were two important sources of information. Also, adaptive capacities to climate change and certification are the key to production success in organic systems. Findings Hameed and Sawicka (2016) showed that there were significant relationship between farmers' knowledge and variables (education level, age, years of work in agriculture. Ben Abdallah *et al.* (2018) concluded that the need to reinforce the economic performance of organic olive growing production system through political strategies focusing on I) the improvement of the productivity by the implementation of good practices II) the increase of the demand of organic products in the local market, essentially by the improvement of the consumer's purchase capacity and III) the adoption of a strategic plan to explore new markets. Papadopoulos *et al.* (2018) showed that the farmer's decision to implement organic farming is determined by their attitude towards organic farming and to a lesser extent by economic reasons closely related to subsidies. Iofrida *et al.* (2020) stated that a similar level of economic profitability in both scenarios, due to the public subsidies for organic farming, which balanced higher production costs. From a social point of view, some differences have been highlighted: organic farming would be suitable not only to increase incomes but also to improve the occupational health of the people involved. The results of study Alhafi Alotaibi *et al.* (2019) also showed that the development of vocational training programs in order to meet the training needs of agricultural extension agents about OA should be based on the current knowledge of extension agents. The training need in OA indicates a lack of knowledge that can be reduced or eliminated through education (Man *et al.*, 2016). According to the model (Borich, 1980), which is widely used in agricultural extension, the training need is the gap between the current capability and the ideal situation of the individual in the same context. The premise of the Borich model is that needs assessment audiences can better judge their performance. Needs assessment identifies the gap between what one should know and do and what one knows and does in the current situation, and shows what education should emphasize (McCawley, 2009). In fact, the training need is the gap between the current and desired level of ability of individuals to perform their duties and responsibilities. Given the importance of apples as the first garden product in Iran and the prominent role of Damavand city in providing this important product, it is important to make arrangements for the stability and health of this product while examining the training needs of gardeners in the first and most important step. Because OA is more knowledge-intensive and information-intensive than input-intensive and needs to promote and improve the level of knowledge and even the use of indigenous knowledge. As Vaarst *et al.* (2009) stated OA and its management is very knowledgeable and training and access to it is important. Because the first step in extension and developing OA is to determine and analyze the gap between current knowledge and the knowledge required by gardeners, Due to the fact that special study was not conducted on the analysis of knowledge of gardeners in order to grow organic apples in Iran and the educational needs of gardeners in this regard were not clear to researchers, the present study was conducted. Thus, the current study aims at determining the training needs of gardeners to produce organic apples based on the Borich model.

2. Material and methods

2.1. *Introducing the study region*

Tehran province with an area of about 12981 square kilometers, is located between 34 to 36.5 degrees' north latitude and 50 to 53 degrees' east longitude. This province has 16 cities, 45 towns and 78 villages and limited from north to Mazandaran province, from south to Qom province, from southwest to Markazi province, from west to Alborz province and from east to Semnan province (Figure 2). This province, with 20% of the country's population, occupies 40% of the total consumer market. The average long-term rainfall in this province is 238.6 mm. Damavand city is a mountainous region located in the southern part of the central Alborz mountain range and in the northeastern part of Tehran province. This city is part of Tehran province and its area is about 24645 square kilometers and has an average height of 2300 meters above sea level and its shape is an irregular hexagon. In terms of temperature, the coldest month of January is with an average of 5 to 8 degrees and the warmest month of July is with an average temperature of 25 to 32 degrees Celsius. The average annual number of frost days in this region is 115 days for Abali, 101 days for Damavand and 95 days for Hamand Absard. The prevailing wind in this city blows from the northeast with an angle of about 30 degrees from the north and the average annual rainfall is more than 380 mm. The average annual relative humidity of the region is about 50.2% and its monthly relative humidity fluctuates between 28.7% in July to 74.7% in February. Thus, it has a semi-humid and cold climate. According to the latest divisions of

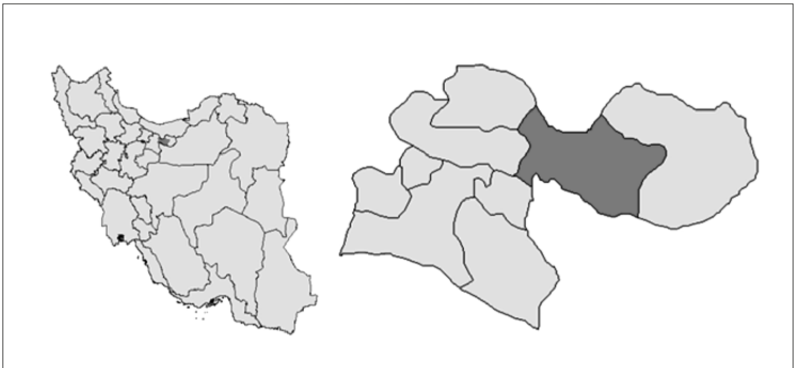

Figure 2 - Area of study (Damavand, Iran).

the country, Damavand city has only two parts, the central and the Rodehen. This is while more than 95% of the area of this city is located in the central part. The central part has three villages: Abarshiveh (with 20 residential villages), Tarroud (with 17 residential villages) and Abaroud (with 30 residential villages); There are a total of 67 villages with a population of more than 20 people and also three urban points of Damavand, Kilan and Absard (OAJT, 2020). According to the results of the present study, in terms of cultivated area, 59% of the studied gardeners had less than 8 hectares, 24.4% between 9-18 hectares, 16% between 19-28 hectares and only 0.6% more than 29 hectares of apple orchards. Among the gardeners studied, 39.2% were privately owned, 27.8% rented, 26.6% shareholders and 6.3% communal.

2.2. *Survey*

The present research is an applied study in terms of purpose, is a non-experimental study in terms of how to control variable, and is a survey in terms of research method, is field study in terms of data collection and is a cross-sectional study in terms of data collection time. The statistical population consists of 3000 gardeners of Damavand city. A sample of 158 individuals was determined using Cochran's formula through simple random sampling method with proportional assignment and table of random numbers (Table 2) and through face-to-face interview. A field study was conducted. Data collection was done in two stages, namely library study and review of research background by searching databases and then in the field stage. In the field stage, a questionnaire was used as the main research tool. The prepared questionnaire was given to a panel of experts and the necessary corrections were made based on the received comments. Accordingly, the face and content validity of the questionnaire was confirmed. In the next stage, the pretest was performed outside the study region to determine the reliability of the research tool. The results of Cronbach's alpha coefficients related to the questionnaire showed good reliability (α = 0.89-0.93).

$$n = \frac{Nt^2S^2}{Nd^2 + t^2 \times S^2} \rightarrow$$

$$\rightarrow n = \frac{(3000)(1.96)^2(0.33)^2}{(3000)(0.05)^2 + (1.96)^2 \times (0.33)^2} = 158$$

N = statistical population
t = Student t value with 95% confidence (significant distance level) and 5% error = 1.96
S = standard deviation of the dependent variable
d = error distance (degree of accuracy) = 0.05
n = Statistical sample size

2.3. *Needs assessment process and data analysis*

Educational needs assessment is an action that identifies the gap between what is and what should be, and shows what education should emphasize. There are several models for assessing educational needs. Among the needs assessment models, Borich's needs assessment model has been widely used in agricultural extension. According to the Borich model, the educational need is the distance between the current competencies and the ideal situation of the individual in the field of the same competencies. The assumption of the Borich model is that people in the needs assessment can better judge their performance. Borich's needs assessment model is based on ranking the difference between the importance of the educational subject and the individual's knowledge in that field (Pezeshki-Rad, 2008).

Table 2 - Statistical population and sample size.

Damavand	*Statistical population*	*Village*	*Statistical population*	*Sample size*
Central region	3000	Abarshiveh	1010	53
		Abaroud	1325	70
		Tarroud	665	35
Total			3000	158

Based on the Borich needs assessment model (Borich, 1980), gardeners were asked to use the Likert scale to determine their current level of knowledge for organic apple production, so that 5 = very high knowledge, 4 = high knowledge, 3 = medium knowledge, 2 = low knowledge and 1 = without knowledge. Gardeners were also asked to determine the importance of each item for organic apple production in the Likert scale based on 5 = very important, 4 = important, 3 = somewhat important, 2 = minor and 1 = insignificant. Then, training needs are determined and prioritized through the following steps and formulas.

Stage 1: Calculate the average amount of knowledge and information and the importance of each item asked from the respondent's point of view

Stage 2: Calculate the training need per item: CAL EN= (Im-Kn) Ig

Where,

CAL EN= Calculated educational need

Im= Importance of the item reported by the respondent

Kn= Perceived knowledge of the item reported by the respondent

Ig= Average importance of the item as rated by all the respondents.

According to these formulas and relationships, if the priority score of each item is higher than 4, it has the highest need for training and is in the training priority group. Items whose priority score is 2 and up or less than 4 have no training priority but need to be reinforced. Items whose priority score is below 2 do not need to be trained (Zarafshani *et al.*, 2011).

The F-test was used to compare between groups. F-test assumptions include the following: Observations are selected from a normal population. The data being compared should have almost the same variance. The collected data should have an interval or ratio scale. Multiple regression is used as a tool to predict the value of a dependent variable from the values of independent multivariable. In multiple regression, the parameters of a linear model are estimated using an objective function and the values of the variables. Regression is closely related to the correlation coefficient. This means that to perform regression, the correlation coefficient must be calculated. If there was a correlation between the studied variables, only then can we use regression to test the research hypotheses. The stronger the correlation between the variables, the more accurate the prediction. The difference between regression and correlation coefficient is that regression seeks prediction, while correlation coefficient examines only the degree of dependence of two variables. Although there are fundamental differences between regression analysis and correlation coefficient, they are used as complementary in data analysis.

3. Results

3.1. *Personal and productive characteristics*

Among the respondents, 98.3% were male and 1.3% female, with a minimum age of 20 and a maximum of 61 years and a mean age of 45 years. In terms of education level, 15.2% were illiterate, 35.4% elementary school, 10.8% middle school, 5.1% high-school diploma, 29.7% bachelor degree and 3.7% master degree. In terms of apple growing history, it was a minimum of one year, a maximum of 20 and an average of 7 years. Given the area under apple orchards, 59% of the subjects were less than 8 hectares, 24.4% were 9-18 hectares, 16% were 19-28 hectares and 0.6% were more than 29 hectares. Given the average annual yield of respondents' apples per hectare, the findings show that 72.9% of them had an average yield of less than 47 tons per hectare. 10.3% had a yield between 48-96 tons, 7.1% had a mean yield between 145-97 tons. 8.5% had a mean yield between 194-146 tons and 0.6% averaged between 243-195 tons per hectare.

3.2. *Current knowledge of gardeners about organic apple production*

The results of the survey of current knowledge of gardeners about the production of organic apples in the planting stage indicate: 23.1%, 41%, 34%, and 1.9% had very poor, poor, moderate and good knowledge, respectively. Also in the growing stage: 5.8%, 38.1%, 48.4% and 7.7% had very poor, poor, moderate and good knowledge, respectively. At the harvest stage: 1.9%, 19.6%, 54.4% and 24.1% had very poor, poor, moderate and good knowledge, respectively (Figure 3).

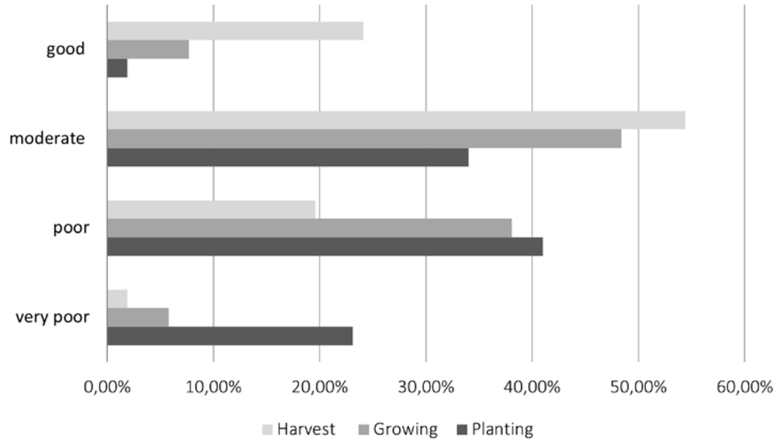

Figure 3 - Current knowledge of gardeners about organic apple production.

3.3. *Tendency to use information sources to produce organic apples*

According to the results of the coefficient of variation, the highest tendency of gardeners to use information resources to produce organic apples include consult experienced and prominent gardeners, consult with extension agents and agricultural experts, participate in training courses, communicate with consulting service centers, participate in certifying institutions (inspectors), visiting organic apple orchards, using training magazines and extension al publications, using training videos and using radio and television training programs (Table 3).

3.4. *Results of prioritizing the training needs of gardeners for organic apple production*

In order to determine the educational needs from the viewpoint of gardeners themselves, the Borich needs assessment model was used using 20 items. For each of the questionnaire questions, gardeners used the Likert scale (1-5) to determine how much knowledge or importance they had in each of the educational subjects measured. How to assess the educational need based on the Borich model was explained in the research methodology. Table 4 shows the prioritization of gardeners' training

Table 3 - Ranking of gardeners' willingness to use information sources to produce organic apples.

Item	*Mean*	*SD*	*Coefficient of variation*	*Priority*
Consult experienced and prominent gardeners	3.72	0.59	0.161	1
Consult with extension agents and agricultural experts	3.94	0.77	0.197	2
Participate in training courses	4.22	0.94	0.225	3
Communicate with consulting service centers	3.97	0.96	0.244	4
Participate in certifying institutions (inspectors)	3.92	0.98	0.252	5
Visiting organic apple orchards	3.85	1.06	0.227	6
Using training magazines and extension al publications	3.89	1.07	0.227	7
Using training videos	3.82	1.18	0.309	8
Using radio and television training programs	2.49	1.15	0.462	9

Evaluation scale: 1 = very low; 2 = low; 3 = moderate; 4 = high; 5 = very high
Source: Authors' survey.

Table 4 - Prioritize the training needs of gardeners for organic apple production.

Stage	*Item*	*Current knowledge mean*	*Importance mean*	*Training need score*	*Priority*
Planting	Knowledge of appropriate non-genetic cultivars of organic apples in the region	1.87	4.13	8.34	1
	Knowledge of characteristics of standard organic apple seedlings	1.93	4.07	7.90	2
	Knowledge of the standard (permitted instructions) of organic apple production	2.26	3.74	5.46	3
	Knowledge of the course and how to convert an ordinary garden to organic	2.44	3.56	4.13	4
	Knowledge of the climatic, soil and water conditions of the planting area	3.7	2.93	-2.84	_
Growing	Knowledge of non-chemical methods including biological, agronomic and mechanical methods to control pests, plant diseases and weeds	2.13	3.92	5.91	1
	Knowledge of time, type, manner and the amount of organic fertilizers used	2.16	3.84	5.54	2
	Knowledge of useful biological organisms in the garden and how to use them	2.15	3.80	5.45	3
	Knowledge of properties of live mulch (clover) for garden floor management	2.29	3.71	4.69	4
	Knowledge of how to prepare and use green manure and compost using waste in the garden	2.50	3.50	3.3	5
	Knowledge of the importance of water testing methods to ensure safe and non-chemical use of water	3.02	2.98	-0.13	_
	Knowledge of the correct method of drip irrigation	3.34	2.66	-.2.24	_
	Knowledge of water needs and management of water consumption in the apple orchard	3.36	2.64	-.2.38	_
	Knowledge of the right time and how to prune apple trees	3.37	2.63	-.2.44	_
Harvest	Knowledge of the conditions and how to obtain organic product label for obtaining a sales license	1.70	4.30	9.83	1
	Knowledge of indicators, criteria and methods of inspection and monitoring of certification bodies	1.89	4.11	8.39	2
	Knowledge of proper packaging for organic apples	2.05	3.87	6.88	3
	Knowledge of the rules of transportation of organic products	2.14	3.86	6.50	4
	Knowledge of the method and time of timely harvest according to different cultivars	3.44	3.99	2.08	5
	Knowledge of non-chemical methods in pest and storage diseases control	3.45	2.55	-3.40	_

Needs training ▭ *Needs strengthened* ▬ *Does not need training* ▭
Source: Authors' survey.

needs for organic apple production based on the Borich needs assessment model. According to this table, 12 training subjects scored above four which are considered as training priorities. The training subjects include: knowledge of the conditions and how to obtain organic product label for obtaining a sales license, knowledge of indicators, criteria and methods of inspection and monitoring of certification bodies, knowledge of appropriate non-genetic cultivars of organic apples in the region, knowledge of characteristics of standard organic apple seedlings, knowledge of proper packaging for organic apples, knowledge of the rules of transportation of organic products, knowledge of non-chemical methods including biological, agronomic and mechanical methods to control pests, plant diseases and weeds, knowledge of time, type, manner and the amount of organic fertilizers used, knowledge of the standard (permitted instructions) of organic apple production, knowledge of useful biological organisms in the garden and how to use them and knowledge of properties of live mulch (clover) for garden floor management. The results also showed that two cases, although they do not have training priorities, but need to be strengthened, which include: knowledge of how to prepare and use green manure and compost using waste in the garden and knowledge of timely harvest according to different cultivars. Other cases do not have training priority.

3.5. *Analysis of variance test results*

The results of analysis of variance (F-test) among gardeners with different characteristics (Table 5) show that the training needs of illiterate gardeners are higher than those with primary education, and the training needs of people with primary education are higher than those with secondary education. Also, gardeners who had less use of information resources had significantly more training needs than those with medium and high communication.

3.6. *Correlation test*

The results of correlation test show that there is a negative and significant relationship between education, work experience, cultivation level and the tendency to use information resources with the knowledge required to produce organic apples, but there is a positive and significant relationship between gardeners' age and training needs (Table 6).

Table 5 - Results of analysis of variance test to compare the training needs of gardeners with different characteristics for organic apple production.

Independent variables	*levels*	*Frequency*	*Dependent variable*	*Mean*	*SD*	*t*	*Sig*
Education	illiterate elementary school middle school diploma bachelor master	24 56 17 8 47 6	the knowledge required to produce organic apples	8.54 7.31 6.09 5.23 4.48 3.30	4.58 3.33 3.18 3.01 2.64 2.21	3.12	0.021*
the tendency to use information resources	Low Moderate High Very high	2 31 110 15		9.70 10.09 7.15 5.77	4.45 3.42 3.30 3.49	10.39	0.0001*

*Source: Authors' survey. * = p<0.05*

Table 6 - Relationship between individual characteristics of gardeners and the knowledge required (training need) to produce organic apples.

Independent variable	*Dependent variable*	*Correlation coefficient*	*Sig*
Age	The knowledge required to produce organic apples	0.532	0.015*
Education		-0.494	0.001*
Work experience		-0.601	0.001*
Cultivation level		-0.491	0.001*
The tendency to use information resources		-0.551	0.001*

*Source: Authors' survey. * = p<0.05*

3.7. *Multiple regression results between independent and dependent variables of the research*

The stepwise multiple regression test was used to explain the variance of the dependent variable and to determine the ability of independent variables in predicting the dependent variable of the research (knowledge required for organic apple production). The variables of age, level of education, level of cultivation, work experience and the tendency to use information sources that had a significant relationship with the research variable were entered into regression to calculate. The results showed that all these variables entered the regression equation in five stages. Indicators Durbin Watson (1.886) and VIF indicate the appropriateness of using regression test for these variables. Values of t and significant level for these variables also indicate the presence of an effect on the dependent variable of the research. Also, the beta values obtained for these variables show that for each change in standard deviation, the independent variable is changed as much as the beta in the dependent variable. The study of standardized regression coefficients shows that the age variable (X2) with a value of B = 0.471 has a more positive role in estimating the knowledge required by gardeners (educational need) to produce organic apples. In other words, a unit change in the standard deviation of the age

Table 7 - Values of the effect of independent variables on the knowledge required for organic apple production.

Variables	*B*	*S.E.B*	*β*	*t*	*Sig*	*VIF*
Constant	13.97	0.995		14.03	0.0001**	
The tendency to use information resources X1	-2.155	0.555	-0.227	-0.378	0.0001**	1.681
Age X2	5.523	0.632	0.471	8.59	0.0001**	1.313
Work experience X3	-0.771	0.404	-0.127	-1.918	0.04*	1.079
Education X4	-0.128	0.044	-0.149	-.2.78	0.005**	1.285
Cultivation level X5	-0.085	0.031	-0.168	-0.265	0.007**	1.362

Table 8 - Multiple regression to examine the relationship between independent and dependent variables of the research.

Model	*R*	*R^2*	*Adjusted R^2*	*Std. Error of the estimate*	*Durbin Watson*
1	0.490	0.240	0.238	3.26	1.886
2	0.598	0.357	0.350	3.01	
3	0.637	0.405	0.399	2.90	
4	0.648	0.419	0.411	2.81	
5	0.690	0.476	0.442	2.87	

variable causes the standard deviation of the dependent variable to change by 0.471. The beta coefficients of other variables indicate that they play a negative role. Also, the rate of change of dependent variable by independent variables, as shown by the adjusted coefficient (Adjusted R^2 = 0.442), these five variables estimate 44.2% of the knowledge changes required for organic apple production (Tables 7 & 8).

Accordingly, the following regression equation to estimate the knowledge required by gardeners (training needs) to produce organic apples is:

$Y= 13.97- 2.155X_1 + 5.523X_2 – 0.771X_3 – 0.128X_4 – 0.085x_5$

4. Discussion

The results show that at the planting stage, most of the respondents show very poor and poor knowledge in the planting stage, and less than the average level in the growing and harvest stages, of knowledge needed to produce organic apples. These conditions indicate a feeling of lack of knowledge required to produce organic apples for the planting growing and harvest process. The poor knowledge of gardeners is considered as one of the important obstacles to the transition from the conventional to the organic pattern. Gardeners can move in this direction if they have the necessary knowledge and ability for organic production. Appropriate and targeted agricultural extension training can help to provide the required knowledge and success in organic production. These results are consistent with that of Hameed and Sawicka (2016).

The results show the tendency of gardeners to use information resources to produce organic apples include consult experienced and prominent gardeners, consult with extension agents and agricultural experts and then participate in training courses, communicate with consulting service centers, participate in certifying institutions (inspectors), visiting organic apple orchards, using training magazines and extension al publications, using training videos and using radio and television training programs. These results indicate that the information-seeking behavior of gardeners is initially more focused on individual resources such as other experienced and prominent gardeners, and then extension agents and agricultural experts. Therefore, experienced and capable gardeners in organic apple production can be identified and organized and used in training and support of other gardeners in the region. Also, if they have the necessary professional qualifications, they should be provided with a valid certificate to provide services. According to these results, in promoting organic apple production, individual training methods and then group methods should be considered. At the same time, attempts should be made to design and establish an organic agricultural knowledge and information system. These results are consistent with that of Aryal *et al.* (2009) and Piadozo *et al.* (2014).

The results of needs assessment to determine the knowledge required by gardeners to produce organic apples based on the Borich model show that 12 training subjects scored above four which are considered as training priorities. The training subjects include: knowledge of the conditions and how to obtain organic product label for obtaining a sales license, knowledge of indicators, criteria and methods of inspection and monitoring of certification bodies, knowledge of appropriate non-genetic cultivars of organic apples in the region, knowledge of characteristics of standard organic apple seedlings, knowledge of proper packaging for organic apples, knowledge of the rules of transportation of organic products, knowledge of non-chemical methods including biological, agronomic and mechanical methods to control pests, plant diseases and weeds, knowledge of time, type, manner and the amount of organic fertilizers used, knowledge of the standard (permitted instructions) of organic apple production, knowledge of useful biological organisms in the garden and how to use them and knowledge of properties of live mulch (clover) for garden floor management. The results also showed that two cases, although they do not have training priorities, but need to be strengthened, which include: knowledge of how to prepare and use green manure and compost using waste in the garden and knowledge of timely harvest according to different cultivars. Other cases do not have training priority.

In fact, if the appropriate training is provided and in accordance with the needs of gardeners, we can be very sure of filling the knowledge gap between the existing knowledge and needed to produce organic apples. These results are consistent with that of Basha and Lal (2019), Häring *et al.* (2009), Sahu *et al.* (2010) and Stolze and Lampkin (2009).

The results of analysis of variance show that there is a significant difference between individuals with different levels of education in the amount of knowledge required to produce organic apples. People with lower levels of education feel the need for more knowledge. Higher education leads to more use of information resources and wider communication, and this leads to more knowledge acquisition and exchange. Therefore, due to the fact that people with higher levels of education felt less training need, so the agricultural extension system should account for these differences in the design and implementation of organic training programs and focus more on gardeners with lower levels of education and support them. This result is consistent with the findings of Al-Shayaa *et al.* (2021) and Ghadimi *et al.*, 2013. Also, the less people were willing to use information resources, the more they needed knowledge. These results indicate that if different sources of information about organic apple production are available to gardeners, it will increase their level of knowledge and awareness and can meet their training needs. This result is consistent with that of Alzaidi *et al.* (2013) and Parveen (2010).

The results of correlation test show that there is a negative and significant relationship between the variables of education level, work experience, cultivation level and the tendency to use information resources with the knowledge required to produce organic apples. This result indicates that the higher the level of education of gardeners, the more the possibility of using reliable sources of information about organic production and therefore their training need decreases. The same is true of the tendency to use information resources. In the case of work experience, the more it is, the less the sense of training need is felt due to the acquired experimental and local knowledge. However, the higher the area under cultivation, the more knowledge is needed to apply better farm management. However, the age of gardeners had a positive and significant relationship with training needs. Younger gardeners also need less training in organic agriculture. Therefore, the older the age, the more the training need. The results of multiple regression test also showed that the variables of age, level of education, area under cultivation, work experience and the tendency to use information sources can predict the dependent variable of knowledge required for organic apple production. Among these, the age variable had a positive effect, but the other variables had a negative effect. That is, as they increase, the amount of training need will decrease. Findings of Hameed and Sawicka (2016) and Wheeler (2005) confirm these results.

5. Conclusions

In recent decades, efforts to ensure food security have been within the framework of the CA model associated with the increasing use of fertilizers and chemical pesticides, which has led to the presence of illegal and substandard food waste and a variety of crises and challenges in human societies. Accordingly, the desire to produce and consume organic and healthy food is increasing worldwide. OA is an integrated, systematic and humane agricultural production system that strengthens the health of biological ecosystems, soil bioactivity, biological cycles and healthy crop production by utilizing the resources available on the farm. For the production of organic agricultural products, including apples, which ranks first in horticultural products in Iran and third in the world, the starting point is the work of the producer, namely, gardeners. The knowledge and awareness of gardeners plays a decisive and important role in changing the production phase from conventional to organic agriculture. Agricultural extension has a great impact on the knowledge of gardeners. The needs should be identified and then the appropriate training should be designed and presented prior to any training. Needs assessment is the starting point of any training activity. The results of the current paper showed that gardeners do not have the necessary level of knowledge in the stages of planting, growing and harvesting for organic apple production. Also, the most important sources of information that gardeners are interested in to obtain information and knowledge for organic apple production were ranked. The results of the needs assessment based on the Borich model identified priority training issues. As gardeners grow older, the need for knowledge for organic production increases. However, this need decreases with increasing level of education, the tendency to use information resources, the level of cultivation and work experience.

Organic farming is more knowledge-intensive than inputs-intensive and requires improving the level of technical and managerial knowledge of gardeners. Therefore, designing and implementing extensional training programs is recommended using the capacity of media and social networks on the subject of organic apple production for producers. Creating local management networks of organic agriculture, organizing organic gardeners and creating demonstration and pattern gardens by agricultural extension centers can be effective in the transition from conventional to organic cultivation pattern. Given that increasing consumer awareness plays an important role in increasing demand for organic products, the necessary policies should be on the agenda for extensive information to urban households, especially women.

Adoption of organic farming policies by managers and policymakers as a good start can make gardeners feel the need to move from a conventional to an organic farming pattern. Of course, the higher prices of organic products alone do not play a major role in the adoption and development of organic agriculture. Rather, the development of organic agriculture requires the role of other factors such as increasing information and awareness, improving individual tendency and attitude, improving technical skills and farm management, social, cultural, institutional and infrastructure issues, as well as removing subsidies from some inputs such as pesticides and fertilizers, and in return supporting for the production and supply of organic inputs and subsidizing them should be considered by policy makers and managers in the agricultural sector. Also, in order to successfully implement organic apple production, the quality assurance system, how to label and provide certification of organic products, the required standards and regulations should be developed and the necessary mechanisms and monitoring should be done to implement them. Also Training in the production of organic products should be considered in the curriculum of agricultural colleges.

In order to complete and continue the present research, it is suggested that an educational needs assessment for the production of organic products to be performed for agricultural experts and extension agents. Also, study the factors affecting on the tendency of gardeners to organic farming, as well as the factors to be identified driving and barriers the production of organic apples.

It should be noted that one of the limitations of the present study is pointed the shortage of similar research on needs assessment to determine the knowledge required by gardeners to produce organic apples based on the Borich model in Iran, the use of questionnaire as research tool and the possibility of respondents making mistakes when answering questions, cross-sectional research, inability to fully control all Unwanted variables and non-generalizability of the results of this study to other areas.

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