نشریه علمی

اقتصاد و توسعه کشاورزی

(علوم و صنایع کشاورزی)

جلد ۳۶ شماره ۴

سال ۱۴۰۱

شماره پیاپی ۵۷

شاپا: ۴۷۲۲-۲۰۰۸

عنوان مقالات

نشریه اقتصاد و توسعه کشاورزی

(علوم وصنایع کشاورزی)

با شماره پروانه 21/2015 / 68/4/11 و درجه علمی – پژوهشی شماره 26524 / 73/10/19 از وزارت علوم، تحقیقات و فناوری

جلد 36 شماره4 تابستان 1401

بر اساس مصوبه وزارت عتف از سال 1398، کلیه نشریات دارای درجه "علمی-پژوهشی" به نشریه "علمی" تغییر نام یافتند.

ناشر: دانشگاه فردوسی مشهد

نشانی: مشهد- کد پستی 91775 صندوق پستی 1163

دانشکده کشاورزی _ دبیرخانه نشریات علمی _ نشریه اقتصاد و توسعه کشاورزی

پست الکترونیکی: Jead2@um.ac.ir

این نشریه در سایت https://jead.um.ac.ir/ به صورت مقاله کامل نمایه شده است.

این نشریه به صورت فصلنامه (4 شماره در سال) چاپ ومنتشر می شود.

بسم الله الرحمن الرحیم

مندرجات

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 337-352

Factors Affecting the Selection of Marketing Strategy in Different Stages of Product Life Cycle

H. Mohammadi[1]*, A.R. Sani Heidary[2], A. Shahraki[3]

Received: 30-10-2018
Revised: 10-05-2022
Accepted: 26-10-2022
Available Online: 15-02-2023

How to cite this article:
Mohammadi, H., Sani Heidary, A.R., & Shahraki, A. (2023). Factors Affecting the Selection of Marketing Strategy in Different Stages of Product Life Cycle. *Journal of Agricultural Economics & Development 36*(4): 337-352.
DOI: 10.22067/JEAD.2022.17748.0

Abstract

A suitable marketing strategy is essential for increasing sales and profitability at different stages of the product life cycle. The main objective of this study was to assess the factors that affect the choice of marketing strategy at various stages of the product life cycle in the food industry in Mashhad, Iran. Data were collected in 2017 through a survey which 88 marketing managers in the food production industry completed the questionnaires. To reach the goal of the study, the multinomial logit model was applied to determine the effects of explanatory variables on the probability of choosing a special marketing strategy at the various stages of the product life cycle. Results showed that the manager's experience, education, type of product, competitiveness, reputable brand, and market share had a significant effect on the chosen strategy at different stages of the product life cycle. Therefore, a company's profitability in a market could be improved by the implementation of a marketing strategy based on product type and in relation to the specific stage of the product life cycle.

Keywords: Comparative advantage, Food industries, Marketing strategies, Product life cycle

Introduction

In terms of marketing, there is a life cycle for each new product from its innovation and introduction phase to termination and obsolesce. Nowadays with increasing competition in the field of production and consumption, successful companies know that survival depends on the successful implementation of effective marketing principles and strategies. In this dynamic, complex, and ambiguous state of competition, occasionally powerful and innovative competition may emerge, so a marketing strategy should be used by companies at different stages of the product life cycle. A product's markets and competition will change over time and the product life cycle can be used to determine changes that companies can apply to a product in the context of the life cycle (Kotler, 2000). Therefore, a clear marketing strategy is necessary for each different stage of the product life cycle because products have different characteristics at different stages. The product life cycle has four stages; including introduction, growth, maturity, and decline. Normally each stage requires a specific marketing strategy that consists of a special combination of marketing and management concerning each particular stage (Kotler, 2000).

Some studies have identified appropriate marketing strategies for each stage of the product life cycle. In the introduction stage,

1, 2 and 3- Associate Professor, Ph.D. Candidate and Ph.D. of Agricultural Economics, Ferdowsi University of Mashhad, Mashhad, Iran, respectively.
(*- Corresponding Author Email: hoseinmohammadi@um.ac.ir)

Fox (1973); Dawson (1975); Wind and Robertson (1983) have suggested useful advertising and heavy marketing costs and Sharma (2013) identified techniques for focus and management at the introduction stage that lead to the optimization of a product's effect and positioning in the market.

Hofer (1975) proposed increasing sales efforts and advertising for brand reputation at the product growth stage. Levitt (1965) and Dawson (1974) suggested important increasing advertising and new complementary products and decreasing food prices as important factors in production management at the product growth stage. Hisrich and Peters (1984) recommended effective psychological advertising and business discounts at the maturity stage.

Sharma (2013) discussed marketing strategies at different stages of the PLC for fast moving consumer goods (FMCG). The results showed that focus and application of management techniques at the introductory stage of the product life cycle led to optimization of output and exposure to effective market positioning. Aitken *et al.* (2003) showed that each stage of the product life cycle had a significant effect on selection of appropriate strategies and supply chain management. Hsueh (2011) showed that various inventory control policies should be adopted at different stages of the product life cycle. Shahmarichartghieh *et al.* (2015) concluded that each aspect of the product life cycle had a different consequence and that decision makers should act with consideration of all of them in order to achieve favorable results.

Porter (2008) discussed strategies for the creation of competitive advantage for producers. The strategies were cost leadership, differentiation, and focus. A company's objective in a cost leadership strategy is to obtain a comparative advantage by lowering production costs for a commodity than its competitors. Porter (2008) proposed a large volume of production at prices lower than those of competitors. According to the differentiation strategy, products and services are offered according to a perception that it is a unique product or service in the desired industry. This strategy gains a competitive advantage through the production of unique products or services with special properties and these products or services should be offered to customers that have not shown much sensitivity to prices. A company can differentiate its products or services in the following five ways; products, services, staff, distribution channels, and imagination. Finally, the focus strategy involves a company focusing on one or several specific products or services or a particular group of customers by understanding the needs and demands of certain sectors of the market such that the producer satisfies the needs of its target market.

Sustainable competitive advantage, as proposed by Porter (2008), is achieved through cost management, differentiation of products or services, and focus on a special part of the market or a special group of consumers. While these strategies aim to maximize profit, each of the various strategies applies a different method of maximization. Market strategies for achieving comparative advantage, are market penetration strategy, market development strategy, product development, and diversification strategy (Porter, 2008).

A company that follows the market penetration strategy tries to increase its share in the current market. Market development includes a variety of ways to attract new customers to present goods including the development of services. Product development strategy includes the creation of new products for existing markets and diversification that tries to increase selling through the introduction of new products in new markets.

In this research, according to Ansoff's product/market expansion grid, the dependent variable was divided into three categories showing the overall marketing strategy adopted by a firm. Ansoff´s Matrix is an analytical technique used in marketing and strategic management (Kotler and Armstrong, 2005). The first strategy was the introduction of new products in the market (or product

development strategy). Product development is a strategy for company growth by offering modified or new products to current market segments. The second strategy was the development of the market by identifying and developing new markets (market development strategy). Market development involves searching for additional market segments or regions. The third strategy was the development of services, price reduction, advertising, and increasing promotion that led to penetration of the current market (market penetration strategy). Market penetration is a strategy for company growth by increasing sales of current products to current market segments without changing the product. The company tries to penetrate more with existing products in an existing market (market segment). The aim is to increase its market share and this is the least risky strategy because the company can take advantage of existing resources, processes, and capacity (Kotler and Armstrong, 2005).

It should mention that diversification strategy that means new products in new markets does not consider in this research because none of the food companies surveyed adopt this strategy. Diversification is the riskiest of all four above-mentioned strategies and the company must innovate an existing product or develop a new one and succeed with it in a new market.

A review of the research literature showed that few studies have been conducted regarding the factors affecting the choice of marketing strategy during the product life cycle. Thus, according to the importance of factors affecting the choice of strategy, this study was conducted with the aim to evaluate and identify factors affecting the selection of marketing strategies at each stage of the product life cycle.

Methodology and Data

Methodology

The statistical population of the present study is the managers of food products companies that have been operating in Mashhad in 2017. Mashhad, is a main center of the food industry in Iran and has a comparative advantage in production and export of food products. There are 887 active food industries in Khorasan Razavi province (mainly in Mashhad), and around $ 400 million of food products were exported from this province to other countries in recent years (Industry, Mine and Trade Organization, 2015).

Data were obtained by questionnaire and by simple random sampling from medium-and large-scale firms or firms holding more than 9 employees, according to the fourth edition of International Standard Industrial Classification (ISIC, 2015) division into sectors 10 (food products) and groups 101 (meat processing and preserving), 103 (processing and preserving of fruit and vegetables) and 105 (manufacturing of dairy products) in 2017. A random sample set of 88 medium-and large-scale companies in the city of Mashhad was selected and interviews with their managers or marketing executives were conducted.

Sometimes in studies, the researcher encounters a discrete dependent variable that has multiple groups or responses (more than two responses) but are not ordered. Therefore, models should be used that can measure the nominal nature of multiple response groups.

The multinomial logit model is the most widely used nominal regression model. In this research, managers' responses to the dependent variable were not ordinal and so the multinomial logit approach was used to assess factors affecting selection of type of food marketing strategy at the different stages of product life cycle. Multinomial logit is a linked set of binary logit models that have the ability to efficiently use data and create logical relationships between parameters. (Long and Freese, 2001). In fact, the multiple logit regression model is a generalization of the binary logit model that estimates it for all comparisons simultaneously. (Greene, 1998; Ben-Akiva and Lerman, 1985; Begg, 1984).

Mathematically, a multinomial logit model can be written as (Long, 1997; Long and Freese, 2001):

$$\ln\Omega_{m|b}(x_i)=\frac{\Pr(y_i=m\mid x_i)}{\Pr(y_i=b\mid x_i)}=x_i\beta_{m|b}\quad for\ m=1\ to\ 3 \qquad (1)$$

Where b is considered as the base or comparison group. Since $\ln\Omega_{b|b}(x_i)=\frac{\Pr(y_i=b\mid x_i)}{\Pr(y_i=b\mid x_i)}=\ln(1)=0$, it must hold that $\beta_{b|b}=0$. That is, the log odds ratio of outcome b compared to itself is always 0, and thus the effects of any Explanatory variables must also be 0.

Multinomial logit model can be expanded as an odds model. In this case, odds ratio of outcome A versus outcome C could be shown as equation (2).

$$\Omega_{A|C}(x_i)=\frac{\Pr(y_i=m|x_i)}{\Pr(y_i=n|x_i)}=\frac{\exp(x_i\beta_A)}{\exp(x_i\beta_C)}=\exp x_i\beta_A-\exp x_i\beta_C \qquad (2)$$

By taking logarithm of the equation (2), odds ratio equation can be converted as equation (3):

$$\ln\Omega_{A|C}(x_i)=\ln(\exp x_i\beta_A-\exp x_i\beta_C)=x_i(\beta_A-\beta_C) \qquad (3)$$

The difference between $(\beta_A-\beta_C)$ is called "*contrast*" that shows the effect of **x** on the logit of outcome **A** versus **C**. In the Multinomial logit model, it is assumed that the probability of observing each group of dependent variables (Y) is defined as follows Equation 4 (Long, 1997; Long and Freese, 2001):

$$\Pr(y_i=m|x_i)=\frac{\exp(x_i\beta_{m|b})}{\sum_{j=1}^{J}\exp(x_i\beta_{j|b})} \qquad (4)$$

Specifically, the probabilities of each of the groups of dependent variables (j= 1,2,3) are respectively determined by Equations 5 to 7 (Yi = 3 is the category base group):

$$\Pr(y_i=1|x_i)=\frac{\exp(x_i\beta_{1|3})}{1+\sum_{j=2}^{3}\exp(x_i\beta_{1|3})} \qquad (5)$$

$$\Pr(y_i=2|x_i)=\frac{\exp(x_i\beta_{2|3})}{1+\sum_{j=2}^{3}\exp(x_i\beta_{2|3})} \qquad (6)$$

$$\Pr(y_i=3|x_i)=\frac{1}{1+\sum_{j=2}^{3}\exp(x_i\beta_{3|3})} \qquad (7)$$

In the Multinomial Logit Model (MNLM), such as simple logit models, explanatory variables do not interpret directly. Therefore, the marginal effects (marginal and discrete change) of descriptive variables must be used to interpret them. Marginal and discrete change can be used in the same way as in models for ordered outcomes.

Marginal change is defined as Equation 8:

$$\frac{\partial\Pr(y=m\mid x_i)}{\partial x_k}=(y=m\mid x_i)\left[\beta_{k,m|J}-\sum_{j=1}^{J}\beta_{k,j|J}\Pr(y=j\mid x_i)\right] \qquad (8)$$

Since this equation combines all of the $\beta_{k,m|J}$'s, the value of the marginal change depends on the levels of all variables in the model. Further, as the value of x_k changes, the sign of the marginal can change.

Discrete change is defined as Equation 9:

$$\frac{\Delta\Pr(y=m\mid x_i)}{\Delta x_k}=\Pr(y=m\mid x_i,x_k=x_E)-\Pr(y=m\mid x_i,x_k=x_S) \qquad (9)$$

Where the magnitude of the change depends on the levels of all variables and the size of the change that is being made. In this study, marginal and discrete changes are measured in three ways: by a unit change around the mean (Δ1), by change of one standard deviation around the mean (Δσ) and change from minimum to maximum of explanatory variable (ΔRange).

Related estimates of the unknown parameters of the model can be calculated using of maximum likelihood method. The

likelihood function is as follows (Hensher *et al.*, 2005):

$$L(\beta_2,...,\beta_J \mid y, X_i) = \prod_{i=1}^{N} P_i = \prod_{m=1}^{J} \prod_{y_i=m} \frac{\exp(x_i \beta_m)}{\sum_{j=1}^{J} \exp(x_i \beta_J)}$$

$$\ln L(\beta_2,...,\beta_J \mid y, X_i) = \sum_{m=1}^{J} \sum_{y_i=m} \ln \left(\frac{\exp(x_i \beta_m)}{\sum_{j=1}^{J} \exp(x_i \beta_J)} \right) \quad (10)$$

$$= \sum_{m=1}^{J} \sum_{y_i=m} (\ln \exp(x_i \beta_m) - \ln(\sum_{j=1}^{J} \exp(x_i \beta_J)))$$

By taking the logarithm of this function, the log-likelihood equation is obtained which can be maximized with numerical methods for calculating the amount of β. (Long, 1997; Hensher *et al.*, 2005)

One important assumption that must be tested in the multinomial logit model is the independence of irrelevant alternatives (IIA). In Equation (2), this assumption means that the odds ratio for any outcome is not related to other outcomes or possible states. In the other words, adding or deleting an outcome does not affect the odds ratio of the remaining outcomes. There are two tests to examine the IIA hypothesis. Hausman and McFadden, (1984) suggested the Hausman test and McFadden, Tai, and Threen (1976) have suggested likelihood ratio tests (LR), these have been improved by Small and Hsiao (1985). Significant values of H (Hausman statistic) indicate that the IIA assumption was rejected. Another assumption that should be considered in the multinomial logit model is a combination of categories tested by the likelihood ratio and Wald tests. This assumption states that if none significantly affects the odds of outcome **m** versus outcome **n**, then **m** and **n** are indistinguishable with respect to variables in the model (Long, 1997).

Consideration of the effect of explanatory variables on the marketing strategy that has been selected by food companies at different stages of PLC, so it is important to identify significant variables on the choice of marketing strategies in different stages of PLC. Hence, this study aimed to evaluate factors affecting the selection of the type of marketing strategy for food company managers at different stages of PLC. To achieve this goal, the multinomial logit model was applied and STATA 14 software was used to estimate the models. The research model was as follows:

$$\ln \Omega_{1|3}(x_i) = \ln \frac{\Pr(y_i = 1 \mid x_i)}{\Pr(y_i = 3 \mid x_i)} = \quad (11)$$

$$= \beta_{0,1|3} + \beta_{1,1|3} \exp + \beta_{2,1|3} edu + \beta_{3,1|3} product$$

$$+ \beta_{4,1|3} brand + \beta_{5,1|3} share + \beta_{6,1|3} competition + u_i$$

$$\ln \Omega_{2|3}(x_i) = \ln \frac{\Pr(y_i = 2 \mid x_i)}{\Pr(y_i = 3 \mid x_i)} = \quad (12)$$

$$= \beta_{0,2|3} + \beta_{1,2|3} \exp + \beta_{2,2|3} edu + \beta_{3,2|3} product$$

$$+ \beta_{4,2|3} brand + \beta_{5,2|3} share + \beta_{6,2|3} competition + u_i$$

Equations (11) and (12) indicate the odds ratio of outcome 1 versus outcome 3 and the odds ratio of outcome 2 versus outcome 3, respectively (Yi= 3 is the base group of the group in which the estimation of coefficients is equal to zero). The dependent variable was divided into three groups and its description is shown in Table 1. Other explanatory variables are described in Table 2 and u_i is error term that has a logistic distribution

Data and variables

Descriptive statistics of data are reported in Table 1 and Table 2. The frequency of each group of the dependent variable is reported in Table 1. The dependent variable was divided into three groups; the first group was product development strategy, the second group was market development strategy, and the third group was market penetration strategy. In the Introduction stage, company managers have selected 53.79% of strategy I, 22.73% of strategy II, and 23.48% of strategy III. In the Growth stage, company managers have selected 24.71% of strategy I, 25.88% of strategy II, and 49.41% of strategy III. In the Maturity stage, company managers have selected 40.15% of strategy I, 20.44% of strategy II, and 39.42% of strategy III. In the Decline stage, company managers have selected 32.14% of strategy I, 33.04% of strategy II, and 34.82% of strategy III.

Table 1- Description of dependent variable and its frequency in various stages of Product Life Cycle

Stages of product life cycle	Dependent variable groups			
	Groups	Product development strategy (strategy I)	Market development strategy (Strategy II)	Market penetration strategy (strategy III)
Introduction stage	Frequency	71	30	31
	Frequency (%)	53.79	22.73	23.48
Growth stage	Frequency	42	44	84
	Frequency (%)	24.71	25.88	49.41
Maturity stage	Frequency	55	28	54
	Frequency (%)	40.15	20.44	39.42
Decline stage	Frequency	36	37	39
	Frequency (%)	32.14	33.04	34.82

Source: Research findings

Table 2- Description of explanatory variables

Variable	Description
Managers Age	Age (continuous)
Managers educational Level	Under Diploma=0, Diploma to Bachelor=1, Bachelor's Degree or higher=2
Managers experience	The number of company management experience years (continuous)
Product type	Mono=0, Multi item=1(dummy variable)
Brand	Degree of importance of having a reliable brand composed from different items measured by Likert scale converting to a continuous variable using the factor analysis method (continuous)
Competition	This variable shows the importance of competitiveness in the market, which is composed from different items with a Likert scale and has finally been converted into a continuous variable using the factor analysis method(continuous)
Market share	The importance of market share at strategy selection (Low=0, Average=1, High=2)

Source: Research findings

It should be noted that some companies chose more than one strategy at each phase of the product life cycle. Therefore, the sum of vertical or horizontal columns in Table 1 was more than the number of questionnaires but as depicted in Table 1, the sum of the frequency percentages in all columns was one. Furthermore, companies operating in the food

industry that studied in this research did not pursue diversification strategy and hence this strategy has not been considered. Table 2 shows descriptive statistics of the explanatory variables.

Results and Discussion

Combinations of dependent variable categories were tested by application of the likelihood ratio (LR) and Wald tests; results for the different stages of PLC are reported in Table 3. The null hypothesis or H_0 in both tests is determined by the mutual combination of categories. Regarding the values of both statistics from Table 3, it can be concluded that the different marketing strategies could not be combined at each stage of the product life cycle; in other words, H_0 assumption was rejected for both tests.

Table 3- Results of marketing strategies combination in different stages of Product Life Cycle

Life cycle stages	Studied groups	The likelihood statistics	Significance level	Wald statistic value	Significance level
Introduction stage	1 & 2	22.59	0.00	16.22	0.06
	1 & 3	45.56	0.00	19.88	0.02
	2 & 3	40.97	0.00	22.89	0.01
Growth stage	1 & 2	18.57	0.03	14.72	0.099
	1 & 3	21.24	0.01	15.95	0.068
	2 & 3	17.33	0.04	14.81	0.096
Maturity stage	1 & 2	60.72	0.00	25.21	0.01
	1 & 3	23.02	0.01	14.81	0.096
	2 & 3	31.72	0.00	17.40	0.04
decline stage	1 & 2	24.88	0.00	15.82	0.07
	1 & 3	27.23	0.00	15.42	0.08
	2 & 3	34.47	0.00	20.59	0.02

Source: Research findings

Another important test for consideration in the multinomial logit model was the IIA test that was examined by using Hausman statistics. The results of this test for different stages of PLC are presented in Table 4.

According to Hausman, LR, and Wald statistics, values were non-significant at all four stages of PLC demonstrating that the IIA assumption was accepted. Hausman statistic values showed the negative for all groups at the growth stage and in the first and third groups at the stage of decline and a significant level has not been reported. Hausman and McFadden (1984) have concluded that a negative value confirms the -IIA- assumption. To ensure this, the generalized Hausman test was applied and results are reported in Table 4. According to results in Table 4, the statistic values have been insignificant for both stages and the IIA assumption was again confirmed.

The selection of a base group is important for estimating the multinomial logit model. STATA software considers the group with the highest frequency as the base group, but in this study, the base group was considered to market penetration strategy to include consideration of the odds ratio of other marketing strategies compared to the market penetration strategy. Results of the multinomial logit model for each of the stages; introduction, growth, maturity, and decline have been reported in Table 5. The estimated coefficients shown in these tables show the direct effects of the independent variables on the selected strategy by companies, while the Relative Risk Ratio (RRR) shows the rate of probability change for each category compared to market penetration strategy when a change in the explanatory variables occurs.

Table 4- Results of Hausman and generalized Hausman tests for assumption of (IIA) in the Product Life Cycle

Life cycle stages	Hausman test				Generalized Hausman test			
	The strategy groups	Statistic value	Freedom degree	Significance level	strategy groups	Statistic value	Freedom degree	Significance level
Introduction stage	1	0.48	10	1.00	1	7.72	10	0.66
	2	1.14	10	1.00	2	2.94	10	0.98
	3	0.21	10	1.00	3	6.96	10	0.73
Growth stage	1	-1.05	10	.	1	4.01	10	0.95
	2	-1.88	10	.	2	4.44	10	0.93
	3	-0.93	10	.	3	1.98	10	1.00
Maturity stage	1	0.57	10	1.00	1	6.77	10	0.75
	2	2.61	10	0.99	2	7.05	10	0.72
	3	3.34	10	0.97	3	19.50	10	0.04
Decline stage	1	-16.77	10	.	1	5.12	10	0.88
	2	0.36	10	1.00	2	9.81	10	0.46
	3	-0.60	10	.	3	9.41	10	0.49

IIA: Independence of Irrelevant Alternatives
Source: research findings

In the introduction stage, according to the results shown in Table 5, an increase in the manager's experience showed an increase probability of selection of the first strategy (product development) compared to the base strategy (market penetration). In other words, highly experienced managers were found more likely to choose product development strategy over the market penetration strategy. As a product is at its introduction stage, product development can be a viable strategy for a company's successful entry into the market. Companies that produce multiple products were more likely to select the second strategy than the market penetration or third strategy. Companies with multiple products on their production lines used market development strategies to find and attract more customers than their competitors and to satisfy them with a variety of products or services such that they were found to have a higher probability of selection of this strategy than the strategy of market penetration. Results shown in Table 5 indicate an increase probability of selection of the first or second strategy compared to the third strategy in companies with reputable brands. In other words, prestigious brands mainly seek new products or new markets rather than penetrating the current market with current products. Other results shown in Table 5 show that increased product competitiveness increased the probability of choosing the first and second strategies compared to the third strategy. Under high competition, the penetration strategy is a very unreliable strategy and other marketing strategies seemed better for attracting and maintaining loyalty among consumers. In addition, the manager's education had a non-significant effect on the choice of the first strategy compared to the third strategy, but a higher level of education lowered the probability of choosing the market development strategy, compared to the base strategy. In other words, managers with a higher level of education selected the market development strategy with a lower probability in comparison to the market penetration strategy in the introductory stage of PLC. Finally, results are shown in Table 5 indicates that companies with an intermediate market share had a higher probability of choosing the first and second strategies than the third strategy.

In the growth stage, according to the results shown in Table 5, increased manager's experience decreased the probability of selecting the first and second strategy compared to base or the market penetration strategy. Normally, a more experienced manager knows that at the product growth stage the main aim of a producer is to gain more profits in the market and product

development or market development is a lower priority. Therefore, marketing managers at the growth stage of PLC focused all their efforts on greater influence in the market and to gain more profit by the market penetration strategy. Results in Table 5 show that reputable brands led to a decrease in the probability of selecting the second strategy in comparison to the base strategy. In other words, increasing brand reputation at the growth stage led to the increased probability of choosing a market penetration strategy over a market development strategy. Other explanatory variables had a non-significant effect on the probability of the dependent variable at the growth stage.

Table 5- Multinomial logit model estimation results in different stages of Product Life Cycle

Group	Stages of PLC		Introductory stage		Growth		Maturity stage		Decline stage	
	Variable name		Coefficient value	RRR	Coefficient value	RRR	Coefficient value	RRR	Coefficient value	RRR
First strategy	Manager experience		0.15***	1.16	-0.08**	0.93	0.05*	1.05	-0.03	0.97
	Product type		1.43	4.18	-0.41	0.67	-0.78	0.46	1.15	3.16
	Brand		0.08***	1.08	1.39	3.93	-0.31*	0.73	0.17	1.18
	Competition		0.02*	1.02	-0.62	0.54	0.41*	1.50	-0.62***	0.54
	Education Level	Diploma to Bachelor	-1.80*	0.16	0.39*	-0.95	0.49	1.63	-1.28	0.28
		Bachelor's Degree or higher	0.21	1.24	1.30	0.27	1.05	2.87	1.03	2.80
	Market share	Average	3.49**	32.96	1.47	0.38	-2.44**	0.09	3.92**	50.5
		High	1.93*	6.95	0.90	-0.11	-1.65	0.19	5.44***	230.2
	Constant		-13.83***	0.009	1.05	2.84	-1.74	0.18	-2.87	0.06
Second strategy	Manager experience		0.07	1.08	-0.04**	0.96	-0.07	0.93	-0.01	0.99
	Product type		3.16***	36.90	-0.65	0.52	-0.30	0.74	-0.94	0.39
	Brand		0.07**	1.07	-1.99*	0.14	0.42*	1.52	-0.11	0.90
	Competition		0.04**	1.04	-1.50	0.23	-0.96***	0.38	-0.62***	0.54
	Education Level	Diploma to Bachelor	-2.96***	0.05	1.24	0.21	-0.57	0.57	1.08	2.94
		Bachelor's Degree or higher	-1.99**	0.14	1.91	0.65	1.29	3.65	2.38***	10.85
	Market share	Average	3.27**	26.29	0.67	-0.39	5.35***	210.9	1.44	4.21
		High	1.11	3.05	0.35	-1.05	4.71**	111.0	4.43***	83.8
	Constant		-12.52***	0.006	4.48***	87.81	1.53	4.62	2.1	8.17
Goodness of fit measures MNL model	Log-Like Intercept only		-130.44	-171.1	-137.45	-122.9	-130.44	-171.1	-137.45	-122.9
	Log-Like Full Model		-94.8	-151.8	-100.4	-93.20	-94.79	-151.8	-100.4	-93.20
	LR		71.31	38.56	74.13	59.57	71.31	38.56	74.13	59.57
	LR (p-value)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	R^2 McFadden's		0.27	0.11	0.27	0.24	0.27	0.11	0.27	0.24
	R^2 ML (Cox-Snell)		0.42	0.21	0.44	0.41	0.42	0.21	0.44	0.41
	R^2 Cragg-Uhler		0.50	0.24	0.50	0.46	0.50	0.24	0.50	0.46
	R^2 Count		0.65	0.59	0.63	0.61	0.65	0.59	0.63	0.61
	Deviance		189.6	303.66	200.8	186.40	189.6	303.66	200.8	186.40
Third strategy	The base group									

Notes: ***, ** and * denote significance levels at 1%, 5% and 10%.
Source: research findings

In the maturity stage, according to the results shown in Table 5, the reputable brand reduced the probability of selecting the first strategy compared to the base strategy. In other words, a reputable brand determines the selection of the market penetration strategy compared to the product development strategy at the maturity stage. However, a reputable brand increased the probability of selecting the market development strategy compared to the base strategy. Of course, selection of the market penetration strategy is a reasonable strategy at this stage of PLC because competitors are numerous in the market, and maximizing sales and profit are the most desired goals for managers particularly close to the final stages of the product life cycle. Therefore, in terms of prioritizing the marketing strategy at the maturity stage when a company has a prestigious brand, market development strategy was the most commonly considered strategy followed by that of market penetration.

Increased product competition decreased the probability of selecting the second strategy compared to the base strategy and there was an increased probability of selecting the first strategy rather than the base strategy (Table 5). In other words, when a company had high market competition, it prefers to select a product development strategy and introduce new products in the current markets rather than selecting the penetration strategy and simultaneously the probability of entering new markets with current products or market development strategy decreased compared to the base strategy. Other results in Table 5 also show the probability of selecting the first and second strategy compared to the base strategy, when other explanatory variables changed.

In the Decline stage, increasing market competition decreases the probability of selecting the first or second strategies compared to the base strategy (Table 5). In other words, increased competition at the decline stage determined utilization of the market penetration strategy to sell more products in current markets and decreased selections of product development or market development strategies. The impact of manager's education on the chosen strategy at the decline stage indicates that managers with an education level of diploma to bachelor were less likely to choose the first strategy compared to the basic strategy and managers with a higher level of education (bachelor and above) were more likely to choose the second strategy compared with the base strategy. Finally, the results of Table 5 show that companies with a high market share were more likely to select the first strategy over the base strategy at the decline stage. At the product decline stage, it is rational that a company with an average or high market share selected the product development strategy to maintain its share and to keep its place in the market. However, companies with a moderate market share were more likely to select the second strategy compared to the base strategy. Generally, at the decline stage, with a moderate or high market share, the selection of a market penetration strategy was not an appropriate choice.

Also, information about the goodness of fit measures for product life cycle stages is reported in Table 5. Results of Table 5 show LR statistics for different stages of product life cycle as 71.31, 38.56, 74.13, and 59.57 respectively, indicating that the regressions were significant. Other measures such as Pseudo R2 also indicate that the results of the regression were reliable.

In general, the sign and significance of explanatory variables at each phase of PLC are reported in Table 6. These Tables indicate that selection of an appropriate marketing strategy at the different stages of PLC depended on various and somewhat opposite factors. Therefore, marketing managers should consider various variables and opposite results and conditions in making selections for a strategy.

Table 6- Summary of the results of the sign and significance of the explanatory variables estimated by the Multinomial Logit model in the stages of the Product Life Cycle

Group	Product life cycle stages / Independent variables		Introduction	Growth	Maturity	Decline
First strategy	Manager experience		+ Significant	- Significant	+ Significant	- Insignificant
	product type		+ Insignificant	- Insignificant	- Insignificant	+ Insignificant
	Brand		+ Significant	+ Insignificant	- Significant	+ Insignificant
	Competition		+ Significant	- Insignificant	+ Significant	- Significant
	Education Level	Diploma to Bachelor	- Significant	- Significant	+ Insignificant	- Insignificant
		Bachelor's or higher	+ Insignificant	+ Insignificant	+ Insignificant	+ Insignificant
	Market share	Average	+ Significant	+ Insignificant	- significant	+ Significant
		High	+ Significant	- Insignificant	- Insignificant	+ Significant
Second strategy	Manager experience		+ Insignificant	- Significant	- Insignificant	- Insignificant
	Product type		+ Significant	- Insignificant	- Insignificant	- Insignificant
	Brand		+ Significant	- Iinsignificant	+ Significant	- Insignificant
	Competition		+ Significant	- Insignificant	- Significant	- Significant
	Education Level	Diploma to Bachelor	- Significant	+ Insignificant	- Insignificant	+ Insignificant
		Bachelor's or higher	- Significant	+ Insignificant	+ Insignificant	+ Significant
	Market share	Average	- Significant	- Insignificant	+ Significant	+ Insignificant
		High	- Significant	- Insignificant	+ Significant	+ Significant

Source: Research findings

The marginal effects of explanatory variables on the different groups of the dependent variable at the different stages of PLC are reported in Table 7 by three different scales for independent variables. In the Introduction stage, for example, results in Table 7 indicate that if the level of market competition changed from minimum to maximum, then selection of the first and second strategies increased by 15.18% and 23.78 % respectively, and selection of the third strategy (basic strategy) was reduced 38.96%. However, if this variable (competitiveness) changed one unit from its mean then selection of the first and second strategies increased by 0.0006% and 0.0029% respectively, and selection of the third strategy reduced by 0.0035%. Furthermore, if competitiveness changed by one standard deviation from its mean, selection of the first and second strategies increased by 1.28% and 6.36% respectively and selection of the basic strategy was reduced by 7.6%. Results for marginal effects at the growth stage are presented in Table 7. These results show that if the level of market competitiveness changed from minimum to maximum then selection of the first and second strategies decreased by 0.78% and 24.18% percent respectively and selection of the third strategy (basic strategy) is increased by 24.96%.

Table 7- Marginal effects of explanatory variables in the stages of Product Life Cycle

Stages of PLC	The explanatory variables		Variation	First strategy	Second strategy	Third strategy
Introductory stage	Manager experience		ΔRange	0.8040	0.1585	-0.9626
			Δ1	0.0311	0.0042	-0.0353
			Δσ	0.2869	-0.0322	-0.3191
	Brand		ΔRange	0.6392	0.1472	-0.7863
			Δ1	0.0096	0.0006	-0.0101
			Δσ	0.1781	0.0132	-0.1913
	Competition		ΔRange	0.1518	0.2378	-0.3896
			Δ1	0.0006	0.0029	-0.0035
			Δσ	0.0128	0.0636	-0.0764
	product type (dummy variable)		0→1	0.0596	0.2612	-0.3208
	Education Level	Diploma to Bachelor	0→1	-0.1873	-0.1991	0.3864
		Bachelor's Degree or higher	0→1	0.3130	-0.3597	0.0467
	Market share	Average	0→1	0.2625	0.0395	-0.3020
		High	0→1	0.3080	-0.0595	-0.2485
Growth stage	Manager experience		ΔRange	-0.6106	-0.2066	0.8172
			Δ1	-0.0147	-0.0011	0.0158
			Δσ	-0.1494	-0.0223	0.1617
	Brand		ΔRange	0.2253	-0.4548	0.2295
			Δ1	0.3173	-0.4289	0.1115
			Δσ	0.0658	-0.0895	0.0237
	Competition		ΔRange	-0.0078	-0.2418	0.2496
			Δ1	-0.0204	-0.2480	0.2685
			Δσ	-0.0054	-0.0596	0.0650
	Product type (Dummy variable)		0→1	-0.0107	-0.1675	0.1781
	Education Level	Diploma to Bachelor	0→1	-0.1643	0.0961	0.0681
		Bachelor's Degree or higher	0→1	0.0003	0.1277	-0.1280
	Market share	Average	0→1	0.0854	-0.0902	0.0048
		High	0→1	0.0382	-0.1929	0.1547
Maturity stage	Manager experience		ΔRange	0.5550	-0.1431	0.4120
			Δ1	0.0125	-0.0040	0.0085
			Δσ	0.1023	-0.0487	0.0536
	Brand		ΔRange	-0.6578	0.2332	0.4146
			Δ1	-0.0936	0.0468	0.0468
			Δσ	-0.2543	0.1327	0.1216
	Competition		ΔRange	0.7346	-0.9794	0.2448
			Δ1	0.1359	-0.0959	-0.0400
			Δσ	0.3337	-0.2630	-0.0707
	Product type (dummy variable)		0→1	-0.1919	0.0207	0.1711
	Education Level	Diploma to Bachelor	0→1	0.1436	-0.0557	-0.08792
		Bachelor's Degree or higher	0→1	0.1966	0.0709	-0.2674
	Market share	Average	0→1	-0.5285	0.8996	-0.3711
		High	0→1	-0.5297	0.4418	0.0879
Decline stage	Manager experience		ΔRange	-0.2780	-0.0910	0.369
			Δ1	-0.0064	-0.0024	0.0088
			Δσ	-0.0901	-0.0329	0.123
	Brand		ΔRange	0.3132	-0.3536	0.0404
			Δ1	0.0471	-0.0408	-0.0063
			Δσ	0.1096	-0.0950	-0.0063
	Competition		ΔRange	-0.3928	-0.4240	0.8168
			Δ1	-0.0692	-0.0740	0.1432
			Δσ	-0.1813	-0.1938	0.1441
	Product type (Dummy variable)		0→1	0.2890	-0.3224	0.0334
	Education Level	Diploma to Bachelor	0→1	-0.3440	0.3571	-0.0131
		Bachelor's Degree or higher	0→1	-0.0862	0.4251	-0.3388
	Market share	Average	0→1	0.6468	-0.2080	-0.4388
		High	0→1	0.5179	0.3218	-0.8396

Source: Research findings

Also, the results of marginal effects in the maturity stage are also reported in Table 7. These effects present the example that if the reputation of a brand increased from its minimum to its maximum, then the probability for selecting the first strategy decreased by 0.65%, and the probability of choosing the second or the third strategy increased by 0.23% and 0.42% respectively. In other words, improving brand position in the market attracted more attention to the second and third strategies.

Finally, Table 7 shows the marginal effects of explanatory variables on the dependent variable categories at the decline stage. These results show that if the level of market competitiveness changed from minimum to maximum then selection of the first and second strategies decreased by 39.28% and 42.40% percent respectively and selection of the third strategy (basic strategy) is increased by 81.68%.

Conclusions and Suggestions

The current study seeks to evaluate factors affecting the selection of marketing strategies for food production companies in different stages of the product life cycle in the city of Mashhad. In this study, the multinomial logit model was used to analyze the important factors on choice of marketing strategy; these were product development strategy, market development strategy, and market penetration strategy. The results showed that at the introductory stage, reputable brand, competitiveness, and market share, had a significant effect on the selection of product development strategies compared to the base strategy. However, the manager experience reduced the probability of product development strategy compared to the base group.

Results of the study at the growth stage of PLC also indicated that the manager's experience had a positive effect on the probability of selection of the first strategy compared to the base strategy. At the growth stage, a more experienced manager selected the first strategy rather than the market penetration strategy. Other variables at this stage had a non-significant effect on selecting the prior strategy because the objective of the company at this stage was to maximize profit and to attract more consumers to products and therefore use all the available marketing strategies together to achieve this goal without any priority. Moreover, results of the growth stage showed that prestigious brands with less probability selected the market development strategy rather than the market penetration strategy. Maximization of profits, especially in the currency markets again helped interpretation of this result.

At the maturity stage of PLC, the probability of selecting the first strategy compared to the base strategy increased according to the manager's experience and competition in the market. Nevertheless, a prestigious brand and increased market share decreased the probability of selecting the first strategy. Furthermore, a prestigious brand, higher market share, and less competition in the market increased the probability of selecting the second strategy compared with the base strategy in the maturity stage of PLC.

Finally, at the decline stage of PLC, results showed that competitiveness and level of a manager's education had a negative effect and market share had a positive effect on the probability of selecting the first strategy compared to the base strategy. Furthermore, competitiveness had a negative effect, and the manager's education and market share had a positive effect on the probability of selecting the second strategy rather than the first strategy.

The results of this research can be interpreted in another way, subject to any independent variable at each stage of the product life cycle. For instance, the manager's experience had a negative effect on the selection of the first strategy compared to the base strategy at the introductory stage, but it had a positive effect at the growth and maturity stages and a non-significant effect on the decline stage of PLC. Results indicate that

experienced managers pursuing market penetration at the introductory stage and the growth and maturity stages selected product development strategies. Experienced managers know that with increasing competition at the growth and maturity stages, producing new products could maintain or even increase their share in the market and so increase profits.

In terms of the importance of selective marketing strategies of companies at different stages of the product life cycle for profitability, it is recommended that similar research be done in other industries testing the same or more explanatory variables. In addition, results showed that selective strategy at different stages of the product life cycle takes different impacts from different variables and this should be considered in company operations in this domain. Furthermore, it is recommended that companies in the introductory stage consider market conditions and competitiveness as well as establish and empower a reputable brand because appropriate marketing strategy selection had a significant impact on company performance at this stage. Company managers must pay a lot of attention to the stabilization of suitable brands at the growth stage because it affects survival and strategy selection in the market. Companies should pay a lot of attention to their market share at the maturity stage because the maximum benefit can be achieved at this stage and thus it is necessary to increase customer loyalty. Eventually, at the stage of decline, attention to product share at the market and brand credibility maintenance and introduction of new products is also essential because at this stage, company sales and profits decrease and each of the above variables affects the choice of strategy and survival in the market.

References

1. Aitken, J., Childerhouse, P., & Towill, D. (2003). The impact of product life cycle on supply chain strategy. *International Journal Production Economics 85*(2): 127–140. https://doi.org/10.1016/S0925-5273(03)00105-1.
2. Ben-Akiva, M.E., & Lerman, S.R. (1985). *Discrete choice analysis: theory and application to travel demand (Vol. 9)*. MIT press.
3. Begg, C.B., & Gray, R. (1984). Calculation of polychotomous logistic regression parameters using individualized regressions. *Biometrika 71*(1): 11-18. https://doi.org/10.1093/biomet/71.1.11.
4. Dawson Jr, L.E. (1975). Dynamic competitive strategy and product life cycles. *Journal of Marketing (pre-1986) 39*(2): 112.
5. Fox, H.W. (1973). A framework for functional coordination. *Atlanta Economic Review 23*(6): 8-11.
6. Greene, W.H. (1998). *LIMDEP user's manual: version 7.0. Econometric Software*, Inc New York.
7. Hsueh, C.F. (2011). an inventory control model with consideration of remanufacturing and product life cycle. *International Journal of Production Economics 133*(2): 645-652. https://doi.org/10.1016/j.ijpe.2011.05.007.
8. Hausman, J., & McFadden, D. (1984). Specification tests for the multinomial logit model. *Econometrical: Journal of the Econometric Society* 1219-1240.
9. Hensher, D.A., Rose, J.M., Rose, J.M., & Greene, W.H. (2005). *Applied choice analysis*: *a primer*. Cambridge university press.
10. Hisrich, R.D., & Peters, M.P. (1984). *Marketing Decisions for New and Mature Products: Planning, Development and Control. Charles E*. Merrill Publishing Company, Ohio, USA.
11. Hofer, C.W. (1975). Toward a contingency theory of business strategy. *Academy of Management Journal 18*(4): 784-810.

12. Kotler, P. (2000). *Marketing Management. Millennium Edition:* Custom Edition for University of Phoenix (10th Ed). Prentice-Hall Inc.
13. Kotler, P., & Armstrong, G. (2005). *Principles of marketing*. Pearson Prentice Hall.
14. Levitt, T. (1965). *Exploit the product life cycle*. Harvard business review.
15. Long, S.J., & Freese, J. (2001). *Regression Models for Categorical Dependent Variables Using Stata.* Stata Press, Stata Press.
16. Long, S.J. (1997). *Regression Models for Categorical and Limited Dependent Variables.* SAGE Publication, London.
17. Porter, M.E. (2008). *Competitive strategy: Techniques for analyzing industries and competitors.* Simon and Schuster.
18. Report: Measures and Performance. Deputy planning and investment. (2015). organization of industry, mining and trade of KHORASAN-RAZAVI province. IRAN.
19. Shahmarichatghieh, M., Tolonen, A., & Haapasalo, H. (2015). *Product life cycle, technology life cycle and market life cycle; similarities, differences and applications*. In Technology, Innovation and Industrial Management Joint International Conference (pp. 1143-1151).
20. Sharma, N. (2013). Marketing strategy on different satages of PLC and its marketing implications on FMCG products. *International Journal of Marketing, Financial Services & Management Research 2*(3): 2277-3622.
21. Wind, Y., & Robertson, T.S. (1983). Marketing strategy: new directions for theory and research. *The Journal of Marketing 47*(2): 12-25. https://doi.org/10.1177/002224298304700203.

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۳۳۷-۳۵۲

عوامل موثر بر انتخاب استراتژی بازاریابی در مراحل مختلف چرخه عمر محصول

حسین محمدی[۱*]– علیرضا ثانی حیدری[۲]– عبدالله شهرکی[۳]

تاریخ دریافت: ۱۳۹۸/۰۸/۰۸

تاریخ پذیرش: ۱۴۰۱/۰۸/۰۴

چکیده

یک استراتژی بازاریابی مناسب برای افزایش فروش و سودآوری در مراحل مختلف چرخه عمر محصول ضروری است. هدف اصلی این مطالعه بررسی عوامل موثر بر انتخاب استراتژی بازاریابی در مراحل مختلف چرخه عمر محصول در صنایع غذایی مشهد می‌باشد. داده‌ها از طریق یک نظرسنجی جمع‌آوری شده و پرسشنامه‌ها توسط ۸۸ مدیر بازاریابی صنعت تولید مواد غذایی- در سال ۱۳۹۶ تکمیل شده است. برای رسیدن به هدف پژوهش، از الگوی لاجیت چند جمله‌ای برای تعیین تأثیر متغیرهای توضیحی بر احتمال انتخاب یک استراتژی بازاریابی ویژه در مراحل مختلف چرخه عمر محصول استفاده بهره گرفته شد. نتایج نشان داد که متغیرهای تجربه مدیر، تحصیلات، نوع محصول، رقابت‌پذیری، برند معتبر و سهم بازار تأثیر معناداری بر استراتژی انتخابی در مراحل مختلف چرخه عمر محصول داشته است. بنابراین، سودآوری یک شرکت در بازار را می‌توان با اجرای یک استراتژی بازاریابی مبتنی بر نوع محصول و در ارتباط با مراحل خاص چرخه عمر محصول بهبود داد.

واژه‌های کلیدی: استراتژی‌های بازاریابی، برتری نسبی، چرخه عمر محصول، صنایع غذایی

۱، ۲ و ۳- به‌ترتیب دانشیار دانشجوی دکتری و دکتری اقتصاد کشاورزی، گروه اقتصاد کشاورزی، دانشکده کشاورزی، دانشگاه فردوسی مشهد، مشهد، ایران

(*- نویسنده مسئول: Email: Hoseinmohammadi@um.ac.ir)

DOI: 10.22067/JEAD.2022.17748.0

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 353-361

The Impact of the Covid-19 Outbreak on the Stock Value of Food Companies: Case Study of the Tehran Stock Exchange-Iran

S.M. Mojaverian[1]*, F. Eshghi[2], S. Ahangari[3]

Received: 25-06-2021
Revised: 18-01-2022
Accepted: 22-01-2022
Available Online: 15-02-2023

How to cite this article:
Mojaverian, S.M., Eshghi, F., & Ahangari, S. (2023). The Impact of the Covid-19 Outbreak on the Stock Value of Food Companies: Case Study of the Tehran Stock Exchange-Iran. *Journal of Agricultural Economics & Development 36*(4): 353-361.
DOI: 10.22067/jead.2022.71165.1053

Abstract

In addition to imposing a negative impact on public health, Covid-19 has made the world face a huge financial-economic crisis. The worldwide spread of the coronavirus has also affected the volume of transactions and the value of stocks. Since the food market is more affected under crisis conditions, this relationship has been investigated in the stock exchange in the present study. In order to investigate the effect of Covid-19 patients on the stock index value of food industry companies as well as the relationship between risk and stock index value, the official daily data of the Ministry of Health and Medical Education and the Financial Information Processing Center of Iran were collected from March 3, 2021 when the first report was announced, to June 2, 2021. Mean Conditional heteroscedasticity variance regression models were used in the current study. The statistical model specification tests showed that, first, the assumption of heteroscedasticity was rejected and the need to use heteroscedasticity models was proved. Secondly, the asymmetry assumption was accepted. Model estimation results showed a relationship between the numbers of Covid-19 patients with the stock value of the food industry that was an increase in the number of infected people causes a decrease in the stock value of the food industry. Therefore, like other economic sectors, the capital market was affected by the Covid-19 crisis, and increasing exchange rate as a competing market had a negative effect on the stock price index. Considering the relationship between risk and stock value of food industries, as expected, there was also an inverse and significant relationship between risk and stock value of food industry companies. In other words, an increase in risk leads to a decrease in the stock price of food industries.

JEL Classification: G17, G41
Keywords: Coronavirus, Conditional heteroscedasticity model, Iran, Stock market

Introduction

According to official statistics, the first Covid-19 related deaths in Iran were recorded in March 2018 (Ministry of Health and Medical Education, 2018). On the other hand, the main problem is not only the number of patients, but also the huge global economic disruption. The lack of unified action to control the virus spread has led global stock markets into a panic. On March 9, 2020, the Morgan Stanley Capital International (MSCI) index, which monitors the average stock price of 1,647 largest companies in the world's stock exchanges, decreased by 8.9% during seven working days (a black week), which was the biggest drop since October 2008 until that time (Morales and Callaghan, 2020). In fact, investors' excitement significantly affects the stock market (Anusakumar *et al*., 2017).

1, 2 and 3- Associate Professor, Assistant Professor and Ph.D. Student of Department of Agricultural Economics, Faculty of Agricultural Engineering, Sari Agricultural Sciences and Natural Resources University, Iran, respectively.
(*- Corresponding Author Email: mmojaverian@yahoo.com)

Coronavirus imposes different impacts on the financial markets of each country because the spread of the disease, the severity and the death rate on different sectors are ambiguous factors (Selmiand Bouoiyour, 2020). Covid-19 destroyed at least five thousand billion dollars of stock market value in one week (black week) and its rapid spread to other countries led to the fear of stock market investors (Saneifar and Saeedi, 2020).

Angel Gurría, as secretary-general of the Organization of Economic Co-operation and Development (OECD), believes that the economic impact of the recent epidemic has been greater than the global crisis of 2008: "Even if we do not witness a global recession, some global economies will either have no growth or their growth will be negative (Hutt, 2020). Kenneth Rogoff, one of the prominent global economic counsellors such as the International Monetary Fund (IMF), claimed that the size of the global economy will decrease continuously. Iran, like other countries, has been affected by the coronavirus (Jafari *et al*., 2020, Taherinia and Hasanvand, 2020). In fact, the global coronavirus pandemic and its subsequent negative impacts on the global markets have led the investors to think that the Iranian stock market, like the stock market of other countries such as America, China, etc., is severely affected by this virus and the economy conditions and the affected companies (decrease in production, sales, exports, etc.), and this concern will cause the stock market to fall sharply; however, the stock market was affected by other important issues (Soheili *et al*., 2020). The world community will experience a different lifestyle and food basket after Covid-19. In the meantime, it is expected that the role of food will find a significant place. Therefore, necessary mechanisms should be established to keep up with these changes in crop production and supply and transactions of this products in the stock market (Abedi and Farhani, 2020).

Recent studies on the impact of the coronavirus on the volume of stock market transactions, showed a fall in the stock prices. In an article that investigated the reaction of stock prices to the coronavirus, researchers came to the conclusion that despite the presence of this virus, investors are worried about the debt and liquidity of companies and a financial crisis is created (Ramelli and Wagner, 2020). Another study titled "Analysis of the impact of the coronavirus on the stock market and potential investment strategies", also showed that most markets react negatively to such events in the short term (Yan *et al*., 2020).

It was shown in an article that Covid-19 caused a sharp drop in the price of oil and in turn a sharp drop in stocks (Sharif *et al*., 2020). The effect of Covid-19 on the fall of stock prices, which resulted in the fall of stock prices in global markets was also investigated in another study (Wang *et al*., 2020). The impact of the coronavirus was investigated on the Indian economy, and it was concluded that the coronavirus has greatly affected various economic sectors and caused a sharp decline in the value of the stock market (Selmi and Bouoiyour, 2020).The reaction of the stock market of the United States and Europe at the onset of the Covid-19 pandemic was investigated, and it was confirmed that the stock market reacts negatively to the announcement of death in a country (Heyden, 2020). Considering the effect of the coronavirus on stock prices, it was shown why the stock markets have fallen sharply, and it was finally concluded that the financial stimulus news will strengthen the market and long-term growth (Gormsen and Koijen, 2020).

There have also been studies on the impact of the coronavirus on the financial markets. The fact that the death rate affects the volatility index of financial markets was investigated (Albulescu, 2020). It was concluded that there is a positive and significant relationship between Covid-19 cases and financial markets (Sansa, 2020). The global stock market network at the onset of the Covid-19 crisis was investigated and an increasing connection was observed between stock markets during the Covid-19 crisis

(Aslam *et al.*, 2020). The effect of Covid-19 on the stock market was investigated in six countries that suffered greatest impact due to this virus and it was concluded that the stock market behavior is affected by the Covid-19 news (Cepoi, 2020). The European stock market fluctuations during the Covid-19 crisis was investigated in France, Germany and England. The results showed that the stock market of England and France is predictable during this period (Li *et al.*, 2020).

The Covid-19 pandemic has impacts on the global economy and health to the extent that most businesses are completely closed due to government restrictions, the food sector must remain active throughout the supply chain in order to feed the nation. It is very important to maintain the health and safety of workers while maintaining a high level of food safety and consumer trust under such a challenging period. Considering the increasing uncertainty, up-to-date and reliable information is more important than ever for both regulatory bodies and this sector. Therefore, the impact of the Covid-19 on the volume of transactions and stock value of food companies is investigated in the present research.

Materials and Methods

A conditional heteroscedasticity model was used in the present study in order to take into account random heteroscedasticity fluctuations. Considering that the variability is demonstrated through the variance, the variance instability in the regression equation can be called uncertainty. It is necessary to use regression models of the mean conditional variance under such a situation (Menjazb and Nosrati, 2018). If Y_t is the studied variable and all the classical assumptions including that the conditional variance remains constant, The conditional mean and variance of Y_t compared to X_t is:

$$E(Y_t|X_t) = \beta_0 + \beta_1 X_t Var(Y_t|X_t) = \sigma^2 \quad (1)$$

In most of the real data, especially the highly fluctuating variables, this classical assumption is violated and the above conditional variance is heterogeneous, in other words:

$$Var(Y_t|X_t) = \sigma_t^2 \quad (2)$$

The conditional mean [E(Y|X)] is calculated when the data of X vector is available, but there is no information about the nature of σ_t^2. The fluctuating models suggest that the disturbance variance in each period depends on the information of the disturbance components of the past periods, that is:

$$\sigma_t^2 = Var(U_t|U_{t-1}, U_{t-2}, \dots) = E(U_t^2|U_{t-1}, U_{t-2}, \dots) \quad (3)$$

According toEquation 3, σ_t^2 can be calculated, if the valueof past errors is known. The number of lagged disturbances that affects the conditional variance at period t can be optimized using lag statistics such as Schwarz Bayesian Information Criterion (SIC), Akaike Information Criterion (AIC) or Hannan-Quinn information criterion (HQ). For example, in the case of one lag, the model determins the Autoregressive Conditional heteroscedasticity (ARCH(1)) model. Consequently, in general cases, ARCH(q) is used as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 U_{t-1}^2$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 U_{t-1}^2 + \alpha_2 U_{t-2}^2 + \dots + \alpha_q U_{t-q}^2 \quad (4)$$

The modified ARCH method was generalized (Balerso,1986) to solve the problems of non-negativity of coefficients and became GARCH, which has a process similar to ARMA models. In this generalized model, sentences with a lag from the dependent variable were added.As an example, the GARCH(p,q) model is as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 U_{t-1}^2 + \alpha_2 U_{t-2}^2 + \dots + \alpha_q U_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \gamma_2 \sigma_{t-2}^2 + \dots + \gamma_p U_{t-p}^2 \quad (5)$$

In this study, based on heteroscedasticity tests, GJR was used to show the presence and absence of symmetry of the effect of previous information for the conditional variance fluctuation, and finally, risk (fluctuations) was added to the main model as a new explanatory variable. Therefore, the method of the present study includes the following steps:

1. Calculation of the residual stock index
2. Testing the presence of conditional heteroscedasticity using F and chi-square statistics

3. Testing asymmetry in the conditional variance with GJR estimation and investigatingthe significance of the coefficient of failure as a dummy variable

4. Determining the final model of changes and estimating coefficients, calculating new residuals (identical)

5. Adding conditional variance as an explanatory variable (risk) to the main model of stock value.

The main model used includes risk (in step 5), the simultaneous free exchange rate (dollar to rial) as a competing market, the simultaneous index of the total stock price as the general trend of stock value in the stock market, and the number of Covid-19 patients as the target variable:

$$Food_t = \beta_0 + \beta_1 Risk_t + \beta_2 Total_{t-1} + \beta_3 Suffering_t \beta_2 Dollar_t + \varepsilon_t \quad (6)$$

In Model 6; Food variable is the stock value index of food industry companies, Risk is the unexplained stock fluctuations as a risk, Total is the total stock index value in the last day, sufferers is the number of patients and Dollar is the daily price of the dollar (in Rials) in the open market as a competing market forinvestors. The non-simultaneity of the total price index is due to the elimination of simultaneity bias and the elimination of simultaneous equations.

In this research, the daily information of the deaceased and infected Covid-19 patients was used from the website of the Ministry of Health of the Islamic Republic of Iran. Also, the information on the food index and the total index was extracted from the website of the Tehran Stock Exchange Technology Management Company - Iran's Financial Information Processing Center. The exchange rate as the most important competing market was collected from the gold, coin and currency information network. The studied time periodincludedFebruary 22, 2020 when the official announcement of the outbreak of the disease was made in Iran untilJune 2, 2021 on a daily basis (working days, five days a week).

Results and Discussion

The statistics of Covid-19 patients are shown based on official and daily statistics in Figure 1. According to this figure, this disease has different prevalence rates in various days and has different peaks. The last two big peaks dated backto the middle of November 2019 and the end of May 2019. The creation of a peak, its speed and size, especially the wavelength, is highly dependent on the crisis management and, of course, the cooperation of people to comply with health guidelines (Morales and Callaghan, 2020). Iran's economic problems have historical roots, and sanctions are the most important barriers to curb them. However, one cannot ignore the coherence of management and decision-making fluctuations.

According to the method section, the first step is extracting the residuals and testing the heteroscedasticity is based on both F and χ^2, the assumption of conditional heteroscedasticity is rejected (p-valueof>99%), and therefore, there is a need for variability models.

Table 1- Calculation of residual stock index of food industry companies

Variable	Coefficient	P-value
F-statistic	11808	0.000
T.R2	248	0.000
Equation testing		
Variable	Coefficient	Std. Error
In[1]	2817229	2382096
RESID[2](-1)	0.961**	0.0088
R^2=0.98	F=11808**	Adjusted R^2=0.98

Source: Research findings

1- Intercept

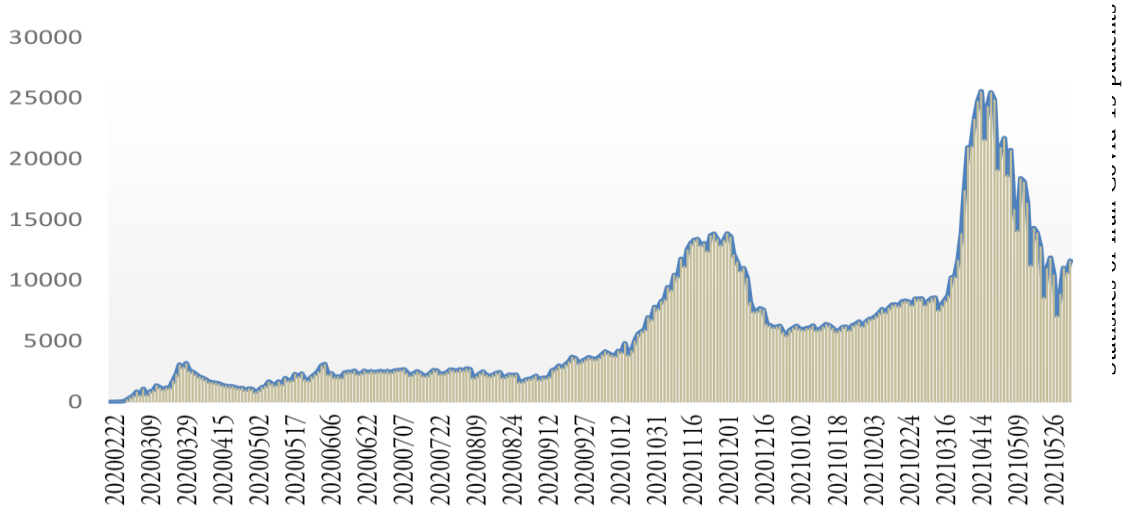

Figure 1- Statistics of Iran Covid-19 patients from the onset of the pandemiconFebruary 21, 2020 to June 2, 2021

Figure 2 shows the disturbance components' value over time, which indicates heteroscedasticity. According to the figure, this variable has a strong upward trend in the early stages of the study, according to every pandemic phenomenon, therefore, the average is changing. Changes stop, but the fluctuations continue at different intensities after about 75 observations. This figure shows that it is possible to achieve a static condition by de-trending in the initial part of the observations (the first 75 observations), but the variance heterogeneity prevents the static regression relationship.

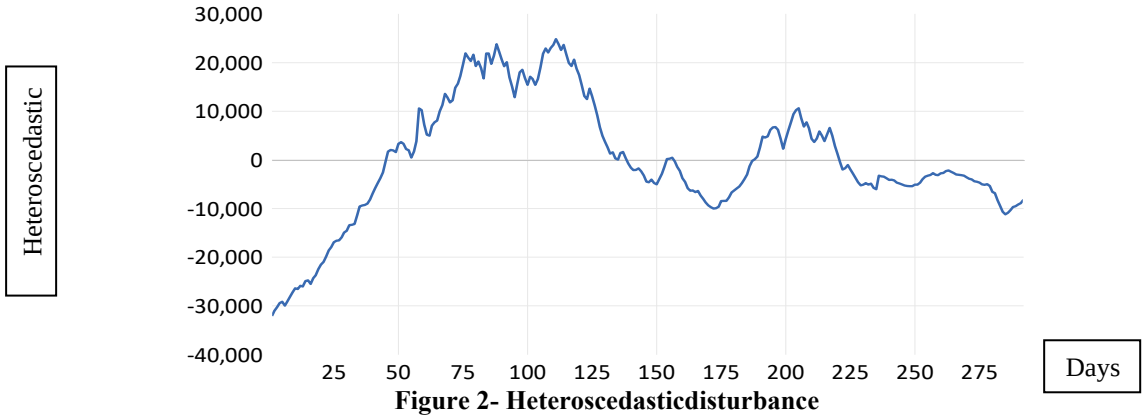

Figure 2- Heteroscedasticdisturbance

Since the stock value index shows different reactions to its drivers (in this study, the exchange rate, the general trend of the stock market, and the exchange rate) during fluctuations, in other words, it has different adhesion as a result of different regimes, according to the third steps mentioned in the research method, GJR hypothesis testing was carried out. Table 2 shows the estimation result. According to the results, the dummy coefficient of failure of the variance equation is not significant and, therefore, the symmetry hypothesis cannot be rejected. The choice of order 1 and 1 for GJR was made based on the optimal lag statistics.

After removing variance failure as the dummy variable, the model was re-fitted in the variance equation without this variable. All the coefficients in the main model and the variance equation are significant (P-value<0.01) (Table 3).

To improve the model, the calculated variance equation fluctuations were added as risk to the main model. Since the conditional variance is obtained from the residuals of the main equation that is the unpredictable part of the stock value fluctuations of the food industry after deducting the effects of the entered variables, it can show the risk of the above-mentioned market. According to the results of this model, which are the final results of the study, as expected, risk has an inverse and significant relationship with stock value(P-value= 6%). In other words, the increase in risk leads to a decrease in the stock price of the food industry, which is contatry to the results of studies (Mojtahedi *et al*., 2020, Ghadiri Moghadam and Rafie, 2010).

Table 2- Asymmetry testing in conditional variance

Variable	Coefficient	Std. Error
In	39997	633
T(-1)	0.03**	0.0003
FER[1]	-0.089**	0.002
SN	-0.114	0.01
Variance equation		
In	125609	85245
RESID^2(-1)	0.991**	0.255
DA[2]	0.408	0.281
Garch(-1)	0.176**	0.056
R^2=0.69	$\bar{R}^2$=0.69	RSS=1.36×10^{10}

Source: Research findings

Table 3- GARCH estimation results (1,1)

Variable	Coefficient	Std. Error
In	40853**	600.07
T(-1)	0.0296**	0.0003
FER	-0.088**	0.003
SN	-0.059**	0.015
Variance equation		
In	265384	156784
RESID^2(-1)	1.065**	0.199
Garch(-1)	0.199**	0.081
R^2=0.7	$\bar{R}^2$=0.69	RSS=1.35×10^{10}

Source: Research findings

Table 4- Estimation results after entering risk

Variable	Coefficient	Std. Error
In	38425**	972
SQRT[3]	-0.135*	0.062
T(-1)	0.28**	0.0004
FER	-0.073**	0.003
SN	-0.022	0.013
Variance equation		
In	62207	68148
RESID^2(-1)	0.756**	0.19
GARCH(-1)	0.389**	0.073
R^2=0.7	Adjusted R^2=0.69	RSS=1.34×10^{10}

Source: Research findings in appendix 4

1- Free Exchanges Rate
2- Dummy Asymmetry
3- Risk Variable from Heteroscedasticity

The indices of the total stock market and food industry are in harmony, and there is a positive and completely significant relationship between the two after using the lagging indicator for the total index of the stock market. From a statistical point of view, it can be stated that the previous day's price index of the entire stock market can be a good predictor for the food industry index. This coordination can indicate the great effects of the Iranian capital market environment, and government interventions, socio-economic crises are important parts of this environment. Study (Rahnamay and Mohseni, 2018) confirms such a result for the Iranian stock market. In addition to the stock market, there are competing markets to attract investors in Iran, such as the gold, housing, cars markets, etc. But one of the most important competing markets is the dollar. In the present study, the dollar market was used as a competing market, due to the quick reaction and high liquidity of this market.

Table 4 shows an inverse and significant relationship between these two markets in such a way that everyhundred toman increase in dollar the stock price is duced by 73 rials. The most important part of the results is related to the effect of patients on stock value. The results show a significant and negative relationship between these two variable (P<0.90). For every 100 patients, the food industry index decreases by 2.2 units, which is similar to results of studies (Albulescu, 2020, Heyden, 2020).

Conclusion

The global spread of the Cocid-19 affected the volume of transactions. Like other countries, Iran also has unexpreienced adverse economic changes and crises following this pandemic. The findings of the present study showed a relationship between the number of Covid-19 patients and the food industry stock value, and it decreases the price of the above index. shows a gradual decreased in the negative impact of the Covid-19pandemic on emerging stock markets. According to the results of the present study, it is suggested that the impact of Covid-19 on the index of other important markets, such as cryptocurrencies, precious metals, etc., should be investigated in future studies. In order to investigate the impact of Covid-19 on the stock market, other variables that represent this pandemic should be used.

References

1. Abedi, M., & Farhani, A. (2020). Socio-economic consequences of corona virus with emphasis on Iran. https://civilica.com/doc/1127302/. (In Persian)
2. Albulescu, C. (2020). Coronavirus and financial volatility: 40 days of fasting and fear. http://doi.org/10.2139/ssrn.3550630.
3. Anusakumar, S.V., Ali, R., & Wooi, H.C. (2017). The effect of investor sentiment on stock returns: insight from Emerging Asian markets. *Asian Academy of Management Journal of Accounting and Finance (AAMJAF), Penerbit Universiti Sains Malaysia 13*(1): 159-178.
4. Aslam, F., Mohmand, Y.T., Ferreira, P., Memon, B.A., Khan, M., & Khan, M. (2020). Network analysis of global stock markets at the beginning of the Coronavirus disease (Covid-19) Outbreak. *Borsa Istanbul Review* 20: 49-61.
5. Cepoi, C.O. (2020). *Asymmetric dependence between stock market returns and news during Covid 19 financial turmoil*. Finance Research Letters, volume 36.
6. Ghadiri Moghadam, A., & Rafie, H. (2010). Investigating and determining the optimal stock portfolio of companies active in the food industry of the Tehran Stock Exchange. *Agricultural Economics and Development (Agricultural Sciences and Industries)* 3: 304-309. (In Persian with English abstract)

7. Gormsen, N.J., & Koijen, R.S. (2020). Coronavirus: Impact on stock prices and growth expectations. *The Review of Asset Pricing Studies* 10: 574-597. https://doi.org/10.1093/rapstu/raaa013.
8. Heyden, K.J., & Heyden, T. (2020). Market Reactions to the Arrival and Containment of Covid-19: An Event Study.*Finance Research Letters*. http://doi.org/10.1016/j.frl.2020.101745.
9. https://www.tgju.org/archive/price_dollar_rl.
10. Hutt, R. (2020). The economic effects of Covid-19 around the world.
11. Jafari, R., Kouhestani, A., & Nejad Zare, SH.)2020). *The impact of Corona on the economy of Iran and the world*. First Conference on Industrial Engineering, Economics and Management. (In Persian)
12. Li, Y., Liang, C., Ma, F., & Wang, J. (2020). The role of the IDEMV in predicting European stock market volatility during the Covid-19 pandemic. *Finance Research Letters*, volume 36.
13. Menjazb, M.R., & Nosrati, R.(2018). *Advanced econometric models*. First Edition, Kind Book Publishing Institute, Tehran.
14. Ministry of Health and Medical Education. < *behdasht.gov.ir*>.
15. Mojtahedi, F., Mojaverian, M., & Hosseini, A. (2020). Modeling systematic risk in determination of optimal portfolio. (A case study of shares of food industrial companies in Tehran stock exchange). *Agricultural Economics and Development (Agricultural Sciences and Industries*) 2: 149-161. (In Persian)
16. Morales, L., & Callaghan, B.A. (2020). Covid-19: Global Stock Markets "Black Swan". *Global Economic and Financial Crises* 1: 1–14.
17. Rahnamay, F., & Mohseni, A. (2018). Political communication, cash dividends and stock returns in companies listed on the Tehran Stock Exchange. *Journal of Financial Research, Securities Analysis Financial Knowledge*.
18. Ramelli, S., & Wagner, A.F. (2020). Feverish stock price reactions to covid-19. *The Review of Corporate Finance Studies* 9: 622–655. https://doi.org/10.1093/rcfs/cfaa012.
19. Saneifar, M., & Saeedi, P. (2020). Comparison of complex networks stock markets and economic variables before and after corona virus outbreaks. *Journal of Economic Modeling Research* 40: 123-158. (In Persian)
20. Sansa, N.A. (2020). The impact of the Covid-91 on the financial markets: evidence from Chinaand USA. *Electronic Research Journal of Social Sciences and Humanities* 2.
21. Selmi, R., & Bouoiyour, J. (2020). Global Market's Diagnosis on Coronavirus: A Tug of War between Hope and Fear. https://hal.science/hal-02514428.
22. Sharif, A., Aloui, C., & Yarovaya, L. (2020). Covid-19 Pandemic, Oil Prices, Stock Market, Geopolitical Risk and Policy Uncertainty Nexus in the US Economy: Fresh Evidence from the Wavelet-Based Approach. *International Review of Financial Analysis* 70.
23. Soheili, H., Haji, M., Gerami, B., & Rezaie, S. (2020). An introduction to the effects of Coronavirus in the Iranian economy. *Ministry of Cooperatives Labour and Social Welfare*. (In Persian)
24. Taherinia, M., &Hasanvand, A. (2020). Economic consequences of Covid-19 disease on the Iranian economy; with an emphasis on employment. *Journal of Nursing Management* 9: 44-58. (In Persian)
25. Wang, C., Li, W., Drabek, D., Okba, N.M.A., Haperen, R., Osterhaus, A.D.M.E., Kuppeveld, J.M., Haagmans, B.L., Grosveld, F., & Bosch, B. (2020). "A human monoclonal 9 antibody blocking SARS-CoV-2 infection". *Nature Communications* 11.
26. Yan, B., Stuart, L., Tu, A., & Zhang, T. (2020). Analysis of the effect of Cvid-19 on the stock market and potential investing strategies. http://doi.org/10.2139/ssrn.3563380.

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۳۶۱-۳۵۳

تاثیر شیوع بیماری کرونا بر ارزش سهام شرکت‌های مواد غذایی در بورس تهران

سیدمجتبی مجاوریان[۱]- فواد عشقی[۲]- صدیقه آهنگری[۳]

تاریخ دریافت: ۱۴۰۰/۰۴/۰۴

تاریخ پذیرش: ۱۴۰۰/۱۱/۰۲

چکیده

ویروس کرونا (کووید-۱۹) علاوه بر تاثیر منفی بر بهداشت و سلامت افراد، جهان را با یک بحران مالی- اقتصادی عظیم روبه‌روساخته است. شیوع ویروس کرونا در سراسر جهان، میزان معاملات و ارزش سهام را نیز تحت تاثیر قرار داده است. از آنجا که در شرایط بحران بازار مواد غذایی تاثیر بیشتری می‌گیرد، در این مطالعه به بررسی این رابطه در بورس اوراق بهادار پرداخته شده است. به منظور بررسی اثر مبتلایان ویروس کرونا بر ارزش شاخص سهام شرکت‌های صنایع غذایی و همچنین ارتباط میان ریسک و ارزش شاخص سهام از داده‌های روزانه رسمی وزارت بهداشت و مرکز پردازش اطلاعات مالی ایران از سوم اسفند که اولین گزارش اعلام گردید تا ۱۲ خرداد ۱۴۰۰ گردآوری گردید. روش مورد استفاده در این مطالعه مدل‌های رگرسیونی میانگین واریانس ناهمسان شرطی است. آزمون‌های تصریح الگو نشان داد اولا فرضیه عدم ناهمسانی واریانس رد شده و لزوم استفاده از الگوهایی با واریانس ناهمسان ثابت گردید. ثانیا فرضیه عدم تقارن پذیرفته گردید. یافته‌های پس از برآورد مدل نشان داد میان تعداد مبتلایان به ویروس کرونا و ارزش سهام صنایع مواد غذایی ارتباط وجود داشته و افزایش تعداد مبتلایان سبب کاهش شاخص مذکور می‌شود. به این ترتیب همانند سایر بخش‌های اقتصاد، بازار سرمایه متاثر از بحران همه‌گیری کرونا گردید افزاش قیمت دلار بعنوان بازار رقیب تاثیر منفی بر شاخص قیمت سهام نشان داد. همچنین با توجه به بررسی ارتباط میان ریسک و ارزش سهام صنایع غذایی، ریسک مطابق انتظار رابطه معکوس و معنی‌دار با ارزش سهام شرکت‌های صنایع غذایی داشته و به عبارت دیگر افزایش ریسک منجر به کاهش قیمت سهام صنایع غذایی می‌شود.

طبقه‌بندیJEL: G17, G41

واژه‌های کلیدی: الگوی ناهمسانی واریانس شرطی، ایران، بورس سهام، کرونا ویروس

۱، ۲ و ۳- به‌ترتیب دانشیار، استادیار و دانشجوی دکتری گروه اقتصاد کشاورزی، دانشکده مهندسی زراعی، دانشگاه علوم کشاورزی و منابع طبیعی ساری ایران

(*- نویسنده مسئول: Email: mmojaverian@yahoo.com)

DOI: 10.22067/jead.2022.71165.1053

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 363-376

The Effects of Agricultural Trade Openness on Food Price in Iran

M. Ghahremanzadeh[1*], M. Samadpour[2], J. Hosseinzad[3]

Received: 13-11-2021
Revised: 18-02-2022
Accepted: 16-03-2022
Available Online: 15-02-2023

How to cite this article:
Ghahremanzadeh, M., Samadpour, M., & Hosseinzad, J. (2023). The Effects of Agricultural Trade Openness on Food Price in Iran. *Journal of Agricultural Economics & Development 36*(4): 363-376.
DOI: 10.22067/jead.2022.73620.1098

Abstract

Trade liberalization of agricultural products and its effect on food prices, because of the importance of food in the household consumption basket, is one of the most important goals of governments for public access to health and food security. The present study investigated the effect of trade liberalization on domestic food prices in Iran. In this context, the single-equation error correction model (SEECM) was applied using the required time series data during 1989-2019. The results show that in the short-term, only increases in global food prices, liquidity, and exchange rates significantly affect domestic food prices. However, domestic food prices show more reaction to exchange rate fluctuations than to world prices. The estimated long-run equilibrium relationship demonstrated that world food prices have a positive and trade liberalization has a negative effect on domestic food prices. In addition, in the long run, the effect of liquidity on the domestic food price of food is more than other factors. The estimated error-correction term indicates that in the long run, if a shock occurs to the domestic food price, the domestic market can adjust it by only 35% annually. Considering the fluctuations of global prices and exchange rates, and their impacts on domestic prices, it is necessary to pay attention to these fluctuations in revising trade policies.

Keywords*:* Exchange rate, Food stuff, Global prices, Trade openness
Classification JEL: C32, F12, Q12

Introduction

The sharp increase in global prices of basic food is a serious threat to global development. The trend of rapid increase in global food prices leads to a significant increase in poverty, a decrease in the level of nutrition and limited access to services such as education and health, all of which have a negative effect on the growth of the global economy in the future (Ivanich and Martin, 2014). It is expected that the increase in food prices in the world markets will be transferred to domestic prices in different countries. In particular, the influence of world markets is greater in countries that import food and face high inflation (Javdan *et al*., 2017).

Food prices have always been the focus of governments and policymakers due to the importance of food in maintaining health, growth and food security in addition to household economy. Since the price of food determines the consumer's ability to provide food, the importance of access to sufficient food at a reasonable price is an important issue. It gets more important especially in countries that import food and as a result, the cost of providing food includes a large share of the total household expenses (Jafari and Farajzade, 2019). In such countries, trade liberalization leads to an increase in the price of exported food products and a decrease in

1, 2 and 3- Professor, M.Sc. Graduated and Associate Professor, Department of Agricultural Economics, Faculty of Agriculture, University of Tabriz, Tabriz, Iran, respectively.
(*- Corresponding Author Email: Ghahremanzadeh@Tabrizu.ac.ir)

the price of imported food products, because domestic prices are adjusted to the global prices. However, exporters who supply food increasingly to the international markets will eventually experience price inflation at home (Eclac, 2008). With the liberalization of agriculture, the price of some agricultural products usually increases, because some developed countries spend significant amounts on granting export subsidies, and naturally, with the removal of these subsidies, the price of these types of products increases (Salem and Yousefpour, 2012). The price of agricultural products fluctuates more compared to the price of other goods, which in general can be considered as a result of changes in food supply or demand. In addition, when food producers see that their products can be sold at a higher price abroad, they allocate a greater share of their production to the exports. Therefore, the domestic supply of these products decreases (Javdan *et al*., 2017). Investigating the effect of the trade liberalization on the food prices can be a good help for the policy makers in this field in planning appropriate and efficient policies. As one of the developing countries, Iran's economic structure is highly dependent on imports, and this can have a significant impact on the domestic prices.

According to the Central Bank of Iran (2019), it can be seen that in 2017, the amount of export of agricultural products and food industries was 6956 thousand tons and worth 6400 million dollars, which was 5.9% in terms of weight and 4.4% in terms of value. It accounts for 14% of the country's total export of non-oil goods. The export value in 2017 compared to the 2016 has decreased by 5.7% and compared to the average of the years of the fifth plan, it has decreased by 3.8%. The amount of import of agricultural products and food industries in 2017 was 20,485 thousand tons with a value of 10,841 million dollars, which was 63.9% by weight and 25.4% by value of the country's total imports. In general, the amount of production of agricultural products in Iran in 2013 was equal to 85,593 thousand tons and with a growth of 18.9% in 2018 reached at 101,744 thousand tons. Meanwhile, the import of agricultural products in 2013 was equal to 39,481.07 thousand tons with a value of 11,517.02 million dollars and in 2018 with 35,816 thousand tons with a value of 7,671.26 million dollars. In other words, 26% of the domestic demand is provided through the import channel. This shows the significant importance of importing agricultural products to ensure the country's food security, and on the other hand, it reflects the impact of domestic food prices on the global price changes. In the meantime, according to the report of the Central Bank of the Islamic Republic of Iran, the consumer price index in the country had a slight upward slope from 1991 to 2011, but since 2011, this index has been increased with a relatively steep slope, where one of the main reasons for that was the economic sanctions from the United States of America. In 2018, the consumer index reached a rapid growth rate of 221, which indicates a significant increase in the food prices in the country. Considering the changes in the exchange rate and world price and in order to properly manage the effect of the increase in the world price on the domestic price, it seems that it is necessary to examine the sensitivity of the domestic price to the increase in the world price, and considering that Iran is an importer of some food items, the potential of being affected by the global prices of these goods seems high. Therefore, identifying the factors affecting the domestic price of food has great importance in Iran's economy. Hence, the current research seeks to evaluate the effect of trade liberalization on food prices in Iran.

Cudjoe *et al*. (2008) studied the affectivity of domestic prices from the global crisis in the transmission of food prices in Ghana using vector error correction mechanism (VECM). The results showed that the price transfer between the regional producer markets and the markets located in the biggest city of the country is very high. Sanusi (2010) developed a structural vector auto-regression (SVAR) model for the Ghanaian economy to estimate the impact of exchange rate changes on the

consumer prices and showed that although the transmission of exchange rate changes to the consumer prices is incomplete, it is significantly high. Debab and Radhi (2011) evaluated the effects of trade liberalization on domestic consumer prices in the Persian Gulf Cooperation Council. Their results show that the policy of trade liberalization regarding domestic consumer prices is positive due to economic growth and capital increase. Flachsbarth and Garrid (2014) investigated the effect of trade liberalization on food prices and using the SEECM method, and how different levels of trade openness affect the transmission of food prices. According to the results, the integration of most markets causes an increase in global price transmission elasticities. Elgaili Elsheikh *et al*. (2015) have investigated the effect of wheat import tariff change on gross domestic product, wheat import, ear corn export and domestic wheat production in Sudan during different scenarios using the calculable general equilibrium model. The results show that decreasing the wheat tariff increases its import and reduces its domestic price. It also led to better GDP, trade and investment balance, and reduced private sector consumption. Berlingieri *et al*. (2018) have studied the impact of trade agreements on EU consumer welfare. The effect of welfare has been investigated in three categories of product price, variety and quality. According to research findings, trade agreements in the European Union increase the quality by about 7 percent on average, but do not affect the price or variety. High-income member states in the European Union see much stronger quality increases and greater overall benefits for consumers. Lim and Breuer (2019) analyzed the agreement of trade liberalization and market integration in South Korea. The results confirmed that free trade agreements reduce tariffs and trade costs and have led to the convergence of domestic prices to foreign prices.(Olipra, 2020) emphasized the impact of agricultural policy liberalization and agricultural trade on price transmission in agricultural markets and showed that market-based agricultural policies and trade liberalization improve price transmission in global agricultural markets. Sun and Zhang (2021) studied the effect of agricultural trade liberalization on four components of food security including food supply and price in Central Asian countries and showed that the negative effects of trade liberalization are still a convincing reason to pursue the food self-sufficiency program in these countries. Inusa and Umaru (2021) investigated the effect of trade liberalization on the agricultural sector in Nigeria using an autoregressive model with time lags (ARDL) with seasonal data from 2010-2020 and showed that trade liberalization had a positive effect on agricultural production. But, financial liberalization has a negative effect on agricultural production.

In Iran, Abrishami *et al*. (2005) investigated the effect of trade liberalization on export and import growth of some developing countries using the dynamic method of panel data and it was concluded that trade liberalization has a positive effect on export growth and it has a positive and significant effect on imports, too. Gholipour *et al*. (2011) used the VAR model in examining the long-run and short-run relationship between the commercial liberalization of the agricultural sector and the share of imports and exports of each of the agricultural sectors in the total export and import of goods and services of Iran during the period of 1340-87. The findings indicated that the increase in trade liberalization in the agricultural sector has increased the share of imports in the agricultural sector in the long and short term, and on the other hand, in the short term, the share of exports in the agricultural sector has been decreased under the influence of these policies. Ghahramanzadeh *et al*. (2018) investigated the extent of trade tariff rate pass-through to the price of major groups of agricultural products in the urban and rural parts of the country during the period of 2014-2016 and the results show incomplete and low pass-through of the tariff rate to the price of the agricultural goods group in Iran. is; Thus, in urban areas, the rate of passing the tariff rate to the prices of agricultural products is in the range of zero

and 17%, and in the rural part, it is in the range of zero and 26%. Sarlak and Ghiasi (2017) evaluated the effect of trade liberalization on the growth of exports and imports of member countries of the Organization of Islamic Cooperation using the dynamic method of panel data during the period of 1981-2015. For this purpose, using the generalized method of moments GMM, it has been shown that trade liberalization has had a significant effect on the growth of exports and imports of these countries, and this effect on the growth of imports is far greater than the effect on the exports. Salarpour and Narooie (2018) have investigated the effects of trade liberalization on the export and import of some agricultural products in Iran. The results showed that with trade liberalization, the amount of export supply and import demand increases. In other words, these two variables have a positive relationship with the commercialization process. Dehkiani *et al*. (2018) analyzed the potential effects of commercial liberalization of the agricultural sector on backward and forward linkages using the updated data-output table and showed that the final demand and added value in the country's economy increases coincided with the commercial liberalization of the agricultural sector and subsequently, the output value will also increase. In addition, the back and front links of the three sub-sectors of agriculture and horticulture, animal breeding and forestry will be smaller. However, the key sectors of Iran's economy will not change before and after the commercial liberalization of the agricultural sector.

Based on the mentioned contents, it can be seen that the issue of trade liberalization is one of the important issues of the economy and several factors effect on it and it has significant effects on the domestic prices of agricultural products and it is in the center of attention of economic studies. On the other hand, despite the importance of the effect of trade liberalization on the price of food, there have not been many studies done in the country on this issue, and the evaluation of the studies, especially the internal studies, shows that in most of these studies, the price transfer between the stages of marketing in the country have been investigated and in them the effect of global price changes on the domestic price has not been taken into consideration. On the other hand, previous limited studies have used VAR and SVAR methods. However, in the present study, this important issue is investigated using the SEECM model, and an attempt is made to analyze the effect of agricultural trade liberalization on food prices in Iran.

Materials and Methods

Methods

Trade liberalization is a term that refers to the removal or reduction of government support for the business sector. This causes the privatization of production, better management and division of work, and ultimately increases income (Salatin and Olfat, 2019). Theoretically, although trade liberalization increases exports and imports, its effect on trade balance and balance of payments is ambiguous and depends more on the relative effects of export and import growth as well as changes in real exchange rates (relative prices). From the supply point of view, trade liberalization leads to economic growth. But from the point of view of demand, this policy has been led to the deterioration of the balance of payments and this will have an adverse effect on economic growth (Abrishami *et al*., 2006). In the discussion about the price effects obtained from trade liberalization, we must first know what are the trade barriers that are removed from international trade during liberalization. The main obstacles include tariff barriers and export subsidies. Tariffs are applied to imported goods so that the domestic price of the imported goods becomes expensive in the importing country, thus supporting the domestic goods. In general, trade policies such as tariffs affect the gap between domestic and foreign prices. When the tariff is reduced, it will affect the internal price of goods and its relative price in the economy. The change in relative prices will cause an imbalance in the market of

production factors, and as a result, it will lead to the adjustment of the income of the production factor (especially wages) (Yazdanshenas *et al*., 2010).

In general, as a result of the removal of tariffs on imports, the prices of products and production of the sector that is accepted by liberalization will decrease. But subsidies are often imposed on export goods so that the producer with government support can compete with foreign goods and sell his goods to the world market (Salem and Yousefpour, 2012). Trade liberalization has been of great interest to economic planners and policy makers. It is a common belief that liberalization leads to economic growth. Therefore, different countries are looking for trade liberalization in order to benefit from its benefits (Salatin and Olfat, 2019). Adoption of support policies in order to support domestic goods is one of the most important areas that provide government intervention in the economy. There is a high level of protectionism in many countries, which is a source of irritation for economists who favor free trade policies. One of the most important and oldest means of supporting industries and one of the most obvious aspects of the government's intervention in the process of international trade is the imposition of customs tariffs. Tariff is a type of tax on imported goods. Imposing a tariff on a product increases the price of that product in the domestic market, generally reduces imports and increases the demand for similar domestic products.

The review of the literature on the subject and theoretical foundations shows that the factors that determine food prices are created by two groups of tradable and non-tradable factors. The process of data generation for the price variable can be expressed as a function of the prices of tradable and non-tradable goods in the form of equation 1 (Flachbarth and Garrid, 2014).

$$P_A = F\left(p_{agt}, p_{agnt}\right) \quad (1)$$

Where P_A, p_{agt} and p_{agnt} are the domestic price of food, tradable, and non-tradable goods, respectively.

Non-tradable products cannot be imported or exported, and their price is determined through the interaction between domestic demand Q^d_{agNT} and domestic supply Q^s_{agNT}, whose mathematical form is given in equation (2).

$$Q^d_{agNT} = Q^s_{agNT} \quad (2)$$

As in developing countries the share of food expenditure in household budget is increasing, it is expected that the demand for agricultural products is influenced by aggregate demand. The domestic price of food is a function of some common economic factors such as money supply, global oil price, exchange rate (Ghahremanzadeh *et al*., 2020).

As (Flachsbarth and Garrid, 2014) explained, the implicit form of the domestic food price relationship can be shown as equation (3):

$$P_A = f\left(Pw_{AG}, xrt, top, M2, Pw_{oil}\right) \quad (3)$$

Where P_A is domestic food price, $M2$ is money supply, Pw_{oil} is world oil price, top is trade liberalization index, xrt is exchange rate, and Pw_{AG} is world food price. The top is the percentage of trade to GDP (Pazhooian *et al*., 2018). The effect of global price changes on the consumer price index (CPI) can be examined by applying equation (4):

$$\frac{\partial P_A}{\partial Pw_{AG}} = \gamma + \chi \times top \quad (4)$$

Which γ and χ are long-run coefficients.

To investigate the mechanism of the effect of world prices and the degree of liberalization on the domestic price of food, the single equation error-correction model (SEECM) can be used, which is a new model and will be used in the current research. In trade liberalization, a cause and effect relationship between world prices and domestic food prices is investigated using the error-correction method of single equations. By using this

model, the impact of domestic food prices on world prices can be investigated and measured for both short-run and long-run periods. This model provides the possibility of measuring the domestic price response to the price shock in global markets for both short-run and long-run periods. Based on the existing literature, a standard modeling approach to move towards ECM models occurs when the two series in question are co-occurring and there is a unidirectional causality relationship between them. In that case, the two-stage Engel and Granger method (EGECM) is used. However, Berlingieri *et al.* (2018) proposed a single-equation error correction model (SEECM) instead of the EGECM model to investigate this co-integration relationship, which has two distinct advantages over the EGECM model.

The advantages and reasons of using the SEECM model are i) in this model, it is not necessary that all relevant time series of a certain degree have a single root in order to provide a long-run equilibrium relationship between them to create an ECM model. Because in order to establish an ECM process, it is necessary that the series have similar characteristics of stationary, that is, they are of a similar degree of integration; ii) by using a SEECM model, a stronger test can be obtained to measure the existence of co-integration between variables and also to relatively estimate parameters with the least bias (Ghahremanzadeh *et al.*, 2020).

Now, if we want to consider the short-run and long-run dynamics regarding equation (3), it can be rewritten as relation (5).

$$P_{A_{it}} = \alpha_0 + \alpha_1 P_{A_{it-1}} + \psi_0 Pw_{AG_{it}} + \psi_1 Pw_{AG_{it-1}} + \phi_0 xrt_{it} + \phi_0 xrt_{it-1} + \zeta_0 M2_{it} + \zeta_1 M2_{it-1} + \beta_0 top_{it} + \beta_1 top_{it-1} + \omega_0 \left(Pw_{AG_{it}} \times top_{it}\right) + \omega_1 \left(Pw_{AG_{it-1}} \times top_{it-1}\right) + \eta_0 Pw_{oil_{it}} + \varepsilon_{it} \quad (5)$$

To obtain SEECM, subtraction of $P_{A_{it-1}}$ from equation (5) is obtained first, whose mathematical form is given in equations (6):

$$P_{A_{it}} = \alpha_0 + (\alpha_1 - 1) P_{A_{it-1}} + \psi_0 \Delta Pw_{AG_{it}} + (\psi_0 + \psi_1) Pw_{AG_{it-1}} + \phi_0 \Delta xrt_{it} + (\phi_0 + \phi_1) xrt_{it-1} + \zeta_0 \Delta M2_{it} + (\zeta_0 + \zeta_1) M2_{it-1} + \beta_0 \Delta top_{it} + (\beta_0 + \beta_1) top_{it-1} + \omega_0 \left(\Delta Pw_{AG_{it}} \times \Delta top_{it}\right) + (\omega_0 + \omega_1)\left(Pw_{AG_{it-1}} \times top_{it-1}\right) + \eta_0 \Delta Pw_{oil_{it}} + \varepsilon_{it} \quad (6)$$

Equation (7) can be derived by arranging equation (6), where $\delta = (\alpha_1 - 1)$; $\lambda_0 = \psi_0$; $\lambda_1 = (\psi_0 + \psi_1)$; $\theta_0 = \phi_0$; $\theta_1 = (\phi_0 + \phi_1)$; $\kappa_0 = \zeta_0$; $\kappa_1 = (\zeta_0 + \zeta_1)$; $\mu_0 = \beta_0$; $\mu_1 = (\beta_0 + \beta_1)$; $\pi_0 = \omega_0$; $\pi_1 = (\omega_0 + \omega_1)$.

Now, the long-run equilibrium relationship estimated by equation (7) between domestic prices and world prices is equal to:

$$\Delta P_{A_{it}} = \alpha_0 + \vartheta \Delta Pw_{AG_{it}} + \rho \Delta xrt_{it} + \kappa \Delta M2_{it} + \mu \Delta top_{it} + \pi \left(\Delta Pw_{AG_{it}} * \Delta top_{it}\right) + \eta \Delta Pw_{oil_{it}} + \delta \begin{pmatrix} P_{A_{it-1}} - \gamma Pw_{AG_{it-1}} - \varphi xrt_{it-1} - \xi M2_{it-1} \\ -\varepsilon top_{it-1} - \chi \left(Pw_{AG_{it-1}} * top_{it}\right) \end{pmatrix} + \varepsilon_{it} \quad (7)$$

Based on this relationship, the following variables show short-run effects: $\vartheta = \lambda_0$: Short-run effect for world prices, $\rho = \theta_0$: Short-run effect of exchange rate, $\kappa = \kappa_0$: Short-run effect of liquidity, $\mu = \mu_0$: Short-run effect of world oil price, $\eta = \eta_0$: Short-run effect of trade liberalization index.

And the following variables show their long-run effects on the growth of domestic food prices:

$\gamma = \left(1 - \lambda_1 / \delta\right)$: Long-run effect of change in world price on domestic food price, $\varphi = \left(1 - \theta_1 / \delta\right)$: Long-run effect of change in exchange rate on domestic food price, $\xi = \left(1 - \kappa_1 / \delta\right)$: Long-run effect of change in liquidity on domestic food price, $\varepsilon = \left(1 - \mu_1 / \delta\right)$: Long-run effect of change in world oil price on domestic food price $\chi = \left(1 - \pi_1 / \delta\right)$: The long-run effect of changes in the trade liberalization index on the domestic food price, and δ: shows the amount of error-correction or the speed of adjustment.

Based on equation (7), the long-run equilibrium relationship between the investigated variables can be shown as equation (8):

$$P_{A_{it}} - \gamma Pw_{AG_{it-1}} - \varphi xrt_{it-1} - \xi M2_{it-1} - \varepsilon top_{it-1} - \chi \left(Pw_{AG_{it-1}} \times top_{it}\right) = 0 \quad (8)$$

In this relationship, it is assumed that ($\gamma \neq 0, \varphi \neq 0, \xi \neq 0, \varepsilon \neq 0,$ and $\chi \neq 0$)is a process of stable data generation. By satisfying the above condition, there is a long-run equilibrium relationship between the domestic price and other variables. For the φ test, the (Campa and Gulberg, 2005) test can be used. According to this method, if the value of φ is not significantly different from zero, it means that there is no effect of changes from the variable to the imported goods, while if its value is equal to one, it means the full effect of the changes of the variable to domestic prices, and if both are rejected, it can be said that there is an incomplete effect. Finally, according to what has been said, by estimating the relationships mentioned under the conditions of each of these models, it is possible to examine and analyze the effect of the liberalization of trade in agricultural products on the domestic price of food.

Data

The required data and information including CPI, Iran's food exports and imports, volume of liquidity, and exchange rate have been collected from the database of the Central Bank of the Islamic Republic of Iran and the Customs of the Islamic Republic of Iran during the years 1989-2019. World food prices were also obtained from FAO and MFI. According to Table 1, in recent years, Iran's total imports have been decreasing due to the US economic sanctions against Iran. However, Iran's total exports have followed an upward trend during 2012-19. On average, 14.5 percent of the total exports and 21.2 percent of the total imports are related to the agriculture sector, which directly impacts the household's consumption basket. As it is clear from Table 1, the share of export and import of the agricultural sector is associated with a downward trend, and the reason for this can be the imposition of sanctions against Iran.

Table 1- Descriptive statistics of variables in the period 2012-2019

Year	Total export (billion dollars)	Agricultural export (billion dollars)	Share of Agricultural export from the total export	Total import (billion dollars)	Agricultural import (billion dollars)	Share of Agricultural import from the total import
2012	32.6	5.6	0.17	53.4	11.5	0.21
2013	31.6	4.6	0.15	49.8	10.6	0.21
2014	36.6	6.1	0.17	53.6	10.09	0.18
2015	35.6	5.2	0.15	41.5	6.7	0.16
2016	36.7	5.5	0.15	43.7	6.3	0.14
2017	40	5.7	0.14	54.5	7.6	0.13
2018	44.7	5.1	0.12	43.2	7.9	0.18
2019	40.3	5.7	0.14	43.7	8.3	0.18

Figure 1 shows the Iran's liberalization index during the period of 2012-2019. Five types of movement can be seen in the mentioned diagram. It can be clearly seen that the trade liberalization index experienced an upward trend with a gentle slope until 1995 and after this year until 2000, it went through a downward trend. After this year, there are low and somewhat stable fluctuations, which are caused by the government's control policies. It is clear that during the years 2012-2018, there were many fluctuations in the downward trend of trade liberalization, which could be the result of American economic sanctions against Iran.

Results and Discussion

In the following, in order to determine the appropriate estimation strategy, the variables' stationary test was conducted first. It should be noted that all variables are in logarithmic form. By comparing the DF-GLS test statistic for the data level with the critical values reported in Table 2, all variables are *I(1)*. Same results were obtained through Augmented Dickey Fuller (ADF) test, and the co-integration test can be applied to these variables.

To estimate the co-integration vector by the *Johanson*'s co-integration test, the number of optimal lags using the Akaike (AIC), Schwartz (SBC) and Hannan and Quinn information criterion (HQIC) was determined to be equal to 4. Then the co-integration test was estimated, and the results are shown in Table 3. Based on this Table, the null hypothesis of the existence of at most one co-integration vector is not statistically rejected at the 5% level. In other words, there is a co-integration vector between these variables.

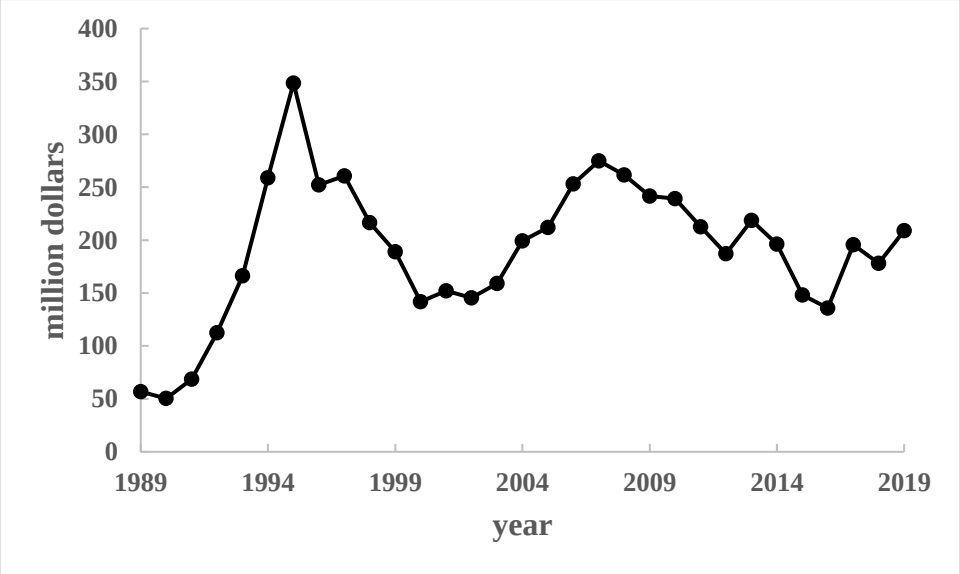

Figure 1- Index of trade liberalization based over 1989–2019 (2016=100)

Table 2- Results of the ADF and DF-GLS tests of the variables

	DF-GLS test		ADF test	
Variables	**Data levels**	**First order differential**	**Data levels**	**First order differential**
World oil price (Pw_{oil})	-1.897	-3.954***	-1.251	-4.912***
World food price index (Pw_{AG})	-1.728	-3.859***	-1.342	-5.069***
Trade liberalization index *(top)*	-1.982	-3.284***	-2.992	-3.865***
Liquidity *(M2)*	-1.746	-3.760***	-1.803	-3.087***
Exchange rate (xrt)	-1.849	-2.840***	-0.466	-3.812***
Food price index (P_A)	-2.912	-3.296***	-0.006	-4.365***

*** Indicates significance at the 1% probability level.

Table 3- Result of the Johansen co-integration test

Null Hypothesis	*Trace* statistic	Critical values (5%)
r=0	94.93	94.15
r≥1	49.45*	68.52
r≥2	29.71	47.21

* Indicates the number of co-integration vectors

Results of SEECM model

After determining the number of co-integration vectors, the long-run and short-run equilibrium relationship between the variables was estimated through the SEECM model. According to the last row of Table 4, the Breusch-Pagan Godfrey LM test to measure the presence of autocorrelation problem from the first lag (LM test) indicates that at the 10% probability level, the fitted model has no

autocorrelation problem and the *Jacobra's* normality test (JB test) also indicates the normality of the distribution of disturbance components of the estimated model. According to the Table 4, δ shows the adjustment speed. Also, as it was expected, the value was between 0 and 1with a negative sign. According to Table 4, the error-correction coefficient was equal to -0.345. It means that in the long run, if a shock occurs on the domestic price of food, the domestic market can adjust it by 30%. It can be seen that in the short term, only the growth of global food prices (ψ_1), liquidity (θ_1) and exchange rate (ϕ_1) have a significant effect on the growth of domestic food prices. Therefore, one percent increase in the global price of food, liquidity, and exchange rate, causes an increase in the growth of domestic food price by 0.21, 0.23 and 0.43 respectively in the short term. However, the effect of exchange rate growth on Food price growth is more than of the liquidity and global food price growth. As a result, this indicates that domestic prices react more to exchange rate changes than global prices, so this clearly indicates the importance of the government's foreign exchange policy position in the nation. One of the ways to prevent the increase of the price of agricultural products, following the occurrence of a currency shock, is to support the import of the most affected sectors. Such support can be provided through the reduction of import tariffs on agricultural products; if it is not possible to produce them inside; or priority in the allocation of preferred currency; to import their products. Of course, the implementation of these policies can be effective in the short term, but in the long term, it is suggested that the government implement the necessary policies to reduce dependence on imported intermediate inputs, which are mainly related to manufactured goods; The noteworthy point is the high exchange rate fluctuations, which can be seen that the rate of exchange fluctuations in the country is much higher than the global price fluctuations, which is one of the reasons for the formation of internal price fluctuations of these inputs.

Table 4- SEECM model result

Short-run equation			Long-run equation		
Parameter	**Coefficient**	**t-statistics**	**Parameter**	**Coefficient**	**t-statistics**
α_0	1.322	2.44	β_1	0.13***	3.42
δ	-0.345***	-2.59	β_2	0.27**	2.56
ζ	0.13	0.36	β_3	-3.5	-0.10***
ψ_1	0.21*	1.84	β_4	0.36***	12.2
ω_1	-0.07	-0.08	β_5	0.65***	15.5
θ_1	0.23***	2.92	β_6	0.37***	7.3
ϕ_1	0.43***	3.01			
JB test: 7.90 (0.001)			LM test: 2.456 (0.117)		

*, **, and *** indicate the significance level of 1%, 5% and 10%, respectively.

According to the results of Table 4, β_1 is equal to 0.13, which is significant and has a positive effect. It explained, if the global price of oil increases by 1% in the long term, the domestic price of food will increase by 0.13%. β_2 represents the logarithm of the world food price, which is statistically significant at the 5% probability level and indicates that in the long term, if the global food price increases by 1%, the domestic food price will increase by

0.27%. β_3 represents the logarithm of the trade liberalization index, whose value is equal to -0.1, which indicates the negative effect of liberalization on the level of domestic prices, so that the price level has decreased with trade liberalization. β_4 represents the logarithm of the unofficial exchange rate, which is significant and has a positive effect, and its value is equal to 0.36, which means that if the unofficial exchange rate increases by one percent, the domestic price of food will increase by 0.36. β_5 shows the logarithm of the liquidity, which is equal to 0.65 and has a positive and significant effect, so that if the volume of liquidity increases by one percent, the domestic price of food will increase by 0.65 percent. β_6 indicates the application of the economic sanctions and has had an effect on the domestic price in the long term and has caused an increase in the domestic price in the long term. In the meantime, the effect of liquidity on the domestic price of food is more than other variables.

The obtained results are line with Flachsbarth and Garrid (2014) and Ghahremanzadeh *et al.* (2020) which they indicated that the global food price have affected significantly the domestic food prices. Also, exchange rate appreciation can curb price shocks to some extent, and monetary policies seem to be a suitable tool to stabilize food prices to protect food access to the poor population.

Conclusion and Suggestion

Considering the importance of food security, lack of food or its price fluctuations can lead to a decrease in social well-being. Due to the fact that Iran supplies a significant amount of food through imports, changes in exchange rates and global prices affect the domestic price of food products. According to the graphical analysis of price changes, it can be seen that the global price of food has a gentle and constant slope until 2017, and this is also true in the domestic price of food. But after this year, international and domestic prices have experienced an upward trend and instability. The graphical analysis of the changes in the trade liberalization index shows five types of movement and the results indicate that the trade liberalization index has an upward trend with a gentle slope until 1995 and after this year until 2000 it went through a decreasing trend and during the years 2012-98, there have been many fluctuations in the downward trend of the degree of trade liberalization, which can be the result of the economic sanctions against Iran. Also, the analysis of the graph related to the export and import of agricultural products shows that Iran's export has always experienced a downward trend since 2013, and the reason for this can be related to the economic sanctions against Iran, and the import is relatively less in a downward trend, and the reason for this is maintaining the market is free trade. The results of Iran's total export and import chart confirm that the export has gone through a downward trend from 2011 to 2018 and the total import has a mild slope with an upward trend. Examining the GDP chart shows an upward trend until 2015, after which it became a downward trend, the most important reasons of which can be found in policy errors at different levels of the country, exchange rate fluctuations, and increasing international sanctions. The liquidity figures show that in recent years, the increase has been high and the most important factor in the growth of liquidity is the government's budget deficit. The reviewing the trend of exchange rates shows that until the end of 2019, they had a steady trend or an increasing trend, but in the last few years, there has been an increasing trend, the main reason of which was the imposition of economic sanctions against Iran.

The results of the estimation of the SEECM model indicate that, as expected, there is a significant long-run relationship between the degree of trade liberalization and the domestic price of food products. The degree of trade liberalization on the domestic price of agricultural products is -0.10 and it indicates that the higher the trade liberalization, the lower the domestic price of food and the reason is that when imports are made in a

country, cheap goods are imported and put pressure to the domestic prices and this causes the prices in the importing country to decrease. Also, the error-correction coefficient is as expected and has a negative sign and a value between zero and one. In the short term, the variable growth of world food prices, exchange rate and liquidity have a significant effect on the growth of domestic food prices, among which the greatest effect is related to the exchange rate with 0.43 and the least effect is related to the world food price with 0.21 on the domestic price of food. In the long-run, the largest effect on the domestic price of food is related to the volume of liquidity, and the world price of oil has the least effect on the domestic price of food. The agricultural trade liberalization shows that consumer prices of food will increase during periods of global price growth. Thus, for poor consumers, world price shocks can worsen in the short run and domestic food prices slowly converge to a higher long-run equilibrium. Especially in increasingly integrated economies, effective policies to contain food price shocks should be implemented, but should be carefully planned with the required available budget. Also, exchange rate appreciation can curb price shocks to some extent, and monetary policies seem to be a suitable tool to stabilize food prices to protect food access to the poor population.

Considering the importance of food in the household consumption basket and the need to import some food items and the effect of trade liberalization on the reduction of food prices, it is recommended to apply trade policies including border tariff measures and price limit system. The adoption of appropriate support policies, both compensatory and complementary, plays an important role in the success of commercial liberalization and reduction of rural poverty in the agricultural sector. On the other hand, considering the effect of exchange rate changes on the domestic price of agricultural products, it is suggested to apply appropriate currency policies to prevent the unreasonable increase of the exchange rate as well as its extreme fluctuations in order to witness price stability.

References

1. Abrishami, H., Mehrara, M., & Mohseni, R. (2005). Effect of trade liberalization on trade balance and current account balance of payments (an econometric analysis). *Journal of Knowledge and Development* 17: 11-38. (In Persian)
2. Abrishami, H., Mehrara, M., & Mohseni, R. (2006). Effect of trade liberalization on export and import growth. *Quarterly Journal of Business Research* 40: 95-126. (In Persian)
3. Baquedano, F., & Liefert, W. (2014). Market integration and price transmission in consumer markets and developing countries. *Food Policy* 44: 103-114. https://doi.org/10.1016/j.foodpol.2013.11.001.
4. Berlingieri, G., Breinlich, H., & Dhingra, S. (2018). The impact of trade agreements on consumer welfare—evidence from the EU common external trade policy, *Journal of the European Economic Association, European Economic Association 16*(6): 1881-1928. https://doi.org/10.1093/jeea/jvx053.
5. Breusch, T.S., & Pagan, A.R. (1979). A simple test for heteroscedasticity and random coefficient variation, *Econometrica* 47: 1287-1294.
6. Campa, J.M., & Goldberg, L.S. (2005). Exchange rate pass-through into import prices. *The Review of Economics and Statistics 87*(4): 679–690. https://doi.org/10.1162/003465305775098189.
7. Cudjoe, G., Breisinger, C., & Diao, X. (2008). Local impacts of a global crisis food price transmission and poverty impacts in Ghana.
8. Debab, N., & Radhi, S. (2011). Effects of trade liberalization on domestic consumer prices a case study of gulf cooperation council. *European Journal of Economics, Finance and Administrative Sciences* ISSN 1450-2275 Issue 37.

9. Dehkiani K.M., Mosavi, S.H., & Khalilian, S.(2019). Analyzing the potential impacts of trade liberalization on agricultural backward and forward linkages using the updated input-output table in 2011. *Journal of Agricultural Economics and Development27* (105): 1-34. (In Persian). https://doi.org/ 10.30490/AEAD.2019.91240.
10. Eclac. (2008). *The escalation in world food prices and its implications for the Caribbean*. The Economic Commission for Latin America, Santiago, Chile.
11. Elgaili Elsheikh, O., Abdelbagi Elbushra, A., & Salih, A. (2015). Economic impacts of changes in wheat'simport tariff on the Sudanese economy. *Journal of the Saudi Society of Agricultural Sciences* 14: 68-75. https://doi.org/10.1016/j.jssas.2013.08.002.
12. Flachsbarth, I., & Garrid, A. (2014). The effects of agricultural trade openness on food price transmission in Latin American countries. *Spanish Journal of Agricultural Research12* (4): 927-940. https://doi.org/10.5424/sjar/2014124-6292.
13. Ghahremanzadeh, M., Faraji, S., & Pishbahar, E. (2020). Transfer of world prices and exchange rates to domestic prices of major imports of livestock and poultry in the country. *Journal of Agricultural Economics14* (2): 23-52. (In Persian). https://doi.org/10.22034/IAES.2020.134731.1780.
14. Ghahremanzadeh, M., Khalili Malakshah, S., & Pishbahar, E. (2018). The range of import pass-through tariffs to agricultural products prices in urban and rural areas of Iran. *Journal of Agricultural Economics and Development31* (4): 311-320. (In Persian with English abstract). https://doi.org/10.22067/JEAD2.V31I3.61571.
15. Gholipour, S., Mohammadzadeh, R., Bakhshoodeh, M., Azarinfar, Y., & Rafati, M. (2011). Study of agricultural trade openness impact on export and import shares of agriculture and services in Iran. *Journal of Agricultural Economics and Development25* (4): 392-399. (In Persian with English abstract)
16. Ivanic, M., & Martin, W. (2014). Implications of domestic price insulation for global food price behavior. *Journal of International Money and Finance* 42: 272–288. https://doi.org/10.1016/j.jimonfin.2013.08.015.
17. Inusa, E.M., & Umaru, A. (2021). Openness and agricultural performance in Nigeria. *Asian Journal of Economic Modelling 9*(2): 132–144. https://doi.org/10.18488/JOURNAL.8.2021.92.132.144.
18. Jafari Samimi, A., & Farajzade, Z. (2019). Factors affecting food price index in Iran. *Journal of Agricultural Economics Research 11*(41): 1-16. (In Persian with English abstract)
19. Javdan, E., Haghighat, J., Pishbahar, E., & Mohammadrezaei, R. (2017). Investigation the pass-through of global food prices to domestic prices in Iran. *Quarterly Journal of Applied Theories of Economics 4*(11): 177-196. (In Persian)
20. Lim, E., & Breuer, J.B. (2019). Free trade agreements and market integration: Evidence from South Korea. *Journal of International Money and Finance, Elsevier 90*(C): 241–256. https://doi.org/10.1016/j.jimonfin.2018.09.010.
21. Mehrabi Boshrabadi, H., & Mousavi Mohammadi, H. (2009). An Examination of the Effects of Trade Liberalization on Food Security of Iranian Rural Households. *Village and Development 12*(2): 1-13. (In Persian with English abstract)
22. Olipra, J. (2020). Price transmission in (de) regulated agricultural markets. *Agrekon 59*(4): 412-425. https://doi.org/10.1080/03031853.2020.1831936.
23. Pazhooian, J., Ahmadi, S., Mehrara, M., & Memarnejad, A. (2018). Trade liberalization and tax structure in WTO member less -developed and developing countries. *Journal of Tax Research 26*(37): 11-40. (In Persian)
24. Sarlak, A., & Ghiasi, M. (2018). The impact of trade liberalization on export growth and import growth in members of the Organization of Islamic Cooperation (OIC). *Iranian Journal of*

Applied Economics 8(25): 61-71. (In Persian with English abstract). https://doi.org/20.1001.1.22516212.1397.8.0.17.2.

25. Salarpour, M., & Narooie, H. (2019). Trade liberalization effects on exports and imports growth of some of agricultural products in Iran. *New Applied Studies in Management, Economics & Accounting 2*(6): 97-112. (In Persian)
26. Salatin, P., & Olfat, A. (2019).The impact of trade liberalization on human development index in selected countries. *Journal of Economic Development Policy 6*(2): 147-165. (In Persian with English abstract). https://doi.org/10.22051/EDP.2019.20120.1150.
27. Salem, B., & Yousefpour, N. (2012). Investigating the effects of trade liberalization in developing countries. *Economic Journal 12*(1): 93-104. (In Persian)
28. Sanusi, A. (2010). Exchange rate pass-through to consumer prices in Ghana: Evidence from structural vector auto-regression, *The West African Journal of Monetary and Economic Integration 10*(1): 25-54.
29. Sun, Z. & Zhang, D. (2021). Impact of trade openness on food security*:* evidence from Panel data for central Asian countries. *Foods 10*(12): 3012. https://doi.org/10.3390/foods10123012.
30. Yazdanshenas, L., Parmeh, Z., & Aghajani, Z. (2010). The effect of tariff policy on domestic prices of poultry and veal in Iran. *Journal of Agricultural Economics Research 1*(4): 107-124. (In Persian with English abstract)
31. Yosofi, H., & Moghadesi, R. (2013). World price transmission to domestic agricultural markets: Case of wheat, barley and rice. *Journal of Agricultural Economics Research 5*(17): 81-99. (In Persian with English abstract)

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۳۷۶-۳۶۳

تأثیر آزادسازی تجارت محصولات کشاورزی بر قیمت مواد غذایی در ایران

محمد قهرمان زاده[1*]- مینا صمدپور[2]- جواد حسین زاد[3]

تاریخ دریافت: ۱۴۰۰/۰۸/۲۲

تاریخ پذیرش: ۱۴۰۰/۱۲/۲۵

چکیده

گسترش تجارت و آزادسازی آن، از متداول‌ترین سیاست‌ها برای دست‌یابی به رشد و توسعه اقتصادی در اغلب کشورها به شمار می‌رود. آزادسازی تجارت محصولات کشاورزی و اثر آن بر قیمت مواد غذایی، به دلیل اهمیت مواد غذایی در سبد مصرفی خانوار، یکی از مهم‌ترین اهداف دولت‌ها برای دسترسی عموم جامعه به مواد غذایی سالم و کافی است. در مطالعه حاضر، تأثیر آزادسازی تجاری بر قیمت مواد غذایی در ایران بررسی شده‌است. بدین منظور، از مدل تصحیح خطای تک‌معادله‌ای (SEECM) با استفاده داده‌های سالانه مورد نیاز طی دوره زمانی سال‌های ۹۸-۱۳۶۸ بهره گرفته شد. نتایج برآورد مدل SEECM نشان‌دهنده آن است که ضریب تصحیح خطا معنی‌دار و برابر با ۰/۳۴۵- بوده و بیانگر این امر است که در بلندمدت اگر یک شوکی بر قیمت داخلی مواد غذایی وارد شود بازار داخلی می‌تواند سالانه فقط ۳۰ درصد آن را تعدیل کند. همچنین روابط تعادلی بلندمدت برآورد شده در مدل SEECM مؤید آن است که قیمت جهانی محصولات غذایی اثر مثبت و آزادسازی تجاری، اثری منفی بر قیمت مواد غذایی داخلی دارند. با توجه به نوسانات قیمت‌های جهانی و تأثیرپذیری قیمت‌های داخلی از آن، لزوم توجه به نوسانات قیمت‌های جهانی و نرخ ارز در تدوین سیاست‌های تجاری توصیه می‌شود.

واژه‌های کلیدی: آزادسازی تجاری، قیمت‌های جهانی، مواد غذایی، نرخ ارز

۱، ۲ و ۳- به‌ترتیب استاد، دانش آموخته کارشناسی ارشد و دانشیار، گروه اقتصاد کشاورزی، دانشکده کشاورزی، دانشگاه تبریز، تبریز، ایران

(*- نویسنده مسئول: Email: Ghahremanzadeh@Tabrizu.ac.ir)

DOI: 10.22067/jead.2022.73620.1098

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 377-392

Identification of barriers to Develop the Fruit Production Chains (Case Study of Orchards in Meshginshahr)

N. Seifollahi[1]*, R. Mohammad Khani[2]

Received: 09-06-2022
Revised: 01-09-2022
Accepted: 11-10-2022
Available Online: 15-02-2023

How to cite this article:
Seifollahi, N., & Mohammad Khani, R. (2023). Identification of barriers to Develop the Fruit Production Chains (Case Study of Orchards in Meshginshahr). *Journal of Agricultural Economics & Development* *36*(4): 377-392.
DOI: 10.22067/jead.2022.76629.1132

Abstract

The lack of a comprehensive information system and application model in the supply chain of agricultural products in Iran has caused this part of the country's economy to be ineffective despite its potential. Therefore, the aim of the current research was to investigate the barriers against the orchards production chains in Meshginshahr located at Ardabil province, Iran. To reach the aim of the study, the semi-structured interviews were used to collect research data from 16 interviews including farmers, faculties and managers in the field of farming production chains. Then we analyzed the data by applying the Strauss and Corbin method and the paradigm model through Max QDA software. Sampling was theoretical and was done using targeted and snowball methods. Based on that, 16 interviews were conducted with gardeners, university professors and managers in the field of barriers to the development of agricultural production chains. The open codes included 38 concepts and the core codes also included 44 major categories, which were finally identified into four groups of selective categories including barriers to i) product production; ii) input supply; iii) product distribution; and iv) customers. Based on the findings of the research on the risk of supply of input resources, the weakness of regulations and rules in supply of inputs, production information barriers, strategic production barriers, competition barriers in production, environmental risks, planning-management, financial-credit, technical-technical barriers, product distribution cost barriers, lack of regulations in the distribution system, and sales barriers; barriers related to the production sector are of the barriers to the development of production chains of agricultural products. Barriers related to the production sector are one of the barriers to the development of production chains of agricultural products.

Keywords: Agricultural products, barriers to develop, Production chains, Meshginshahr orchards

Introduction

The value chain is a sequence of purposeful combinations of production factors that lead to the creation of a product or service that can be offered in the market from a concept to the final product. This process includes activities such as design, production, marketing, distribution and support services for the final customers. The activities in the value chain can be obtained independently from one company or from different companies. The term value chain refers to the fact that value is added to the primary product by combining different resources. A value chain refers to the sequence of connected factors and processes that transform inputs and services into products with features that consumers are ready to buy. (Devaux *et al.*, 2018). In India,

1 and 2- Associate Professor and Ph.D. Student, Department of Management, Faculty of Social Sciences, University of Mohaghegh Ardabili, Ardabil, Iran, respectively.
(*- Corresponding Author Email: n.seifollahi@uma.ac.ir)

inadequacy of infrastructure, frequent price fluctuations, low quality and product incompatibility, problems related to harvesting, losses during and after harvesting, and the length of the chain are among the problems of the value chain. Through measures such as production efficiency by providing healthy seedlings and providing suitable plants, training operators, providing suitable financial resources, practical recommendations related to the cultivation of suitable cultivars, observing the principles of planting, and harvesting in the farm - strengthening the private sector participating, creating a structure in order to increase the participation of the chain members in the direction of the common goal, can help to improve the production chain in the agricultural sector (Niazi and Mobini, 2019).

In 2019, the agriculture sector accounted for 11.5% of GDP and 12% of non-oil exports. Therefore, the growth of this sector determines the country's economic growth to some extent Shahbazi and Alizadeh (2018). In order to increase productivity in Iran's economy, special attention should be paid to the agricultural sector as one of the most important and major sectors of economic activities in the country. Because compared to other economic sectors, this sector is of special importance in terms of production, employment, foreign exchange, food supply and less dependence on foreign currency.(Kazemi *et al.*, 2017) During the year 2021, the export value of agricultural and food products was over 11 billion dollars (Gomrok Iran, 2021). Challenges and problems such as competitors with low-cost products, price fluctuations of agricultural products, increasing consumer expectations (Miri *et al.*, 2017). If the barriers to the development of the production chain in the agriculture sector are identified, it is possible to increase the production of agricultural products by planning and formulating a suitable strategy. Previous researches in the field of agricultural products are limited, one-sided and quantitatively oriented, and the introduction of new ideas and qualitative analyzes into the field of production seems necessary. Since the formation of a strong sector of horticultural products is necessary to have a suitable strategy and these strategies will not be very useful and effective without identifying and recognizing the effective and important factors, therefore, in this research, barriers to the development of agricultural product production chains (case study: horticultural products) has been discussed based on the method of Grande's theory. Creating a strong agricultural sector requires having a proper strategy, and these strategies will not be very useful and effective without identifying and recognizing the effective and important factors. Therefore, the current research is to investigate the barriers to the development of production chains of horticultural products in Meshginshahr city and based on the grounded theory method. The current research seeks to increase the richness of our understanding of the experiences and knowledge of specialists and managers of agricultural producers about the barriers to the development of the chain of agricultural production. Another importance of this research is that it aims to identify all the aspects of agricultural production barriers in order to be a guide for policy makers in the field of production to plan according to the existing development factors and provide solutions in line with the development of production.

In the 1980s, with the increase in diversity in the expected patterns of customers, companies and organizations became increasingly interested in developing flexibility in production lines and developing new products to satisfy the needs and demands of customers. In the 90s, along with the improvement and development in production processes and the application of re-engineering patterns, the managers of many industries realized that to continue being present and active in the market, only improving and developing internal processes and increasing flexibility in the company's capabilities are insufficient; Rather, suppliers and suppliers of

parts and materials must also produce high-quality materials at the lowest cost, and product distributors must be closely related to the manufacturer's market development policies; With such an attitude, the approaches of the production chain and its management emerged and developed. Isfahani Zanjani *et al.* (2021) Supply chain management is defined as the management of materials, information and capital flows, as well as cooperation between supply chain organizations, in order to coordinate the goals of the economic, environmental and social fields, which affects the performance of organizations. Hong *et al.* (2017) Supply chain risks and barriers are defined as the possibility and impact of macro or unexpected events or conditions that negatively affect any part of the production chain and cause failure or disorder at the operational, tactical or strategic level. Food supply chain is one of the eight Conditions affecting food security. It starts from providing food with the farmer (producer) and finally ends with the consumer.

Zhang *et al.* (2019) considers the most important challenges of agricultural production cooperatives around the world to be the lack of access to current knowledge of the managers of these cooperatives. In the Czech Republic, Pedroshki *et al.* (2015) identified the land consolidation plan and other support policies as effective in the development of the production chain of the agricultural sector (Pedroshki *et al.*, 2015). In his study, Sexton examined imperfect competition in agricultural markets and cooperative role in it. This researcher considered the most important feature of most agricultural products markets to be the high cost of transporting raw materials and the relatively low cost of modified products (Sexton, 2011).

Chadney Candaval *et al.* (2021) in a study titled the problem identification model of precise agricultural management based on the intelligent supply chain, argued that the four main categories of supply chain coordination, supporting production resources, scientific and technological equipment, and structural system construction are the problems that hinder precise agricultural management. And to solve this problem, they presented proposals that included two aspects, corporate practice and government policy. Li and Zheng (2016), regarding supply chain risk in the business of international organizations, stated that paying attention to costs, increasing income, attracting customers, branding and preventing crisis are effective factors in reducing business risk. In addition to this, Gadj *et al.* (2017), by examining the supply chain risk assessment approach, found that before any type of risk occurs in the supply chain, it is necessary for managers to take measures such as; product security, accurate knowledge of the current market situation and accurate supply. In most of the studies conducted regarding the supply chain, the focus has mainly been on the importance of managing the production chain of the agricultural sector and examining the role of identifying front and back links, identifying the problem of agricultural management, the challenges of adopting the Internet of Things in the agricultural and food supply chain, risk assessment. In the agricultural sector, managerial ability in the agricultural sector, etc.

Methodology

According to the existing gap in studies regarding the identification of the barriers of the production chains of agricultural products, in this research, based on the Granded theory of the foundation, the barriers of the production chains of agricultural products have been identified. In this research, using the foundational data theory research strategy, the pattern of barriers to the development of agricultural production chain in 2021 has been done. In terms of philosophical foundations, this research is under interpretive paradigm, in terms of research orientation, it is fundamental, in terms of approach Reshape the table to reflect the contains clearly and format the table according to instructions, it is inductive, and in terms of data type, it is qualitative research. In this research, the systematic method of Strauss and Corbin has been used for theorizing; because this

approach is more structured and leads to a comprehensive and applicable model compared to the other two approaches of foundation data, i.e. Glazer's new approach and Charms' constructivist approach (Hasanqoli Pouro *et al*., 2015).

Table 1- Qualitative research methodology

Data analysis	Time horizon	Method selection	Research strategy	Research approac	Philosophy of research
Semi-structured interviews, document review, meta-analysis, Maxqda software	Intermittent	Several methods	Strauss and Corbin	induction	Commentary

The method of Granded theory is based on social science research, has a pragmatic approach. In this method, in comparison with phenomenological studies, interviews are rarely used as the only way to collect data (Sudabi, 2006). In fact, the variety of data collection methods is a useful tool that prevents the researcher from being limited to one method or type (Moser and Corgenes, 2018). In this research, in order to collect data with 16 experts including university faculty members, managers of agricultural units and agricultural experts, as well as producers and suppliers and distributors of horticultural products, consultants and the agents of business cluster development were interviewed. Also, the text of the documents, such as macroeconomic policies of resistance economy, country development plans and reports of development projects, especially the development reports of business clusters, were reviewed. The demographic characteristics of the interviewees and the relevant codes are given in the table below.In this research, using the theoretical sampling method, after analyzing the data obtained from each information source, the source that could provide suitable data to the researcher in the next step was determined based on the theory under construction. Based on theoretical sampling, samples were selected to maximize the possibility of discovering diversity and enrich the categories in terms of features and dimensions, and the sampling continued until the theoretical adequacy of the findings was obtained (Strauss and Corbin, 2012). In fact, conducting interviews and examining the text of documents and written reports continued until the categories reached saturation; that is, in the review of the latest information sources, no more new ideas and concepts were identified, and the existing concepts were not challenged by further data analysis. To collect data, library studies and interview tools were used. The current research is one of the qualitative-exploratory researches. Data analysis was done based on a systematic approach, which included three stages of open, central, and selective coding. For this purpose, in the open coding stage, after reviewing and organizing the texts of the interviews, the codes of the primary concepts were identified and then the similar codes were placed in certain categories. Then, for each of these classes, the titles that represent all the codes of that class were selected, and as a result, the Conditions of the barriers to the development of the agricultural production chain were identified. In the central coding stage, the relationship between the central phenomenon and other categories and concepts was specified and presented based on the paradigm model. In the following and in the selective coding stage of the main variable or the basic process hidden in the data, how the stages of occurrence and its consequences are charted. The researcher first identified 10 experts using the purposeful sampling method and increased the number of these experts to 16 using the snowball method. In the following, by using the snowball sampling method, the statistical sample will be increased to the extent that we reach the theoretical saturation limit in the current research. In the first step of the research, all the interviews, analysis and concepts were extracted. At this stage, nearly 210 initial concepts were extracted from the conducted interviews.

Table 2- Characteristics of demographics and coding of interviewees

Round the interview	Background	Education	Age	Organizational position	ID
First round	11	Bachelor of Business Administration	35	Producer and gardener	M1
First round	10	Bachelor of Agriculture	33	Producer and gardener	M2
First round	13	Master of Industrial Engineering	37	Producer and gardener	M3
First and second round	10	Master of Management	29	Supplier of garden inputs	M4
First and second round	15	Master 0f agriculture	38	Supplier of garden inputs	M5
First and second round	17	Master 0f agriculture	35	Distributor and seller of agricultural products	M6
First and second round	11	Watershed Master	33	Agricultural expert	M7
First and second round	13	Bachelor of Commerce	40	Producer and gardener	M8
Second and third round	12	Master of Industry	42	Producer and gardener	M9
Second and third round	19	Agricultural expert	47	Producer and gardene	M10
Second and third round	21	PhD in economics	38	University faculty	M11
Second and third round	26	PhD in International Business	48	University faculty	M12
Second and third round	21	PhD in Marketing	36	University faculty	M13
Second and third round	24	Master of Agricultural Management	50	CEO of Agriculture Unit	M14
Second and third round	12	Master of Industry	33	Agricultural products sales expert	M15
Second and third round	13	Master of Marketing	43	Master of marketing	M16

Research Findings

The three stages of coding that were used to develop a coherent, orderly and detailed theory are open, central and selective coding. Open coding helps create a set of first-hand concepts that are both raw data and abstract. At this stage, the researcher reviewed the data line by line and identified its processes and coded those using points and phrases. Then, by continuously comparing the codes in terms of similarities and differences in concepts, categories were formed and the characteristics of the dimensions of each of them were determined. In the second stage, the layers are connected and a set of theorems is made. Basically, the question raised in main coding is how are the classes connected to each other? At this stage, the codes and categories were compared and the relationships between the categories and subcategories were determined in order to obtain a more accurate interpretation of the phenomenon in question. Strauss and Corbin have used words called coding paradigm, which are used to describe a set of concepts and are the basis of communication and connections between the topics considered in the research process. This paradigm focuses on things such as causal conditions - phenomenon - context - intervention conditions - strategies and consequences. Finally, during selective coding, selective communication, analytical combination was done on all stages and the classes were combined with each other. The result of this stage was the main class, which was related to other classes, explained them, and was actually the refined result of the initial codes.

Validity and Reliability of Data

Reliability is the consistency of research findings. Reliability in the interview is discussed in stages such as the interview situation, transcription and analysis. In relation to the reliability of the interviewee, it is mentioned how the questions are directed. In the reliability of copying, it is necessary to pay attention to the reliability within the subject of the copies made while typing the texts by two people. While classifying the interviews, paying attention to the percentages reported by two coders is a method to determine the reliability of the analysis. Calculating the reliability between coders: To calculate the reliability between coders, several interviews are selected as a sample from among the conducted interviews and each of them is coded again in a short and specific time interval. Then, the specified codes are compared in two time intervals for each of the interviews. The retesting method is used to evaluate the stability of the researcher's coding. In each of the interviews, codes that are similar in two time intervals are identified with the title (agreement) and dissimilar codes with the title (disagreement). The method of calculating the reliability between the coding done by the researcher in two time intervals is as follows.

Relationship 1) The number of agreements × 2 divided by the total number of codes × 100% = reliability percentage between coders

Table 3- The Results of Coding

Reliability between coders	Number of disagreements	Number of agreements	Total number of codes	Interview title	Row
%79	26	34	86	P2	1
%78	22	31	79	P6	2
%78	48	65	165	Total	

As can be seen in the table, the total number of codes recorded by the researcher and his colleague is 165, the total number of agreements between the codes is 65, and the total number of non-agreements in these two times is 48. The inter-coder reliability for the interviews conducted in this research using equation 1 is equal to 78%. Considering that this reliability level is more than 60%, the reliability of coding is confirmed (Khastar, 2009).

Validity of the Interview

Three criteria of reliability and validity (credibility), transferability, reliability were considered for evaluation. To achieve each of the mentioned criteria, the following actions were taken: 1- Credit: the researcher spent enough time, confirmed the research process under the supervision of eight specialists, used two coders, coded several interview samples in order to ensure the same point of view of the coders, raised objective and measurable questions such as writing domain notes and reminders during the research. , especially in Excel forms, has increased the reliability of the research data to an acceptable level.2- Transferability: To ensure the transferability of the research findings, three experts in the field of organization who did not participate in the research were consulted regarding the research findings.

2- Transferability: To ensure the transferability of the research findings, three experts in the field of organization who did not participate in the research were consulted regarding the research findings. 3- In all stages of the work and in order to create reliability, research details and notes were recorded and as a result, the validity of the interview questions was confirmed.

Causal Conditions

Causal categories include categories that accelerate the risk and risks of agricultural production chain development. In the below table, the causal categories of the model are presented.

The Main phenomenon: Barriers to the Development of Supply Chain of Agricultural Product

The main phenomenon of "barriers to the development of the agricultural production chain" according to the purpose of the current research, the category includes all the development barriers of the agricultural production chain.

Strategic Conditions: Steps to Reduce Production Chain barriers

The measures that should be taken by the responsible or relevant institutions in order to reduce the barriers to the development of the agricultural production chain (Kothari, 2004) are known as the strategies category in the table, concepts and codes of the strategies category.

Grounded Conditions

Grounded categories indicate some specific conditions that affect the strategy (Stress and Corbin, 2013). The Table 7 shows how to choose these categories in the research model.

Consequences: Consequences of the Existence of Barriers and Risks in the Development of Agricultural production Chains

The most important consequences of the existence of barriers in the development of the agricultural production chain are the reduction in production and export, the reduction in competition, and the reduction in the sale of products. In the table, the concepts and codes of the results subset are presented.

Intervener Conditions: Influencing Factors

Those factors that have a negative effect on development of the agricultural production chain, form interfering categories (Danaeifar and Slami, 2010). The concepts and codes of the following interfering categories are presented in the Table 8.

Selective Coding

At this stage, the central category is methodically selected and by connecting it with other categories, the theory is written, which provides an abstract description for the process investigated in the research (Danaeifar and Emami, 2007).

Table 4- Categories of causal Conditions

Open coding	Casual categories
Taking heavy bank collaterals, existence of non-specialized banks, lack of guaranteed purchase and monitoring of product sales, lack of loan sleep time, high loan repayment rate, existence of strict and bureaucratic rules and process of obtaining loans.	Financial and credit barriers
Imported inputs, poor quality of inputs, high price of inputs (seeds, cuttings and seedlings), dispersion and lack of input procurement center in the province	barriers to supply of inputs
Absence of law and practical instructions regarding export, lack of law in stability and price monitoring in the market	barriers lack of rules and regulations of the product distribution system
Lack of protective laws and support for providing inputs, lack of consumption subsidies in horticulture.	barriers laws and regulations in providing inputs

Table 5- Main Categories of Research

Open coding	Main phenomenon
Financial and credit barriers, barriers to providing inputs, barriers to the lack of law and regulations in the product distribution system, barriers to the lack of laws and regulations in providing inputs, barriers to the cost of product distribution, technical and technical, environmental barriers, infrastructural and operational barriers, production barriers, competition barriers, sales barriers, information barriers, planning and management barriers.	All internal and external supply chain barriers

Table 6- Strategic Categories of Research

Open coding	Strategic categories
Lack of up-to-date information about horticulture, lack of technical and specialized knowledge, lack of holding specialized courses by Jihad Agriculture and Engineering, inadequate knowledge and efficient information, lack of expert and skilled personnel, lack of attention to the exact time of harvest.	Production information barriers
Lack of application of management knowledge and principles in horticulture, reduction of production and lack of productivity, lack of supervision of gardeners by relevant organizations.	Planning and management barriers
Lack of supervision of the production process, lack of government support for the producer, lack of coordination between relevant agricultural organizations, lack of appropriate policies for export development.	Strategic barriersto production

Table 7- Grounded Categories of Research

Open coding	Grounded categories
Lack of supervision of the transportation and distribution system of products, the high cost of the product distribution system to the consumer market, lack of timely product delivery in the market	Product distribution cost barriers
Lack of sorting system, lack of product packaging system	Technical barriers to product distribution

Table 8- Research Intervention Categories

Open coding	Interfering categories
The risk of pests and diseases and cold in the climatic conditions of the region	Environmental barriers
Non-mechanization of horticulture, non-integration of horticulture (complex), lack of use of modern equipment, improper design of gardens.	Infrastructure and operational barriers

Table 9- Research Implications

Open coding	Consequences
Lack of ability to know customers in the market, lack of ability to compete with foreign countries, lack of competitive spirit, lack of knowledge of domestic and foreign competitors, lack of ability to cooperate and participate	Disadvantage in competition
Lack of supervision over the selling price of the product in the market, the high price of the finished product, the lack of law to eliminate middlemen and brokers, the active presence of middlemen and brokers in the market to earn profit, not paying attention to the tastes and interests of the customer.	weakness of sales
Inadequate production, increase in product waste, decrease in employment, dissatisfaction of gardeners.	weakness of production

Table 10 shows the sub-model of selective coding resulting from the coding listed in the above lines. According to the six dimensions of the paradigmatic model, the causal factors were considered as the factors and drivers of reducing the development of the agricultural production chain, which include (financial and credit barriers, barriers to providing input resources, barriers to the lack of rules and regulations of the product distribution system, barriers were the lack of rules and regulations in providing inputs. The central phenomenon of this paradigm model was considered as the indicators of the barriers to the development of agricultural production chain, which included all internal and external barriers and risks. The environmental and grounded factors influencing the creation of barriers to the development of the product production chain also included (environmental barriers, operational and infrastructure barriers, product distribution costs, technical and technical barriers to product distribution). These barriers are removed, i.e., they included information barriers, planning and management barriers, production strategy barriers and finally the consequences that these barriers can have for the product production chain include (deficiencies in production and exports, lack of competition and lack of were selling products).

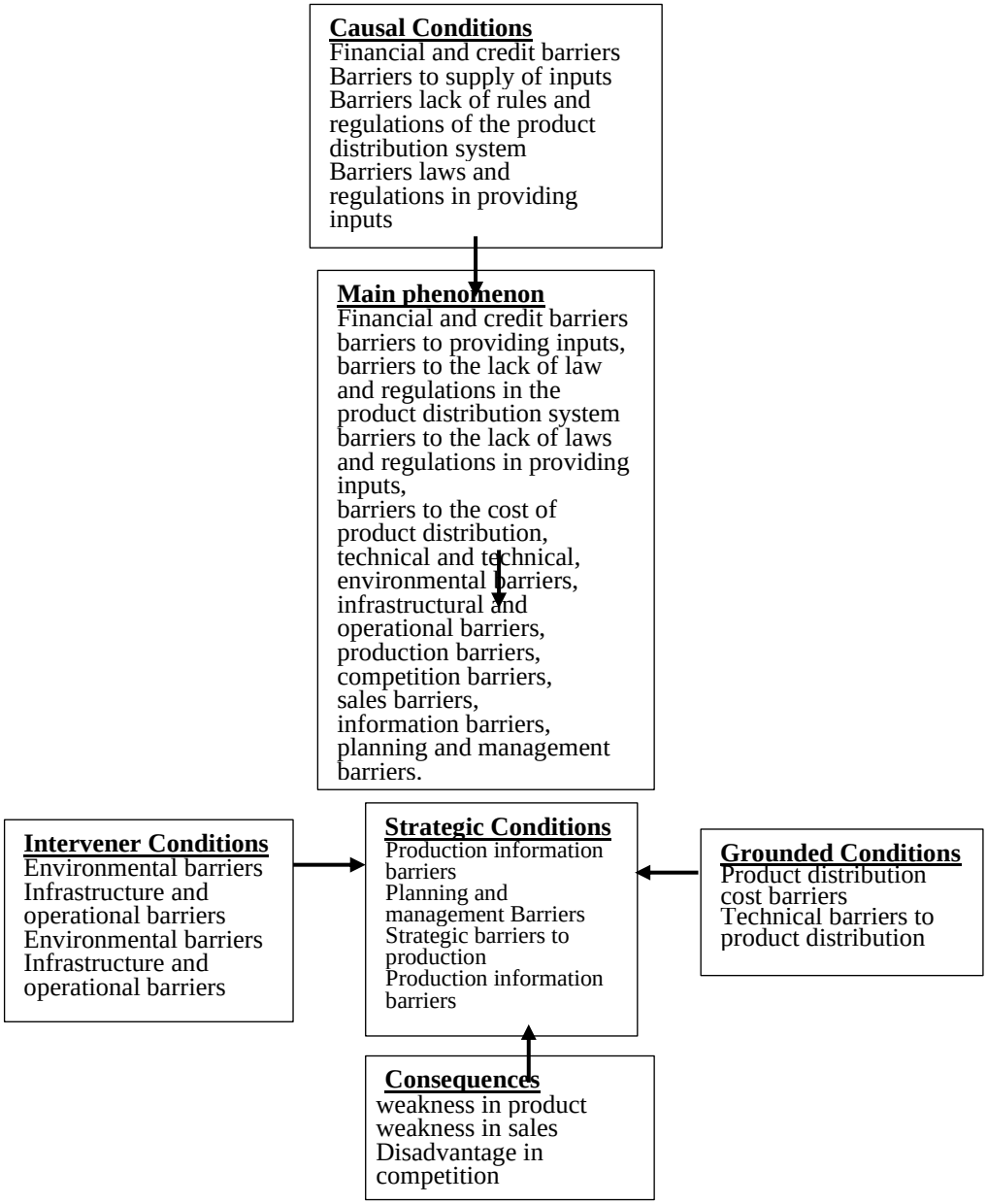

Figure 1- The model derived from the Grounded Theory in a systematic way

Discussion and Conclusion

Four categories (barriers to production, supply of inputs, product distribution and sales) were among the main factors affecting the weakness of the horticulture production chain, which were extracted and explained from the qualitative data. In order to speed up the better understanding of the coding stage, the extracted codes in this research are shown in the above tables. In this research, existing barriers have been categorized based on the opinions and views of the interviewees (gardeners, agricultural managers and experts, and university professors) and the dual structure model of Bohl (2001) regarding the weakness of risks in the form of barriers and internal and external risks. These barriers include risks such as information barriers (internal barriers), production strategic barriers (external barriers), production competition barriers (external barriers), environmental barriers (external barriers) and planning-

management barriers (internal barriers). A brief description of them has been given. One of the risks and deficiencies that was clearly visible and understandable in the business of the people under investigation and emphasized by most of the people under study is the issue of lack of sufficient knowledge and practical scientific information in order to carry out activities in the horticulture environment. Horticulture is one of the agricultural businesses that requires knowledge and expertise to be successful in it, including knowing the types of crops, planting time and harvesting methods, micronutrients, each of which requires its own knowledge and practical information. Therefore, the lack of applied science and information based on practice can be considered as one of the important internal risks in horticulture.

Table 10- Main and Selected Categories in the Research Model

Selected categories	Main codes	
Driver sofreducing the development of agricultural production chain	Financial and credit barriers barriers to supply barriers of lack of laws and regulations of the product distribution system barriers of lack of law and regulations in providing inputs	Causal Conditions of research
Strategies and factors that, in the event of a deficiency in its implementation, are among the barriers to the development of the agricultural production chain	Information barriers Planning and management barriers Strategic barriers to production	Strategic Conditions
Indicators and Conditions of barriers to the development of agricultural production chain	All internal and external barriers and dangers	Core categories
Influential factors in creating barriers in the supply chain of agricultural products	Environmental barriers Infrastructure and operational barriers Product distribution cost barriers Technical barriers to product distribution	Intervener and Grounded categories
Consequences of barriers to the development of agricultural production chain	Production weakness weakness to competition Sales weakness	consequences

Regarding managerial-planning barriers, it can be said that by looking at the field of agricultural products production (especially garden products) in Iran, it is clear that the amount of production per unit level of producers is very different compared to the leading countries in the production of agricultural products. Perhaps one of the reasons for the decrease in productivity in the field of horticulture is the low level of knowledge and technical knowledge of farmers and the lack of information and, as a result, the lack of use of the achievements of previous researchers in the sector. This problem has caused the low level of production and productivity in garden products to become a production obstacle and affect the gardener's income. On the other hand, the low level of production and productivity in this sector can be considered as the lack of basic application of production methods and expert and efficient people. In this research, according to the conducted interviews, it was found that one of the important problems of gardeners is low competitiveness and lack of identification of work competitors in this field. Creating a competitive environment in the society and improving domestic and international competitiveness provides the necessary grounds for entering the global and internationalization process. Considering the need to expand and improve the export of the horticulture sector, developing a specific and appropriate strategy for competitiveness in this field is necessary and necessary because the competitiveness of a quality business is realized through the market and activities based on the relative advantages of a product. The obstacle and risk of the strategy in the cultivation of horticultural crops is actually a

symbol of the transition from traditional agriculture to science, which saves money, creates jobs, uses minimal land for crop production, increases productivity and efficiency of water consumption, increases planned production, the ability to control crops and pests, production and Off-season product diversity, adjusting the cultivation plan according to the market's needs is one of the most important planning and policies in the agricultural system. In some interviews, people mentioned that the planning and policy making system in the field of horticulture is weak and the activity of this field is affected by this issue. The development of agricultural products is inevitable in the face of the increasing need for food for the growing population, but along with that, adverse environmental consequences may also occur, therefore, it is necessary to use environmental resources and high-quality inputs with pollution. In a part of this research, the interviewees raised the issue of banks providing credit and facilities as one of the most important barriers and risks to the progress of gardeners. They stated that in order to receive loans and facilities from banks, they have to provide heavy collaterals to the bank. At the same time, the repayment rate of bank interest is much higher than their financial capacity and leads to non-payment of debt on time, and this problem causes the bank's inability to fulfill its obligations. On the other hand, compared to the producers of other sectors, the recipients of loans and facilities in the horticulture sector are faced with the risk caused by natural factors, the lack of loan repayment period and fluctuations in the sale price of agricultural products; Therefore, they often face the problem of financial inability to repay their due installments on time (Ishraqi Semani, 2015).

In the current research, the risk of supplying resources includes; the risk of resources (external obstacle) and the risk of lack of laws and regulations in supplying inputs (external obstacle). One of the most important needs of gardeners is access to seeds, seedlings, poisons, fertilizers and all healthy, high-quality and standard inputs. In this study, input provision by gardeners was mentioned. They stated that there are many problems in supplying inputs such as, lack of access to quality inputs in the province, high purchase price of inputs, difficulty in importing inputs (high exchange rate), lack of support for purchasing domestic inputs, density of input procurement centers and the lack of subsidy for purchasing inputs. On the other hand, the people under investigation and gardeners stated that there is no written law and regulation in the field of monitoring the preparation and distribution of inputs. This problem has caused the role of dealers and brokers to become more prominent than the government and they earn a lot of profit in this sector as well.

In the section on the barriers of the product distribution system, the gardeners expressed several factors as barriers and risks, including; Technical risk, distribution cost risk and the risk of lack of laws and regulations in the product distribution system. In the production chain of agricultural products, a distribution channel, in addition to transferring goods from the producer to the consumer, is an important factor in saving time, connecting producers of goods to customers. The people interviewed said that there is no proper distribution system to bring the product to the market, and if there is a distribution system or channel, they demand a lot of money for this, and most importantly, there is no monitoring in this area. This issue has caused disruption in the final price of the product and also leads to not sending the product to the customer on time. One of the most important problems faced by producers of garden products is the existence of price differences in the market. When the price difference increases, customers and consumers lose their purchasing power. This issue causes the product to remain in the target market and the producer suffers a lot of losses (Mullah Hosseini and Jabbarzadeh, 2011). In the context of this obstacle, the interviewees stated that there is no supervision by the government on the selling price and due to the presence of brokers and dealers, the finished

price of the product increases significantly and a little profit goes to the producer. On the other hand, they said that the government is not able to prevent the activity of dealers and their number is increasing day by day in the market of selling products.

The most important central category in this research, based on the opinions of the gardeners and the surveyed people, is the existence of barriers and producer risks (internal and external risks) which play a fundamental role in the occurrence of the weakness of the production chain. Meanwhile, the three factors of grounded conditions, intervener and causal conditions also have a significant effect on the central category. In the producer's obstacle and risk section, a producer of horticultural products faces many types of internal and external barriers, including: strategy barriers (lack of supervision of the production process, lack of support from the government, etc.), market competition barriers (lack of the ability to recognize domestic and foreign customers, the inability to compete with foreign countries, the lack of competitive spirit, etc.), environmental risk, managerial barriers, informational barriers, time risk, operational barriers (lack of automation of the horticulture system, technical problems in construction and design) structure, financial-credit barriers, and all these barriers and risks are influenced by three background factors, causal and mediating conditions. Causal conditions include internal and external supplier risks. According to the findings regarding laws and regulations, it can be said that the lack of laws and written instructions regarding export, as well as the lack of laws regarding price stability and monitoring in the market, or the lack of a product packaging system. Another obstacle is the distributor (external risk) which affects the producer in the production chain.

Conclusion and Suggestions

According to this study, among the 12 weakness factors in the production chain of horticultural products, i.e. input supply, production barriers, product distribution and sales such as the risks of providing input resources, lack of laws and regulations in input supply, production information barriers, production strategic barriers, competition barriers in production, climate risks, planning-management, financial-credit, technical barriers, lack of laws and regulations in the distribution system and sales barriers; and barriers related to the production sector have a lot to do with weakness. As the research findings show, the product production chain has six weakness factors that play an important and key role in the product production process and is considered as the main weakness factor in the production chain. For example, the lack of information about horticultural activities, as well as the lack of skilled and specialized labor or worker, plays an important role in planning cultivation methods and improving the quality of products, and will create internal barriers. The lack of government support and the lack of coordination between organizations and institutions related to the agriculture sector are also one of the external barriers to production, because if these conditions occur, business owners will not be able to control the affairs of gardens when faced with changes and critical conditions.

Regarding the barriers and dangers of competition in production, we should also pay attention to the fact that globalization requires better and more knowledge of the domestic and foreign markets. Therefore, the members of the production chain must be able to identify the market and be able to compete with their other competitors at different levels. This weakness factor can lead to the increase of competition barriers in product production.

Regarding the environmental risks, the atmospheric and geographical location of the region, the coldness and warmth of the air, the amount and intensity of light, the intensity of strong winds and the fall of snow and rain, water resources and water quality, the conditions and characteristics of the soil in the region are some of the most important points that failure to pay attention to them can lead to creating barriers and making the gardening environment vulnerable. Regarding the climate

risks, the atmospheric and geographical location of the region, the coldness and warmth of the air, the amount and intensity of light, the intensity of strong winds and the fall of snow and rain, water resources and water quality, the conditions and characteristics of the soil in the region are some of the most important points that Failure to pay attention to them can lead to creating barriers and making the gardening environment vulnerable.

In general, the results of the research confirmed that weakness management can be considered as the first step in the management of barriers in the production chain of horticultural agricultural products, because according to the available results, it is clear that the risks of product production in the production chain play the most important role. The existence of production vulnerabilities and awareness of them can implement appropriate measures to manage them and make appropriate decisions for the conditions of the chain during occurrence-disruption. Based on the findings of this research, the following are suggested in order to reduce the barriers to the development of the production chain of horticultural agricultural products and to reduce the level of weakness and increase its productivity; Creating a culture of obstacle and risk management in business in order to identify all types of risks and barriers, make decisions according to crisis conditions and be flexible against barriers in order to reduce the level of sensitivity in high-risk situations; Creating a platform in order to register documents and documents related to business information along the production chain and specify each member of the production chain and the relationships between them as a single source of information for each part of the production chain; Creating a system for monitoring and tracking barriers in the production chain; Responding to weakness through accurate identification of barriers and risks and determining activities that strengthen the infrastructure and reduce barriers and vulnerabilities related to horticulture business goals. These reactions should be based on the degree of importance and the amount of each weakness and be effective in terms of cost when dealing with the risk.

References

1. Aven, T. (2011). On different types of uncertainties in the context of the precautionary principle. *Risk Analysis 31*(10): 1515-1525. https://doi.org/10.1111/j.1539-6924.2011.01612.x.
2. Bohle, H.G. (2001). *Weakness and Criticality: Perspectives from Social geography*", IHDP update 2/2001, Newsletter of the International Human Dimensions Program on Global Environmental Change: 1-10.
3. Danaee Fard, H., & Eslami, A. (2010). Discovering theory of organizational indifference: a data collection and analysis. *European Journal of General Practice 24*(1): 9-18.
4. David, C., Love, E.M., Nussbaumer, Jamie Harding., J.A., Gephart James, L., Anderson Frank,. Asche Joshua, S., Stoll Andrew, L., Thorne-Lyman Martin, W.B. (2021). *Risks shift along seafood supply chains*. Bloomberg School of Public Health.
5. Devaux, A., Torero, M., Donovan, J., & Horton, D. (2018). Agricultural innovation and inclusive value-chain development: a review, *Journal of Agribusiness in Developing and Emerging Economies* 4: 11-073. https://doi.org/10.1108/JADEE-06-2017-0065.
6. Eshraghisaman, M., Fakhrmojahedi, A., &Charagi, M.A. (2015). Efective factors contributing to the non-repayment of Keshavarzi bank facilities by farmers case: Ilam county. *Space Economics and Rural Development Journal 4*(12): 71-91. (In Persian)
7. Ghadge, A., Fang, X., Dani, S., & Antony, J. (2017). Supply chain risk assessment approach for process quality risks, *International Journal of Quality and Reliability Management 34*(6): 3-31. https://doi.org/10.1108/IJQRM-01-2015-0010.

8. Gopal Naik, D.N. (2017). Suresh challenges of creating sustainable agri-retail supply chains grounded theory strategy. *European Journal of Scientific Research 40*(3): 450-46. https://doi.org/10.1016/j.iimb.2018.04.001.
9. Hasanqalipour, T., Irvani, M.J., Notash, M.R., Anousheh, M., Mousavi Niqabi, S.M. (2014). Designing a model for the development of small and medium industries studied: food and beverage industries. *Management and Development Process 28*(3): 21-46.
10. Heydari Qarabalag, H. (2009). Identification and troubleshooting of supply chain management. *Management Quarterly 6*(14): 1-7.
11. Hong, J., Zhang, Y., & Ding, M. (2017). Sustainable supply chain management practices, supply chain dynamic capabilities, and enterprise performance. *Journal of Cleaner Production* 172: 3508-3519. https://doi.org/10.1016/ j.jclepro. 2017.06.093.
12. Kazemi, J., Dehghan, K., & Khalilzadeh, M. (2017). Ranking of Iranian agricultural products, *Agricultural Economics Research 9*(3): 145-162.
13. Khandel, C., Singhal, M., Dangayash, G,S., & Meeua, M.L. (2021). Agriculture supply chain Managemen. *New Marketing Research 47*(11): 3144-3155. https://doi.org/10.1016/j.matpr.2021.06.193.
14. Kothari, C.R. (2004). *Research Methodology: Methods and Techniques*. New Age International.
15. Li, S., & Zeng, W. (2016). Risk analysis for the supplier selection problem using failure modes and effects analysis (FMEA). *Journal of Intelligent Manufacturing 27*(6): 1309–1321. https://doi.org/10.1007/ s 10845-014-0953.
16. Miri, M., Sharifzadeh, Sh., Abdollahzadeh, Gh.H., & Abedi-Sarvestani, A. (2017). An analysis of supply chain in agriculture sector: case of strawberry production in Ramian County, Golestan Province, *Journal of Entrepreneurship in Agriculture 4*(3): 89-104. https://doi.org/10.22069/JEAD.2017.13541.1275.
17. Mollahosseini, A., & Jabarzadeh, B. (2011). Study of effect of risk, value and price awareness on the tendency to buy gray market goods in Kerman province. *New Marketing Research 1*(1): 1-22. (In Persian)
18. Moser, A., & Korstjens, I. (2018). Practical guidance to qualitative research. Part 3: Sampling: *Data Collection and Analysis 24*(1): 9-18. https://doi.org/10.1080/13814788.2017.1375091.
19. Niazi Shahraki, S., & Mobini, A. (2019). Examining the challenges of the value chain of horticultural products with a resistance economy approach by comparing the current and desired situation. *Scientific Quarterly Journal of National Defense Strategic Management Studies of National Defense 3*(10): 129-148.
20. Pakravan, R., & Nikpoor, A. (2018). Examining the perspective of export potential in the competitiveness of Iranian agricultural products in the Middle East, *University of Tehran Press* 54: 123-154. (In Persian)
21. Podhrázská, J., Vaishar, A., Toman, F., Knotek, J., Ševelová, M., Stonawská, K., & Karásek, P. (2015). Evaluation of land consolidation process by rural stakeholders. *European Countryside 7*(3): 144-155. https://doi.org/10.1515/euco-2015-0010.
22. Rasekhjahromi, A., & Abedi, F. (2011). The study of relationship between agricultural exports and economic growth & development during 1355-1388. *Economic Growth and Development Research 1*(2): 95-112. (In Persian)
23. Sexton, R.J. (2011). The formation of cooperatives: A game-theoreticapproach with implication for cooperative finance, decision making, and stability. *American Journal of Agricultural Economics* 68: 214-232. https://doi.org/10.2307/1241423.
24. Shahbazi, K., & Alizadeh, S. (2018). The effect of government spending on production efficiency of the agricultural sector, *Agricultural Economics Research* 2: 33-48.

25. Strauss, A., & Corrbin, J. (2014). *Basic qualitative reasearch granded theory procedure & techniques for developing grounded theory Juliet Corbin* - San Jose State University.
26. Strauss, A., & Corbin, J. (2012). *Basic theory*, translated by Buick Mohammadi, Tehran: Institute of Humanities and Cultural Studies.
27. Suddaby, R. (2006). From the editors:What grounded theory is not. *Academy of Management Journal 49*(4): 633-645. https://doi.org/10.5465/amj.2006.22083020.
28. Vaibhav, S., Narwane, A. Gunasekaran, B., & Gardas, B. (2022). Unlocking adoption challenges of IoT in Indian agricultural and food supply chain. *Smart Agriculture Technology 3*(23): 1-14. https://doi.org/10.1016/j.atech.2022.100035.
29. Weihua, L., Shuang, W.S., Wanga, M., Lim, B., & Yujie, W. (2022). Problem identification model of agricultural precision management based on smart supply chains: An exploratory study from China. 352: 234-255. https://doi.org/10.1080/09537287.2022.2088424.
30. Zhang, X., de Vries, W.T., Li, G., Ye, Y., Zheng, H., & Wang, M. (2019). A behavioral analysis of farmers during land reallocation processes of land consolidation in China: Insights from Guangxi and Shandong provinces. *Land Use Policy* 89: 104-230. https://doi.org/10.1016/j.landusepol.2019.104230.

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۳۷۷-۳۹۲

طراحی مدل موانع توسعه زنجیره‌های تولیدی محصولات کشاورزی (مطالعه موردی: باغات مشگین شهر)

ناصر سیف اللهی[1*]- رحیم محمدخانی[2]

تاریخ دریافت: ۱۴۰۱/۰۳/۱۹

تاریخ پذیرش: ۱۴۰۱/۰۷/۱۹

چکیده

کشاورزی یکی از مهم‌ترین بخش‌های تأثیرگذار در اقتصاد هر کشور است که نقش مهمی در استقلال سیاسی و اقتصادی آن ایفا می‌کند. عدم وجود یک سیستم اطلاعاتی جامع و مدلی کاربردی در زنجیره‌ی تامین محصولات کشاورزی سبب شده است این بخش از اقتصاد کشور با وجود استعداد بالقوه، کارایی لازم را نداشته باشد. بنابراین، هدف پژوهش حاضر بررسی موانع زنجیره‌های تولیدی محصولات کشاورزی (باغداران) استان اردبیل بود. برای گردآوری داده‌های تحقیق از مصاحبه‌های نیمه‌ساختاریافته استفاده شد و تجزیه‌وتحلیل اطلاعات به روش استراوس و کوربین و مدل پارادایمی و به کمک نرم‌افزار مکس کیو دا انجام شده است. نمونه‌گیری به روش نمونه‌گیری نظری بود و با بهره‌مندی از روش‌های هدفمند و گلوله برفی انجام شد که بر مبنای آن، ۱۶ مصاحبه با باغداران، اساتید دانشگاه و مدیران در زمینه موانع توسعه زنجیره‌های تولیدی محصولات کشاورزی انجام شد. نتایج تحلیل داده‌های به‌دست‌آمده از مصاحبه‌ها، طی فرایندهای کدگذاری باز، محوری و انتخابی به شکل‌گیری مدل موانع توسعه زنجیره‌های تولیدی بخش کشاورزی بر مبنای نظریه‌پردازی داده‌بنیاد انجامید. بر اساس رهیافت نظامند در نظریه داده‌بنیاد کدهای شناسایی‌شده در ۶ طبقه هسته‌ای شامل شرایط علی، مقوله محتوایی، شرایط زمینه‌ای، عوامل مداخله‌گر، راهبردها و پیامدها قرار گرفتند. کدهای باز، شامل ۳۸ مفهوم و کدهای محوری نیز شامل ۴۴ مقوله عمده بود که در نهایت، به چهار گروه مقوله گزینشی: موانع تولید محصول، تأمین نهاده، توزیع محصول و مشتری در قالب موانع داخلی و خارجی برای هرکدام شناسایی گردید. براساس یافته‌های تحقیق ریسک تامین منابع نهاده، ضعف مقررات و ضوابط در تأمین نهاده، موانع اطلاعاتی تولید، موانع راهبردی تولید، موانع رقابت در تولید، خطرات زیست محیطی، برنامه‌ریزی- مدیریتی، مالی- اعتباری، موانع فنی- تکنیکی، موانع هزینه توزیع محصول، موانع فقدان مقررات در سیستم توزیع و موانع فروش؛ موانع مربوط به بخش تولید، از موانع توسعه زنجیره‌های تولیدی محصولات کشاورزی هستند.

واژه‌های کلیدی: باغات مشگین شهر، محصولات کشاورزی، موانع زنجیره‌های تولید

۱ و ۲- به‌ترتیب دانشیار و دانشجوی دکتری مدیریت بازاریابی، گروه مدیریت، دانشکده علوم اجتماعی، دانشگاه محقق اردبیلی، اردبیل، ایران

(*- نویسنده مسئول: Email: n.seifollahi@uma.ac.ir)

DOI: 10.22067/jead.2022.76629.1132

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 393-411

Recognizing and Prioritizing Smart Solutions in the Poultry Industry based on Sustainability Criteria

A. Khadiver[1*], F. Mojibian[2], Z. Torkashvand[3]

Received: 11-06-2022
Revised: 05-09-2022
Accepted: 14-09-2022
Available Online: 15-02-2023

How to cite this article:
Khadivar, A., Mojibian, F., & Torkashvand, Z. (2023). Recognizing and Prioritizing Smart Solutions in the Poultry Industry based on Sustainability Criteria. *Journal of Agricultural Economics & Development 36*(4): 393-411.
DOI: 10.22067/jead.2022.76267.1130

Abstract

Livestock and poultry production and supply is one of the significant food sectors in which more production can lead to a decrease in dependence on exports and earning foreign exchange. Poultry farming is a vital industry for sustainable food supply in all countries. In this research, intelligent applications and solutions in the poultry industry are identified and prioritized using the simultaneous evaluation of criteria and alternatives (SECA) method based on criteria representing the sustainable development. Analysis showed that eighteen principal fields of intelligent solutions are identified in the poultry industry. The weights obtained for sustainable development criteria based on the SECA method are economic (0.351), social (0.3383), and environmental (0.3065) in order of value. Economic sustainability should be most important in implementing smart solutions-based projects in the poultry industry. One of the main challenges of the agricultural sector, especially the poultry industry, is traditional production utilization which leads to the overuse of land capacity. Globalization trends, climate changes, moving from a fossil fuel-based economy to an environment-based economy, competition for land, freshwater, and labor shortage have also led to more complications in supplying nutrition. Considering the potential of smart solutions in realizing sustainable development objectives, it is suggested to focus more on the environmental aspects of poultry industry projects.

Keywords: Internet of things, Poultry industry, Sustainable development, Smart solutions, SECA method

Introduction

Due to its tight relationship with the environment, the agriculture industry has the most destructive effect on the environment (Quintero and González, 2018). In order to realize higher efficiency and greater environmental compliance, we need to identify scientific and environmental-friendly methods. Various variables and parameters are influential in agricultural development, such as water, soil, livestock inputs, organizational services, and proper management of natural resources. One of the challenges of developing countries is the limited resources and ignorance of farmers in correctly using resources (Bani Asadi and Mehrjerdi Zare, 2010). In general, the development of the agricultural sector has various environmental effects, such as the emission of greenhouse gases, the destruction of biodiversity, pollution caused by fertilizers and pesticides, soil degradation, and increased risk to human health (DeLonge, 2016). Considering the importance and role of agriculture in the development of communities and environmental concerns on the one hand and global challenges such as food security and

1- Associate Professor, Department of Management, Alzahra University, Tehran, Iran
(*- Corresponding Author Email: a.khadivar@alzahra.ac.ir)
2- Ph.D. of Industrial Management, Department of Management and Economics, Tarbiat Modares University, Tehran, Iran
3- Master of IT Management, Department of Management, Alzahra University, Tehran, Iran

population growth on the other hand, it seems necessary to implement extensive measures to realize sustainability in agriculture (Wang, 2017).By achieving targets such as reducing poverty, guaranteeing sustainable patterns of production and consumption, taking immediate action to resolve climate change and its effects, the protectingand sustainable use of oceans, seas, and natural resources (Williams *et al*., 2018), agriculture performs a vital responsibility in achieving the Sustainable Development Goals (SDGs) approved in September 2015 by 193 countries in order to improve the social, economic and environmental conditions of the world (GeSI, 2016).

The Internet of Things (IoT) is one of the innovations of the digital age using advanced and related technologies such as mobile and wireless communication technology, Nano-technology, identification technology based on radio waves, and smart sensor technology that can connect all objects in any time and place by anything or anyone.

One of the applications of IoT is poultry farming, which can turn a manual farm into a modern semi-automatic poultry farm. In addition, the system can be installed on the android mobile applications and help control operations such as feeding, object detection, water spraying, and gas reduction in poultry farms. The proposed system can reduce the need for human labor to feed the chickens, reduce unwanted gas, and control the temperature in the farm fully automatically. Therefore, this system reduces cost, time, workforce, and environmental pollution (Azarinfar, 2015). Another achievement of the IoT is precision livestock farming (PLF) techniques, established in the last few decades.

The world population is expected to reach 10 billion people by 2050 (United Nation Website, 2023). In order to eliminate hunger and supply the necessary food for all these 10 billion people, the current capacity of agriculture should be increased by about 70%. It is impossible to achieve this objective without relying on scientific innovations. Today, smart agriculture, which refers to the usage of technologies like Internet of Things, sensors, location systems, robots and artificial intelligence on farms, has introduced information and communication technologies as an influential factor in the efficiency and profitability of agriculture (O'Grady and O'Hare, 2017).

Information and communication technologies (ICT) have a favorable potential for improving efficiency, effectiveness, and productivity. However, these technologies are rarely used in agriculture. Small changes in production or efficiency can significantly impact the resulting profitability (O'Grady and O'Hare, 2017).Smart agriculture can construct a homogeneous path, including sanctioned techniques and technologies. Such a path is determined through market comparison and segmentation. One of the objectives of smart agriculture is to realize diversity in technologies, network the components of the agricultural sector, and ultimately move crop and livestock production systems toward sustainable agriculture (Walter *et al*., 2017).

Poultry farming is one of the vital industries for sustainable food supply. The implementation of a smart poultry farm (SPF) includes a smart system for automatic food feeding, water sprinklers to control the temperature of the environment, and also the use of soil mixture to reduce gas in the environment. The user can remotely control the system through the android mobile applications. The operation of this smart system, in the first place, leads to the reduction of human labor activity. Also, the development of automatic chicken-feeding devices can be very useful for the growth of the poultry industry. In existing systems, chickens are fed manually by human labor. The proposed system can replace the role of the worker in the nutrition of poultry and fulfill a semi-automatic process in the poultry industry. Also, it is very important to save and adjust the high expenses of poultry houses, including the construction cost, labor cost, fuel costs of heaters, the amount of electricity consumed by lamps and fans and etc. Relying on modern science in the development of SPF provides

the possibility of saving costs (Williams *et al*., 2018). Smart systems help poultry farmers to control their poultry farming activities. This system can facilitate poultry management and monitoring with wireless sensors and mobile solutions. Also, environmental parameters such as temperature, light, and ammonia gas are automatically controlled (Archana and Uma, 2018).

The current study regarding the purpose is considered applied research. At the same time, it is classified in the framework of descriptive research because the researcher describes smart solutions in the poultry industry based on sustainability criteria and subsequently evaluates and prioritizes the identified components and criteria in the form of a case study in the poultry industry, especially the laying hens sector. Therefore, considering the potential of the Internet of Things technology and smart solutions in creating a new path of innovative research in the field of agriculture, as well as the increasing speed of the production of scientific resources, it is necessary to identify smart solutions in the poultry industry based on sustainability criteria. To the best of our knowledge, there has been no research on smart solutions in the poultry industry based on sustainability criteria in domestic and foreign literature. As a result, based on the new approach of simultaneous evaluation of criteria and alternatives (SECA) in multi-criteria decision-making, this research has identified smart solutions in the poultry industry and then prioritized these solutions.

Background of Study

Due to the unstable production costs and global economic uncertainty, the role of PLF in sustainable food production and processing is very important. This technique uses wireless technology to collect data through the Internet of Things. One of the goals of smart agricultural systems is providing enough data to producers and ranchers to optimize the efficiency of the agricultural system and, as a result, increase the overall performance of animals or agricultural systems. The major role of PLF is related to the optimal reduction of losses in the entire production process (Molo *et al*., 2009). By reducing the need for manual observations and human decisions, PLF systems facilitate the automation of these processes and reduce the time and effort required to manage large numbers of livestock. PLF systems provide real-time monitoring and livestock management. Livestock management through PLF is sometimes done as a unique livestock management approach (Halachmi *et al*., 2019). This process allows producers to manage a larger number of animals with a reliable level of care (Smith *et al*., 2015). Individual livestock management in large poultry farms containing thousands of birds is not always possible. However, it is possible to use PLF technology to control a subset of birds and use these inputs to assess flock health (Dalimour, 2017). According to previous studies, the review and prioritization of smart solutions in the poultry industry have not been done in any research. After reviewing the research literature, smart applications and sustainability criteria have been identified in the poultry industry, presented in Table1.

Methodology and data

According to the review of the research literature in the field of sustainable development criteria in agriculture, all the final criteria and sub-criteria identified are presented in Table 2. It should be noted that the sustainable development criteria mentioned in agriculture are all in the class of positive criteria.

Methodology Steps

In 2022, about two thousand poultry holdings were active in the laying hens' sector in Iran. The statistical population selected in this research includes faculty members of Alzahra university and poultry industry experts on poultry industry management and smart computer applications. The statistical sample of this research is selected from among the companies active in the poultry industry based on sampling methods.

Table 1- Identifying innovative smart applications in the poultry industry		
Application	**Resource**	**Field**
Environmental monitoring systems (To control environmental inputs, including temperature, air speed, ventilation rate, substrate quality, humidity and concentration of gases such as carbon dioxide and ammonia)	(Chowdhury and Morey, 2019), (Bora *et al*., 2020), (Bustamante *et al*., 2012), (David *et al*.,2015), (Jackman *et al.*, 2015), (Calvet *et al*., 2014), (Epp, 2019), (Bordin *et al*.,2013), (McDougal,2018)	IoT
Precision feeding systems (Technology to achieve accurate food conversion rate and maintain bird weight)	(Astill *et al.*, 2020),(Park *et al*., 2022), (Zuidhof *et al*., 2017), (Hadinia *et al*., 2018), (Zuidhof, 2018), (Xin and Liu, 2017)	
Poultry welfare monitoring systems (Technology to understand the welfare of birds in terms of temperature, humidity, etc.)	(Melor *et al.*, 2020), (Astill *et al.*, 2020),(Park *et al*., 2022),(Sassi *et al*., 2016)	
Digital imaging (Achieving movement patterns of chickens to evaluate factors related to welfare)	(Corkery *et al.*, 2013), (Marchoka *et al.*, 2013), (Silvera *et al.*, 2017), (Colles *et al*., 2016), (Sassi *et al.*, 2016), (Vanderhasselt *et al.*, 2013)	
Analysis of bird sounds (Evaluation of the sound of birds as an indicator of health and welfare)	(Manteuffel *et al*., 2004), (Fontana *et al.*, 2015), (Bright, 2008), (Carroll *et al.*, 2014), (Rizwan *et al*., 2017)	
Infrared thermal imaging (Control of the chicken's health status by determining the surface temperature of objects based on infrared rays)	(Nääs *et al*., 2014), (Shinder *et al*., 2019)	
Raman spectroscopy (Imaging technique to assess the gender of the chicken embryo)	(Galli *et al.*, 2016), (Neethirajan *et al.*, 2017), (Carol *et al*., 2014), (Galli *et al.*, 2016), (Peebles,2018)	
Wearable sensors for the detection of avian influenza virus (Clinical symptom detection sensor and quick virus diagnosis)	(Neethirajan*et al*., 2017), (Okada *et al.*, 2009), (Okada *et al.*, 2014)	
Avian influenza virus biosensors (Biological receptor to detect the presence of a pathogen, protein, nucleic acid, etc.)	(Astill *et al*. 2020), (Nuñez and Ross, 2019), (Luka *et al*., 2015), (Chen and Neethirajan, 2015)	
Internet of things and smart poultry farming	(Park *et al.*, 2022), (Banhazi, 2009),(Bello and Zeadally,2015),(Zuidhof *et al*., 2017)	
Clustering to monitor the growth status of chickens and real-time disease diagnosis	(Aengwanich *et al*., 2012), (Ghufran Ahmed *et al.*, 2021)	Data mining
PLF technology and data	(Astill *et al.*, 2020), (Banhazi, 2009)	
Data collection and storage	(Banhazi, 2009), (Schuetz *et al*., 2018), (Smith *et al*., 2015), (Chen *et al.*, 2014), (Wolfert *et al.*, 2017)	
Data access for smart poultry management systems	(Bumanis *et al*., 2022), (Davis, 2016)	
Data governance	(Information Builders, 2011), (Wizman *et al*., 2018), (Saykota, 2016)	
Big data analysis systems in the poultry industry	(Sicular, 2013), (Kamilaris *et al.*, 2017), (Wolffort *et al*., 2017), (Chen *et al.*, 2014), (Manika *et al*., 2011)	
Tracking the chickens in poultry halls to determine the time of rest, the time of feeding, etc.	Ronald and Siarhei, 2012), (Rani and Devarajan, 2012), (Praveen and Satish, 2012), (Zhang *et al*., 2007)	RFID Tags
Mobile management system and farm management system to transfer and receive farm environmental information	Chakchai *et al.*, 2014	Mobile technology and GPS mapping
Note: a. abbreviation: Radio-frequency identification (RFID)		

Table 2- The final criteria of sustainable development

The main criterion	Sub criterion	Resource
Economical	Productivity	(Veisi *et al*., 2016; Chiou *et al*., 2005; Quaddus and Siddique, 2001; Rezaei Moghaddam and Karami, 2008)
	Profitability	(Rezaei-Moghaddam and Karami, 2008; Quaddus and Siddique, 2001)
	Employment	(Senoret *et al*., 2022), (Rezaei-Moghaddam and Karami, 2008)
Social	Quality of life	(Comim and Hirai, 2022), (Rezaei-Moghaddam and Karami, 2008)
	Fairness	(Quaddus and Siddique, 2001; Rezaei-Moghaddam and Karami, 2008)
	Partnership	(Rezaei-MoghaddamandKarami,2008)
Environmental	Environmental protection	(Gunnarsdottir *et al*., 2022), (Comim and Hirai, 2022), (Rezaei-Moghaddam and Karami, 2008); (Zarei, Mohammadian and Ghasemi, 2016)
	Reasonable use of resources	(Rezaei-MoghaddamandKarami, 2008)
	Quality of products	(Bordin *et al*., 2022), (Rezaei-Moghaddam and Karami, 2008; Poursaeed *et al*., 2010)

A total of 40 questionnaires have been distributed among 20 experts. The first 20 questionnaires have been distributed to identify the components and change and remove some components. The information from the second batch of questionnaires has been used to prioritize alternatives and criteria through the SECA method. This method was presented by Keshavarz-Ghorabaee *et al.* (2018) in research entitled "simultaneous evaluation of criteria and alternatives in multi-criteria decision making."The purpose of this method is to determine the total score of the alternatives and the weight of the criteria at the same time. To achieve this goal, a multi-objective nonlinear mathematical model is formulated.

Research Steps

In order to identify and prioritize smart solutions in the poultry industry based on sustainability criteria, a literature review and a study of references and background papers have been studied. As Figure 1 illustrates the steps of methodology including i) extracting criteria from literature review and interviewing with exert; ii) the relevant components and indicators were identified and finalized through consultation with experts; iii) subsequently, the importance score and weight of the criteria have been calculated with the help of poultry industry experts through the SECA method and Finally, iv) their prioritization and evaluation have been completed (Keshavarz-Ghorabaee *et al.*, 2018).

SECA Method

The steps to implement the SECA method proposed by Keshavarz-Ghorabaee *et al.* (2018) are as follows:

First, the n× m decision matrix, including n alternatives and m criteria, is prepared as follows.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{bmatrix}$$

Where X_{ij} is the evaluation of the i^{th} alternative concerning the j^{th} criterion.

Then the decision matrix is normalized based on the following relations:

$$X^N = \begin{bmatrix} x_{11}^N & \cdots & x_{1m}^N \\ \vdots & \ddots & \vdots \\ x_{n1}^N & \cdots & x_{nm}^N \end{bmatrix}$$

$$x_{ij}^N = \begin{cases} \dfrac{x_{ij}}{\max k\ x_{kj}} if\ j \in BC \\ \dfrac{\min\ k\ x_{kj}}{x_{ij}} if\ j \in NC \end{cases}$$

Where BC includes profit-focused criteria (or positive criteria), and NC includes cost-focused criteria (or negative criteria).

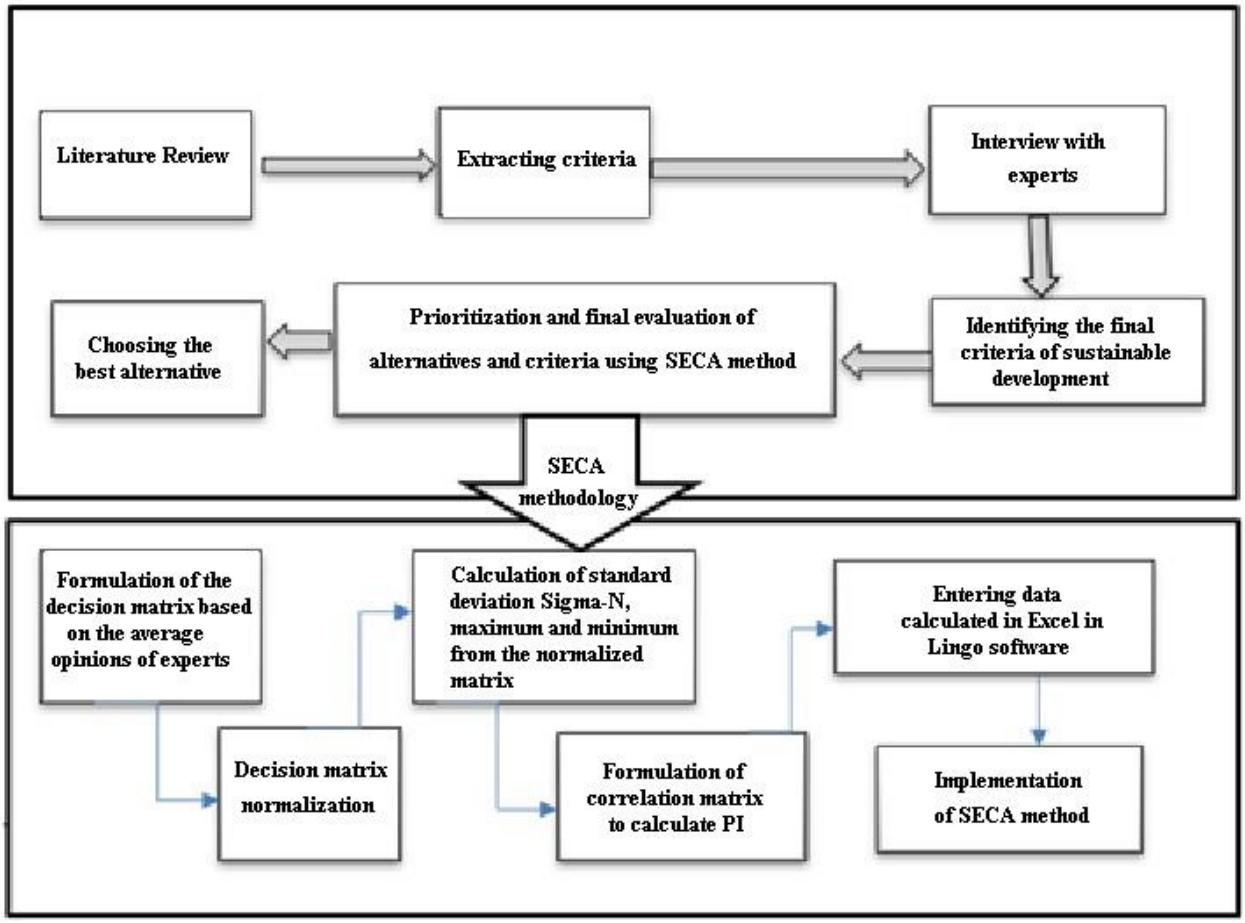

Figure 1- The research procedure

The standard deviation of the elements of each vector can provide the information of intra-criteria. The correlation between each pair of criteria vectors in the decision matrix is calculated to obtain information on inter-criteria. This correlation is denoted by rji. The following relationship can show the difference between the j[th] criterion and other criteria.

$$\pi j = \sum_{i=1}^{m} (1 - rji) \quad (1)$$

Increasing the variance in the vector of a criterion (j) and increasing the difference between criterion j and other criteria increases the importance (weight) of the criterion. Accordingly, the normalized values of σ_j^N and π_j^N are defined as reference points for the weights of the criteria. These values can be calculated as follows:

$$\sigma_j^N = \frac{\sigma_j}{\sum_{i=1}^{m} \sigma_i} \quad (2)$$

$$\pi_j^N = \frac{\pi_j}{\sum_{i=1}^{m} \pi_i} \quad (3)$$

In light of the above, a nonlinear multi-objective programming model is obtained as follows:

$$max\, S_i = \sum_{j=1}^{m} w_j x_{ij}^N \quad , \quad \forall_i \in \{1,2,3,\cdots,n\} \quad (4)$$

$$min\, \lambda_b = \sum_{j=1}^{m} (w_j - \sigma_j^N)^2 \quad (5)$$

$$min\, \lambda_c = \sum_{j=1}^{m} (w_j - \Pi_j^N)^2 \quad (6)$$

$$\text{s.t} \sum_{j=1}^{m} w_j = 1 \quad (7)$$

$$w_j \leq 1, \forall_i \in \{1.2.3 \cdots m\} \quad (8)$$

$$w_j \geq, \forall_i \in \{1.2.3 \cdots m\} \quad (9)$$

Equation 4 increases the overall performance of each alternative. Also, equations 5 and 6 minimize the weight criteria deviation from each criterion's reference points. Equation 7 guarantees that the sum of the weights is equal to 1. Equations 8 and 9

determine the weights of the criteria for some values in the interval $[\varepsilon, 1]$. It should be said that ε is a small positive parameter considered a lower bound for the criterion weight. In this method, the value of this parameter is set equal to 0.003. To optimize the above model, we can convert the objective function into a constraint. A single-objective relationship is formulated as follows.

$$Max\ Z = \lambda_a - \beta(\lambda_b + \lambda_c) \quad (10)$$

$$s.t\ \lambda_a \leq S_i,\ \forall_i \in \{1,2,3,\cdots,n\} \quad (11)$$

$$S_i = \sum_{j=1}^{m} w_j x_{ij}^N = 1 \quad , \quad \forall_i \in \{1.2.3\ \cdots n\} \quad (12)$$

$$\lambda_a = \sum_{j=1}^{m} (w_j - \sigma_j^N)^2 \quad (13)$$

$$\lambda_a = \sum_{j=1}^{m} (w_j - \Pi_j^N)^2 \quad (14)$$

$$\sum_{j=1}^{m} w_j = 1 \quad (15)$$

$$w_j \leq 1, \forall_i \in \{1,2,3,\cdots,m\} \quad (16)$$

$$w_j \geq , \forall_i \in \{1,2,3,\cdots,m\} \quad (17)$$

According to the objective function of the model above, the minimum overall performance score of the alternatives is maximized. Since the deviation from the reference points must be minimal, their differences from the objective function are calculated with the coefficient B. This coefficient affects the importance of achieving reference points of weight criteria. The overall performance score of each alternative (Si) and the weight of each criterion (wj) are determined by solving this model. Model formulation and calculations have been done in Lingo software.

Data Acquisition

Primary data, including smart solutions and sustainable development criteria in the poultry industry, have been extracted and listed in the Table 3.

Using the questionnaire, extracting options related to smart solutions in the poultry industry will be prioritized based on sustainable development criteria in agriculture.

Results

The proposed model can simultaneously determine the overall performance score of the alternatives and the objective weight of the poultry industry's criteria. In order to verify the SECA method, the objective weight of the criteria and the overall performance of the resulting alternatives are analyzed.

Table 3- Related alternatives to smart solutions in the poultry industry

Alternatives	Symbol
Environmental monitoring systems	A1
Precision feeding systems	A2
Welfare monitoring systems	A3
Digital imaging	A4
Analysis of bird sounds	A5
Infrared thermal imaging	A6
Raman spectroscopy	A7
Wearable sensors for the detection of avian influenza virus	A8
Avian influenza virus biosensors	A9
Internet of things and smart poultry farming	A10
Clustering to monitor the growth status of chickens and real-time disease diagnosis	A11
PLF technology and data	A12
Data collection and storage	A13
Data access for smart poultry management systems	A14
Data governance	A15
Big data analysis systems in the poultry industry	A16
Tracking the chickens in poultry halls Using RFID tags	A17
Mobile management system and GPS mapping	A18

Table 4- Related alternatives to smart solutions in the poultry industry	
Attributes	**Symbol**
Productivity	C1
Profitability	C2
Employment	C3
Quality of Life	C4
Fairness	C5
Partnership	C6
Environmental protection	C7
Reasonable use of resources	C8
Quality of products	C9

The results show that determining the appropriate value for the component (β) facilitates the determination of the sustainability weight for the criteria and performance scores of the alternatives. Finally, the results of the SECA method are compared with the results of the SD and CRITIC methods.

Related alternatives to smart solutions in the poultry industry are listed in Table 4.

In this section, final model is executed using the normalized decision matrix table data and various values for the coefficient β = (0.1, 0.2, 0.3, 0.4, 0.5, 1, 2, 3, 4, 5). After execution of the model, ten sets of weights for the criterion are obtained. The different weight values of the criteria resulting from the change of β value are shown in Table 3. Figure 2 also shows the variation of these weights.

Table 3- Different weight values of the criteria resulting from changing the value of β

	β									
	0.1	0.2	0.3	0.4	0.5	1	2	3	4	5
W1	0.1273	0.1550	0.1571	0.1539	0.1517	0.1404	0.1339	0.1278	0.1247	0.1228
W2	0.1281	0.1197	0.1208	0.1217	0.1225	0.1162	0.1097	0.1083	0.1077	0.1072
W3	0.2751	0.2368	0.2001	0.1789	0.1661	0.1375	0.1271	0.1200	0.1164	0.1142
W4	0.2743	0.2579	0.2158	0.2025	0.1952	0.1617	0.1311	0.1230	0.1191	0.1166
W5	0.0246	0.0783	0.0939	0.1123	0.1240	0.1283	0.1215	0.1159	0.1131	0.1113
W6	0.0010	0.0010	0.0010	0.0010	0.0010	0.0498	0.0880	0.0994	0.1049	0.1085
W7	0.1457	0.1188	0.1281	0.1326	0.1351	0.1325	0.1284	0.1259	0.1245	0.1238
W8	0.0010	0.0010	0.0362	0.0479	0.0542	0.0770	0.0963	0.1019	0.1046	0.1064
W9	0.0230	0.0316	0.0469	0.0492	0.0501	0.0565	0.0640	0.0778	0.0850	0.0892

Table 4- Ranking criteria according to different values of β

rank	*β*									
	0.1	0.2	0.3	0.4	0.5	1	2	3	4	5
W1	5	3	3	3	3	2	1	1	1	2
W2	4	4	5	5	6	6	6	6	6	7
W3	1	2	2	2	2	3	4	4	4	4
W4	2	1	1	1	1	1	2	3	3	3
W5	6	6	6	6	5	5	5	5	5	5
W6	8	8	9	9	9	9	8	8	7	6
W7	3	5	4	4	4	4	3	2	2	1
W8	8	8	8	8	7	7	7	7	8	8
W9	7	7	7	7	8	8	9	9	9	9

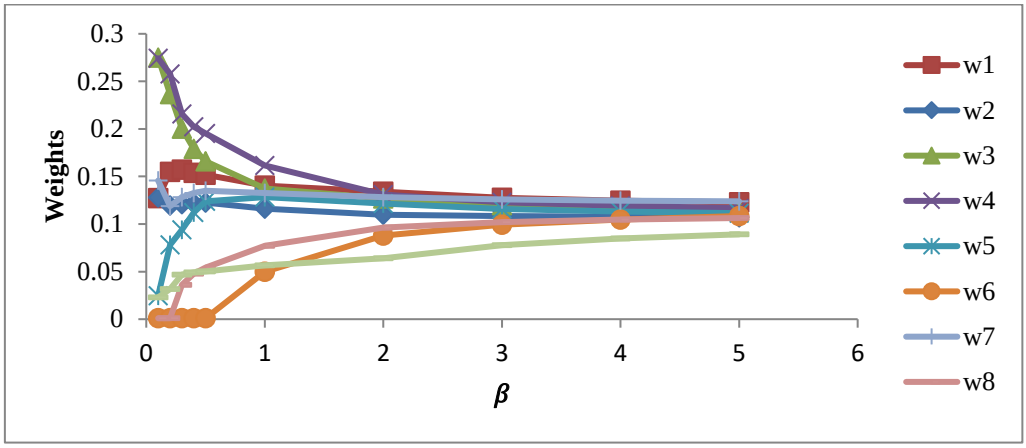

Figure 2- Variation of criteria weight according to different values of β

As shown in Figure 2, when the values of β are greater than 3 (β ≥ 3), the criteria weights are more sustainable.

Now, to verify the results, the criteria weights are also determined using other methods. Two methods, SD and CRITIC, have been chosen for comparative analysis. The weights of the criteria obtained from these three methods are shown in Table 5. If the correlation value is greater than 0.6, there is a reasonable link between the results (Walters, 2009). Table 6 shows the correlation values between the results.

Table 5- Comparing the objective weight of criteria with other methods

	STD	CRITIC
W1	0.1022	0.1155
W2	0.1082	0.1104
W3	0.1020	0.1178
W4	0.1084	0.1073
W5	0.0883	0.1295
W6	0.1259	0.1187
W7	0.1122	0.1121
W8	0.1264	0.1041
W9	0.1266	0.0845

Table 6- Correlation between the weights of the criteria according to the values of β

	STD	CRITIC
0.1	-0.4168	0.1174
0.2	-0.5770	0.2065
0.3	-0.6275	0.2046
0.4	-0.6889	0.2410
0.5	-0.7273	0.2676
1	-0.7805	0.4223
2	-0.7594	0.6431
3	0.6903	0.6596
4	0.6145	0.6567
5	0.5272	0.6477

As shown in Table 6, the correlation values for β ≥ 3 are greater than 0.6 (these values are highlighted in bold in the table). Likewise, β=3 can be a suitable threshold value for performing calculations in the proposed method.

Now, the overall performance score of each criterion is calculated by the proposed model based on the normalized decision matrix table, as well as β values and, subsequently, the weight of the obtained criteria. The calculated scores of the alternatives' overall performance

and correlation ranking are presented in Tables 7 and 8, respectively. Additionally, performance scores are visualized in Figure 3.

Table 7- Overall performance scores of alternatives with different values of β

	β									
	0.1	0.2	0.3	0.4	0.5	1	2	3	4	5
S1	0.683	0.671	0.652	0.647	0.644	0.627	0.612	0.603	0.598	0.596
S2	0.653	0.650	0.628	0.618	0.612	0.578	0.553	0.539	0.532	0.528
S3	0.636	0.629	0.615	0.610	0.606	0.582	0.564	0.553	0.548	0.545
S4	0.709	0.716	0.690	0.681	0.677	0.639	0.609	0.592	0.584	0.579
S5	0.734	0.753	0.727	0.724	0.723	0.681	0.641	0.624	0.615	0.609
S6	0.657	0.674	0.656	0.651	0.649	0.615	0.586	0.570	0.563	0.558
S7	0.674	0.678	0.656	0.649	0.645	0.614	0.589	0.576	0.569	0.565
S8	0.796	0.784	0.752	0.740	0.733	0.689	0.656	0.639	0.631	0.626
S9	0.722	0.722	0.695	0.686	0.682	0.642	0.610	0.594	0.586	0.581
S10	0.652	0.650	0.631	0.627	0.625	0.595	0.569	0.557	0.551	0.547
S11	0.672	0.680	0.667	0.661	0.657	0.630	0.610	0.598	0.592	0.588
S12	0.750	0.758	0.727	0.718	0.714	0.674	0.640	0.623	0.615	0.609
S13	0.636	0.639	0.622	0.617	0.615	0.583	0.556	0.543	0.536	0.532
S14	0.642	0.640	0.616	0.610	0.606	0.575	0.550	0.536	0.530	0.526
S15	0.672	0.673	0.671	0.671	0.671	0.650	0.634	0.625	0.621	0.618
S16	0.636	0.629	0.615	0.610	0.606	0.575	0.550	0.548	0.548	0.548
S17	0.636	0.629	0.615	0.610	0.606	0.575	0.550	0.536	0.530	0.526
S18	0.636	0.629	0.615	0.610	0.606	0.616	0.626	0.624	0.622	0.621

Table 8- Ranking the overall performance scores of alternatives according to different values of β

	β									
	0.1	**0.2**	**0.3**	**0.4**	**0.5**	**1**	**2**	**3**	**4**	**5**
A1	6	10	10	10	10	8	6	6	6	6
A2	11	11	12	12	13	15	15	16	16	16
A3	14	15	17	17	14	14	13	13	14	14
A4	5	5	5	5	5	6	9	9	9	9
A5	3	3	3	2	2	2	2	3	4	4
A6	10	8	8	8	8	10	11	11	11	11
A7	7	7	9	9	9	11	10	10	10	10
A8	1	1	1	1	1	1	1	1	1	1
A9	4	4	4	4	4	5	7	8	8	8
A10	12	12	11	11	11	12	12	12	12	13
A11	9	6	7	7	7	7	8	7	7	7
A12	2	2	2	3	3	3	3	5	5	5
A13	14	14	13	13	12	13	14	15	15	15
A14	13	13	14	14	14	18	16	17	17	17
A15	8	9	6	6	6	4	4	2	3	3
A16	16	15	15	14	14	16	16	14	13	12
A17	16	15	17	14	14	16	16	17	17	18
A18	16	15	15	17	14	9	5	4	2	2

Table 9- Spearman's correlation coefficient of the resulting ranks

	β									
	0.1	0.2	0.3	0.4	0.5	1	2	3	4	5
0.1	1.000	0.964	0.947	0.938	0.938	0.843	0.759	0.672	0.619	0.613
0.2	0.964	1.000	0.977	0.969	0.963	0.836	0.722	0.640	0.596	0.590
0.3	0.947	0.977	1.000	0.986	0.986	0.894	0.782	0.720	0.679	0.673
0.4	0.938	0.969	0.986	1.000	0.990	0.870	0.735	0.673	0.622	0.614
0.5	0.938	0.963	0.986	0.990	1.000	0.915	0.793	0.729	0.679	0.668
1	0.843	0.836	0.894	0.870	0.915	1.000	0.959	0.926	0.896	0.885
2	0.759	0.722	0.782	0.735	0.793	0.959	1.000	0.976	0.959	0.948
3	0.672	0.640	0.720	0.673	0.729	0.926	0.976	1.000	0.992	0.987
4	0.619	0.596	0.679	0.622	0.679	0.896	0.959	0.992	1.000	0.997
5	0.613	0.590	0.673	0.614	0.668	0.885	0.948	0.987	0.997	1.000

As shown in Figure 3 and Table 7, when the value of β is greater than 3 (β ≥3), the performance of alternatives is more distinct and stable.

In order to check the sustainability of the ranking criteria in different values of β, the Spearman correlation coefficient of the rankings in each column of Table 8 is calculated. The results are reflected in Table 9. As shown in Table 9, when the values of β are greater than 1, the ranks have complete sustainability. It can be said that β=3 is a suitable threshold value for determining the overall performance score and ranking of alternatives.

The results show that determining the appropriate value for the coefficient (β) facilitates realizing the sustainability weight for the criteria and performance scores for the alternatives. Table 10 shows the weight of sustainability criteria for β =3.

Table 11 shows the prioritization of alternatives based on the resulting performance scores.

Smart solutions in the poultry industry in order of priority are rapid diagnosis/point of care diagnosis, smart systems for poultry management, analysis of bird sounds, mobile technology, GPS mapping, sensors, and new technologies in poultry operations, environmental monitoring systems, communication between sensors and used equipment, wearable sensors to detect avian influenza viruses, digital imaging, Raman spectroscopy, infrared thermal imaging, biosensors for detection of avian influenza virus, welfare monitoring systems, data privacy and security, distributed data storage systems, precision feeding systems, poultry tracking using RFID tags, and other data storage systems such as cloud-based operating systems and hybrid storage systems (Table 11).

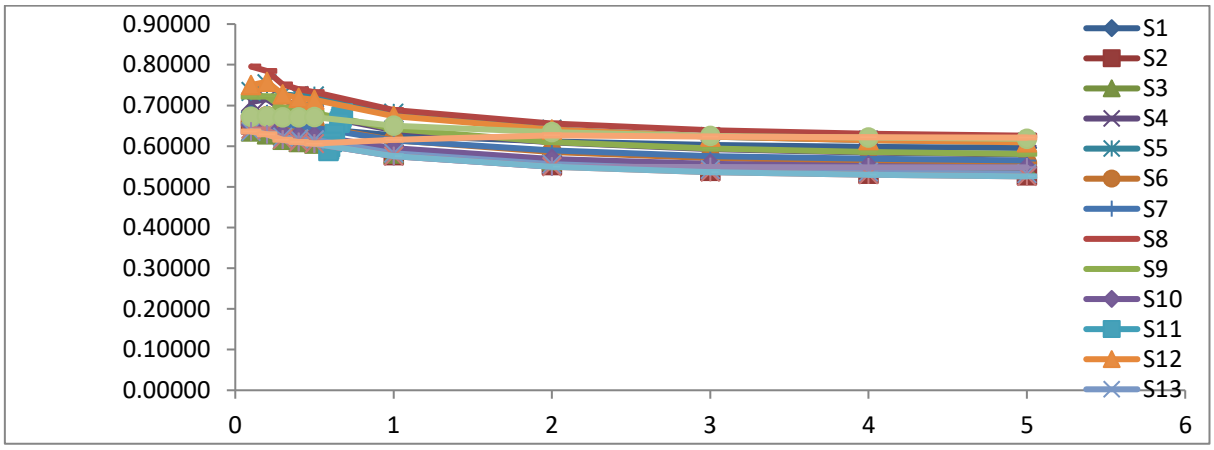

Figure 3- Variability in overall performance scores associated with β value

Table 10- Prioritizing sustainability criteria in the poultry industry based on the SECA method for (β =3)

Criteria symbol	Criteria	Weight of criteria	Ranking of criteria
C1	Productivity	0.1278	1
C 2	Profitability	0.1083	6
C 3	Employment	0.1200	4
C 4	Quality of Life	0.1230	3
C 5	Fairness	0.1159	5
C 6	Partnership	0.0994	8
C 7	Environmental protection	0.1259	2
C 8	Reasonable use of resources	0.1019	7
C 9	Quality of products	0.0778	9

Table 11- Prioritizing solutions and achievements based on smart applications in the poultry industry based on the SECA method according to (β=3)

Alternatives symbol	Alternatives	Weight of alternatives	Ranking
A1	Environmental monitoring systems	0.603	6
A2	Precision feeding systems	0.539	16
A3	Poultry welfare monitoring systems	0.553	13
A4	Digital imaging	0.592	9
A5	Analysis of bird sounds	0.624	3
A6	Infrared thermal imaging	0.570	11
A7	Raman spectroscopy	0.576	10
A8	Rapid diagnosis/point of care diagnosis	0.639	1
A9	Wearable sensors for the detection of avian influenza virus	0.594	8
A10	Avian influenza virus biosensors	0.557	12
A11	Communication between sensors and equipment used	0.598	7
A12	Sensors and new technologies in poultry operations	0.623	5
A13	Distributed data storage systems	0.543	15
A14	Other data storage systems, such as cloud-based operating systems and hybrid storage systems	0.536	17
A15	Smart systems for poultry management	0.625	2
A16	Data privacy and security	0.548	14
A17	Poultry tracking using RFID tags	0.536	17
A18	Mobile technology and GPS mapping	0.624	4

Conclusion

Over the past few decades, various methods for multi-criteria decision-making have been proposed. Most of these methods evaluate several alternatives based on a default set of criteria weights. In addition, there are methods to determine the objective and subjective weight of the criteria. In this study, a new approach was introduced for applying the method of simultaneous evaluation of criteria and alternatives (SECA). Subsequently, a nonlinear multi-objective mathematical model was formulated based on the introduced approach. The objective function of the model seeks to maximize the overall performance of each alternative according to the diversity of intra-criteria and inter-criteria information and the decision matrix. The results show that determining the appropriate value for the coefficient (β) can facilitate the determination of sustainability weights for criteria and performance scores for alternatives. In the research process, smart solutions in the poultry industry were first identified based on the SECA method. Based on the analysis, 18 main areas of smart solutions in the poultry industry were determined. The identified innovative applications were prioritized based on sustainable development criteria in the next step.

The weights obtained for sustainable development criteria based on the SECA method are economic (0.351), social (0.3383), and environmental (0.3065) in order of value. Economic sustainability should be most important in implementing smart solutions-based projects in the poultry industry. One of the main challenges of the agricultural sector, especially the poultry industry, is traditional production utilization which leads to the

overuse of land capacity. Also, the globalization trends, climate changes, moving from a fossil fuel-based economy to an environment-based economy, competition for land, freshwater, and labor shortage have led to more complications in supplying nutrition. Considering the potential of smart solutions in realizing sustainable development objectives, it is suggested to focus more on the environmental aspects of poultry industry projects.

References

1. Archana, M.P., & Uma, S.K.(2018). Monitoring and controlling of poultry farm using IOT, *International Journal of Innovation Research in Computer and Communication Engineering 6*(4).
2. Aengwanich, W., Intarakhamhaeng, M., Wandee, J., Nongbua, T., Chaiyasak, S., Srikot, P., Thammasar, K., Junsanitsri, N., Sritongtuam, K., & Tawinwaang, T. (2012). Poultry Production Clusters (PPCs) after AI Outbreaks in Thailand: Past, Present and Future Direction, *International Journal of Poultry Science 11*(8): 541-550.
3. Astill, J., Dara, R.A., Fraser, E.D.G., & Sharif, S. (2020). Smart poultry management: smart sensors, big data, and the internet of thing, *Computers and Electronics in Agriculture* 170: 105291.
4. Banhazi, T. (2009). Precision Livestock farming: a suite of electronic systems to ensure the application of best practise management on livestock farms. Aust. *Journal Multi-disciplinary Engineering* 7. https://doi.org/10.1080/14488388.2009.11464794.
5. Baniasadi, M., & Zare Mehrjerdi, M.R. (2010). Studying the effects of optimal cultivation pattern on rural poverty: case study of Orzoo'iyeh District in Baft (Kerman – Iran), *Journal of Agricultural Economics 4*(2): 183-209.
6. Bello, O., & Zeadally, S. (2015). Intelligent device-to-device communication in the internet of things. *IEEE Syst. Journal* 10: 1–11. https://doi.org/10.1109/JSYST.2014.2298837.
7. Bora, R.R., Lei, M., Tester, J.W., Lehmann, J., & You, F. (2020). Life cycle assessment and technoeconomic analysis of thermochemical conversion technologies applied to poultry litter with energy and nutrient recovery. ACS Sustain. *Chemistry Engineering 8*(22). https://doi.org/10.1021/acssuschemeng.0c02860.
8. Bordin, F.M., Linke, B.S., Fredel, M.C., Xavier, F.A., & Weingaertner, W.L. (2022). Grinding sustainability analysis using a fatigue failure-related product life indicator, *CIRP Journal of Manufacturing Science and Technology* 38: 1-15.
9. Bright, A. (2008). Vocalizations and acoustic parameters of flock noise from feather pecking and non-feather pecking laying flocks. Br. *Poultion Science* 49: 241249. https://doi.org/10.1080/00071660802094172.
10. Bumanis, N., Arhipova, I., Paura, L., Vitols, G., & Jankovska, L. (2022). *Data conceptual model for smart poultry farm management system*, 3rd International Conference on Industry 4.0 and Smart Manufacturing, 517-526.
11. Bustamante, E., Guijarro, E., García-Diego, F.J., Balasch, S., Hospitaler, A., & Torres, A.G. (2012). Multisensory system for is temporal measurements to assess indoor climatic conditions in poultry farms. *Sensors (Switzerland)* 12: 5752–5774.https://doi.org/10.3390/s120505752.
12. Calvet, S., Campelo, J., Estellés, F., Perles, A., Mercado, R., Serrano, J., Calvet, S., Campelo, J.C., Estellés, F., Perles, A., Mercado, R., & Serrano, J.J. (2014). Suitability evaluation of multipoint simultaneous CO_2 sampling wireless sensors for livestock buildings. *Sensors* 14: 10479–10496. https://doi.org/10.3390/s140610479.
13. Carroll, B.T., Anderson, D. V., Daley, W., Harbert, S., Britton, D.F., & Jackwood, M.W. (2014). *Detecting symptoms of diseases in poultry through audio signal processing*. 2014 IEEE Glob. Conf. Signal Inf. Process. 1132–1135. https://doi.org/10.1109/GlobalSIP.2014.7032298.

14. Chakchai, S., Mongkonchai, N., Aimtongkham, P., Wijitsopon, K., & Rujirakul, K. (2014). An evaluation of data-mining classification models for network intrusion detection. In 4th international conference on digital information and communication technology and it's applications (pp. 90–94). Bankok.
15. Chen, J., Hu, T., Wu, J.H., Si, H.P., & Lin, K.Y. (2014). Applications of internet of things in facility agriculture. *Applied Mechanics and Materials* 685: 517–523. https://doi.org/10.4028/www.scientific.net/AMM.685.517.
16. Chen, L., & Neethirajan, S. (2015). A homogenous fluorescence quenching based assay for specific and sensitive detection of influenza virus *Ahemag glutininantigen*. *Sensors* (Basel) 15: 8852–8865. https://doi.org/10.3390/s150408852.
17. Chen, M., Mao, S., & Liu, Y. (2014). Big data: A survey. Mob. Networks *Appl.* 19: 171–209. https://doi.org/10.1007/s11036-013-0489-0.
18. Chowdhury, E.U., & Morey, A. (2019). Intelligent packaging for poultry industry, *Pultry Scince Association Inc.* 791-800.
19. Colles, F.M., Cain, R.J., Nickson, T., Smith, A.L., Roberts, S.J., Maiden, M.C.J., Lunn, D., & Dawkins, M.S., (2016). Monitoring chicken flock behavior provides early warning of infection by human pathogen Campylobacter. *Proc. R. Soc. B Biology Science* 283: 1–6. https://doi.org/10.1098/rspb.2015.2323.
20. Comim, F., & Hirai, T. (2022). Sustainability and human development indicators: a poset analysis, *Ecological Economics* 198: 107470.
21. David, B., Mejdell, C., Michel, V., Lund, V., & Oppermann Moe, R. (2015). Air quality in alternative housing systems may have an impact on laying hen welfare. PartII—Ammonia. Anim. *Open Access Journal from MDPI* 5: 886–896. https://doi.org/10.3390/ani5030389.
22. De Longe, M.S., Miles, A., & Carlisle, L. (2016). Investing in the transition to sustainable agriculture. *Environmental Science & Policy* 55: 266-273.
23. Epp, M. (2019). Poultry Technology: Rise of the robots [WWW Document]. Can. Poult.URL https://www.canadianpoultrymag.com/production/new-technology/rise-ofthe-robots-30876?jjj=1570740094606 (accessed 10.10.19).
24. FAO. (2017). Ending poverty and hunger by investing in agriculture and rural areas. Food and Agriculture Organization of the United Nations (FAO).
25. Fontana, I., Tullo, E., Butterworth, A., & Guarino, M. (2015). An innovative approach to predict the growth in intensive poultry farming. *Computer Electronic Agriculture* 119: 178–183. https://doi.org/10.1016/j.compag.2015.10.001.
26. GeSI. (2016). How Digital Solutions Will Drive Progress Towards The Sustainable Development Goals. Brussels: Global e-Sustainability Initiative (GeSI).
27. Ghasemi, R., Mohaghar, A., Safari, H. (2016). "Prioritization of IoT technology applications in the Iranian health sector: a stimulus for sustainable development", Faculty of Management, University of Tehran, 8(1). (In Persian)
28. Gunnarsdottir, J., Davidsdottir, B., Worrell, E., & Sigurgeirsdottir, S. (2022). Indicators for sustainable energy development: an Icelandic case sturdy, *Energy Policy* 164: 112926.
29. Halachmi, I., Guarino, M., & Bewley, J. (2019), Smart animal agriculture: application of real-time sensors to improve animal well-being and production. *Annu. Rev. Animal Bioscience* 7: 403–25
30. Huang, L., & Liu, Ch. (2016) "The Application Mode in Urban Transportation Management Based on Internet of Things", Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering (ICCSE 2013) B. Nonnecke, M. Bruch," IoT & Sustainability: Practice, Policy and Promise", Center for Information Technology Research in the Interest of Society& the Banatao Institute University of California.

31. Hadinia, S.H., Carneiro, P.R.O., Ouellette, C.A., & Zuidhof, M.J. (2018). Energy partitioning by broiler breeder pullets in skip-a-day and precision feeding systems. *Poultry Science*. http://doi.org/10.3382/ps/pey283.
32. Information Builders. (2011). Seven Steps to Effective Data Governance: A White Paper.
33. Jackman, P., Ward, S., Brennan, L., & Corkery, G. (2015). Application of wireless technologies to forward predict crop yields in the poultry production chain. *CIGR Journal* 17: 287–295.
34. Kamilaris, A., Kartakoullis, A., & Prenafeta-Boldú, F.X. (2017). A review on the practice of big data analysis in agriculture. *Computer Electronic Agriculture* 143: 23–37. https://doi.org/10.1016/J.COMPAG.2017.09.037.
35. Kesharavz-Ghorabaee, M., Amiri, M., Zavadskas, E.K., Turshis, Z., & Antucheviciene, J. (2018). Simultaneous evaluation of criteria and alternatives (SECA) for multi-criteria decision-making, *INFORMATICA 29*(2): 265-280.
36. Kocovic, P., Behringer, R., Ramachandran, M., & Mihajlovic, R. (2017). Emerging Trends and Applications of the Internet of Things. Hershey, PA: IGI Global. http://doi.org/10.4018/978-1-5225-2437-3.
37. Manika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., & Byers, A.H. (2011). Big Data: The Next Frontier for Innovation, Competition, and Productivity. McKinsey Global Institute.
38. Marchewka, J., Watanabe, T.T.N., Ferrante, V., & Estevez, I. (2013). Welfareassessmentinbroiler farms: Transect walks versus individual scoring. *Pollution Science* 92: 2588–2599. https://doi.org/10.3382/ps.2013-03229.
39. Manteuffel, G., Puppe, B., & Schön, P.C. (2004). Vocalization of farm animals as ameasureofwelfare. *Appl. Animal Behavier Science* 88: 163–182. https://doi.org/10.1016/j.applanim.2004.02.012.
40. Merad, M., Dechy, N., Serir, L., Grabisch, M., & Marcel, F. (2013). Using a multi-criteria decision aid methodology to implement sustainable development principles within an organization. *European Journal of Operational Research 224*(3): 603-613. http://doi.org/10.1016/j.ejor.2012.08.019.
41. McDougal, T. (2018). Poultry World - French poultry robot up and running, https://www.poultryworld.net/Meat/Articles/2018/1/Frenchpoultry-robotup-and-running-231202E/(accessed 1.22.19).
42. Mohammadian, A., Heidari Dehvaei, J., & Ghorbani, A. (2020). Prioritize IoT applications in agriculture using sustainable development indicators. *Iranian Agricultural Economics and Development Research 51*(4): 759-745. (Persian)
43. Mohammadzadeh, A., Ghafoori, S., Mohammadian, A., Mohammadkazemi, R., Mahbanooei, B., & Ghasemi, R. (2018). A Fuzzy Analytic Network Process (FANP) approach for prioritizing internet of things challenges in Iran. *Technology in Society* 53: 124-134. http://doi.org/10.1016/j.techsoc.2018.01.007.
44. Nääs, I.A., Garcia, R.G., & Caldara, F.R. (2014). Infrared thermal image for assessinganimalhealth and welfare. *Journal Animal Behavier Biometeorology* 2: 66–72. https://doi.org/10.14269/2318-1265/jabb.v2n3p66-72.
45. Neethirajan, S., Tuteja, S., Huang, S.-T., & Kelton, D. (2017). Recent advances inwearablesensors for animal and livestock health management. *Biosens. Bioelectron* 98: 398–407. https://doi.org/10.1016/j.sbsr.2016.11.004.
46. Nuñez, I.A., & Ross, T.M. (2019). A review of H5Nx avian influenza viruses. *Ther. Adv. Vaccin. Immunother.* 7: 2515135518821625. http://doi.org/10.1177/2515135518821625.
47. Luka, G., Ahmadi, A., Najjaran, H., Alocilja, E., Derosa, M., Wolthers, K., Malki, A., Aziz, H., Althani, A., &Hoorfar, M. (2015). Microfluidics integrated biosensors: A leading

technology towards lab-on-A-chip and sensing applications. *Sensors (Switzerland)* 15: 30011–30031. https://doi.org/10.3390/s151229783.
48. Obedient Langroudi, S.H., & Shamsai, E. (2007). Rural development based on agricultural continuity and sustainability, *Geographical Research Quarterly* 86: 85-104. (In Persian)
49. Okada, H., Itoh, T., Suzuki, K., & Tsukamoto, K. (2009). Wireless sensor system fordetectionof avian influenza outbreak farms at an early stage. *IEEE Sensors* 1374–1377. https://doi.org/10.1109/ICSENS.2009.5398422.
50. Okada, H., Suzuki, K., Kenji, T., & Itoh, T. (2014). Applicability of wireless activity sensor network to avian influenza monitoring system in poultry farms. *Journal Sens. Technology* 4: 18–23.
51. O'Grady, M.J., & O'Hare, G.M.J.I. (2017). Modelling the smart farm. 4(3): 179-187.
52. Park, M., Britton, D., Daley, W., MsMurray, G., Navaei, M., Samoylov, A., Usher, C., & Xu, J. (2022). Artificial intelligence, sensors, robots, and transportation systems drive an innovative future for poultry broiler and breeder management, *Animal Frontiers 12*(2): 40-48.
53. Poursaeed, A., Mirdamadi, M., Malekmohammadi, I., & Hosseini, J. (2010). The partnership models of agricultural sustainable development based on Multiple Criteria Decision Making (MCDM) in Iran. *African Journal of Agricultural Research 5*(23): 3185-3190.
54. Praveen, K., & Satish, C. (2012). An intelligent system based on sensor integration & sensor fusion. *International Journal of Advanced Research in Computer Science and Software Engineering 2*(3): 2277–2283.
55. Quaddus, M., & Siddique, M. (2001). Modelling sustainable development planning: A multicriteria decision conferencing approach. *Environment International 27*(2-3): 89-95. http://doi.org/10.1016/S0160-4120(01)00066.
56. Quintero-Angel, M., & González-Acevedo, A. (2018): Tendencies and challenges for the assessment of agricultural sustainability. *Agriculture, Ecosystems & Environment* 254: 273-281.
57. Regan, Á. (2019). 'Smart farming'in Ireland: A risk perception study with key governance actors. *NJAS-Wageningen Journal of Life Sciences* 90: 100292.
58. Rezaei-Moghaddam, K., & Karami, E. (2008). A multiple criteria evaluation of sustainable agricultural development models using AHP. *Sustainable Agricultural Development Models 10*(4): 407-426.
59. Rizwan, M., Carroll, B.T., Anderson, D.V., Daley, W., Harbert, S., Britton, D.F., & Jackwood, M.W. (2017). *Identifying rale sounds in chickens using audio signals for early disease detection in poultry*. 2016 IEEE Glob. Conf. Signal Inf. Process. Glob. 2016 - Proc. 55–59. https://doi.org/10.1109/GlobalSIP.2016.7905802.
60. Ronald, B., & Siarhei, S. (2012). Experiments for evaluating sensors' precision in wireless sensor networks. *International Journal of Ad Hoc, Sensor & Ubiquitous Computing 3*(3): 105–121.
61. Rani, K.S.S., & Devarajan, N. (2012). Multi objective sensor node deployment in wireless sensor networks. *International Journal of Engineering Science and Technology 4*(4): 1262–1266.
62. Sandelowski, M., & Barroso, J. (2006). *Handbook for Synthesizing Qualitative Research*. New York: Springer Publishing Company, Inc.
63. Sassi, N. Ben, Averós, X., Estevez, I. (2016). Technology and poultry welfare. *Animals* 6: 1–21. https://doi.org/10.3390/ani6100062.
64. Schuetz, C.G., Schausberger, S., & Schrefl, M. (2018). Building an active semantic data ware house for precision dairy farming. *Journal Organ. Computer Electronic Commer.* 28: 122–141. https://doi.org/10.1080/10919392.2018.1444344.

65. Senoret, A., Ramirez, M., & Rehner, J. (2022). Employment and sustainability: the relation between precarious work and spatial inequality in the neoliberal city, *World Development* 153: 105840.
66. Shang, X. (2012). "Internet of Things (IOT) Service: Architecture and its application in E_ Commerce", *Journal of Electronic Commerce in Organizations 10*(3): 44-55.
67. Shinder, D., Rusal, M., Giloh, M., & Yahav, S. (2009). Effect of repetitive acute cold exposures during the last phase of broiler embryogenesis on cold resistance through the lifespan. *Poult. Science* 88: 636–646. https://doi.org/10.3382/ps.2008-00213.
68. Sicular, S. (2013). Gartner's Big Data Definition Consists of Three Parts, Not to Be Confused with Three "V"s [WWW Document]. URLhttps://www.forbes.com/sites/gartnergroup/2013/03/27/gartners-big-datadefinition-consists-of-three-parts-notto-be-confused-with-threevs/#4912508b42f6 (accessed 5.22.18).
69. Silvera, A.M., Knowles, T.G., Butterworth, A., Berckmans, D., Vranken, E., & Blokhuis, H.J. (2017). Lameness assessment with automatic monitoring of activity in commercial broiler flocks. *Poult. Science* 96: 2013–2017. https://doi.org/10.3382/ps/pex023.
70. Smith, D., Lyle, S., Berry, A., Manning, N., Zaki, M., & Neely, A. (2015). Internet of animal health things opportunities and challenges data and analytics: Internet of Animal Health Things. https://doi.org/10.13140/RG.2.1.1113.8409.
71. Sun. Chunling. (2012). "*Application of RFID Technology for Logistics on Internet of Things* ", AASRI Conference on Computational Intelligence and Bioinformatics, Published by Elsevier.
72. Vanderhasselt, R.F., Sprenger, M., Duchateau, L., & Tuyttens, F.M. (2013). Automated assessment of footpad dermatitis in broiler chickens at the slaughter-line: Evaluation and correspondence with human expert scores. *Poult. Science* 92: 12–8. https://doi.org/10.3382/ps.2012-02153.
73. Veisi, H., Liaghati, H., & Alipour, A. (2016). Developing an ethics-based approach to indicators of sustainable agriculture using analytic hierarchy process (AHP). *Ecological Indicators* 60: 644-654.
74. Verma, N., & Usman, A. (2016). Internet of Things (IoT): A relief for Indian farmers. 2016 IEEE Global Humanitarian Technology Conference (GHTC) (pp. 831-835). Seattle: IEEE.
75. Walters, S.J. (2009). *Quality of Life Outcomes in Clinical Trials and Health-Care Evaluation: A Practical Guide to Analysis and Interpretation.* Wiley, New York.
76. Walter, A., Finger, R., Huber, R., & Buchmann, N. (2017). Opinion: Smart farming is key to developing sustainable agriculture. *Proceedings of the National Academy of Sciences 114*(24): 6148–6150. http://doi.org/10.1073/pnas.1707462114.
77. Wang, T.-C., & Lee, H.-D. (2009). Developing a fuzzy TOPSIS approach based on subjective weights and objective weights. *Expert Systems with Applications 36*(5): 8980–8985.
78. Wang, Y., & Qi, H. (2012). "Research of intelligent transportation system based on the internet of things frame", *Wireless Engineering and Technology 3*(3): 21471. http://doi.org/10.4236/wet.2012.33023.
79. Weersink, A., Fraser, E., Pannell, D., Duncan, E., & Rotz, S. (2018). Opportunities and challenges for big data in agricultural and environmental analysis. *Annual Review of Resource Economics* 10: 19-37.
80. Williams, J., Alter, T., & Shrivastava, P. (2018). Systemic governance of sustainable agriculture: Implementing sustainable development goals and climate-friendly farming. *Outlook on Agriculture 47*(3): 192-195. http://doi.org/10.1177/0030727018795907.
81. Xin, J., & Zazueta, F.J.A.E.I.C.J. (2016). Technology trends in ICT–towards data-driven, farmer centered and knowledge-based hybrid cloud architectures for smart farming 18(4): 275-279.

82. Xin, J., & Zazueta, F. (2016). Technology trends in ICT–towards data-driven, farmer-centered and knowledge-based hybrid cloud architectures for smart farming. Agricultural Engineering International: *CIGR Journal* 18(4): 275-279.
83. Xin, H., & Liu, K. (2017). Precision livestock farming in egg production. Animal Front. 7: 24. https://doi.org/10.2527/af.2017.0105.
84. Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M.J. (2017). Big data in smart farming–a review. *Agricultural Systems* 153: 69-80.
85. Zarei, M., Mohammadian, A., & Ghasemi, R. (2016). Internet of things in industries: a survey for sustainable development. *Innovation and Sustainable Development 10*(4): 419-442.
86. Zhang, Q,, Yang, X.L., Zhou, Y.M., Wang, L.R., Guo, X.S. (2007). A wireless solution for greenhouse monitoring and control system based on Zig Bee technology. *Journal of Zhejiang University Science 8*(10): 1584–1587.
87. Zuidhof, M.J. (2018). Lifetime productivity of conventionally and precision-fedbroilerbreeders. *Poult. Science* In Press. https://doi.org/10.3382/ps.
88. Zuidhof, M.J., Fedorak, M.V., Ouellette, C.A., & Wenger, I.I. (2017). Precision feeding: Innovative management of broiler breeder feed intake and flock uniformity. *Poult. Science* 96: 2254–2263. https://doi.org/10.3382/ps/pex013.

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۴۱۱-۳۹۳

شناسایی و اولویت‌بندی راه‌حل‌های هوشمند در صنعت طیور براساس معیارهای پایداری

آمنه خدیور[1*]- فاطمه مجیبیان[2]- زهرا ترکاشوند[3]

تاریخ دریافت: ۱۴۰۱/۰۳/۲۱

تاریخ پذیرش: ۱۴۰۱/۰۶/۲۳

چکیده

یکی از بخش‌های غذایی که تولید هر چه بیشتر در آن می‌تواند ضمن از بین بردن وابستگی به خارج صادرات ارزآوری نیز داشته باشد، بخش تولید و عرضه دام و طیور است. مرغداری صنعت مهمی برای تأمین پایدار غذا در کشورها می‌باشد. در این پژوهش کاربردها و راه‌حل‌های هوشمند در صنعت طیور شناسایی شده و با استفاده از شاخص‌های توسعه پایدار و با بهره‌گیری از روش ارزیابی همزمان معیارها و گزینه‌ها (SECA) به اولویت‌بندی این کاربردها پرداخته شده است. بر اساس تحلیل‌های صورت گرفته ۱۸ حوزه اصلی از راه‌حل‌های هوشمند در صنعت مرغداری شناسایی گردیده است. اوزان شاخص‌های توسعه پایدار بر اساس روش SECA، اقتصادی (۰/۳۵۱)، اجتماعی (۰/۳۳۸۳) و زیست محیطی (۰/۳۰۶۵) نشان می‌دهد که برای پیاده‌سازی پروژه‌های مبتنی بر راه‌حل‌های هوشمند در صنعت مرغداری بایستی بیشتر به پایداری اقتصادی اهمیت داد. این در حالیست که یکی از چالش‌های اصلی که بخش کشاورزی بخصوص صنعت مرغداری با آن روبرو است استفاده از روش‌های تولید کشاورزی سنتی است که باعث شده بیش از ظرفیت زمین استفاده کند. علاوه بر آن جهانی شدن، تغییرات آب و هوایی، حرکت از اقتصاد مبتنی بر سوخت فسیلی به سوی اقتصاد مبتنی بر محیط‌زیست و رقابت بر سر زمین، آب شیرین و نیروی کار منجر به پیچیدگی‌های بیشتر و ایجاد چالش تغذیه در جهان و بهره‌برداری اضافی شده است. با توجه به پتانسیل بالقوهٔ راه‌حل‌های هوشمند در تحقق اهداف توسعهٔ پایدار، پیشنهاد می‌شود که بیشتر بر روی جنبه زیست‌محیطی پروژه‌ها تمرکز شود.

واژه‌های کلیدی: اینترنت اشیا، توسعهٔ پایدار، راه‌حل‌های هوشمند، روش SECA، صنعت طیور

۱ و ۳- به‌ترتیب دانشیار گروه مدیریت و کارشناس ارشد، دانشگاه الزهرا، تهران، ایران

(*- نویسنده مسئول: Email: a_khadivar@yahoo.com)

۲- دکترای تخصصی، دانشکده مدیریت و اقتصاد، دانشگاه تربیت مدرس

DOI: 10.22067/jead.2022.76267.1130

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 413-429

Determinants of Agricultural Export and Trade Balance in Iran

S. Zolanvari Shirazy[1], Z. Farajzadeh[2*]

Received: 04-08-2022
Revised: 07-12-2022
Accepted: 04-01-2023
Available Online: 15-02-2023

How to cite this article:
Zolanvari Shirazy, S., & Farajzadeh, Z. (2023). Determinants of Agricultural Export and Trade Balance in Iran. *Journal of Agricultural Economics & Development 36*(4): 413-429.
DOI: 10.22067/jead.2023.77925.1148

Abstract

Iran attempts to expand the non-oil exports for diminishing the dependency on oil export income. This research tries to examine the export and trade balance of Iran's agricultural sector. Accordingly, the gravity model was used for export, applying panel data from 1997 to 2017. The trade balance of Iran's total agricultural and the related sectors' commodities was also examined. It should be noted that for the trade balance, time series data from 1978 to 2018 were used. The results of the gravity model show a negative effect for the variable of distance. The coefficients of Iran's per capita GDP and also the GDP of trading partners are positive, as expected. It was found that a one percent increase in the per capita GDP of Iran causes a rise of 3.42 percent in the export of agricultural products; however, that of importing countries has low statistical significance. Based on the coefficient obtained for the population, an increase in the population of the importing countries raises the demand for Iran's agricultural products. The degree of trade openness revealed a positive and significant effect on the export of agricultural products. The coefficient for the real exchange rate was found to be around 0.9%. It was also found that the volatility of the exchange rate is related directly to the export of agricultural products. Comprehensive sanctions have a negative and significant effect, while less restricting sanctions have an insignificant effect on the export of agricultural products. The global economic crisis has also had a dampening effect on exports. For trade balance, the results show that the value added of the agriculture has a positive effect on the trade balance of entire agriculture and sectors. The real exchange rate has a negative effect on the trade balance of agricultural commodities as a whole and livestock and agronomy sectors, confirming the J-Curve theory while it was not supported for the horticultural sector. The variable of exchange rate volatility was included in the model using two measures of positive and negative series of exchange rate changes and the Autoregressive Conditional Heteroskedasticity (ARCH) effect, but their effect on the trade balance was not the same in terms of both the direction and statistical significance. The trade openness for the agricultural and horticultural sector was found with a positive coefficient, indicating that their production is based on comparative advantage. However, for the sectors of agronomy and livestock, it illustrated a negative effect. Sanctions have also harmed the trade balance.

Keywords: Agricultural Sector, Export, Gravity model, Trade balance

Introduction

The Iranian government is highly dependent on oil and energy export revenues. There have been some attempts to reduce dependency on these revenues, and non-oil export, and mainly agricultural export has received an increasing attention[3] in recent years. Iran enjoys some advantages, including fertile agricultural land, the diverse climate, and the young and educated labor force, providing more chances to meet the non-oil

1 and 2- M.Sc. Graduate and Associate Professor of Agricultural Economics, Department of Agricultural Economics, Faculty of Agriculture, Shiraz University, Shiraz, Iran, respectively.
(*- Corresponding Author Email: zakariafarajzadeh@gmail.com)

export targets (Mehrparvar Hosseini *et al.*, 2013).

Despite the necessity of agricultural export expansion, it has experienced significant fluctuation over the past two decades. For instance, agricultural and food industries have exerted 4.9 billion UDS in a 9-month period of 2019, which is 9.7% lower than the 6-year average of 2012-2018. Although the export expansion of agricultural commodities has drawn attentions, agricultural imports also account for a significant amount of Iranian imported commodities. In fact, contrary to export, Iran has experienced an increasing trend of agricultural commodities import, around 9.2 billion USD in 9-month of 2019, accounting for 51.7% of Iranian imports of commodities (Iran Chamber of Commerce, Industries, Mines & Agriculture (ICCIMA), 2019). For the most of years, imports of agricultural commodities have exceeded their exports. Strategic commodities including maize, rice, and soybean account for most of agricultural imports (Food and Agriculture Organization, 2018).

Dependence of domestic consumption on imports may mean that agricultural commodities import is not necessarily affected by important variables like exchange rate significantly, while agricultural export is expected to be affected by driving forces like relative prices, real interest rate, agriculture value added, GDP, and terms of trade (Hosseini and Homayounpour, 2013). Thus, it is crucial to examine the trade balance of agricultural commodities. Among the underlying driving factors of trade balance, exchange rate is extremely critical (Esmaili *et al*., 2020). Currency devaluation is expected to increase the trade balance in long-run; however, it is accompanied by a reduction in the balance of trade in the short-run. This phenomenon that illustrates a "J-shaped" time path for trade balance was defined as "J-Curve" by Magee (1973). The former changes account for the increasing part of the J-curve while the latter changes will form the decreasing part of the J-curve. Changes in the exchange rate affect trade balance directly via import and export prices and indirectly via changes in import and export quantity resulting from changes in relative prices. Therefore, an increase in the exchange rate, on the one hand, raises the import costs and results in a lower trade balance; however, on the other hand, it encourages exports and induces a reduction in imports (Pedram *et al.*, 2011). There is a great body of literature using the gravity model and J-Curve as tools to examine international trade and trade balance at the economy-wide level. However, the sectoral level, especially agricultural commodities, has not received adequate attentions. This shortcoming particularly holds true for the Iranian agriculture trade. Therefore for two reasons, it is essential to examine the agricultural trade balance. First, agricultural export accounts for a significant part of non-oil exports. Second, agricultural commodities account for a significant amount of the Iranian imports of commodities, resulting in an undesirable situation of the trade balance. Accordingly, for many developing countries, fluctuations in trade balance have a significant effect due to lower access to the global capital market and lower elasticity of foreign capital supply (Najarzadeh *et al.*, 2009).

The objective of this study is to examine the factors affecting the trade balance and export of agricultural commodities in Iran. For this purpose we applied the Gravity model to examine the factors affecting Iranian agricultural exports, and for trade balance, J-Curve approach was applied.

Theoretical Background and Empirical Works

We have attempted to review the theoretical and empirical works to know the factors affecting the trade balance and export of agricultural commodities in Iran.

Export (the gravity model)

The analogy to Newton's law of gravity, the trade gravity model is presented as follows:

$$X_{ij} = G\frac{M_i^{\alpha} M_j^{\beta}}{D_{ij}^{\theta}} \quad (1)$$

Where X_{ij} is the bilateral trade between country i and j, and G is constant. M_i^{α} and M_j^{β} show the size of the countries, and D_{ij}^{θ} is the distance between the two the countries. By the size of country we mean the gross domestic product of nations. α, β and θ are also elasticities.

Soloaga and Winters, (2001)investigated the trade agreements from the 1990s.They found no significant evidence of increasing local trade blocs. However, Sandberg (2004)suggests that historical linkage is essential in the trade pattern of the Western Hemisphere. Martinez-Zarzoso *et al.* (2009), indicate that there is evidence of regionalism positive effect on intra and extra-bloc trade for the EU and NAFTA members, which is more significant than those for developing countries. This holds true for the USA-Canada as McCallum, (1995) reported a significant effect on Canada's trade with America. Agostino *et al.* (2007) for eight major OECD members have reported similar results. Shaghaghi Shahri, (2017) suggests a higher regional integration, for Islamic Conference members, who in turn, lead to enhance of the common market and foreign direct investment. Similar results were reported by Karimi Hasnijeh, (2007) for agricultural commodities in these countries. Additionally, as investigated by Zarif *et al.* (2011), Iranian agricultural exports to Islamic Conference members are affected by the exchange rate, and its fluctuations, GDP, and distance between Iran and the trading partners. These variables have been suggested as driving forces of Iranian shrimp export to the EU (Mortazavi *et al.*, 2014) and agricultural export to the ECO[1] members (ZargarTalebi *et al.*, 2016).

There is a great body of literature in which the effect of macroeconomic variables has been considered. For instance, Roy and Rayhan, (2011) found that Bangladesh's trade is positively affected by the economy size, and inversely, is related to trade barriers. For Oman's imports from Asia it was found that the imports are strongly affected by population, per capita GDP, real exchange rates, and distance (Gani and Al-Mawali, 2013). Pakistan GDP per capita showed a positive effect on trade value with the trading partners, while distance and cultural similarities showed a negative relationship (Khan *et al.*, 2013). However, language and distance showed an insignificant effect on trade of Western Hemisphere trading blocs (Croce *et al.*, 2004).

Iran has faced sanctions for many years. This barrier has been considered by some studies. For example, Arman *et al.* (2018) reported that sanctions have contracted the Iranian trade. Although Iran has tried to change its trading partners, the effect of the sanctions has been prohibitive, and export, and import have been reduced (Dizaji, 2018). The gravity model has been applied to examine the agrictural commodities export. For instance, GDP, per capita GDP, and exchange volatility indicated a significant effect on Egyptian agricultural export to its major trading partners (Abu Hatab *et al.*, 2010). For Chinese forest trade also, GDP, distance, and the global economic crisis were found to be driving factors (Nasrullah *et al.*, 2020). Cekyay *et al.* (2020), reported the significant effect of road transport quotas on Turkish export to selected EU countries. Serrano and Pinilla, (2012) suggest that the low demand elasticity for agricultural products and the protection against trade are the reason for relatively slow growth. Also, Tesfaye (2014), found that GDP, and import tariffs affect agricultural export of Sub-Suharan Africa significantly.

In general, there is a vast literature that applies the gravity model, and J-curve and different regions have been considered. The main distinguishing feature of the empirical studies is the region of the study, while there are some differences in terms of the variables applied as driving forces. However, most of the studies have used the gravity model while they cover the total trading of a country or a

1- Economic Cooperation Organization

selected region, and the agricultural commodities have not received competent attention. This gap exists for Iranian agricultural export even more significant. As far as the Iranian case is concerned, there are some facts like sanctions that make it a more interesting case for international trade literature, deserving to be investigated more deeply. Another contribution of the current study to the existing literature is that it examines the effect of exchange fluctuations by applying two proxies, i.e., positive and negative components of exchange variations and the ARCH effect.

Trade balance and J-Curve

Currency devaluation in the short run leads to higher prices for imported goods in terms of domestic prices while imports and exports volume do not experience significant changes, resulting in a temporary reduction in trade balance (moving from A to B in Fig. 1). As time passes, both consumers and producers will respond to the changes in the exchange rate. Imports will become more expensive, leading to lower demand, while exports will become cheaper, resulting in higher demand for exporting commodities (moving from point B to point C) (Dogru *et al*., 2019; Bahmani-Oskooee and Fariditavana, 2016). This phenomenon in international trade, as presented in Fig. 1, is known as J-Curve (Dogru *et al*., 2019).

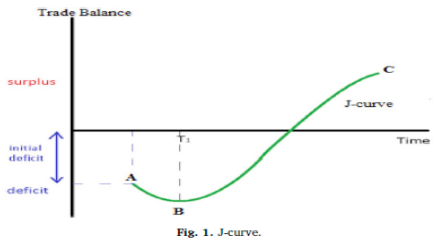

Figure 1- J-Curve

Evidence of the J-Curve phenomenon has been reported for Iran's trade with major trading partners (Pedram *et al*., 2011). Also, for South Asia (Lal and Lowinger, 2002), and the USA (Cheng, 2020) this theory has been reported. However, it was not approved for the trade balance between Sri Lanka and its trading partners (Malith *et al*., 2021).

As far as the J-Curve phenomenon is regarded, the exchange rate is the main driving force of trade balance; however, other variables are determinant. For instance, tariff barriers have been noticed as determinants in trading between Iran and Turkey (Ghanbari and Sagheb, 2010). Trade flow between Iran and China, in addition to trade barriers, has been affected by economic growth (Ahmadian Yazdi *et al*., 2015). A similar result was observed for a group of countries from Asia, Africa, and Latin America, as trade liberalization was found to promote economic growth. However, it showed a trade balance worsening effect for Asian economies (Parikh and Stirbu, 2004).

As for the non-agricultural trade balance, in the agricultural empirical works also, exchange rate has been considered. For instance, Esmaili *et al*. (2020) suggested exchange rate as an influential factor in agricultural trade along with value added. They also reported the evidence of the J-Curve theory for trading between Iran and China as well as India. The exchange rate was also declared as the main determinant of the U.S. agricultural trade balance in both the short- and long-run (Beak and Koo, 2007). However, in addition to the exchange rate effect, the response of trade balance to exchange fluctuations is essential. The reverse effect of exchange fluctuations was reported for the trade balance of Iranian agricultural commodities (Khosravi and Mohseni, 2014).

Method

The gravity model has been able to explain the growing trend of international trade (Yu, 2009). The basic explanatory variables included, i.e., distance and the GDP explain the trade potentials between countries. Regarding the capability of this model in examining the driving forces of international trade, it may be more appropriate for the Iranian case since it faces some restrictions in international trade such as sanctions. Thus, we

used the gravity model to accomplish the goal of the study.

Gravity Model

The explanatory variables can be classified into two categories. The first group includes variables that affect the trade costs like distance, common border, and tariff. The second group is related to the trade volume including GDP and GDP per capita. The applied explanatory variables are presented as below:

Distance: geographical distance is expected to affect bilateral trade negatively (Kabir *et al*., 2017).

Common border: Theoretically common border is related to bilateral international trade costs (Kabir *et al*., 2017).

Tariff: tariff also affects trade costs indirectly. This factor may be presented in trade cost specification (Anderson and Van Wincoop, 2003).

Gross Domestic Product (GDP): in the basic specification of the gravity model, the trade between two countries is proportional to their income. A higher income in a country is expected to be associated with a higher reduction, leading to an increase in the availability of goods for trade (Jagdambe and Kannan, 2020).

GDP per capita: GDP per capita represents the level of economic development (Pass, 2002). Based on the Linder's hypothesis also, relative demand changes with per capita income (Bergstrand, 1990). Higher income is expected to raise the demand for commodities, leading to an increased consumption and production of commodities.

The variables mentioned above are those that have been applied broadly. However there are some other variables included in the standard gravity model, including population, the exchange rate volatility, trade openness, Linder's similarity index, and global economic crisis (Arman *et al*., 2018).

Population: the size of an economy may be measured through GDP and population. However its effects may be positive or negative depending on the economies of scale effect (Oguledo and MacPhee, 1994; Martinez-Zarzoso and Lehmann, 2003).

Exchange rate: the exchange rate may affect the trade volume through both price and income effect. Depreciation of exchange rate induces an increase in export; the income effect also may lead to an increase in the prices of non-tradable prices and bring about an appreciation (Dubas, 2009). The real exchange rate is defined as follows:

$$\boldsymbol{ER_t = E_t \frac{P_t^F}{P_t}} \quad (2)$$

Where ER is the real exchange rate, E is the nominal exchange rate, P^F is the foreign price index, and P stands for the domestic price index.

As declared by Chit and Judge (2011), real exchange rate volatility has a negative impact on exports, especially in developing countries. However, its effects may be dampened, depending on the level of financial development. Exchange rate volatility can be measured in different ways including the ARCH effect (Zargar Talebi *et al*., 2016). The effect of the exchange rate may be asymmetric, i.e., the appreciation effect of the real exchange rate is different from depreciation. Thus the movement of the real exchange rate should be decomposed into positive and negative components (Bahmani-Oskooee and Fariditavana, 2016).

Trade openness: economists believe that economies that are more open grow faster since it is expected to improve resource allocation. Openness may show the degree to which an economy is open having trade (Tesfaye, 2014). The ratio of trade-GDP usually is applied as an openness indicator. We used the following indicator (Nguyen, 2007):

$$OP_{ijt} = \frac{1}{2}\left(\frac{\boldsymbol{EXP_{it}+IMP_{it}}}{\boldsymbol{GDP_{it}}} + \frac{\boldsymbol{EXP_{jt}+IMP_{jt}}}{\boldsymbol{GDP_{jt}}}\right) \quad (3)$$

Where EXP_{it}, IMP_{it}, and GDP_{it} are total import, total export and GDP of the country i, respectively; EXP_{jt}, IMP_{ij}, and GDP_{jt} are those for the country j. The greater the value of this indicator, the more open the country will be.

Linder similarity index: based on the Linder's hypothesis, more intensive international trade flow is expected between

countries with similar demand structures. The Linder effect variable is calculated as follows (Kitenge, 2021):

$$LnLIN_{ijt} = Ln(YP_{it} - YP_{jt})^2 \quad (4)$$

Where YP_i and YP_j denote the per capita income in exporting and importing countries, respectively.

Sanction: sanctions effect was considered using dummy variables. Iran has experienced sanctions for many years enacted by the United States, the EU, and Canada. Sanctions were enacted from 1984 and were supplemented by comprehensive sanctions in 2010 and 2012 by the U.S., the EU, Canada, and the UN Security Council (Hufbauer *et al.*, 2012). We considered before 2010 as mild sanctions period, while the remaining period was included as period with severe and comprehensive sanctions.

Global economic crisis: the period for the global economic crisis includes 2007-2009 (Kahouli and Maktouf, 2015), which was considered using a dummy variable.

Regarding the explanatory variables discussed above, the empirical gravity regression model of this study is as follows:

$$Ln\,X_{ijt} = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_1} Ln\,GDP_{it} + \boldsymbol{\alpha_2}\,Ln\,GDP_{jt} + \boldsymbol{\alpha_3} Ln\,POP_{it} + \boldsymbol{\alpha_4}\,Ln\,POP_{jt} + \boldsymbol{\alpha_5} Ln\,D_{ij} + \boldsymbol{\alpha_6}\,Ln\,LIN_{ijt} + \boldsymbol{\alpha_7}\,Ln\,ER_{ijt} + \boldsymbol{\alpha_8}\,Ln\,OP_{ijt} + \boldsymbol{\alpha_9}\,Ln\,VER^{+}_{ijt} + \boldsymbol{\alpha_{10}}\,Ln\,VER^{-}_{ijt} + \boldsymbol{\alpha_{11}} Low_t + \alpha_{12} EXT_t + \alpha_{13} Crisis_t + \boldsymbol{U_{ijt}} \quad (5)$$

where X_{ijt}, GDP_{it}, POP_{it}, $Ln\,D_{ij}$, $Ln\,LIN_{ijt}$, $Ln\,ER_{ijt}$, $Ln\,OP_{ijt}$, $Ln\,VER^{+}_{ijt}$, $Ln\,VER^{-}_{ijt}$, Low_t, EXT_t, and $Crisis_t$ represent the export of agricultural commodities from the country i (Iran) to the country j, the gross domestic of country,population, the distance between the country i and j, the Linder similarity index, the real exchange rate, the trade openness, the positive and negative components of exchange rate fluctuations, the mild and severe (comprehensive) sanctions against Iranian economy, and the global economic crisis, respectively. U is an error term. iitands for Iran, and j represents the trading partners or importing countries and t shows time. The monetary values are expressed in 1997 constant prices.

Trade balance is the difference between the monetary value of exports and imports. Due to negative values when the imports exceed the exports, the logarithmic form will not be possible to calculate. Therefore, it can be measured as the ratio of export to import. The advantage of using this ratio is that it is insensitive to the units of measurement, and the real or nominal values of measuring export and import (Bahmani-Oskooee, 1991). In J-Curve analysis, the exchange rate is the most critical variable; however, there are other driving forces that have been applied to the agricultural commodities trade balance. The trade balance equation for agricultural commodities can be written as follows (Esmaili *et al.*, 2020; Arman *et al.*, 2018; Jagdambe and Kannan, 2020):

Trade balance and J-Curve

$$Ln\,TB_t = \alpha_0 + \alpha_1 Ln\,AGRI_t + \alpha_2\,Ln\,RER_t + \alpha_3\,Ln\,OP_t + \alpha_4\,Ln\,VER^{+}_{ijt} + \boldsymbol{\alpha_5}\,Ln\,VER^{-}_{ijt} + \boldsymbol{\alpha_6} Low_t + \boldsymbol{\alpha_7} EXT_t + U_t \quad (6)$$

Where$TB$is trade balance, $AGRI$ represents the agricultural value added of Iran and t stands for time. Other variables are similar to those presented in the gravity specification. It is worth noting that exchange rate fluctuations were examined using the ARCH effect as well. This effect was obtained based on an ARMA model estimated for the exchange rate. For the gravity model, the panel data related to 1997-2017 was used. The corresponding period for trade balance is 1978-2018. The data were obtained from Food and Agriculture Organization (2018), the Central Bank of Iran (2017), the Statistical Center of Iran (2017), and TRADE MAP (2018) website. The importing countries are Afghanistan, the United Arab Emirates, Germany, Hong Kong, India, Pakistan, Russia, Turkmenistan, Turkey,

Vietnam, Azerbaijan, Kuwait, Lebanon, Oman, Qatar, and Saudi Arabia.

Results and Discussion

Export (Gravity model)

Before estimating the model, the unit root test and Chaw and Hausman test was carried out. The results of unit root test support the stationary of the applied series at usual critical levels. The results for the Chaw test also indicated the pool ability of the applied data. Housman's test statistics did not reject the random effect hypothesis. It is worth noting that due to first order serial correlation we applied the first lag of the dependent variable. However, this variable is expected to be correlated with error terms, and the instrumental variables (IV) method is used due to the endogeneity problem (Baltagi, 2008). Table 1 represents the related results.

The distance variable, in agreement with the related theory, shows a negative effect; however, the absolute value of the related coefficient is not significant. Based on the coefficient, a 10% difference in physical distance of two distinctions may lead to only around 1% export distinction. The significant values of the fixed cost compared to the costs induced by distance may be responsible for this negligible effect. Gani and Al-Mawali, (2013) also found a negative impact on Oman's import from Asian economies, while the corresponding result for export, contrary to expectations, was positive. They suggest that the distance is not for Oman's export as friction, since its export is oil-based export and energy requirements. Croce *et al*. (2004) also reported lower importance for distance for western hemisphere trading blocs. However, Zarif *et al*. (2011) suggest a significant effect of distance.

The coefficients of per capita GDP, as expected, are positive however, for importing partners is not significant statistically. Based on the coefficient estimated, an increase in Iranian per capita GDP by 1% may result in higher agricultural export by 3.4%. The higher GDP may be translated into higher investment in infrastructure in the economy and providing more chances for export expansion. There is weak evidence of similar effects on Chinese export (Nasrullah *et al*., 2020).

Table 1- Estimation results for agriculture gravity model (Export)

Variables	Coefficients	Standard errors	t-statistics
Constant	-32.367***	6.267	-5.164
Iran's per capita GDP[1]	3.429***	0.669	5.125
GDP of the Iran's trading partners	0.014	0.022	0.625
Trading partners population	0.063***	0.020	2.764
Linder similarity	0.127	0.132	0.962
Trade openness	0.128*	0.073	1.740
Real exchange rate	0.608***	0.179	3.388
Distance	-0.098*	0.051	-1.897
Severe (comprehensive) sanctions	-0.232**	0.098	-2.373
Mild sanctions	-0.034	0.084	-0.406
Positive fluctuations of exchange rate	0.383***	0.127	3.008
Negative fluctuations of exchange rate	-0.981***	0.166	-5.885
World Economy crisis	-0.248***	0.066	-3.719
Lagged export variable	0.910***	0.051	17.610
Statistics JB	J-statistic	Adjusted R-squared	R-squared
262.1(0.000)	5.80(0.325)	0.865	0.871

1- Regarding the high correlation of Iran's GDP and population with other variables, these variables were transformed and applied as per capita GDP.

The population of importing countries has a positive effect on the Iranian agricultural exports, which is in line with the findings of Nasrullah *et al*. (2020) and Gani and Almawali (2013). Contrary to the theoretical expectation, the Linder similarity index shows a positive effect, indicating that agricultural export is inclined to partners with lower similarity in terms of per capita GDP. This may cause from the identical taste in the countries with similar per capita GDP. As declared by Markusen *et al*. (1995), identical testes may result in a no-trade situation. Usually, the per capita income is interpreted as the level of development; therefore, this may show that the countries with higher divergence in per capita income are expected to have more trade with Iran. A similar result was also reported by Razini *et al*. (2015).

Trade openness affects the export of agricultural commodities positively. It is worth noting that this variable is calculated at an economy-wide level, revealing the extent of the tendency of the economy toward the global economy. A similar result was obtained for ECO members (Zargar Talebi *et al*., 2016). The real exchange rate, as expected, has a positive effect on agricultural export. The related coefficient is around 0.6, indicating that a 10% increase in the real exchange rate will increase the agricultural export by 6%. This finding is in line with the result obtained by Zargar Talebi *et al*. (2016). Exchange fluctuations that were considered in positive and negative components show that it affects the export directly, i.e., the positive changes raise the export while the negative changes result in lower export. A similar result has been reported by Abu Hatab *et al*. (2010) for Egyptian agricultural export.

Severe sanctions may affect agricultural export significantly, while the effect of mild sanctions in terms of both the magnitude of coefficient and the statistical significance sound negligible, indicating that in enacting sanctions against Iran, agricultural commodities have lower priorities. These results are in line with the findings by Dizaji, (2018) and Arman *et al*. (2018). Another variable is the global economic crisis which shows a negative effect. The recession that occurred in the worldwide economy resulted in lower demand for importing commodities. The impact of the crisis on agricultural commodities export is significant in terms of coefficient value. It is worth noting that the effect of the economic crisis is more effective than sanctions. The global economic crisis is expected to affect the countries and restrict trade between countries, while international trade is a systematic phenomenon (Dourandish *et al*., 2018).

Trade Balance of Agricultural Commodities

The results of the unit root test of the applied series support the stationary in the applied series at a 5% significance level. Table 2 presents the trade balance equation for total agricultural commodities, while the results for the agricultural sectors, including livestock, agronomy, and horticulture sectors, are reported in Table 3. Two specifications have been estimated for agricultural trade balance; the first one applies positive and negative components of changes in exchange rate, while the second one uses the ARCH effect as the proxy for real exchange rate fluctuations. In Model 1, agricultural value added has a positive effect, as expected (Table 2). An increase in agricultural production is expected to raise the export and dampen agricultural imports, resulting in an improvement in the trade balance. The related coefficient shows that a 1% increase in agricultural value added will increase the agricultural trade balance by more than 2%.

The real exchange rate also, is negatively related to the trade balance of agricultural commodities, which supports the J-Curve theory. However, it should be noted that strategic commodities, like most the cereals, are provided by the government at subsidized prices and, government plays an important role in their imports. Similar results are also reported in the literature (Najarzadeh *et al*., 2009; Pedram *et al*., 2011; Piraee *et al*., 2015).

The effect of exchange rate is not significant. It is worth noting that the impact of the exchange fluctuations on imports and exports in opposite directions may result in an insignificant impact on the trade balance. The degree of openness also shows a significant impact on the trade balance. Piraee *et al.* (2015) suggest that trade liberalization can increase non-oil exports.

Table 2- Estimation results for agriculture trade balance

	Mode1		Model 2	
Variables	**Coefficients**	**Standard errors**	**Coefficients**	**Standard errors**
Constant	***-25.613	2.778	***-27.971	2.700
Agriculture value added	***2.175	0.257	***2.321	0.231
Real exchange rate	***-0.648	0.240	*-0.385	0.234
Trade openness	0.143	0.555	-0.031	0.502
Mild sanctions	**-0.721	0.304	**-0.604	0.283
Severe (comprehensive) sanctions	**-0.891	0.372	***-0.916	0.305
Negative fluctuations of exchange rate	-0.373	0.468	-	-
Positive fluctuations of exchange rate	0.034	0.328	-	-
ARCH effect		-	2.70	4.280
Statistics				
R^2	0.802		-	0.824
JB	)0.847(0.331		-	)0.781(0.493
Q(1)	)0.016(5.850		-	)0.116 (2.468
Q(2)	)0.047(6.109		-	)0.259 (2.698

Sanctions at both severe and mild level affect the agricultural trade balance negatively. This means that exports will be under more pressure than imports, worsening the trade balance. It is worth noting that, as presented in Table 1, sanctions will affect export adversely, indicating that exports are expected to be affected more significantly compared to imports.

In Model 2, exchange rate fluctuations were examined using the ARCH effect extracted from an ARMA model estimated for the exchange rate. The impact of added value, real exchange rate, and sanctions are the same as Model 1. Contrary to the expectations, trade openness affects trade balance reversely in Model 2; however, regarding the absolute value and the statistical significance, its coefficient is not influential. Trade openness is expected to promote economic growth, accompanied by exports. The lower technology may dampen international trade, as declared in the literature (Ahmadian Yazdi *et al.*, 2015). The ARCH effect failed to affect the trade balance significantly, which is in line with the findings of Khosravi and Mohseni, (2014). The Ljung–Box Q-statistics presented in Table 2 show that the residuals are not significantly correlated. Table 3 presents the trade balance estimations results for agricultural sectors. The model estimated for the livestock sector may contribute explaining more than 88% of changes in trade balance of this sector using explanatory variables. Based on the results, value added with the coefficient of more than 3 accounts for a significant part of changes in the trade balance in the livestock sector. Although the positive effect is interesting for this variable, it may indicate an unsatisfactory situation.

The real exchange rate has a remarkable impact on trade balance; however, the effect of positive and negative changes in exchange is not the same in terms of value and statistical significance. The negative changes failed to affect the trade balance significantly. This supports the existence of the J-Curve theory, meaning that the devaluation of Iranian currency leads to worsening trade balance. This mainly causes from the fact that most of the trade in this sector is faced with the government intervention and the changing nature of the policies taken by government.

Table 3- Estimation results for agricultural sub-sectors trade balance

variable	Horticultural				Agronomy				Livestock			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	Coefficients	Standard errors	Coefficients	Standard Errors	Coefficients	Standard Errors	Coefficients	Standard Errors	Coefficients	Standard Errors	Coefficients	Standard Errors
Constant	-5.581**	2.787	-9.467***	2.850	-33.777***	3.206	-11.358*	6.110	-37.266***	8.410	-44.614***	9.433
Value added	0.583**	0.262	0.875***	0.248	2.649***	0.283	1.224**	0.516	3.171***	0.795	3.709***	0.816
Real exchange rate	0.565**	0.220	0.553**	0.233	-0.212	0.355	-0.131	0.308	-2.988***	0.726	-1.321*	0.723
Trade openness	0.293	0.379	0.044	0.524	-2.583**	1.158	-2.363***	0.487	-5.779***	1.299	-5.784***	1.283
Mild sanctions	-0.107	0.196	-0.225	0.291	-0.813***	0.233	-0.826***	0.250	-2.317***	0.768	-1.445*	0.750
Severe(comprehensive) sanctions	-0.446*	0.243	-0.854***	0310	-2.758***	0.596	-2.225***	0.376	-4.679***	1.030	-3.941***	0.957
Negative fluctuations of exchange rate	-0.284	0.232	-	-	-0.177	0.682	-	-	-0.091	1.147	-	-
Positive fluctuations of exchange rate	-0.553**	0.237	-	-	0.150	0.378	-	-	1.883**	0.833	-	-
ARCH effect			2.679	4.268	-	-	-26.964***	3.609	-	-	4.462	11.201
Dummy variables of 1978-83)					-	-	-	-	-2.647***	0.902	-1.527*	0.873
Lagged dependent variable					0.305**	0.109	0.741***	0.088	-	-	-	-
Statistics												
R^2	0.618		0.549		0.959		0.928		0.884		0.881	
JB	0.024(0.987)		0.404(0.816)		0.859(0.650)		0.876(0.645)		0.099(0.951)		0.045(0.977)	
Q(1)	1.971(0.160)		0.888(0.346)		4.243(0.039)		0.764(0.382)		1.657(0.198)		2.312(0.128)	
Q(2)	1.998(0.368)		0.913(0.633)		4.259(0.119)		0.778(0.678)		3.857(0.145)		5.886(0.053)	

The negative effect of trade openness also will induce pressure on the trade balance of livestock commodities. This implicitly indicates the lack of comparative advantages in the production of livestock products. Parikh and Stirbu, (2004), suggest that in some developing countries, trade liberalization may lead to faster growth of imports compared to exports, resulting in worsening trade balance. Similar results also have been reported by other Iranian studies (Ahmadian Yazdi *et al*., 2015). Sanctions at any level are expected to put pressure on the trade balance, indicating that exports of livestock commodities are expected to be more affected compared to their imports. Dummy variables for 1978 and 1983 show a significant adverse effect. Production and export of Iran in the livestock sector after 1978 have experienced tremendous changes (Food and Agriculture Organization, 2018). Model 2 of livestock specification significantly is similar to Model 1; however, the effect of exchange fluctuation proxied by ARCH effect terms is not statistically significant. Regarding the results obtained for exchange rate fluctuation variables in both models, it can be concluded that the trade balance is sensitive to positive changes in the exchange rate, and the negative fluctuations are not taken into account. Another critical difference between Model 1 and 2 in livestock specification relates to the magnitude of the exchange rate coefficient, which is around two times higher in the first specification compared to the second one. However, in both models, J-Curve phenomenon is supported.

The first model for the agronomy sector does not support the existence of the J-Curve theory. A similar finding has also been reported in the literature (Najarzadeh *et al*., 2009; Piraee *et al*., 2015; Pedram *et al*., 2011). Positive and negative components of the real exchange rate also have the expected sign; however, their effect is not statistically significant. Trade openness is expected to affect the trade balance of the agronomy sector negatively. It is worth noting that, as mentioned before, Iran is considered a major importing of cereals, and becoming more exposed to the global market may result in faster growth in imports rather than exports, as declared by Parikh and Stirbu, (2004). Another closely related variable is sanctions, which will put pressure on the trade balance at both levels, and the greater the extent of sanctions, the more will be pressure on the trade balance, indicating more restrictions on export compared to imports. Added value, as expected, will improve the trade balance. The related coefficient amounts to a significant value of 2.65.

The effect of explanatory variables in Model 2 for the agronomy sector is similar to Model 1. The ARCH terms, as a proxy for real exchange rate fluctuations, are negative. As a distinguishing feature, we may point out the magnitude of variable value added that is less than half in Model 2 compared to model 1. To some extent, the effect of severe sanction has decreased in Model 2. Like specificationsfor the agronomy and livestock sectors, the trade balance of horticultural sector is also related positively to value added, and increased domestic production of horticultural output is expected to stimulate their exports, leading to improvement in the trade balance. The real exchange rate affects the horticultural trade balance positively, which doesn't support the J-Curve theory. This effect may represent the long-run effect of the exchange rate since it indicates that the increase in the exchange rate results in a higher trade balance that may be translated into lower imports and higher exports. The nature of agricultural products that is time-consuming to be produced may be responsible for this effect. The negative component of the real exchange rate failed to affect the trade balance significantly. This insignificant effect may be the result of a similar effect by the exchange rate on imports and export in which the opposite direction of changes in imports and export leads to slight changes in the trade balance.

Trade openness has no significant relation with the trade balance of horticultural commodities, which is in line with the findings of Piraee *et al*. (2015). Sanctions influence the trade balance of horticultural products

adversely; however, their effect is less restrictive compared to those seen for the agronomy and livestock sectors. The export of horticultural products experienced a remarkable reduction in 2009 due to a significant decrease in precipitation (Food and Agriculture Organization, 2018). This effect was included using a dummy variable. In Model 2, the fluctuations of the exchange rate sound insignificant.

Conclusion and Policy Implications

Expansion of non-oil exports, especially agricultural exports, has been a targeted intervention in policies. Accordingly, this study attempted to examine the determinants of agricultural export and trade balance. However, it should be noted that exports expansion in agricultural commodities will demand more environmental resources. As the findings show, there are some threats and opportunities in the agricultural commodities trade. Globalization and the progresses in international trade may promote agricultural trade as declared by some empirical works like Gani and Al-Mawali, (2013), and nowadays, trading is not limited to common-border partners. There are two implications based on the current study findings; first, the impact of the global economic crisis that occurred in 2007 has been stronger even than sanctions enacted against Iranian trade. Second, distance is not a restricting factor, indicating that there are high other fixed costs that outweigh the distance trade costs. The lower importance of distance has been reported in some empirical works in the related literature (Gani and Almawli, 2013; Croce *et al*., 2004). It might be related to globalization which has been resulted in diminished importance of distance. Therefore, distant destinations also can be considered. The targeted countries for Iranian agricultural exports are those with growing per capita income and population while providing the domestic demand also should not be forgotten. In addition, similarity in per capita GDP is not a determinant, and differences in production technology and commodities composition are expected to be more determinants in international trade (Markusen *et al*., 1995; Razini *et al*., 2015). For instance, some common-border countries like Iraq, while in terms of per capita GDP, may be close to Iran, due to limited conditions for producing agricultural products, are as central importing countries. For exports expansion, both integrations with the global economy and removing barriers like sanctions are essential. The comprehensive period of sanctions covering the period after 2011 (Hufbauer *et al*., 2012), has been restricting the exports of agriculture and the entire economy (Aghaei *et al*., 2018). The exchange rate deserves to be treated as the main driving force of agricultural exports. Regarding the potential of asymmetric effects (Bahmani-Oskooee and Fariditavana, 2016), it was examined while the changes were decomposed into positive and negative components. Positive changes in exchange may expand agricultural exports, which is in line with the empirical works like Zargar Talebi *et al*. (2016), for Iran and Abu Hatab *et al*. (2010), for Egypt. However, fluctuations may affect exports adversely.

The trade balance of agricultural commodities is positively affected by the domestic output expansion. This contribution may be realized if exports expand and imports contract. However, the contribution of exchange to the trade balance needs time, based on the J-Curve evidence, putting pressure on the trade balance in the short run while it is expected to be improved in the long run and after passing the downward part of the J-Curve. However, the evidence for the J-Curve for horticultural commodities is not significant, which may be related to the nature of their output, which is perennial plant. This also recommends the significance of time in policy implementation. As far as the agricultural sectors are concerned, agronomy and horticultural sectors have more potential for exports while livestock is more exposed to increased imports. These tendencies toward exports and imports will be reinforced with more integration with the global economy. Sanctions also will put more pressure on exports rather than imports, resulting in

worsening trade balance of agricultural commodities. Accordingly, the livestock sector will be more vulnerable to confronting the global economy, needing more caution in implementing the policies. In order to expand agricultural exports, some attempts should be made including, dampening the exchange rate fluctuations, lowering trade barriers to be more integrated with the global economy, especially accession to the World Trade Organization (WTO), and targeting the nations with growing income and populations.

References

1. Abu Hatab, A., Romstad, E., & Huo, X. (2010). Determinants of Egyptian agricultural export: A gravity model approach. *Modern Economy* 1: 134-143. http://doi.org/10.4236/me.2010.13015.
2. Aghaei, M., Rezagholizade, M., & Mohammdrezaei, M. (2018). Impact of economic and commercial sanctions on Iran's trade relations and their major trading partners. *Strategic Studies of Public Policy* 28: 49-68. http://sspp.iranjournals.ir/article_30294.html. (In Persian)
3. Agostino, M.R., Aiello, F., & Cardamone, P. (2007). Analyzing the impact of trade preferences in gravity models: Does aggregation matter?. *TRADEAG Working Paper* 7294: 1-35. http://doi.org/10.22004/ag.econ.7294.
4. AhmadianYazdi, F., Salimifar, M., & Ahmadi Shadmehri, M. (2015). The impact of trade liberalization and economic growth on non-oil bilateral trade flow between Iran and china over the period 1981-2012. *Economic Growth and Development Research* 20: 11-30. (In Persian). http://doi.org/20.1001.1.22285954.1394.5.20.1.5.
5. Anderson, J.E., & Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle, *The American Economic Review* 93: 170-192. https://www.jstor.org/stable/3132167.
6. Arman, S.A., Salahmanesh, A., & Alaei, R. (2018). Investigating the effect of the comprehensive sanctions of the Security Council on the trade volume of Iran and selected countries, focusing on the effect of the recent financial crisis. *Strategy and Development* 53: 188-214. (In Persian). https://www.magiran.com/volume/131812.
7. Bahmani-Oskooee, M. (1991). Is there a long-run relation between the trade balance and the real effective exchange rate of LDCs?. *Economic Letter* 36: 403-407. https://doi.org/10.1016/0165-1765(91)90206-Z.
8. Bahmani-Oskooee, M., & Fariditavana, H. (2016). Nonlinear ARDL approach and the J-Curve phenomenon. *Open Economic Review* 27: 51-70. https://doi.org/10.1007/s11079-015-9369-5.
9. Baltagi, B.H. (2008). *Econometric Analysis of Panel Data*. 4th edition. John Wiley & Sons Ltd, Chic Ester. https://doi.org/10.1007/978-3-030-53953-5.
10. Beak, J., & Koo, W.W. (2007). Dynamic interrelationships between the U.S. agricultural trade balance and the Macroeconomy. *Journal of Agricultural and Applied Economics 39*(3): 457–470. https://doi.org/10.1017/S1074070800023208.
11. Bergstrand, J.H. (1990). The Heckscher-Ohlin-Samuelson model, the Linder hypothesis and the determinants of bilateral intra-industry trade. *The Economic Journal 100*(403): 1216-1229. https://doi.org/10.2307/2233969.
12. Cekyay, B., Kabak, O., Ulengin, F., Ulengin, B., Palut, P.T., & Ozaydin, O. (2020). A multi-commodity network flow and gravity model integration for analyzing impact of road transport quotas on international trade. *Research in Transportation Economics* 80: 100816. https://doi.org/10.1016/j.retrec.2020.100816.
13. Central Bank of Iran. (2017). A yearly publication. http://tsd.cbi.ir/Display/Content.aspx.
14. Cheng, K.M. (2020). Currency devaluation and trade balance: Evidence from the US services trade. *Journal of Policy Modeling 42*(1): 20-37. https://doi.org/10.1016/j.jpolmod.2019.09.005.
15. Chit, M.M., & Judge, A. (2011). Non-Linear effect of exchange rate volatility on exports: The role of financial sector development in emerging East Asian economies. *International Review of Applied Economics 25*(1): 107-119. https://doi.org/10.1080/02692171.2010.483463.
16. Croce, E., Juan-Ramon, V.H., & Zhu, F. (2004). Performance of Western hemisphere trading blocs: A cost corrected gravity approach. *International Monetary Fund 4*(109): 3-22.

https://www.imf.org/en/Publications/WP/Issues/2016/12/30/Performance-of-Western-Hemisphere-Trading-Blocs-A-Cost-Corrected-Gravity-Approach-17425.
17. Dizaji, S.F. (2018). Trade openness, political institutions, and military spending. *Empirical Economics Forthcoming 57*(6): 2013-2041. https://doi.org/10.1007/s00181-018-1528-2.
18. Dogru, T., Isik, C., & Sirakaya-Turk, E. (2019). The balance of trade and exchange rates: Theory and contemporary evidence from tourism. *Tourism Management* 74: 12-23. https://doi.org/10.1016/j.tourman.2019.01.014.
19. Dourandish, A., Aminzadeh, M., Riahi, A., & MehrparvarHosseini, E. (2018). Assessing the role of trade sanctions and global economic crisis on Iran's saffron exports. *Saffron Agronomy and Technology* 22: 499-511. (In Persian). https://doi.org/10.22048/jsat.2017.85769.1231.
20. Dubas, J.M. (2009). The importance of the exchange rate regime in limiting misalignment. *World Development 37*(10): 1612-1622. https://doi.org/10.1016/j.worlddev.2009.02.003.
21. Esmaili, S., Ghahramanzadeh, M., Mahmoudi, A., Mehrara, M., &Yavary, G. (2020). The impact of exchange rate and oil price fluctuations on Iran's agriculture trade balance: Application of the J-curve approach. *Journal of Agricultural Economics and Development 34*(2): 179-200. (In Persian with English abstract). https://doi.org/10.22067/JEAD2.V34I2.85637.
22. Food and Agriculture Organization (FAO). (2018). Retrieved from http://www.fao.org/faostat/en/#home.
23. Gani, A., & Al-Mawali, N.R. (2013). Oman's trade and opportunities of integration with the Asian economics. *Economic Modeling* 31: 766-774. https://doi.org/10.1016/j.econmod.2013.01.015.
24. Ghanbari, M., & Sagheb, H. (2010). The impact of the free trade agreement (FTA) between Iran and Turkey on the expansion of non-oil export and the import of capital and intermediate goods to Iran. *The Scientific Journal of Strategy* 57: 277-295. http://rahbord.csr.ir/?_action=article&kw=320883&_kw=Free+Trade+Agreement%28FTA%29&lang=en. (In Persian)
25. Hosseini, S.S., & Homayounpour, M. (2013). Factors affecting agricultural commodities export in Iran. *Agricultural Economics 6*(4): 1-16. (In Persian). https://www.sid.ir/paper/124407/fa.
26. Hufbauer, G.C., Schott, J.J., Elliott, K.A., &Muir, J. (2012). Case studies in economic sanction and terrorism: Post- 2000 sanction episodes. Peterson Institute for International Economics. https://www.piie.com/commentary/speeches-papers/case-studies-economic-sanctions-and-terrorism.
27. ICCIMA (Iran Chamber of Commerce, Industries, Mines & Agriculture), (2019). The publication section. https://iccima.ir/
28. Jagdambe, S., & Kannan, E. (2020). Effects of ASEAN- India free trade agreement on agricultural trade: The gravity model approach. *World Development Perspectives* 19: 100212. https://doi.org/10.1016/j.wdp.2020.100212.
29. Kabir, M., Salim, R., & Al-Mawli, N. (2017). The gravity model and trade flows: Recent developments in econometric modeling and empirical evidence. *Economic Analysis and Policy* 56: 60-71. https://doi.org/10.1016/j.eap.2017.08.005.
30. Kahouli, B., & Makttouf, S. (2015). The determinants of FDI and the impact of the economic crisis on the implementation of RTAs: A static and dynamic gravity model. *International Business Review 24*(3): 518-529. https://doi.org/10.1016/j.ibusrev.2014.10.009.
31. KarimiHasnijeh, H. (2007). The trade potential of agricultural products. *Agricultural Economics 1*(2): 141-154. (In Persian)
32. Khan, S., Haq, I., & Khan, D. (2013). An empirical analysis of Pakistan'sbilateraltrade: A gravity model approach. *The Romanian Economic Journal* 48: 103-120. https://doi.org/10.1.1.906.7050.pdf.
33. Khosravi, M., & Mohseni, R. (2014). The effect of exchange rate uncertainty on agricultural trade balance (An application of GARCH, EGARCH and TGARCH model). *Agricultural Economics 8*(2): 69-86. http://www.iranianjae.ir/article_9163.html?lang=en. (In Persian)

34. Kitenge, E. (2021). The Linder hypothesis during the globalization era. *Economic Letters*, 200, 109775. https://doi.org/10.1016/j.econlet.2021.109775.
35. Lal, A.K., & Lowinger, T.C. (2002). Nominal effective exchange rate and trade balance adjustment in South Asia countries. *Journal of Asian Economics* 13: 371-383. https://doi.org/10.1016/S1049-0078(02)00120-3.
36. Magee, S.P. (1973). Currency contracts, pass-through, and devaluation. *Brookings Papers on Economic Activity* 1: 303–325. https://doi.org/10.2307/2534091.
37. Malith, P.G.D., Perera, M.S.S., & Perera, G.A.N. (2021). *An analysis of the determinants of Sri Lanka's trade balance with major trading partners*. 12th International Conference on Business & Information ICBI, University of Kelaniya, Sri Lanka. ISSN 2465-6399 (pp. 198-211). http://dx.doi.org/10.2139/ssrn.4117101.
38. Markusen, J.R., Melvin, J.R., Kaempfer, W.H., & Maskus, K.E. (1995). *International Trade, Theory and Evidence*. McGraw-Hill. The USA. https://books.google.com/books/about/International_Trade.html?id=Yc_WHwAACAAJ.
39. Martinez-Zarzoso, I., Felicitas, N.L.D., & Horsewood, N. (2009). Are regional trading agreements beneficial? Static and dynamic panel gravity models. *The North American Journal of Economics and Finance 20*(1): 46-65. https://doi.org/10.1016/j.najef.2008.10.001.
40. Martinez-Zarzoso., & Lehmann, N. (2003). Augmented gravity model: An application to Mercosur- European Union Trade Flows. *Journal of Applied Econometrics* 6: 291–316. https://doi.org/10.1080/15140326.2003.12040596.
41. McCallum, J. (1995). National borders matter: Canada-U.S regional trade patterns. *The American Economic Review 85*(3): 615-623. https://www.jstor.org/stable/2118191.
42. Mehrparvar Hosseini, E., Aminzadeh, M., Rafiee, H., Riahi, A., & Bastani, M. (2013). Designing of Iranian dates trade model; Application of trade advantages and theory of market structure. *Agricultural Economics 7*(2): 19-46. (In Persian). http://www.iranianjae.ir/article_9259.html?lang=en.
43. Mortazavi, A., Javadi Yanbolagh, R., & Vakilpour, M. (2014). The determinants and trade potentials of export of the Iran's shrimp in European Union: Using a gravity model. *Journal of Agricultural Economics Research* 23: 21-41. (In Persian). https://doi.org/20.1001.1.20086407.1393.6.23.2.6.
44. Najarzadeh, R., Agheli, L., & Shaghaghi Shahri, V. (2009). The effect of the exchange rate and the real exchange rate on the deficit of the foreign trade in Iran's economy. *Economic Research (Sustainable Growth and Development) 9*(2): 73-102. (In Persian). https://doi.org/20.1001.1.17356768.1388.9.2.5.1.
45. Nasrullah, M., Chang, L., Khan, K., Rizwanullah, M., Zulfiqar, F., & Ishfaq, M. (2020). Determinants of forest product group trade by gravity model approach: A case study of China. *Forest Policy and Economics* 113: 102117. https://doi.org/10.1016/j.forpol.2020.102117.
46. Nguyen, T. (2007). Determinants of business cycle synchronization in East Asia: An extreme bound analysis. *DEPOCEN Working Paper* No. 14. https://EconPapers.repec.org/RePEc:dpc:wpaper:1407.
47. Oguledo, V., & MacPhee, C. (1994). Gravity models: A reformulation and an application to discriminatory arrangements. *Applied Economics 26*(2): 107–120. https://doi.org/10.1080/00036849400000066.
48. Parikh, A., & Stirbu, C. (2004). Relationship between trade liberalization, economic growth and trade balance: An econometric investigation. Hamburg Institute of International Economics, *Discussion Paper No. 282*. http://hdl.handle.net/10419/19254.
49. Pass, T. (2002). Gravity approach for exploring Baltic Sea regional integration in the field of international trade. Hamburg Institute of International Economic, *Discussion Paper No.*180. http://hdl.handle.net/10419/19342**.**

50. Pedram, M., Shirinbakhsh, S., & Rahmani, M. (2011). The J-Curve dynamics of Iran foreign trade. *Journal of Economic Research and Policies 19*(60): 5-18. (In Persian). http://qjerp.ir/article-1-183-fa.html.
51. Piraee, K., Tasan, M., &Daneshnia, M. (2015). The effect of foreign direct investment, real exchange rate and economic liberalization on non – oil exporting in Iran (Using Toda Yamamoto causality test). *Journal of Economic Research* 50: 75-98. (In Persian). https://doi.org/.10.22059/JTE.2015.54097.
52. Razini, E., Mirzaeinehad, M., & Shirinzadeh, M. (2015). Survey of trade potentials between Iran and potential candidate countries in region (Turkey, Syria, Kuwait, Oman, Bahrain, Qatar, Saudi Arabia, and United Arab Emirates): The gravity model approach. *Trade Studies 20*(77): 147-167. (In Persian). https://doi.org/20.1001.1.17350794.1394.20.77.6.9.
53. Roy, M., &Rayhan, M.I. (2011). Trade flows of Bangladesh: A gravity model approach. *Economics Bulletin 31*(1): 950-959. https://ideas.repec.org/a/ebl/ecbull/eb-11-00050.html.
54. Sandberg, H.M. (2004). The impact of historical and regional linkages on free trade in the Americas: A gravity model analysis across sectors. *American Agricultural Economics Association Annual Meeting, Denver, Colorado 2*(4): 1-29. https://doi.org/10.22004/ag.econ.20201.
55. Serrano, R., & Pinilla, V. (2012). The long-run decline in the share of agricultural and food products in international trade: A gravity equation approach to its causes. *Applied Economics 44*(32): 4199-4210. https://doi.org/10.1080/00036846.2011.587786.
56. Shaghaghi Shahri, V. (2017). Regional integration and its impact on foreign direct investment (FDI). *Trade Studies 21*(84): 27-64. (In Persian). https://doi.org/20.1001.1.17350794.1396.21.84.2.0.
57. Soloaga, I., & Winters, L.A. (2001). Regionalism in the nineties: What effect on trade?. *The North American Journal of Economics Finance 12*(1): 1-29. https://doi.org/10.1016/S1062-9408(01)00042-0.
58. Statistical Center of Iran. (2017). http://amar.sci.org.ir.
59. Tesfaye, E. (2014). Determinants of agricultural export in sub-Saharan Africa: Evidence from panel study. *American Journal of Trade and Policy 1*(2): 62-70. https://doi.org/10.18034/ajtp.v1i2.364.
60. Trade Map. (2018). Retrieved from https://www.trademap.org/Index.aspx.
61. Yu, M. (2009). Revaluation of the Chinese Yuan and triad trade: A gravity assessment. *Journal of Asian Economics* 20: 655–668. https://doi.org/10.1016/j.asieco.2009.09.008.
62. Zargar Talebi, M., Mojaverian, M., & Sedeghi, S. (2016). Determinants of intra-regional agriculture trade intensity: Case study of ECO. *Trade Studies 20*(80): 149-169. (In Persian). https://doi.org/20.1001.1.17350794.1395.20.80.6.9.
63. Zarif, M., Salarpour, M., &Karbasi, A. (2011). Trade Evaluation of Iranian Agricultural Sector, Using Gravity Model and Panel Data. *Journal Agricultural Economics and Development 25*(2): 192-199. (In Persian with English abstract). https://doi.org/10.22067/JEAD2.V1390I2.9709.

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۴۲۹-۴۱۳

تعیین‌کننده‌های صادرات و تراز تجاری بخش کشاورزی ایران

سپیده ذوالانواری شیرازی[۱]- زکریا فرج زاده[۲*]

تاریخ دریافت: ۱۴۰۱/۰۵/۱۳

تاریخ پذیرش: ۱۴۰۱/۱۰/۱۴

چکیده

ایران با هدف کاهش وابستگی به درآمدهای حاصل از صادرات نفت و گاز، قصد دارد صادرات غیرنفتی را گسترش دهد. در همین راستا، این پژوهش سعی دارد عوامل تعیین‌کننده صادرات و تراز تجاری بخش کشاورزی ایران را بررسی کند. برای صادرات از مدل جاذبه و داده‌های ترکیبی سال‌های ۱۹۹۷تا ۲۰۱۷ استفاده شد. هم‌چنین تراز تجاری بخش کشاورزی و زیربخش‌های آن با استفاده از داده‌های دوره ۱۹۷۸ تا ۲۰۱۸ مطالعه شد. نتایج مدل جاذبه نشان داد متغیر فاصله بر میزان صادرات اثر منفی دارد. در حالی که اثر متغیرهای تولید ناخالص داخلی ایران و کشورهای واردکننده مطابق انتظار، مثبت به‌دست آمد. یافته‌ها نشان داد یک درصد افزایش تولید ناخالص داخلی سرانه ایران موجب افزایش صادرات محصولات کشاورزی به میزان ۳/۴۲ درصد خواهد شد. اما ضریب به‌دست آمده برای تولید ناخالص کشورهای واردکننده از اهمیت آماری پایینی برخوردار بود. هم‌چنین مشخص گردید افزایش جمعیت کشورهای واردکننده موجب افزایش تقاضا برای صادرات محصولات کشاورزی ایران خواهد شد. درجه بازبودن اقتصاد اثر مثبت و معنی‌داری بر صادرات نشان داد. ضریب متغیر نرخ ارز واقعی در حدود ۰/۹ به‌دست آمد و مشخص گردید تغییرات صادرات با تغییرات نرخ ارز هم جهت است. تحریم‌های شدید بر صادرات محصولات کشاورزی ایران اثر منفی نشان داد اما تحریم‌های کم، فاقد اثر معنی‌دار ارزیابی شد. هم‌چنین نتایج نشان داد متغیر بحران جهانی اقتصاد می‌تواند موجب کاهش صادرات محصولات کشاورزی ایران شود. در تصریح تراز تجاری مشخص گردید ارزش‌افزوده بخش کشاورزی و زیربخش‌های آن بر بهبود تراز تجاری اثر مثبت دارد. اما اثر نرخ ارز واقعی بر تراز تجاری بخش کشاورزی و زیربخش‌های زراعت و دام و طیور منفی ارزیابی شد که نشان‌دهنده تأیید تئوری منحنی J است. اما برای زیربخش باغبانی مورد تأیید قرار نگرفت. نوسانات نرخ ارز با استفاده از دو متغیر تغییرات مثبت و منفی این متغیر، و هم‌چنین اثر ARCH حاصل از تخمین مدل خودتوضیح میانگین متحرک در مدل لحاظ شد. اثر این دو متغیر ضمن تفاوت در اندازه ضریب، الزاماً هم‌جهت نبود. اثر متغیر درجه بازبودن اقتصاد بر تراز تجاری بخش کشاورزی و زیربخش باغبانی مثبت ارزیابی شد. به این معنی که تولید آنها مبتنی بر مزیت نسبی است. در حالی‌که اثر این متغیر بر تراز تجاری زیربخش‌های زراعت و دام‌وطیور منفی به‌دست آمد. هم‌چنین پیامد تحریم‌ها بر تراز تجاری منفی ارزیابی شد.

واژه‌های کلیدی: بخش کشاورزی، تراز تجاری، صادرات، مدل جاذبه

۱ و ۲- به‌ترتیب دانش آموخته کارشناسی ارشد ودانشیار،گروه اقتصاد کشاورزی، دانشکده کشاورزی، دانشگاه شیراز، شیراز، ایران

(*- نویسنده مسئول: Email: zakariafarajzadeh@gmail.com)

DOI: 10.22067/jead.2023.77925.1148

Journal of Agricultural Economics & Development

Homepage: https://jead.um.ac.ir

Full Research Paper
Vol. 36, No. 4, Winter 2023, p. 431-445

The Effects of Adaptation Strategies on Water Resources Management in Mashhad Plain: The Application of Hydro-economic-behavioural Modeling

H. Sakhdari[1], S. Ziaee[2 *], M. Ahmadpour Borazjani[3], H. Mohammadi[4]

Received: 17-08-2022
Revised: 30-11-2022
Accepted: 12-12-2022
Available Online: 15-02-2023

How to cite this article:
Sakhdari, H., Ziaee, S., Ahmadpour Borazjani, M., & Mohammadi, H. (2023). The Effects of Adaptation Strategies on Water Resources Management in Mashhad Plain: The Application of Hydro-economic-behavioural Modeling. *Journal of Agricultural Economics & Development* *36*(4): 431-445.
DOI: 10.22067/JEAD.2022.78289.1151

Abstract

Khorasan Razavi Province suffers from the most critical groundwater resources in Iran, i.e. the groundwater decline has reached 1 m; 34 out of 37 water plains are banned in Khorasan Razavi Province. Recently, Mashhad plain has been fighting with the crisis of drought and water scarcity. Illegal harvesting from groundwater resources and the warming trend caused by change in climate have exacerbated the crisis. Comprehensive water resources management, assuming the complicated nature of water-related issues, rapid growth of population, water requirement for a variety of purposes, and limited water resources, requires novel methods to stack up technical, economic, environmental, social, and logical perspectives in an integrated forum. One of the tools for comprehensive water resources management is utilizing hydro-economic models to simulate the present status of drainage basins and evaluate the impacts of different scenarios and policies. The current study used a hydro-economic model to simulate the hydrological status of Mashhad plain and evaluate the impacts of different scenarios. Then, the agent-based model (ABM) was used in order to reach an agreement with stakeholders on executing different conservation scenarios. The hydro-economic model results revealed that reducing the water demand of the agricultural sector and, as a result, surface and groundwater consumption is possible through following adaptation scenarios. Implementing various adaptation scenarios may alter the present cultivation pattern. Moreover, the ABM results showed a significant difference between the volume of available water, due to the execution of strategies, and water demand, bringing about the lack of farmers' cooperation regarding the implementation of conservation scenarios. However, through applying some incentive policies, a number of representative farmers may agree to pursue adaptation scenarios.

Keywords: Adaptation strategies, Water resources, Hydro-economic model, Mashhad Plain

Introduction

The evaluation of the water resources worldwide revealed that more than 50% of renewable and available water is consumed by human beings (Gleick and Palaniappan, 2010). In the last 60 years, the global population has more than doubled, from 2.6 billion in 1950 to 6.9 billion in 2010 (Ahmad and Dawadi, 2013), which has affected the water requirement, i.e. water demand has tripled from 1950 to 2003 and will double by 2035. Iran is an arid and semi-arid region in the globe with an average annual rainfall of 230 to 240 mm or annually 413 billion m^3 (Nazem al-Sadat *et al.*, 2006). Iran's population is rapidly rising which it is expected to reach 100 million

1, 2, 3 and 4- Ph.D. Student in Agricultural Economics, Associate Professors and Assistant Professor Department of Agricultural Economics, University of Zabol, Zabol, Iran, respectively.
(*- Corresponding Author Email: samanziaee@uoz.ac.ir)

by 2050 (Hosseini and Bagheri, 2012). Iran is located in the arid belt of the earth and is exposed to numerous droughts. Moreover, environmental degradation accelerated by population growth and its consequences on intensify use of resources to produce food while facing limited water resources have made the water crisis as a main challenge for Iran (*Poran et al.*, 2017). Factors that have created and intensified the crisis are water consumption patterns, ways of using the water resources, consumption situations, consumption technology, precipitation rate, and climatic changes (Shahnooshi *et al.*, 2016). Khorasan Razavi Province suffers from the most critical status of groundwater resources in Iran. The groundwater level declined by 1 m. Also, 34 out of 37 water plains are banned in Khorasan Razavi Province. Mashhad plain has been struggling for years with the crisis of drought and water scarcity (Yazdani *et al.*, 2016). Mashhad Plain is one of the plains of the Kashfrud watershed. Accordingly, considering the problems in Kashafrud basin, the hydro-economic modeling method was used to simulate the current and future status of the plain and apply different adaptation scenarios. Hydro-economic models consider hydrological, economic, engineering, and environmental aspects in the form of a coherent framework in line with the requirements of integrated management of water resources. The main purpose is to include economic concepts in the water resources plans models (Harou *et al.*, 2009). Different studies have used this method to simulate drainage basins. Forni *et al.* (2016) and Esteve *et al.* (2015) integrated WEAP[1] and mathematical programming models in a hydro-economic model framework to assess the impacts of climate change and its adaptation methods in the Guadiana River Basin (Portugal and Spain) and the San Joaquin Basin (United States). Zekri *et al.* (2017) used a dynamic mathematical programming model and a hydrological groundwater simulation model in a hydro-economic model framework for feasibility of groundwater monitoring by adopting smart water meters at individual farms and a centralized online information management system. Sharafpour *et al.* (2019) used an integrated hydro-economic model to allocate agricultural water according to economic value in six irrigation networks at downstream of Zayanderud Dam.

Nevertheless, hydro-economic models running based on basin simulation do not consider issues like the acceptance and cooperation of stakeholder in prescriptive optimization models. In other words, hydro-economic models do not answer the question whether or not the optimization models obtained from the mathematical model are executable regarding the basin. Hence, to fill the leakage of the mathematical models the Agent-based model (ABM) is introduced by unique features and applied in studies concerned the water resources management (Barthel *et al.*, 2010)(Nikolic and Simonovic, 2015) As research argued the agent-based models (ABM) covers the analysis to confront socio-economic and environmental inter-relationships. The ABM or multi-agent systems involve a set of agents specified by unique features and interact with each other based on adequate rules defined in an environment (Nasirzadeh *et al.*, 2008).

Here, provide a paragraph on goal(s) of your study and how adjust the method(s) for following the goal(s). Then close the introduction.

Materials and Methods

Conceptual Framework

Figure 1 depicts the conceptual framework. First, the impact of the drought scenario and adaptation measures on optimal water allocation to different water consumption sectors including agriculture, industry, drink, and environment is evaluated using the hydro-economic model.

This section evaluates different scenarios' effect on the amount of available water for each sector in Mashhad plain. The optimal crop pattern of the representative farmers and

1- Water Evaluation and Planning System

different scenarios' impact on the crop pattern and each farmer's expected yield are assessed using the hydro-economic model (alterations in available water) and a multi-objective economic optimization model (at the farm level). Then, the representative farmers' cooperation in running various adaptation measures is assessed using the ABM and the economic optimization model. The statistics of Agriculture Jihad, Khorasan Razavi Regional Water Authority, and different sources such as the website of the Department of Basic Studies of Water Resources, planning and optimization reports of Mashhad plain water resources, and questionnaires were compiled in the statistics section and data related to hydro-economic modeling and ABMs.

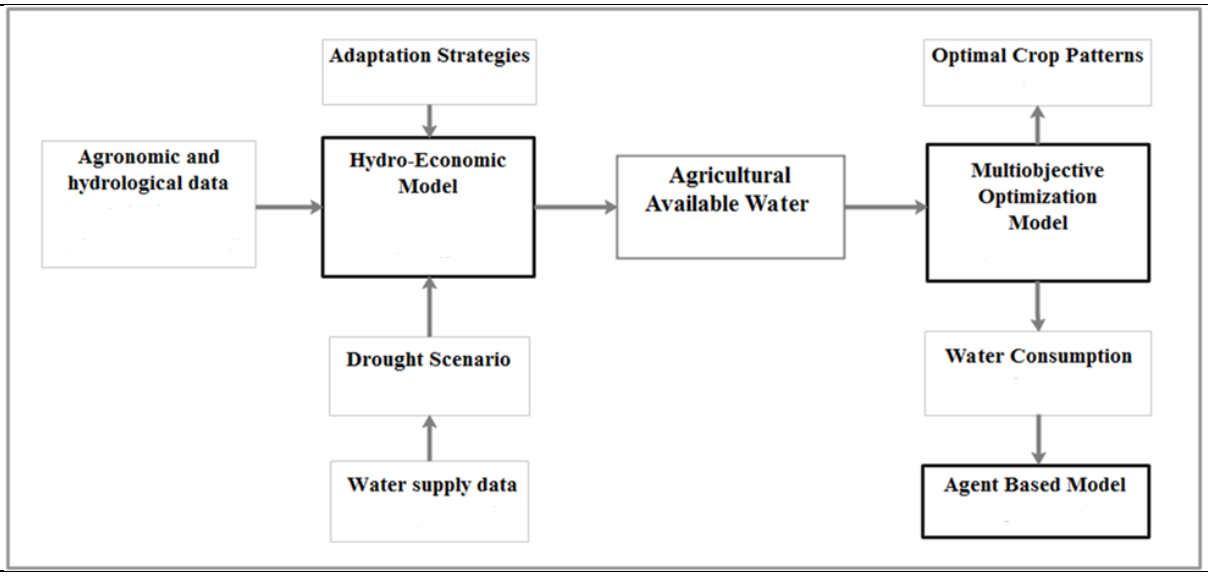

Figure 1- Conceptual framework of the model for assessing the impact of drought on the agricultural and hydrologic status of Mashhad plain

Hydro-economic Model

Allocating water to different sectors in the Kashfrud Basin is based on the principle of maximum economic advantage, emphasizing efficiency in the allocation of water. So, an objective function of water allocation model refers to the maximization of the net economic benefit of decreasing water consumption in different sectors, expressed as Relations (1) and (2) (Ward and Pulido-velazquez, 2008):

$$NPV_1 = \sum_u \sum_t \frac{NB_{ut}}{(1+r_u)^t} \quad (1)$$

$$NPV_2 = \sum_e \sum_t \frac{NB_{et}}{(1+r_e)^t} \quad (2)$$

NPV_1 is the discount net present value with r discount rate, obtained from the sum of economic benefits of water consumption (NB_{ut}) for agriculture, urban, and industry sectors (u). NPV_2 is the sum of environmental advantages (NB_{et}) for the environment sector through a specific time period (t).

Model Constraints

In optimization models, the values of all decision variables are computed for the maximization or minimization of the objective function under a set of constraints. Hence, a variety of constraints have been taken into account in different water distribution studies. The constraints below are applied to each model node.

Simple Nodes Constraints

This constraint states that the water exit from these nodes (a subset of the model nodes) is equal to the sum of the water entering the same nodes (Relation 3).

$$\sum_{n} R(n,t) = \sum_{n} Q(n,t) \quad (3)$$

$R(n,t)$ is the water exit from the simple node in the t^{th} time period, and $Q(n,t)$ is the water entering the simple node in the t^{th} time period. In addition to the so-called constraint, canal capacity constraint was applied to the simple nodes. Based on this constraint, the maximum water input and output from simple nodes must be lower than each canal's capacity. The canal capacity constraint can be expressed as Relation (4):

$$Q(n,t) = R(n,t) \le R_{Max} \quad (4)$$

R_{Max} is the maximum water conveyance capacity through the dam's irrigation canals.

Irrigation Node Constraint

Based on this constraint, the water demand of agricultural nodes is gained by multiplying the area under cultivation by the water requirement of plants cultivated in these nodes. Relation (5) shows this constraint for agricultural nodes merely integrating surface and groundwater resources (nrr):

$$Demand(nrr,t) = \sum_{j} X1_{j} * Da(j,nrr) \quad (5)$$

In Relation (5), $Demand(nrr,t)$ is the water demand of agriculture node, and $Da(j,nrr)$ is the water demand of different plant types. Relation (6) shows this constraint for agricultural nodes merely using surface water (nrw):

$$Demand(nrw,t) = \sum_{jj} X2_{j} * Da(j,nrw) \quad (6)$$

Another constraint was applied to the model based on the water supplied (released) to the agricultural demand nodes equal to the demand of this node. Relation (5) shows this constraint for both groups of agricultural nodes as Relations (7) and (8):

$$Divert(nrr,t) = Demand(nrr,t) \quad (7)$$

$$Divert(nrw,t) = Demand(nrw,t) \quad (8)$$

The constraint of area under cultivation was applied to the model based on the maximum area under cultivation of agricultural nodes as Relations (9) and (10):

$$X1(nrr,t) = X1_{Max} \quad (9)$$

$$X2(nrw,t) = X2_{Max} \quad (10)$$

$X1_{Max}$ is the maximum cultivation area of agricultural nodes integrating surface and groundwater, and $X2_{Max}$ is the maximum cultivation area of agricultural nodes using merely surface water.

Environmental Node Constraint

Another constraint is the environmental constraint, based on which the water allocated for the environment must be equal to or more than the minimum environment requirement:

$$R(nl,t) \ge MDT(nn,t) \quad (11)$$

$MDT(nn,t)$ is the minimum environment water need of the basin downstream in the t^{th} period of time.

Groundwater Node Constraint

Groundwater nodes ($n\lg$) are the source of supplying agricultural water with wells and using the groundwater resources through pumping. This relation is similar to the continuity equation and states that there must be a mass balance between the input and output values to the groundwater sources in all optimization stages. This constraint for all groundwater nodes is presented in Relation (12):

$$S(n\lg,t) = S(n\lg,t-1) + \sum_{n \in in} Q(n\lg,t) - \sum_{n \in out} R(n\lg,t) \quad (12)$$

$S(n\lg,t)$ is the volume of groundwater in the t^{th} period, and $R(n\lg,t)$ is the amount of harvest from the groundwater resources, and $Q(n\lg,t)$ is the amount of water entering the groundwater resources in t^{th} period of time. In addition to the above constraint, a constraint was also applied to the model named the maximum harvest from groundwater nodes. Based on this constraint, the maximum harvestable water from groundwater nodes must be lower than the maximum harvestable water from active irrigation wells in farms (Reltion (13)):

$$R(n\lg,t) \le R_{Max}(n\lg) \quad (13)$$

R_{Max} (n lg) is the maximum harvestable water from the wells in farms, determined based on the well discharge.

Farm-level Optimization Model

The farm-level optimization model is a dual-objective linear optimization model to maximize farmer's planned yield and minimize water use to save for environment use (Kal Tangal Shur). In this model, the optimal combination of land allocation ($X_{c,r}$) to agricultural crops and different irrigation techniques (r) are gained by maximizing the farmer's planned yield and minimizing water use based on technical, structural, and political constraints. The objective functions are defined as Relations (14) and (15):

$$Max\ Z_1 = \sum_c \sum_r p_c . y_{c,r} . x_{c,r} - \sum_c \sum_r tc_{c,r} . X_{c,r} - \sum_c \sum_r wp . (nw_c / ef_r) X_{c,r} \quad (14)$$

$$Min\ Z_2 = \sum_c \sum_r (wf_c) . X_{c,r} \quad (15)$$

p_c is the price of each crop unit (c); $y_{c,r}$ is the crop yield with irrigation technology (r) per unit area. $tc_{c,r}$ is the production cost of agricultural crops per unit area; wp is the price of each unit of water use, nw_c and wf_c are, respectively, the net water requirement and water footprint of agricultural crops per unit area. ef_r is the efficiency of irrigation techniques. The model variables are $X_{c,r}$ which is the decision variable of the area under cultivation with irrigation technology (r), Z_1 which is the farmer's planned yield, and Z_2 which is the water footprint.

The model constraints include Relations (16) to (18):

$$\sum_c \sum_r X_{cr} \le land \quad (16)$$

$$\sum_c \sum_r ie_r . X_{cr} \le Energy \quad (17)$$

$$\sum_e (wreq_c / h_i) . x_{c,i} \le Available\text{Water} . \text{Eff}_i \quad (18)$$

land and *Energy* indicate the available land and the energy of agricultural crops per unit area. $wreq_c$ is the net water need of agricultural products. h_i is the i irrigation technique efficiency. AvailableWater is the available water for each farm, and Eff_i is the efficiency of the water conveyance system.

To solve the dual-objective optimization model, the Augmented Epsilon Constraint Method was used, where the constraints are converted from inequation to equation, for which slack and surplus variables are used:

$$\begin{aligned}
&\max(Z_h(x_1,x_2,...,x_n) + eps(s_1 + s_2 + ... + s_{h-1} + s_{h+1} + ... + s_k)) \\
&Z_1(x_1,x_2,...,x_n) - s_1 = e_1 \\
&Z_2(x_1,x_2,...,x_n) - s_2 = e_2 \\
&\vdots \\
&Z_{h-1}(x_1,x_2,...,x_n) - s_{h-1} = e_{h-1} \\
&Z_{h+1}(x_1,x_2,...,x_n) - s_{h+1} = e_{h+1} \\
&\vdots \\
&Z_k(x_1,x_2,...,x_n) - s_k = e_k
\end{aligned} \quad (19)$$

eps is a negligible value, usually 10^{-3} to 10^{-6}. $s_i.r_i$ is used instead of s_i variables in the objective function to avoid the measurement scale problem, where r_i is a range of the i^{th} objective function (the distance of the worst and the optimum value of the expected objective). Thus, the objective function is changed to Relation (20):

$$\max(Z_h(x_1,x_2,...,x_n) + eps(\frac{s_1}{r_1} + \frac{s_2}{r_2} + ... + \frac{s_{h-1}}{r_{h-1}} + \frac{s_{h+1}}{r_{h+1}} + ... + \frac{s_k}{r_k})) \quad (20)$$

The best response was chosen from among the Pareto efficiency responses obtained from the above technique based on different opinions of decision-makers and stakeholders using the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method.

ABM

The ABM was used to evaluate the cooperation or non-cooperation of water harvesters with the optimal model gained from the previous two models for Mashhad plain (base scenario). If farmers' cooperation is based on the model, it will positively affect the environment; otherwise, it will have a negative impact. Moreover, the government can positively protect the environment via creating incentives and imposing fines and new laws with respect to cooperation or non-cooperation of harvesters. Furthermore, the adaptation

management policies of water resources were evaluatred using the ABM, like utilizing new technologies related to water resources and new water tariffs, altering the cultivation pattern, and indicating environmental water requirements for rivers. Formulating the ABM and assessing farmers' cooperation in each scenario are given in the following relations (Akhbari and Grigg, 2015):

$$TAW_{y,m} = f\,(\mathrm{Q}_{in,y,m}, \mathrm{Q}_{min,y,m}) \quad (21)$$

$$AW_{i,y,m} = f\,(TAW_{y,m}, LA_i, \mathrm{CWD}_i) \quad (22)$$

$$\begin{aligned} &if\ \ AW_{i,y,m} < D_{Max,i,y,m} \Rightarrow i \rightarrow NC \\ &if\ \ AW_{i,y,m} \geq D_{Max,i,y,m} \Rightarrow i \rightarrow C \end{aligned} \quad (23)$$

$TAW_{y,m,d}$ is the total available or allocated water obtained from the simulation model. $AW_{i,y,m,d}$ is the available or allocated water to each water harvester. LA_i is the land area of each water harvester. CWD_i is the water demand of the crop cultivated by the harvester agent. $D_{Max,i,y,m}$ is the maximum water demand for each harvester. m and y are, respectively, the month and year. Thus, if the allocated water to each agent is lower than the maximum demand of that agent, the agent's behavior is non-cooperative (NC), otherwise cooperative (C). After indicating the agents' cooperation or non-cooperation, the utility of different agents to continue or alter their behavior is estimated using Relations (24-27) (Edwards *et al.*, 2005):

$$U_i(\mathrm{C} \rightarrow \mathrm{C}) = \mathrm{a} \times \mathrm{V}_i(C) + F_m \quad (24)$$

$$U_i(\mathrm{C} \rightarrow N\ \mathrm{C}) = b \times \mathrm{V}_i(\mathrm{N}C) \quad (25)$$

$$U_i(\mathrm{NC} \rightarrow \mathrm{C}) = c \times \mathrm{V}_i(C) + F_m \quad (26)$$

$$U_i(\mathrm{NC} \rightarrow N\ \mathrm{C}) = d \times \mathrm{V}_i(\mathrm{N}C) \quad (27)$$

$U_i(\mathrm{C} \rightarrow \mathrm{C})$ is the utility of agent i with cooperative behavior who still wishes to remain cooperative. $U_i(\mathrm{C} \rightarrow N\ \mathrm{C})$ is the utility of agent i with cooperative behavior who wants to alter his behavior to be non-cooperative. $\mathrm{V}_i(C)$ and $\mathrm{V}_i(\mathrm{N}C)$ are, respectively, a fraction of neighbors of agent i having cooperative and non-cooperative behavior. In other words, others' behavior affect agents' cooperation or non-cooperation. The values of *a*, *b*, *c*, and *d* model parameters were considered $\mathrm{a} = \mathrm{b} = 0.7$ and $c = d = 0.7$ in the study of Edwards *et al.* (2005). F_m is the adjustment factor and a function of allocated water, representing different water management scenarios (government activities and education). If the available water to farmers is sufficient, $F_m = F_m^*$ (Relation (28)):

$$F_m^* = \begin{cases} 1 - [0.7 \times V_i(\mathrm{C})] \\ 1 - [0.3 \times V_i(\mathrm{C})] \end{cases} \quad (28)$$

By substituting F_m^* (Relation (14)) in Relations (24) and (26), $U_i = 1$ is obtained (utility 100 %). Thus, if the available water meets agent i demand, this agent will cooperate in the scenario and achieve 100% utility. If he does not cooperate, the government may fine him or he may encounter stricter laws or may be sued by the environmental agent. F_m can vary from 0 to F_m^*; 0 means the lack of management scenarios, and F_m^* means strict practices and forcing farmers to bear cooperation in the optimal model. Management scenarios may involve motivating farmers to cooperate, imposing fines, and education by the government. So, it is possible to find out which scenario or what incentive or fining can close the water consumption status to the optimal status or the theory. The following relation indicates the agent's new demand: based on the relation, if an agent's maximum demand is more than the allocated water ($D_{\max,i,y,m} > AW_{i,y,m}$), that agent will not cooperate. Thus, that agent's excess demand is obtained from $(D_{\max,i,y,m} - AW_{i,y,m}) \times (1 - U_i)$. U_i is the utility of the non-cooperative agent and wishes to alter to cooperative status. If the maximum demand of an agent is lower than the allocated water, i.e. $D_{\max,i,y,m} \leq AW_{i,y,m}$, that agent will cooperate. Thus, its excess demand ($D_{i,y,m}^m$) is 0.

$$\begin{cases} D_{i,y,m}^m = (D_{\max,i,y,m} - AW_{i,y,m}) \times (1 - U_i);\ \forall \mathrm{y,m},\ D_{\max,i,y,m} > AW_{i,y,m} \\ D_{i,y,m}^m = 0;\ \forall \mathrm{y,m},\ D_{\max,i,y,m} \leq AW_{i,y,m} \end{cases} \quad (29)$$

Thus, the maximum new demand of each agent is given (Relation (30)):

$$ND_{\max,i,y,m} = AW_{i,y,m} + D^{m}_{i,y,m} \quad (30)$$

In this study, the necessary information has been prepared from the Regional Jihad Agricultural and Water Organization of Razavi Khorasan Province. The data used in this research include: price, yield, production cost, cultivated area, inflow of rivers, discharge of hydrometric stations, information of dams (storage capacity, volume-height diagram), monthly water demand of different sectors (drinking, industry, agriculture and environment), geographical location, water requirement of crops and irrigation efficiency.

Results and Discussion

Simulation results of the economic water allocation to agriculture, drink, industry, and environment sectors in Mashhad plain are shown in Table 1. Agriculture sector has harvested the most groundwater and surface water (Table 1). The agriculture sector of Mashhad has the greatest share (396 million m^3). Harvesting water for drink and sanitation ranks the second. Among different cities, groundwater harvesing in Mashhad ranks the first (115 million m^3), which is justifiable considering the extent and higher population of Mashhad in comparison with other cities. This is also true about the industry sector. The comparison of harvesting water from groundwater and surface water reveals that 79% of harvested water is supplied by groundwater, out of 1116 million m^3 of harvested water in Mashhad plain, confirming the prominence of groundwater in Mashhad plain. However, evaluation of the consumption indicates that 45 million m^3 of environmental requirements are provided through surface water in the base scenario. The optimal allocation of water in drought shows that harvesting groundwater and surface water will decline because of reduction in water supply in the drought scenario. The reduction of the total water supply in the drought from 1116 to 829 million m^3 (26 %) decreases water harvesting, which is normal value. However, among different water consumtions, the maximum decrease in water harvesting is related to agriculture. In general, the available water in the industry sector has decreased from 107 to 57 million m^3, manifesting the highest variation (Table 1). However, the available drink water has had a lower decrease, i.e. water harvesting in this sector has declined from 292 to 271 million m^3. This is justifiable assuming the significance of drink water in terms of safety and being vital. The available water for agriculture has decreased from 671 to 475 million m^3. The allocated water to the environment has decreased by 45% from 45 to 24.75 million m^3. As previously stated, farmers can adopt numerous adaptation measures to overcome drought to save agricultural water and receive water requirement of other sectors.

Table 1- Results of economic water allocation model in Mashhad plain under different scenarios

The whole basin	Environment	Industry			Drink			Agricultural areas			Water resource	Scenario
		Chenaran	Binaloud	Mashhad	Chenaran	Binaloud	Mashhad	Chenaran	Binaloud	Mashhad		
878.2	-	11.56	13.48	78.76	30.98	25.02	115.81	184.94	61.67	355.98	Groundwater	Base
238.09	45	0.42	0.46	2.88	21.71	17.53	81.16	21.15	7.05	40.7	Surface water	
1116.29	45	11.98	13.97	81.64	52.69	42.55	196.97	206.09	68.72	396.68	Total	
643.54	-	11.56	11.46	49.41	30.98	25.02	115.81	134.63	41.62	214.03	Groundwater	Drought
188.50	31.78	0.30	0.37	1.84	21.71	17.53	75.85	13.36	4.83	20.89	Surface water	
823.04	31.78	11.86	11.83	51.25	52.69	42.55	191	148	46.46	234.92	Total	
643.54	-	11.56	11.46	49.41	30.98	25.02	115.81	134.63	41.62	214.03	Groundwater	Deficit irrigation
188.50	31.78	0.30	0.37	1.84	21.71	17.53	75.85	13.36	4.83	20.89	Surface water	
823.04	31.78	11.86	11.83	51.25	52.69	42.55	191	148	46.46	234.92	Total	
624.18	-	11.56	10.07	51.72	30.98	25.02	115.81	124.27	43.01	211.71	Groundwater	Saffron cultivation
187.97	34.17	0.30	0.37	1.84	21.71	16.90	81.16	9.69	4.92	16.88	Surface water	
812.16	34.17	11.86	10.45	53.57	52.69	41.92	196.97	133.97	47.94	228.60	Total	

Source: Research findings

An adaptation agricultural measure to overcome drought in the Mashhad plain is benefiting from the deficit irrigation technique. Accordingly, the effect of employing the deficit irrigation was studied on water allocation status to different sectors. The results show that the deficit irrigation scenario largely decreases water consumption in the agricultural sector. The groundwater and surface water harvest in the agricultural sector has decreased from 475 to 429 million m^3. This stored water (36 million m^3) has been conveyed to other sectors. The total available water in the drink sector in drought conditions has reached 287 million m^3 from 272 million m^3. The remaining stored water is consumed by the industry and environment, i.e. the available water of the industry sector also increases by 17 million m^3.

The environment available water has increased from 24 to 31 million m^3. The low amount of released water for the environment is because the water requirement of the environment is supplied by surface water (Kashfrud), and the volume of surface water released from the agricultural sector cannot supply the environment requirement. Another scenario to reduce the influences of drought regarding the hydro-economic status of Mashhad plain is increasing the area under cultivation of saffron by 20% of the area under cultivation of the base year (Table 1). The results demonstrated that employing this scenario may decrease the volume of water consumed in the agricultural sector (surface and groundwater) from 475 to 410 million m^3. Assessment of the safforn cultivation scenario with deficit irrigation scenario shows that the volume of stored water is higher in safforn cultivation scenario.

The impact of different scenarios on the optimal cultivation pattern of representative farmers in Mashhad

This section presents the optimal cultivation pattern of representative farmers and drought adaptation scenarios' imoacts on the optimal pattern of cultivation. The results about farmer M1 shows that the largest area under cultivation is for tomato. The area under cultivation of tomato in the base status is 11.54 ha (54.9%). Wheat and barley are ranked the next, 21.6 and 17.86% (4.55 and 3.75 ha), respectively. The total area under cultivation of fruit crops (cherries and apples) is 5.5% (1.17 ha). However, by employing the drought scenario and reducing the available water, the area under cultivation of tomato, a water-demanding intensive crop, is reduced and is allocated to wheat and barley which are less water-intensive. Fruit crops are also eliminated from the cultivation pattern, and their area under cultivation is allocated to these agricultural crops. Applying the adaptation strategy of deficit irrigation could in part compensate the volume of available water and reduce the area under tomato cultivation. However, increasing the area under cultivation of saffron by 20% of the base cultivation area has also decreased wheat, barley, and tomato crops. The barley has had the greatest decrease, which is justifiable due to the low planned yield of barley. Moreover, the volume of water saved by the deficit irrigation technique returns cherry to the cultivation pattern.

The evaluation of farmer M2 results shows that in the base status, wheat has the largest area under cultivation (31.5%, 3.93 ha). Sugar beet is ranked the next (27%, 3.38 ha). The area under cultivation of apple, walnut, and pear is around 24% (3 ha). Barley has the least area under cultivation (17.29%). The area under cultivation of wheat and sugar beet decreases by application of the drought scenario due to their high water requirement, and the area under cultivation of barley increases. Furthermore, the area under cultivation of two fruit crops of apple increases and walnut is eliminated from the pattern as its water requirement is high. Nevertheless, barley is replaced by wheat and sugar beet via the deficit irrigation scenario. The area under cultivation of wheat and barley decreases and is replaced by saffron and sugar beet through 20% saffron cultivation scenario. The results of the representative farmer in Torghabeh show that, in the base status, the

greatest area under cultivation is related to wheat, i.e. its area under cultivation is 3.64 ha (52%). Onion and barley are ranked the next with 19.94 and 13.77% (1.39 and 0.96 ha), respectively. The total area under cultivation of cherry and apple is 14.29% (1 ha). However, apple and onion have been eliminated from the cultivation pattern through the drought scenario and reducing the available water. The area under cultivation of onion is allocated to wheat and barley and the area under cultivation of apple is allocated to cherry. The reason for elimination of onion from the cultivation pattern is its higher water requirement. Applying the adaptation strategy of deficit irrigation, however, has compensated for the volume of available water and has returned onion to the cultivation pattern. Increasing the area under cultivation of saffron by 20% with regard to the base area under cultivation has reduced the area under cultivation of wheat and onion; the utmost decrease has been observed in the wheat. Its area under cultivation has decreased from 56% to 20%. The fruit crops and cherry did not change (14.29%) with employing deficit irrigation and increasing the area under saffron cultivation.

Tomato has the largest area under cultivation (31.23%) in the optimal cultivation pattern of Shandiz in the base status. Wheat and barley are ranked the next, 23.38 and 16.92%, respectively. The only fruit crop in Shandiz is cherry with 14.08% area under cultivation. Cherry is eliminated from the cultivation pattern through applying the drought scenario, and the area under cultivation of tomato is decreased by about 4% and the freed area under cultivation is allocated to wheat and barley. However, by applying the deficit irrigation scenario, the area under cultivation of tomato is increased by 4%, and cherry is returned to the cultivation pattern. But, by the scenario of 20% increase in the area under cultivation of saffron, the area under cultivation of wheat, barley, and tomato decreases and the area under cultivation of onion increases as compared to the drought scenario. Wheat crop faced the highest decrease from 33 to 18%.

Figure 2 shows that wheat and tomato have the largest area under cultivation of the optimal cultivation pattern of Ch1 representative farmer (27%, about 4 ha). Saffron is ranked the next (22.56%, 1 ha). Among fruit crops, pistachio and pear have 6.58 and 4.39% of the area under cultivation. By applying the drought scenario, the area under cultivation of tomato and wheat decreased by 14 and 7%, respectively, as compared to the base status, and instead, the area under cultivation of saffron and barley increased by 11% (1.32 ha) and 13% (1.87 ha), respectively.

This is justifiable considering the water requirement and adequate planned yield of these crops as compared to the other two crops. However, the evaluation of fruit crops indicates that by applying the drought scenario, pear has been eliminated from the cultivation pattern and has been replaced by pistachio. However, the area under cultivation of barley partially decreases using the deficit irrigation scenario and is replaced by tomato. Pear also does not exist in the cultivation pattern of fruit crops. However, the scenario of increasing saffron cultivation has decreased by 20% the area under cultivation of wheat and has increased the area under cultivation of tomato by almost 2% as compared to the drought scenario. The evaluation of the cultivation pattern of horticultural crops also shows that the pistachio cultivation area has not changed.

Saffron (37.5%, about 4.5 ha) has the largest area under cultivation of the optimal cultivation pattern of Ch2 representative farmer. Wheat is ranked the next (24%). Pistachio, cherry, and apple have a total of 16.67% of the area under cultivation. However, the application of the drought scenario reduced the area under cultivation of saffron and wheat by about 4%. Instead, barley increased by 7% (0.9 ha), which is justifiable assuming the low water requirement of barley as compared to the other two crops. The comparison of the optimal area under

cultivation of fruit crops in the base status and drought scenario reveals that apple and cherry have been eliminated from the cultivation pattern and replaced by pistachio through employing this scenario. However, the deficit irrigation scenario has reduced the area under cultivation of barley by 13%, and wheat and saffron are replaced. But apple and cherry are still eliminated from the cultivation pattern of fruit crops. However, the scenario of increasing saffron cultivation by 20% (compared to the base year) has decreased the area under cultivation of barley and wheat by 13 and 10%, respectively. The cultivation pattern of fruit crops also shows that cherry has returned to the cultivation pattern.

Evaluation of farmers' behavior in the face of adaptation scenarios

Employing adaptation strategies with regard to climate change is done by farmers at the farm level. A number of non-cooperative farmers in adopting different adaptation strategies hinder the studied strategies to be executed at the basin. Accordingly, farmers' behaviour in encountering adaptation scenarios must be assessed to indicate the feasibility of each scenario at the farm and the whole basin. Thus, the scenarios' impact on the planned yield of representative farmers in different areas was first evaluated. According to Table 2, the drought scenario may reduce the planned yield per hectare of representative farmers of all areas. The maximum decrease in the planned yield is observed in representative farmers of Mashhad (M1 and M2) and the minimum in Chenaran (Ch1 and Ch2). However, the deficit irrigation scenario has greatly decreased the drought impact on the planned yield of farmers. For instance, the deficit irrigation scenario has reduced the planned yield of Ch1 representative farmer from 95.5 to 79.6, exceeding the base status (62.6). The improvement rate was high in the representative farmers of Mashhad (M1 and M2), and their total planned yield increased from 4.91 and 4.17 to 6.27 and 5.21 million tomans per ha, respectively. The deficit irrigation scenario has mostly affected the farmer of Shandiz and has decreased the planned yield of this farmer from 26 to 3.79%. The saffron cultivation scenario has greatly affected the farmers of Mashhad. For example, the planned yield of the representative farmer M1 has increased from 4.91 to 6.36 million tomans per hectare. In general and assessing all representative farmers, these scenarios may have a considerable impact on the economic status of all farmers in Mashhad.

Despite the positive impact of these scenarios on the farmers' planned yield, the farmers must be convinced about these strategies so that the adaptation scenarios can be implemented in Mashhad plain. Accordingly, incentive policies, fining, and legislation can be influental. Incentive strategies to persuade farmers to follow adaptation strategies at the farm level are as below:

Encouraging farmers to adopt the adaptation strategy of saffron cultivation through guaranteeing the reasonable purchase price of saffron.

Encouraging farmers to use the deficit irrigation method by subsidy payment for fertilizers and pesticides to those implementing the deficit irrigation technique.

Table 3 compares the volume of available and demand water with and with no incentives. In most areas, the volume of available water by adaptation strategies and water demand with no incentive greatly differ; however, this difference is different depending on different areas and strategies. The results revealed that incentives can bring the water demand of representative farmers closer to the volume of available water. A closer look at Table 3 shows that the demand of farmers in Chenaran in the two scenarios and their available water differ greatly. For Ch1 representative farmer, this difference is, respectively, 775 and 811 m^3/ha for the deficit irrigation and saffron cultivation.

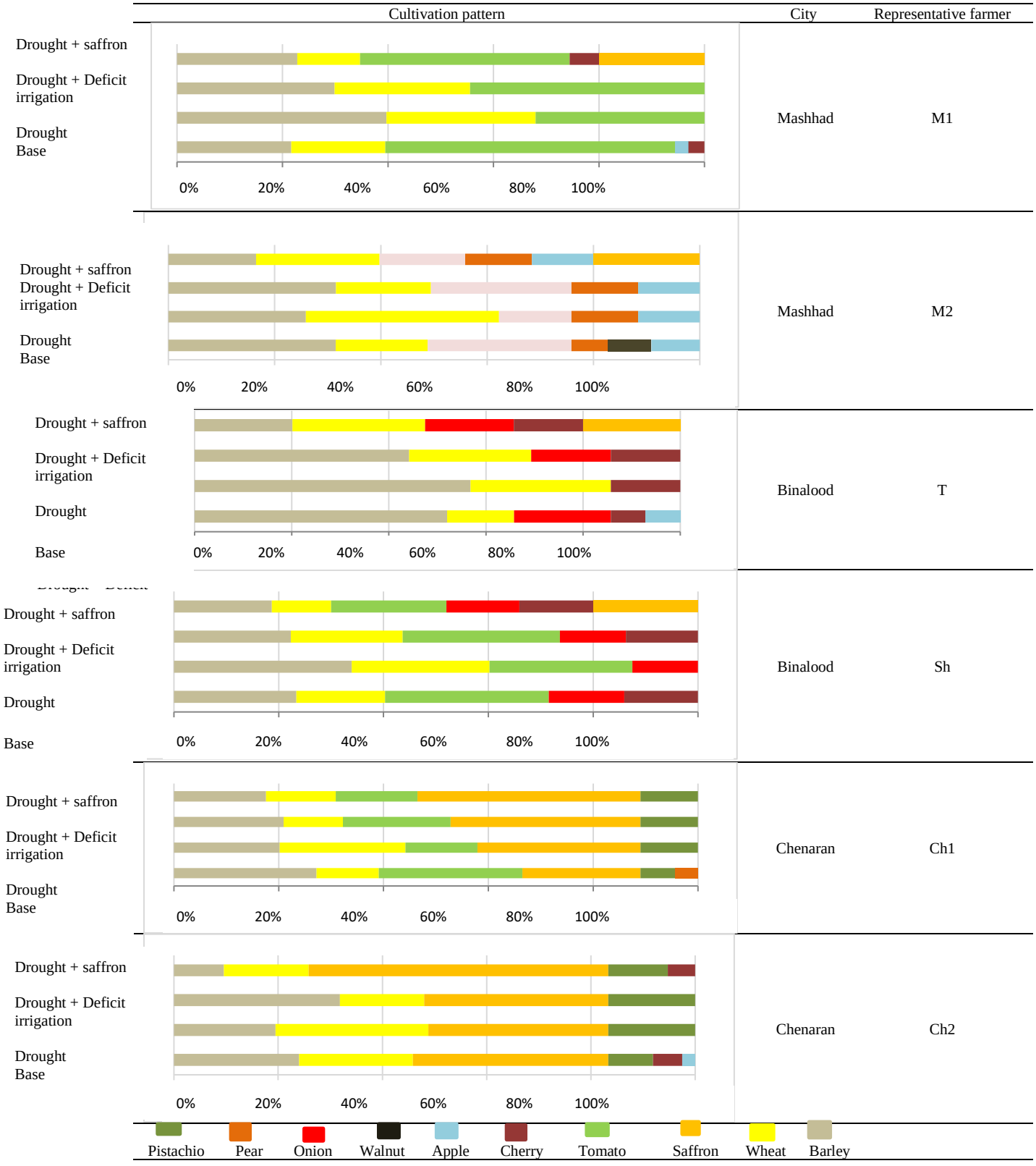

Figure 2- The effects of different scenarios on the cultivation pattern of representative farmers of Mashhad plain

Table 2- The effect of adaptation strategies on the planned yield of representative farmers of different areas (million Tomans/ha)

Variation (%)	Drought + Saffron cultivation	Variation (%)	Drought + Deficit irrigation	Variation (%)	Drought	Base	Strategies
-9.62	6.36	-10.91	6.27	-30.15	4.91	7.04	M1
-10.91	5.23	-11.29	5.21	-28.93	4.17	5.87	M2
-1.8	5.6	-3.92	5.19	-11.95	4.75	5.40	T
-6.32	6.31	-3.79	6.48	-26.48	4.95	6.74	Sh
-0.46	6.59	2.44	6.79	-10.20	5.95	6.62	Ch1
-4.03	5.82	-12.25	5.32	-16.88	5.04	6.06	Ch2

Source: Research findings

This difference for Ch2 representative farmer is, respectively, 764 and 561 m^3/ha. In fact, the farmers of Chenaran are less inclined to cooperate in adaptation scenarios, while this is different for the farmers of Mashhad. For example, the difference between the water demand (with no incentive) and the available water of farmer M1 for deficit irrigation and saffron cultivation scenarios is 157 and 126 m^3/ha, respectively, which is much lower compared to the difference between the water demand and the available water of Chenaran representative farmers. The table also shows that the difference in the water demand with no incentive and the available water of the representative farmers of Binaloud is in the middle of two other cities. The evaluation of the available water and the water demand with incentive for the deficit irrigation scenario demonstrates that applying the so-called solutions, such as subsidy payment for fertilizers and pesticides, can decrease the water demand of M1, M2, and Sh representative farmers and persuade them to accept this scenario.

Table 3- Water demand of representative farmers with and with no incentive solution (m^3/ha)

Water demand considering social pressures and incentive solution		Water demand considering social pressures and no incentive solution		Available water		Agricultural areas
Drought + Saffron cultivation	Drought + Deficit irrigation	Drought + Saffron cultivation	Drought + Deficit irrigation	Drought + Saffron cultivation	Drought + Deficit irrigation	
5245.18	5067.96	5431.46	5299.76	5305.05	5142.47	M1
5650.50	5590.95	5765.57	5763.66	5669.39	5605.61	M2
4453.31	4463.62	4551.46	4552.02	4276.64	4304.52	T
5464.10	5631.86	5625.68	5728.09	5302.52	5643.89	Sh
4689.09	4361.79	4835.88	4812.44	4204.71	4037.33	Ch1
4056.97	3642.59	4103.73	4024.85	3542.63	3260.93	Ch2

Source: research findings

Conclusion and Suggestions

Considering the complicated nature of water-related issues, rapid increase of population, water demand for various consumptions, and limited water resources, comprehensive water resources management require novel methods to assemble technical, economic, environmental, social, and logical perspectives into a coherent framework. One of these tools is utilizing hydro-economic methods to simulate the current status of drainage basins and evaluate the role of different scenarios and policies. Accordingly, considering the recent frequent droughts in the Kashfrud Basin, the present study used the hydro-economic modeling to simulate the current and future status of the plain and apply different adaptation scenarios. This model consists of an optimal water allocation model between different sectors and a multi-objective optimization model at the farm level, used to simulate the current status of the water

resources of the Kashfrud Basin as the base scenario. The role of adaptation scenarios, i.e. the deficit irrigation and the cultivation of saffron, in the cultivation pattern and sustaining management of water resources was studied. The optimal water allocation model manifested that the drought scenario may reduce the available water in different areas. Moreover, this scenario differently affects the hydro-economic status of various cities. However, the assessment of conservation scenarios including the deficit irrigation and saffron cultivation indicated that they may in part reduce the consequences of drought. Afterwards, the ABM was applied to establish an agreement with stakeholders to execute different conservation scenarios. Furthermore, the model findings disclosed a great difference between the volume of available water, due to implementing the strategies, and the water demand, which may impede the farmers' cooperation regarding the conservation scenarios. However, incentive policies may partially satisfy farmers with running the adaptation scenarios.

References

1. Akhbari, M., & Grigg, N.S. (2015). Managing water resources conflicts: Modelling behaviour in a decision tool. *Water Resources Management 29(14*): 5201-5216. https://doi.org/10.1007/s11269-015-1113-9.
2. Pouran, R., Raghofer, H., Ghasemi, A., & Bazazan, F. (2016). Calculating the economic value of virtual water with the approach of maximizing the productivity of irrigation water. *Applied Economic Studies of Iran* 21: 189-212. (In Persian with English abstract)
3. Barthel, R., Janisch, S., Nickel, D., Trifkovic, A., & Hörhan, T. (2010). Using the multiactor-approach in Glowa-Danube to simulate decisions for the water supply sector under conditions of global climate change. *Water Resources Management 24*(2): 239-275. https://doi.org/10.1007/s11269-009-9445-y.
4. Dawadi, S., & Ahmad, S. (2013). Evaluating the impact of demand-side management on water resources under changing climatic conditions and increasing population. *Journal of Environmental Management* 114: 261-275.
5. Edwards, P., Preece, A., Pignotti, E., Polhill, G., & Gotts, N. (2005, June). *Lessons learnt from deployment of a social simulation tool to the semantic Grid*. In Proceedings of First International Conference on e-Social Science (pp. 22-24).
6. Esteve, P., Varela-Ortega, C., Blanco-Gutiérrez, I., & Downing, T.E. (2015). A hydro-economic model for the assessment of climate change impacts and adaptation in irrigated agriculture. *Ecological Economics* 120: 49-58.
7. Forni, L. G., Medellín-Azuara, J., Tansey, M., Young, C., Purkey, D., & Howitt, R. (2016). Integrating complex economic and hydrologic planning models: An application for drought under climate change analysis. *Water Resources and Economics* 16: 15-27. https://doi.org/10.22067/jead.2021.17801.0.
8. Gleick, P.H., & Palaniappan, M. (2010). Peak water limits to freshwater withdrawal and use. *Proceedings of the National Academy of Sciences 107*(25): 11155-11162.
9. Harou, J.J., Pulido-Velazquez, M., Rosenberg, D. E., Medellín-Azuara, J., Lund, J.R., & Howitt, R.E. (2009). Hydro-economic models: Concepts, design, applications, and future prospects. *Journal of Hydrology 375*(3-4): 627-643.
10. Hosseini, S.A., & Bagheri, A. (2011). Dynamic modeling of Mashhad plain water resources system for analyzing sustainable development strategies. *Journal of Water and Wastewater* 4: 39-28. (In Persian with English abstract)
11. Nasirzadeh, F., Afshar, A., & Khanzadi, M. (2008). Dynamic risk analysis in construction projects. *Canadian Journal of Civil Engineering 35*(8): 820-831.

12. Nazim Al Sadat, M., Samani, N., Bari, A., & Molayi Niko, M. (2006). The effective force of El Nino-Southern Oscillation phenomenon on climate change in Iran, using precipitation data analysis. *Iranian Journal of Science and Technology* 4: 565-555. (In Persian with English abstract)
13. Nikolic, V.V., & Simonovic, S.P. (2015). Multi-method modeling framework for support of integrated water resources management. *Environmental Processes 2*(3): 461-483.
14. Shahnooshi, N., Naqvi, S., & Azam Rahmati, A. (2015). *The relationship between population and water crisis and its impact on macroeconomic variables*. First National Water Economics Conference, Tehran: Iran Water and Wastewater Engineering Company. (In Persian with English abstract)
15. Sherafatpour, Z., Roozbahani, A., & Hasani, Y. (2019). Agricultural water allocation by integration of hydro-economic modeling with Bayesian networks and random forest approaches. *Water Resources Management 33*(7): 2277-2299.
16. Ward, F.A., & Pulido-Velazquez, M. (2008). Water conservation in irrigation can increase water use. P*roceedings of the National Academy of Sciences 105*(47): 18215-18220. https://doi.org/10.1073/pnas.0805554105.
17. Yazdani, Qanadzadeh, M., & Faiz Elahi, H. (2016). *Quantitative and qualitative analysis of groundwater resources of Mashhad-Chenaran plain*. The third international conference on research in agriculture and environment, permanent secretariat of the conference, Hamedan. (In Persian with English abstract)
18. Zekri, S., Madani, K., Bazargan-Lari, M.R., Kotagama, H., & Kalbus, E. (2017). Feasibility of adopting smart water meters in aquifer management: An integrated hydro-economic analysis. *Agricultural Water Management* 181: 85-93. https://doi.org/10.1016/j.agwat.2016.11.022.

Journal of Agricultural Economics & Development

https://jead.um.ac.ir

مقاله پژوهشی

جلد ۳۶ شماره ۴، زمستان ۱۴۰۱، ص. ۴۴۵-۴۳۱

اثرات راهبردهای تطبیقی بر مدیریت منابع آب در دشت مشهد: کاربرد مدل‌های اقتصادی- هیدرولوژیکی و رفتاری

حسن سخدری[۱]- سامان ضیایی[۲]*- محمود احمدپور برازجانی[۳]- حمید محمدی[۴]

تاریخ دریافت: ۱۴۰۱/۰۵/۲۶

تاریخ پذیرش: ۱۴۰۱/۰۹/۲۱

چکیده

استان خراسان رضوی هم‌اکنون بحرانی‌ترین منابع آبی زیرزمینی در سطح کشور را داراست به طوری که افت سطح آب‌های زیرزمینی در این استان به یک متر رسیده است. دشت مشهد در طی سال‌های اخیر با بحران خشکسالی و کم‌آبی دست و پنجه نرم می‌کند. منشا بحران خشکسالی برداشت‌های بی‌رویه و گرمایش جهانی است. مدیریت جامع منابع آب با توجه به ماهیت پیچیده مسائل آب، رشد سریع جمعیت، نیاز به آب برای مصارف مختلف و منابع آبی محدود، نیازمند روش‌هایی است که دیدگاه‌های فنی، اقتصادی، زیست‌محیطی، اجتماعی و منطقی را در یک قالب یکپارچه گردآوری نماید. یکی از ابزارهای مدیریت جامع منابع آب، استفاده از روش‌های هیدرولوژیکی اقتصادی به منظور شبیه‌سازی وضعیت کنونی حوضه‌های آبریز و بررسی اثرات سناریوها و سیاست‌های مختلف می‌باشد. در مطالعه‌ی حاضر به منظور شبیه‌سازی وضعیت هیدرولوژیکی دشت مشهد و بررسی اثرات سناریوهای مختلف از یک مدل اقتصادی- هیدرولوژیکی استفاده شد. در گام بعد به منظور رسیدن به توافق با ذینفعان بر سر اجرای سناریوهای مختلف حفاظتی از مدل عامل محور استفاده گردید. نتایج مدل هیدرولوژیکی- اقتصادی نشان دادند که با اتخاذ سناریوهای تطبیقی امکان کاهش تقاضای آب بخش کشاورزی و در نتیجه مصرف آب سطحی و زیرزمینی در این بخش وجود دارد. همچنین اجرای سناریوهای مختلف تطبیقی موجب تغییر الگوی کشت کنونی خواهد شد. از سوی دیگر نتایج مدل‌سازی عامل محور نشان داد که میان میزان آب در دسترس ناشی از راهبردها و تقاضای آب تفاوت زیادی وجود دارد که این موضوع موجب خواهد شد که کشاورزان با اجرای سناریوهای حفاظتی همکاری نکنند. اما با به کارگیری سیاست‌های تشویقی می‌توان برخی از کشاورزان نماینده را به اجرای سناریوهای تطبیقی راضی نمود.

واژه‌های کلیدی: دشت مشهد، راهبردهای تطبیقی، منابع آب، مدل اقتصادی-هیدرولوژیکی

۱، ۲، ۳ و ۴- به‌ترتیب دانشجوی دکتری اقتصاد کشاورزی، دانشیاران و استادیار گروه اقتصاد کشاورزی، دانشگاه زابل، زابل، ایران

(*- نویسنده مسئول: Email:samanziaee@uoz.ac.ir)

DOI: 10.22067/JEAD.2022.78289.1151

Contents

Agricultural Economics & Development

(AGRICULTURAL SCIENCES AND TECHNOLOGY)

Vol. 36 No.4 2023

Published by: Ferdowsi University of Mashhad (College of Agriculture) Iran.

Editor in charge: Valizadeh, R. (Ruminant Nutrition)

General Chief Editor: Shahnoushi, N(Economics & Agricultural)

Publisher: Ferdowsi University of Mashhad (College of Agriculture).

Address: College of Agriculture, Ferdowsi University of Mashhad, Iran.

P.O.BOX: 91775- 1163

Fax: +98 -0511- 8787430

E-Mail: Jead2@um.ac.ir

Web Site: https://jead.um.ac.ir/

Ferdowsi University of Mashhad

Vol.36 No.4

2023

Journal of Agricultural Economics & Development

(Agricultural Sciences and Technology)

ISSN:2008-4722

Contents