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Assessment of the Economic Viability and Sustainability of Olive Production in the Sistan Region

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ABSTRACT

This study aimed to assess the economic status and sustainability of the olive production system in the Sistan region. Data were collected through face-to-face interviews and questionnaires from 64 gardeners, retailers, and wholesalers in the region between 2021 and 2022, and analyzed using empirical methods and spatial regression. The total support of olive production systems in the cities of Zabol, Zahak, Hamoun, Hirmand and Nimroz was 1.06×10^{16}, 1.19×10^{16}, 1.60×10^{16} and 7.72×10^{15} sej ha^{-1}, respectively. The inefficiency in the olive product was more than the inefficiency in olive oil, which itself indicates the efficiency of the olive oil market. Therefore, it can be said that the processing of these products leads to the improvement of its marketing and increases the technical efficiency. The R^2 values of olive and olive oil in the simple regression model were 0.99 and 0.63 respectively. In contrast, the R^2 values in the spatial regression model were 0.98 and 0.99, highlighting the superiority of the spatial regression model over the simple regression model. The results indicate a spatial relationship among olive oil producers. Due to the positive sign of marketing costs, it can be said that marketing cost has a positive effect on the marketing margin and with its increase, the marketing margin of these products will increase. The mechanization and industrialization of olive cultivation and exploitation can enhance the economic empowerment of the farmers, leading to increased profits from the sale of this product. Therefore, the level, appropriate selection and correct use of machine inputs in agriculture have a significant impact land productivity, labor productivity, agricultural profitability, sustainability, environmental outcomes and quality of life fir those involved in agricultural trade.

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1. Introduction

The olive (*Olea europaea* L.) is a perennial evergreen plant that is a native in Mediterranean regions (Arenas-Castro *et al.*, 2020) and has high drought resistance (Connor and Fereres, 2010). This species covers approximately 11 million hectares of cultivated land, making it an important part of global tree production (García-Tejero *et al.*, 2017). Olives are one of the most important horticultural products, with their oil, fruit, and preserves used worldwide. The cultivation has become widespread in many parts parts of the world. The development of this crop can not only meet the country's population's need for edible oil in the dietary pattern but also the development of olive production not only meets the population's need for edible oil but also contributes to other industries such as wood, livestock, and soap-making, resulting in significant foreign and domestic currency savings. The economic importance of olives is doubled by presenting statistics on the annual production of oil and preserves. According to relatively accurate statistics from the International Olive Council (IOC, 2018), global olive oil production in recent years has been about 1.7 million tons per year, with an average annual production growth of 1.2 percent and consumption growth of 1.7 percent. Approximately 90 percent of global olive production is dedicated to oil extraction, and about 10 percent is allocated for table olives

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(FAOSTAT, 2018). Concerns about human longevity and health, along with greater awareness of olive oil's nutritional value, have boosted its consumption. Consequently, the cultivated area has rapidly expanded in recent decades, and production and consumption are expected to keep rising (Fabbri *et al.*, 2004). Iran has not been exempt from this rule, witnessing growth in both area and geographical distribution of olive cultivation. In Sistan and Baluchestan province, 200 tons of olives are harvested from 300 hectares of orchards in this province. The olive tree, due to its high adaptability to environmental conditions, can grow in a wide range of different soil types, and olives can also be cultivated in specific topographical conditions that are not suitable for other oilseed crops. All these unique features have led to olive cultivation being regarded as a strategic product in the Sistan region.

One of the outstanding traits of the olive is its adaptability to different geographical regions. In modern olive cultivation, a set of traits such as fruitfulness, resistance to pests and unfavorable natural conditions, high oil content, good oil quality, appropriate size and shape, and high ratio of meat to kernel are important (Issaoui *et al.*, 2010). It is common knowledge that aquaculture faces an increasing challenge in terms of increasing water scarcity and uncertainty in water resources, not only due to prolonged droughts and global climate change, but also due to the intensification of competition between environmental, domestic, and industrial waters (DeJonge *et al.*, 2015). These considerations create maximum water productivity in all agricultural activities, including olive production. Since the Sistan region is currently facing the challenge of severe water crisis, the maximum use of environmental resources, especially water, should be of special attention to the managers and beneficiaries of the agricultural sector in the Sistan region.

Recently, sustainable production has been considered as a strategic path in all production activities. In addition to the technical aspect of production, this strategy has economic, social, and environmental aspects (Dekamin *et al.*, 2022). Also, energy sustainability is expressed as a key principle of sustainable development (Prashar, 2019). Increasing energy efficiency and cleaner production are the guiding principles of the circular economy. The circular economy seeks to maximize the use of resources in the production process (Barros *et al.*, 2021). In fact, in a linear economy, the goal of production is to achieve maximum profit, but in a circular economy, in addition to achieving maximum profit, waste management and intergenerational social welfare are considered as one of the basic pillars. The application of a circular economy in the production of agricultural products leads to an increase in profit margins, cost savings, reduction of environmental impacts of production, and conservation of natural resources (Dekamin *et al.*, 2022). Today, the basis of linear economy, which is the unlimited resources and capacity of the environment to absorb environmental waste and pollution, has been rejected in the world. By implementing a circular economy in the field of agriculture, it is possible to drastically reduce energy consumption (especially fossil fuels), natural raw materials, and especially water consumption, and at the same time bring cleaner production. Material flow costing is an environmental management tool that serves the circular economy.

Due to the increasing growth of olive cultivation in the Sistan region, it is necessary to study olive production from the perspective of environmental, economic and energy consumption effects. In order to measure the sustainability of agricultural ecosystems, there are various analytical tools (Fartout Enayat *et al.*, 2023). Agricultural ecosystems are complex systems with economic and environmental inputs (Wang *et al.*, 2018) and agricultural production is the result of the interactions of environmental inputs such as sunlight, wind, rain, soil, etc., and economic inputs (Yang *et al.*, 2018). If the share of environmental free flows relative to economic flows is ignored, management strategies will be based on incomplete analyses (Cheng *et al.*, 2017). The Emergy technique is useful in the evaluation of agricultural systems by considering the quality of various types of energy and translating all inputs into the same equivalents of the solar module to quantify the environmental and economic costs (Zhang and Long, 2010).

A sustainable supply chain takes into account the management of the flow of materials, information, and capital, as well as cooperation between firms along the supply chain, along with the integration of objectives from all three dimensions of sustainable development, including economic, environmental, and social dimensions, derived from the needs of customers and stakeholders (Thomé *et al.*, 2021). Currently, the sustainable supply chain of agricultural products has become an important and evolving issue. Sustainable supply chains in the agricultural sector are very complex and include production inputs (input factories), farmers, wholesalers, traders, food companies, and retailers, all of which must meet the diverse demands of consumers of intermediate and finished goods sustainably and satisfactorily a (Zamzami *et al.*, 2022). As globalization expanded, the direct relationships between farmers and consumers shifted to a complex system involving a large number of intermediaries. This phenomenon has led to the loss of biodiversity and ecosystems, food poverty, and insufficient information for consumers about the origin and quality of food (Pulker *et al.*, 2018; Qaim, 2017). International experiences have shown that the analysis of sustainable supply chain issues can be an important tool to improve the performance of agricultural systems and related industries. By identifying the strengths and weaknesses in the supply chain, policymakers and stakeholders active in the chain will be able to improve the performance of this chain (Bryceson and Kandampully, 2004). Since the widespread consumption of resources is related to industrial activities around the world, efficient use of resources has become much more important. In this regard, resource productivity can be called the maximum use of material resources with minimal waste of any kind (such as materials, energy, time, and money) from the extraction stage to consumption. From another perspective, sustainable development practices are highly dependent on industrial activities around the world (Della Santa Navarrete *et al.*, 2020; Lokko *et al.*, 2018).

The sustainability of olive production in the region, due to the inefficiency of the use of inputs in this system and the concerns about the lack of sustainable water resources in the region on the one hand, and the low economic level of farmers on the other hand, have made the study of environmental and economic aspects very important. This study investigates the sustainability of olive production, using the market margin index to assess profits along the olive supply chain. The results of this study could help optimize market processes and maximize the profits of the production and distribution chain of this product, and guide farmers toward sustainable practices.

2. Materials and methods

In this study, the olive production system, which is one of the horticultural products, and olive oil as a processed product of this plant, which is of interest to farmers in Sistan region, was investigated (Table 1). Data on input quantities, production costs, and product selling prices were gathered through interviews with gardeners operating in the Sistan region.. stratified random sampling approach was employed among the beneficiaries of each studied product. Data were collected through face-to-face interviews and questionnaires involving 64 gardeners, retailers, and wholesalers in the Sistan region during the 2021-2022 period. Regarding the price information in other parts of the supply chain, the price and costs related to the price of each section were obtained by referring to and interviewing local wholesalers, distributors, merchants, and retailers. In the present study, two parts, ecology (related to product production) and marketing chain (related to sales chain) of products in the Sistan region were investigated using the empirical technique and marketing margin and at the end, the data obtained by geographically weighted regression (GWR) model were investigated to achieve an accurate understanding of the production and distribution of horticultural products in this region.

Table 1. Number of samples of olive in different regions of Sistan

City	Part	Number of studied gardens	Total gardens in each city
Zabol	Central	14	14
Zahak	Central	7	14
	Jazinak	7	
Hirmand	Central	12	12
Nimruz	Central	6	12
	Saburi	6	
Hamon	Central	12	12

2.1. Evaluation of olive stability using the Emergy technique

The emergy flow of renewable resources for orchards is considered according to the extent of their utilization of renewable emergy flows including sunlight, wind energy, river water energy and other environmental energies. The amount of chemical fertilizers and pesticides will be calculated based on the amount of their active ingredient (Jafari *et al.*, 2018). The information about the machinery, fuel and oil consumed was extracted from the manual and the average useful life of the machines in Iran was considered to be 10 years. To calculate the input of the machines, the total weight of the used machines was divided by their annual application area and then by their useful life (Houshyar, 2011). The renewability factor was also determined for all inputs.

In order to investigate and analyze the studied production systems, four sources of environmental resources: renewable (R), non-renewable environmental resources (N), renewable purchased resources (FR), and non-renewable purchased resources (FN) were used (Jafari *et al.*, 2018). The emery of each input will be calculated by multiplying the raw value of that item by the corresponding solar emergy conversion coefficient (the value of the emery unit) (Odum, 2000). It should be noted that the conversion coefficients were selected from the studies that were most similar to this study. The conversion coefficients in this study were standardized based on the planetary base coefficient of 12×10^{24} sej ha^{-1} (Brown and Ulgiati, 2016).

After calculating all the inlet (U) and outlet (Y) flows, the raw data in joules or grams for the olive production system were multiplied by their conversion coefficients. The conversion coefficients for electricity and money taken from the study of Asgharipour et al. (2019) should be considered in accordance with the conditions of Iran. Indicators obtained from the environmental and economic assessments were used to analysis the underlying causes (Amiri *et al.*, 2021; Yang *et al.*, 2018). In the present study index, Renewable emergy percentage (R%), Transformity (TR), emergy Yield Ratio (EYR), emergy Investment Ratio (EIR), Environmental Loading Ratio (ELR) and modified version (ELR^*), emergy Sustainability Index (ESI), and modified version (The ESI^* were used for making a comparison between agroecosystems.

2.2. Marketing margin

The marketing margin is the difference between the stages in the marketing chain. Three types of marketing margins are commonly discussed in the literature retail margin (MR), wholesale margin (MW), and absolute margin (mm) marketing (Mm) are presented. The difference between the retail price of selected crops (PR) and the price of these crops at the farm level (PF) indicated the total margin of marketing. The difference between the price of these products at the wholesale level (Pw) and the price of the olive at the farm level of wholesale margin was further calculated. The difference in retail and wholesale prices is called the retail margin as shown in Equations 1-3.

(1) $MR = PR - Pw$

(2) $Mw = Pw - PE$

(3) $Mn = PR - PF$

The marketing cost includes the difference in price of the olive at retail and farm levels. The vertical distance between the equilibrium points of supply and demand of each of the products at the farm level equals the amount sold at the retail level. The relative margin of marketing (RT), representing the share of each marketing agent in the price of the final product, represents the absolute margin of marketing. In Equation 4, the relative margin of marketing shows the ratio of prices at different levels of marketing (farm, wholesaler, and retailer) (Kohansal and Rafiki, 2019).

(4) $RT = PF/PR$

2.3. Regression space

Simplified: "A key issue in survey studies is the spatial relationship and dependence of samples, particularly in studies carried out in specific geographical areas."In this study, prior to estimating econometric models of marketing margin, spatial autocorrelation of marketing margin was measured by Moran statistic Geographic rhythmic regression is a reliable approach in modeling spatial dissimilar processes (Brunsdon *et al.*, 1996). The underlying concept idea of geographically weighted regression is that the pattern parameters may be estimated at any point in the sampling space with respect to the values of the dependent and independent variables of the pattern at that point (Anselin, 2013). Accordingly, due to the spatial correlations between points in the pattern and their influence from adjacent areas, the neighboring points are generally considered more important in the model estimation (Brunsdon *et al.*, 1996). Thus, if the following general regression model is considered (Equation 5).

(5) $yi = \beta o + \beta_1 x_{i1} + \beta_2 xi_1 + \ldots + \beta_n x_{in} + \varepsilon_i$

The geographically weighted regression method called an extended traditional regression method, is a spatial status of samples which is entered into the pattern (Fotheringham *et al.*, 1997); so, the above general pattern is rewritten in the framework of the geographically weighted regression model (Equation 6) (Fotheringham *et al.*, 1997).

(6) $yi = \beta_0(u) + \beta_1(u)x_{i1} + \beta_2(u)xi_1 + ... + \beta_n(u)x_{in} + \varepsilon_i$

In Equation 6, β1(u) indicates that the parameter β1 specifies an association around position u and the estimate for this model is similar to the general pattern of Weight Least Squares (WLS), but the weight given depends on the relative position of u in each sample relative to the other samples. The estimated coefficients in the geographically weighted regression are as follows (Equation 7) (Charlton and Fotheringham, 2009).

(7) $\hat{\beta}(u) = (X^T w(u) X)^{-1} X^T w(u) y$

In Equation 7, β1(u) is the estimated parameters and W(u) is the square matrix n×n of the relative weighting of position u in the studied regions, XTW(u)X is the geo-weighted variance-covariance matrix and y is the vector of the dependent variable values, W(u) matrix contains a geographic weighted in the main diameter and the other elements are zero (Equation 8).

(8) $$W(u) = \begin{bmatrix} 0W_n(u) \dots 0 \\ \dots \\ \dots \\ \dots \\ 0W_n(u) \end{bmatrix}$$

A weighting pattern is used to measure the weights. Equation 9 (Lee and Wong, 2001) illustrates the common pattern with a fixed spatial core, and Equation 10 shown the pattern with an adaptive spatial core.

(9) $W_i(u) = e^{-0.5(\frac{d_i(u)}{h})^2}$

(10) $W_i(u) = (1 - \left(\frac{d_i(u)}{h}\right)^2)^2$

In Equations 9 and 10, di(u) is a measure of the distance between the observation i and the location of the reference point (ui, vj) and h is the value of bandwidth, in particular, bandwidth refers to the distance that each observation takes into account relative to the reference point. The greater the distance, the less weight the observation weighs in the pattern, and the closer it is, the greater its weight. The regression equation of this model is econometric, which was estimated in the present study using $EVIEWS_{V5}$ and GIS software.

3. Results and discussion

3.1. Emergy analysis of olive production systems in the Sistan region

Table 2 shows the flow of free, purchased, economical environmental inputs and outputs based on physical units for the olive production system in different regions of Sistan. The total supporting emergy olive production systems for the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz were estimated to be 1.06×10^{16}, 1.19×10^{16}, 1.60×10^{16} and 7.72×710^{15} sej ha^{-1}, respectively. should be clarify: "Among these, Hirmand exhibited the highest total input emergy, while Nimroz showed the lowest."

3.2. Renewable environmental inputs

In this study, the high emergy of olives in Hamoon county was due to the high use of non-renewable environmental inputs (groundwater) and purchased inputs (seedlings). In a study based on emergy analysis, the inflow to traditional barley, wheat and alfalfa forage systems in India was reported to be 2.94×10^{15}, 3.65×10^{15} and 2.35×10^{15} sej ha^{-1}, respectively (Pelliciardi *et al.*, 2014). In a study by Martin et al. (2006) that evaluated the emergy and sustainability of three farming systems with different scales and management, the total renewable input for the corn system in the United States was 6.56×10^{14} sej ha^{-1}. The input inputs in the three studied systems were divided into renewable environmental inputs (R), non-renewable environmental inputs (N), renewable economic inputs (FR) and non-renewable economic inputs (FN).

Renewable environmental currents branch directly from the energies of sunlight, wind, rain, and river water (Asgharipour *et al.*, 2019). In all the systems in this study, solar energy was the largest item among free environmental inputs. The R-flow for olive production systems in Zabol, Zahak (central and Jazinak part), Hamoun, Hirmand and Nimroz counties was estimated to be 1.92×10^{15}, 1.75×10^{15}, 1.92×10^{15}, 2.71×10^{15}, 2.85×10^{15} and 1.92×10^{15} sej ha^{-1}, respectively (Table 2).

Table 2. Emergy synthesis and input structure of olive in Sistan Region (sej ha^{-1})

			ZABOL			CENTRAL ZAHAK			JAZINAK DISTRICT OF ZAHAK		
	Unit	Emergy	Raw	Emergy (sej)	Share	Raw	Emergy (sej)	Share	Raw	Emergy (sej)	Share
Renewable environmental inputs (R)											
Solar energy	J	1.00E+00	4.93E+13	4.93E+13	0.46%	4.93E+13	4.93E+13	0.53%	4.93E+13	4.93E+13	0.47%
Wind, kinetic energy	J	1.24E+03	4.77E+11	5.91E+14	5.55%	4.77E+11	2.23E+14	6.35%	4.77E+11	5.91E+14	5.69%
Rain, chemical	J	2.34E+04	2.52E+09	5.89E+13	0.55%	2.52E+09	5.89E+13	0.63%	2.52E+09	5.89E+13	0.57%
River warer, chemical energy	J	3.61E+04	5.17E+10	1.87E+15	17.53%	4.70E+10	1.70E+15	18.23%	5.17E+10	1.87E+15	17.98%
Subtotal				1.92E+15	17.99%		1.75E+15	18.76%		1.92E+15	18.45%
Non-renewable environmental inputs (N)											
Groundwater	J	1.92E+05	2.33E+10	4.46E+15	41.92%	1.63E+10	3.12E+15	33.57%	1.86E+11	3.57E+15	34.40%
Subtotal				4.46E+15	41.92%		3.12E+15	33.57%		3.57E+15	34.40%
Purchased inputs (FR & FN)											
Human labor	J	2.22E+06	4.68E+08	1.04E+15	9.76%	4.68E+08	1.04E+15	11.16%	3.12E+08	6.93E+14	6.67%
Machinery	g	1.01E+10	2.24E+03	2.26E+13	0.21%	4.05E+03	4.09E+13	0.44%	2.43E+03	2.46E+13	0.24%
Fossil fuel and lubricant	g	8.60E+04	3.74E+09	3.21E+14	3.02%	2.34E+09	2.01E+14	2.16%	1.40E+09	1.20E+14	1.16%
Olives	Rials	6.76E+07	4.27E+07	2.89E+15	27.10%	4.67E+07	3.16E+15	33.91%	6.00E+07	4.06E+15	39.08%
Subtotal				4.27E+15	40.09%		4.44E+15	47.67%		4.90E+15	47.15%
Total				1.06E+16	100%		9.31E+15	100.00%		1.04E+16	100.00%
Output											
Olive fruit	g			2.00E+05			9.50E+04			5.50E+04	
Olive fruit	J			9.70E+10			4.61E+10			2.67E+10	
Olives oil	lit			3.80E+05			1.81E+02			1.04E+02	
Olives oil	J			3.428E+11			1.633E+11			9.381E+10	
				HAMOON			HIRMAND			NIMROZ	
	Unit	Emergy	Raw	Emergy (sej)	Share	Raw	Emergy (sej)	Share	Raw	Emergy (sej)	Share
Renewable environmental inputs (R)											
Solar energy	J	1.00E+00	4.93E+13	4.93E+13	0.47%	4.93E+13	4.93E+13	0.31%	4.93E+13	4.93E+13	0.64%
Wind, kinetic energy	J	1.24E+03	4.77E+11	5.91E+14	5.69%	4.77E+11	5.91E+14	3.70%	4.77E+11	5.91E+14	7.65%
Rain, chemical	J	2.34E+04	2.52E+09	5.89E+13	0.57%	2.52E+09	5.89E+13	0.37%	2.52E+09	5.89E+13	0.76%
River warer, chemical energy	J	3.61E+04	7.52E+10	2.71E+15	22.74%	7.76E+10	2.80E+15	17.51%	5.17E+10	1.87E+15	24.16%
Subtotal				2.71E+15	22.74%		2.85E+15	17.81%		1.92E+15	24.80%
Non-renewable environmental inputs (N)											
Groundwater	J	1.92E+05	2.56E+10	4.91E+15	41.14%	1.92E+05	7.59E+15	47.45%	1.86E+10	3.57E+15	46.23%
Subtotal				4.91E+15	41.14%		7.59E+15	47.45%		3.57E+15	46.23%
Purchased inputs (FR & FN)											
Human labor	J	2.22E+06	3.12E+08	6.93E+14	5.80%	3.12E+08	6.93E+14	4.33%	4.68E+08	1.04E+15	13.45%
Machinery	g	1.01E+10	3.13E+03	3.16E+13	0.26%	3.17E+03	3.20E+13	0.20%	2.50E+03	2.52E+13	0.33%
Fossil fuel and lubricant	g	8.60E+04	2.34E+09	2.01E+14	1.68%	3.74E+09	3.21E+14	2.01%	8.41E+09	7.23E+14	9.36%
Olives	Rials	6.76E+07	4.94E+07	3.34E+15	27.95%	6.67E+07	4.51E+15	28.19%	6.67E+06	4.51E+14	5.84%
Subtotal				4.26E+15	35.70%		5.55E+15	34.73%		2.24E+15	28.97%
Total				1.19E+16	100.00%		1.60E+16	100.00%		7.72E+15	100.00%
Output											
Olive fruit	g			5.50E+04			8.50E+04			1.10E+05	
Olive fruit	J			2.67E+10			4.12E+10			5.34E+10	
Olives oil	lit			1.04E+02			1.62E+02			2.10E+02	
Olives oil	J			9.381E+10			1.461E+11			1.894E+11	

A comparison of the R values of the studied areas indicates that the olive production system in Hamoon county has more benefits from environmentally renewable flows. In general, the high use of free environmental inputs in the Sistan region can be attributed to the coincidence of the olive growth period with the sunny days of the crop year and its location in the 120-day wind period of the Sistan region. Researchers in China estimated the R of the rice production system to be 1.82×10^{15} sej ha^{-1} (Su *et al.*, 2020). The input of renewable environmental resources in the production system of rose, ginger and wheat is 17.54%, 6.42% and 0.07%, which indicates that the damask rose production system benefits more from renewable environmental resources than other systems (Su *et al.*, 2020).

The main non-renewable environmental resource in this study included the consumption of groundwater resources. Free non-renewable environmental inputs (groundwater) in olive production systems in the cities of Zabol, Zahak (central and Jezink part), Hamoun, Hirmand and Nimroz were 4.46×10^{15}, 3.12×10^{15}, 3.57×10^{15}, 4.91×10^{15}, 7.59×10^{15} and 3.57×10^{15} sej ha^{-1}, respectively. Hamoon and around Khajeh Mountain, therefore, in times of drought, is considered one of the areas prone to the construction of wells due to the presence of groundwater in this area. During the drought period, the beneficiaries turned significantly to groundwater to supply water to the agricultural sector, among which the wells constructed in Hamoon city were of high quality due to their proximity to the Hamoon wetland, so the cultivation of olives in this area is somewhat dependent on the water of the well, and as can be seen in the city of Hamoon, the consumption of groundwater as a A non-renewable resource is about twice as much as other regions.

The results of the research investigating different forms of input energy indicated that in the olive production system, the share of non-renewable environmental free inputs was higher than renewable environmental free inputs. This finding is consistent with the findings of other researchers (Taxidis *et al.*, 2015). The limitation of non-renewable energies on the one hand and the environmental problems caused by the consumption of this form of energy multiply the necessity of reducing the use of non-renewable energies and replacing them with renewable energy sources. Replacing chemical fertilizers with manures, green manures, biofertilizers, using no-tillage or low-tillage systems, and water consumption management that is related to the consumption of electricity or fossil fuels for pumping irrigation water are among the issues that can help reduce the share of non-renewable energy in the total energy input in the process of horticultural products production (Vafabakhsh and Mohammadzadeh, 2019).

The purchased input inputs are such as human resources, machinery, fossil fuels and seedlings. The FN and FR values in the olive production system in Zabol, Zahak (central and Jazinak districts), Hamoun, Hirmand and Nimroz are 4.27×10^{15}, 4.44×10^{15}, 4.90×10^{15}, 4.26×10^{15}, 5.56×10^{15} and 2.24×10^{15} sej ha^{-1}, respectively. According to the results, a high amount of the purchased input inputs is related to the purchase of seedlings and human resources, and the lowest amount is related to machinery. In general, it is observed that Hirmand and Nimroz have the highest and lowest FN and FR levels among the regions, respectively. Field observations and investigation of the results of the system outputs also indicate that in Nimroz city, due to the high planting distance of trees and the low volume of trees per hectare, fewer seedlings have been planted in the area, which is the main reason for the low FN and FR levels in this city.

The use of more human resources in Nimroz has increased the economic output of the system, which indicates the weakness of management and low productivity of human resources in this city. Hirmand has the highest FN and FR levels due to the high consumption of seedlings per hectare, the amount of fossil fuels and the higher use of agricultural machinery. Due to the high cultivation area of olive trees per hectare, Hirmand has a low level of economic yield of olive fruit. Due to the high rate of labor, this can be due to the low efficiency and productivity of the economic system in this region. In the research of Asgharipour et al. (2019) the reason for the high share of purchased input flows in the olive oil production system was the high cost of purchasing seedlings, which in this study was stated in terms of the weight of the seedlings and emergy based on the currency of Iran (Rial). In a study that emergy analyzed three production systems of wheat, ginger and roses in China, the results indicated that the ginger production system had the highest input in the purchased renewable resources with a value of 8.92×10^{16} solar joules per hectare per year, and the rose production farm was the most energy-efficient production system with a labor force input of 2.18×10^{16} sej ha^{-1}. In the cultivation of plants whose cultivation is other than seeds and by scallions, tubers, etc., a high share of production costs is related to seed preparation (Amiri *et al.*, 2021). In their study, Su et al. (2020) reported in their study that different types of chemical fertilizers and pesticides account for a major share of the purchased input flows (FN).

3.3. Evaluation of emergy indices

Evaluation using emergy indices is effective in identifying the distinction between different regions of the olive production system in terms of functional characteristics including ecological sustainability, resource use efficiency, environmental impacts, economic productivity, and market competitiveness. The results of the emergy indices are given in Table 3.

3.3.1. Transformity (Tr)

Conversion ratio is an effective indicator for evaluating the effervescent efficiency emergy of crop production (Brown and Ulgiati, 2004). A higher amount of Tr in the same production shows a lower economic and environmental effectiveness of Emergy (Lu *et al.*, 2010). Among the different regions studied (Zabol, Zahak (central and Jezink parts), Hamoun, Hirmand and Nimroz), the highest value of Tr index in olive and olive oil production systems in Hamoon city (4.47×10^5 and 1.27×10^5 sej ha^{-1}) and the lowest value of this index was related to these production systems in Zabol city (1.10×10^5 and 1.11×10^4 solar joules in Joule, respectively). The effectiveness of olive and olive oil production is higher in Zabol city. In Jafari et al. (2018), the conversion coefficients of pistachio and date plants in Iran were 1.71E+9 and 1.47E+9 sej ha^{-1}, respectively. As reported by Zhang et al. (2012) and Cavalett and Ortega (2009), soybean production systems in China and Brazil were 8.37E+4 and 1.01E+5 sej ha^{-1}, respectively. Fallahinejad et al. (2021) reported Tr coefficients for sugar beet and saffron production systems as 1.17E+5 and 2.99E+8 sej ha^{-1}, respectively.

Table 3. Investigation of emergy indices in olive production systems of Sistan region

	Zabol	Zahak (Centeral ppart)	Zahak (Jazinak distract)	Hamoon	Hirmand	Nimruz
Transformity for olive fruit	1.10E+05	2.02E+05	3.89E+05	4.47E+05	3.88E+05	1.45E+05
Transformity for olives oil	3.11E+04	5.70E+04	1.11E+05	1.27E+05	1.09E+05	4.08E+04
Specific emergy for olive	5.32E+10	9.80E+10	1.89E+11	2.17E+11	1.88E+11	7.02E+10
Specific emergy for olives oil	2.80E+10	5.14E+13	9.98E+13	1.15E+14	9.87E+13	3.68E+13
R%	24.39%	26.66%	26.93%	29.33%	23.89%	27.31%
EYR	2.495	2.098	2.121	2.801	2.879	3.452
EIR	0.669	0.911	0.892	0.555	0.532	0.408
EIR*	2.228	2.541	2.556	1.542	1.950	1.168
ELR	4.559	4.331	4.420	3.318	4.614	3.032
ELR*	3.101	2.751	2.713	2.410	3.187	2.662
ESI	0.547	0.484	0.480	0.844	0.624	1.138
ESI*	0.805	0.762	0.782	1.162	0.903	1.297

3.3.2. Percentage of renewables (R%)

The ratio of renewable inputs to total emergy is called the percentage of emergy (R) (Zhang and Long, 2010). In the long run, in order to succeed in economic competitiveness, a smaller amount of non-renewable resources must be used than renewable resources (Brown and Ulgiati, 2004; Lefroy and Rydberg, 2003). In the present study, the percentage of emergy renewability of the olive production system in the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz was calculated to be 24.39, 26.66, 26.93, 29.33, 23.89 and 27.31 percent, respectively. The larger R of the olive system in Hamoon city compared to the other studied systems was due to the high share of the use of renewable environmental inputs. In this study, the lowest R among the different studied areas was related to the olive system of Hirmand city, which indicates the fact that a high percentage of the emergy used in this city is dependent on non-renewable environmental resources. The low R-value of the olive system in Hirmand city can indicate the instability of this system in this city (Table 2). The R values in the production system of rose, ginger, potato, and wheat were 20.68%, 21.5%, 34.06%, and 44.11%, respectively (Su *et al.*, 2023). In a study in China, the R values of traditional rice production and vegetables in the compact method were estimated to be 52.66 and 12.30, respectively (Su *et al.*, 2020). R for beans in Iran in the ecological production system and the system with high input consumption were reported to be 53.69 and 35.35 percent, respectively (Asgharipour *et al.*, 2019), so the change in the type of consumption of inputs in the system was reported from high consumption of conventional and chemical inputs (with low renewability) to the consumption of inputs with more renewable and ecological sources, R, improvement in the sustainability of the systems.

3.3.3. Emergy yield ratio (EYR)

The emergy Yield Ratio index is the ratio of total emergy performance to emergy purchased from the market and is widely used as a measure to demonstrate the ability of a process to absorb local renewable and non-renewable resources by investing in economic resources (Odum, 2000). Higher EYR values indicate a higher ratio of purchased versus free resources emergy in the process (Brown and Ulgiati, 2004; Odum, 2000).

According to the results, the EYR values of the olive production system in the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz were 2.495, 2.098, 2.121, 2.801, 2.879 and 3.452, respectively. The main reason for the higher EYR index in the olive production systems of Nimroz city was the higher share of non-renewable environmental input (groundwater 46.23% of the total emergy) compared to other areas studied. The greater share of the emergy input from the source of non-renewable free streams in the olive of Nimroz city was due to the use of improper extraction of groundwater that has been excavated more frequently (due to the existence of groundwater resources obtained from the existence of the Hamoon International Wetland) during the plant growth period. In a large number of emergy assessments, the EYR index has been reported as one of the main indicators. The EYR values in the emergy of rose, ginger, potato, and wheat production systems were 11.16, 0.07, 1.96, and 4.16, respectively (Su *et al.*, 2023). The value of this index in a study on new triple cultures, dual systems and traditional triple culture systems in China was 1.12, 0.98, and 1.03, respectively (Dou *et al.*, 2023). In Amiri et al. (2021) EYR rates in the commercial and subsistence production system of rapeseed was 2.31 and 1.53. In a research, the size of EYR in the traditional system of rice and vegetables production by intensive method was 1.45 and 1.05, respectively (Ghaley *et al.*, 2018; Su *et al.*, 2020). In the garden crops of banana, papaya, guava and wimpy, EYR levels were 1.04, 1.16, 1.31 and 1.30, respectively (Lu *et al.*, 2010).

3.3.4. Emergy investment ratio (EIR) and modified (EIR*)

The emergy investment ratio (EIR) provides information on how the system is emergy in using investment-induced emergy compared to free environmental imperatives (Odum, 1996). The EIR is derived from the ratio of purchased entries to free system entries. A lower value of this index indicates more dependence of the system on environmental resources (Wang *et al.*, 2014). The highest value of the EIR index in the present study was related to the olive production system in the Jazinak part of Zahak city with the amount of 0.911 and the lowest value was related to the olive production system in Nimroz city with the amount of 0.408 and the EIR* in the olive production systems of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz were 2.228, 2.541, 2.556, 1.542, 1.950 and 1.168, respectively, so the lowest level of this index was also in the system of Nimroz city and The highest is observed in Zahak County. The emergy of seeds, human resources and fossil fuels in the olive production system of Zahak city was the reason for the high value of EIR index in this city compared to other areas studied in this study. Considering that the lower level of EIR index indicates more dependence of the system on environmental resources, the reason for the low EIR index in the olive production system of Nimroz city can be emergy as the high share of free renewable environmental inputs (24.80% of the total emergy environmental inputs).

In the study of Su et al. (2023), the value of the EIR index for olive, ginger, potato, and wheat production systems was reported to be 3.84, 1.07×103, 11.23, and 6.09, respectively. The value of this index in a study that investigated the new triple-cropping systems, dual systems, and traditional triple-cropping systems in China was 0.35, 0.35, and 0.36, respectively (Dou *et al.*, 2023). In a study on the sustainability status of Huanjiang Rangeland Forest Area, China, the trend of EIR changes during 16 years was reported to be increasing. The value of this index was calculated to be 0.12 in 2000 and 0.71 in 2015 (Zhai *et al.*, 2017). The EIR values for canola production systems in commercial and traditional units were 0.76 and 1.86, respectively, and the obtained EIR* values in commercial and traditional systems were 9.00 and 8.94, respectively (Amiri *et al.*, 2019). In another study to compare the three production systems of crops, poultry and fish, it was stated that the EIR in these three systems was 3.98, 4.63 and 5.87, respectively, which indicates that the EIR in agricultural systems is low compared to non-agricultural systems of livestock and fisheries (Cheng *et al.*, 2017). In a study of soybean production systems in Brazil, the EIR value was calculated to be 1.25 (Cavalett and Ortega, 2009).

3.3.5. Environmental loading ratio (ELR) and modified (ELR)*

The indices of standard environmental load ratio (ELR) and modified environmental load ratio (ELR*) indicate the pressure imposed by the study system on the environment. ELR is calculated by emergy the ratio of non-renewable environmental inputs and purchased inputs to renewable environmental inputs and ELR* is calculated by calculating the ratio of non-renewable to renewable energy inputs (Ortega *et al.*, 2005). The high ratio of these two indicators means that there is a high pressure on the environment. The ELR values in the present study for the olive production system in the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz were 4.559, 4.331, 4.420, 3.318, 6.614 and 3.032 kJ, respectively. Also, the ELR* for these areas was 3.101, 2.751, 2.713, 2.410, 3.187 and 2.662, respectively. Based on the ELR and ELR* values calculated in this study, the pressure on the environment from olive systems was the lowest in Nimroz city and the highest in Hamoon city. In the olive production of Nimroz city, the pressure on the environment was less due to the higher utilization of free environmental inputs (R). Also, the olive production system of Hamoon city exerted the most pressure on the environment due to the use of free non-renewable environmental resources (N). In the study of Lu et al. (2010) in Guadeloupe region, the ELR index values were 0.10, 6.6, 4.1 and 3.2 in the Guadeloupe region, respectively. The ELR index for the production systems of rose, ginger, potatoes and wheat were 3.84, 18.19, 1.94 and 1.27, respectively (Su *et al.*, 2023).

The value of this index in a study that investigated the new triple-cropping systems, dual systems, and traditional triple-cropping systems in China was 0.66, 0.70, and 0.69, respectively (Dou *et al.*, 2023).

In the study of canola production sites in Iran, the values of ELR and ELR* were calculated as 19.75 and 17.85 in the commercial system and 12.68 and 4.00 in the subsistence system of rapeseed production, respectively, and based on the two indices of ELR and ELR*, the unstable trade system was introduced (Amiri *et al.*, 2019). Giannetti et al. (2011) reported that ELR, coffee production in Brazil, was 2.89 in the commercial ecosystem and it ranged between 0.39 and 2.06 in protected areas, so it was argued that the commercial coffee production system studied had low sustainability and protected area systems would be sustainable in the medium to long term. ELR (10.62) was also reported in a study of corn production in northern China (Zhang and Long, 2010). In a comparison of ELR*, stability of three systems of pure lotus, shrimp and lotus-fish production systems and the ELR values of these systems were 2.3, 2.8, and 2.4, respectively. The pure lotus production system was more stable than the others.

3.3.6. Emergy sustainability index (ESI) and modified version (ESI)*

The ESI index is a composite index that is obtained from the fraction of the ratio of the emission performance to the ratio of environmental load. It measures the benefits achieved by a system per unit area (Ulgiati and Brown, 1998). In other words, environmental sustainability calculates the system's advantage over its costs. Hence, the ESI index illustrates two aspects of the economy and the environment. The higher values of the Environmental Sustainability Index indicate higher stability of the system, ranging between zero (0) and infinite (∞) (Brown and Ulgiati, 2004).

In the present study, the ESI for olive production systems in the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz were calculated as 0.547, 0.484, 0.480, 0.884, 0.624 and 1.138 MJ, respectively. Also, the ESI* values for olive production systems in the mentioned areas were 0.805, 0.762, 0.782, 1.162, 0.903 and 1.297 sej ha^{-1}, respectively. The ESI* values showed somewhat more stability in the studied areas than the ESI values. Since EYR, ELR and ELR* indices are involved in the calculation of ESI and ESI*, the distance between the values of ESI index and the values of the modified version of ESI* in the studied areas was due to the difference between the values of ELR and ELR*. The high level of ESI in the olive production system of Nimroz and Hamoon counties can be attributed to the high share of free renewable environmental input (R) and the allocation of a large amount of purchased inputs in this region. According to the correlation between ESI and ESI*, the higher rate of these indicators is not only provided by the decrease in the purchased inputs, but also the higher rate of environmental renewable inputs leads to an increase in this ratio and the magnitude of the ESI and ESI* indices. Considering that all the studied areas except Nimroz city in this study have an ESI level of less than one, these areas do not have a desirable stability. By minimizing the purchased inputs while increasing the flow of free environmental inputs, especially from a renewable source, the ESI index can be improved. in China, the environmental sustainability index in low-inlet maize farms was 0.45 (Zhang *et al.*, 2012), and in banana, papaya, Wampee, and guava, it was less than 0.40 (Lu *et al.*, 2010). The value of ESI index in the study of Su et al. (2023) for the production systems of rose, ginger, potatoes and wheat was 2.91, 0.004, 1.01, and 3.28, respectively. The value of this index in a study on new triple cultures, dual systems, and traditional triple culture systems in China was 0.54, 0.50, and 0.53, respectively (Dou *et al.*, 2023).

3.4. Olive marketing margin in Sistan region

Retail margin is the difference between retail price and wholesale price, wholesale margin is the difference between wholesale price and producer price, and the total market margin is also the sum of retail margin and wholesale margin. Marketing margin actually includes all the activities and operations performed by marketing agencies and intermediaries. The results indicate that the lowest retail margin in olive production was observed in Nimroz (central part) and Hirmand county, respectively, and the highest in Zahak county (Jazinak part), respectively. The study of the wholesale margin in olive production showed that the cities of Hirmand and Zahak (Jazinak part) had the lowest and highest wholesale margins, respectively. According to the results in the olive crop of Zabol and Nimroz (central part), the wholesale margin is lower than the retail margin, the reason for this can be mentioned as the presence of more intermediaries in the market (due to its proximity to the main sales market or the wet square of Zabol city) as well as the bargaining power of retailers in front of customers to determine the price (Fig. 1), which shows the demand of people for olive oil Therefore, it increases the demand for this product and increases its price. Another factor affecting this difference is the amount of olive oil production, because the amount of production of this product is less than its demand, and the market is out of competitive conditions and the marketing margin increases.

The high absolute marketing margin for olives is primarily attributed to the substantial retail margin associated with this product. Unlike many agricultural goods, olives are not fully sold at the time of harvest. Instead, a significant portion is processed into olive oil, which generates considerable added value. Producers strategically sell the product at a higher price when market conditions are favorable or supply it to wholesalers at elevated prices. This dynamic drives an increase in the wholesale margin, which in turn contributes to the overall rise in the absolute marketing margin.

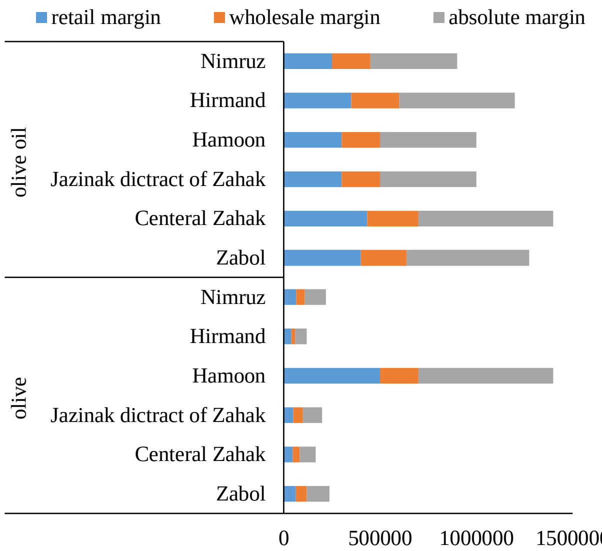

Figure 1. Investigation of retail, wholesale and absolute margin of olive and olive oil products in different regions of Sistan (Rial)

3.4.1. Market efficiency

Market efficiency indicates that for each unit of marketing cost, several margin units are created in the market, and the closer this number is to one, the more efficient the market is. Therefore, olive oil is very close to one in terms of total efficiency and its market is more efficient. The price inefficiency of olive seed in the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz is 0.143, 0.246, 0.251, 0.027, 0.335 and 0.271, respectively, and the technical inefficiency for this crop is 0.0056, 0.0091, 0.008, 0.0016, 0.0266 and 0.0162, respectively. The price inefficiency of olive oil in the cities of Zabol, Zahak (central and Jazinak parts), Hamoun, Hirmand and Nimroz Saberi and Nimroz (central and Saberi parts) are 0.0157, 0.0136, 0.024, 0.030, 0.0216 and 0.018, respectively, and the technical inefficiency for this product is 0.027, 0.022, 0.038, 0.038, 0.033 and 0.030, respectively. As can be seen, the technical inefficiency in the olive product is less than the price inefficiency, which is due to the low waste of the products and the quick sale of fresh products to the neighboring markets or converting them into oil and selling them at the right time. According to the results, in general, the inefficiency in the olive product is more than the inefficiency in olive oil (as a processed product), which indicates the efficiency of the olive oil market product. Therefore, it can be said that the processing of these products leads to the improvement of its marketing and increases its technical efficiency (Fig. 2).

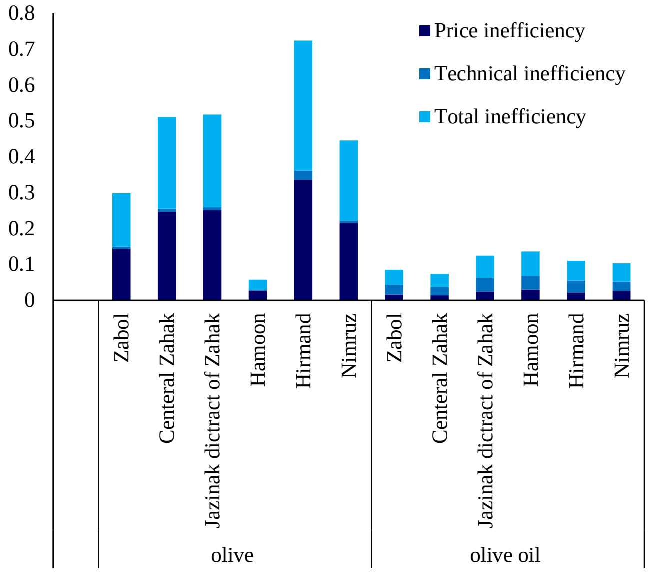

Figure 2. Comparison of price, technical and total inefficiency in olive and olive oil crops in different regions of Sistan region

3.5. Spatial regression

In order to determine the factors affecting marketing margin, the absolute margin model along with other probable influencing variables in marketing margin has been estimated according to the relationships mentioned in the previous section. In this model, the variables of marketing margin as a dependent variable and retail price, wholesale price, value of the product offered, marketing costs, and the total amount of product produced in the production unit are presented as independent variables, and first, the model was estimated by the old method in Eviews software and in the next step, using spatial regression in GIS software.

In Table 4, the R^2 value is equal to 0.99, which indicates that the model is well-fitted. Cost and income variables have a negative effect on market margin, which is not significant. While retail and wholesale prices have a significant effect on the market margin, the retail price has a positive and significant effect and the wholesale price has a negative and significant effect on the market margin. The retail price has the greatest effect on the olive market margin so with a point increase in the retail price, the market margin increases by 1.08 points. However, with an increase of one unit in the wholesale price, the market margin decreases by 1.02 points.

Table 4. Factors affecting olive marketing margin (Simple model)

Product	Variables	Coefficients	std	t	sig
Olive	Marketing costs	-0.94	1.12	0.84	0.42
	Revenue from sales	-0.00012	0.00015	-0.85	0.41
	Retail prices	1.08	0.23	4.67	0.00
	Wholesale price	-1.02	0.27	-3.74	0.00
	y	48.17	21.67	2.22	0.04
	Breusch–Pagan test	0.41		R^2	0.99
	Durbin-Watson	1.7		R^2 adjusted	0.98
Olive oil	Marketing costs	14.25	14.97	0.95	0.36
	Revenue from sales	-0.00004	0.00007	-0.64	0.53
	Retail prices	1.03	0.27	-3.46	0.00
	Wholesale price	-0.92	0.27	-3.46	0.00
	y	-211.92	435.01	-0.48	0.64
	Breusch–Pagan test	0.01		R^2	0.63
	Durbin-Watson	2.3		R^2 adjusted	0.5

In the case of olive oil, it can be said that the income from sales and marketing costs do not affect the market margin, but retail and wholesale prices have an effect on the market margin. Considering that the marketing costs of olive and olive oil products have no effect on the regression by the OLS method, and according to previous researches, one of the reasons for the lack of significance of marketing cost in the marketing margin equations can be considered due to the lack of consideration of the distance from the farm to the market, and this issue can be considered due to the lack of use of distance costs in the model (Kohansal and Rafiei, 2019). Also, the Pagon Brosh statistic indicates the existence of variance heterogeneity among the research variables and shows that the simple OLS model cannot fit the model well. For this reason, the effect of different variables on marketing margin was studied using GIS software and spatial regression.

The results of the spatial model (Table 5) for olive production show me that in this model, marketing costs, sales revenue, and wholesale prices have a negative effect and retail prices have a positive effect on the market margin. Of course, it should be noted that only retail prices and wholesale prices, such as the OLS model, have a significant effect on the market margin. Therefore, it can be concluded that in the case of olives, spatial and spatial factors have no effect on the marketing margin of olives. The results of both equations are nearly identical,, indicating that marketing margin for this product is not influenced by the geographical position of farmers relative to different regions. This is also confirmed by the test of heterogeneity of variance. In Table 5 the probability of the Pagon method statistic is given. The null hypothesis in this statistic suggests that there is no significant variance in the similarity between the research variables. Since the probability rate exceeds 0.05, the null hypothesis is accepted, indicating that the model does not exhibit variance heterogeneity.

Table 5. Factors affecting olive marketing margin (Simple model)

Product	Variables	Coefficients	std	t	sig
Olive	Marketing costs	-1.78	1.62	-1.1	0.42
	Revenue from sales	-0.00023	0.00024	-1.09	0.41
	Retail prices	0.21	0.009	22.27	0.00
	Wholesale price	-1.43	0.62	-2.29	0.00
	y	66.09	31.03	2.13	0.04
				R^2	0.98
Olive oil	Marketing costs	17.24	4.15	4.24	0.0
	Revenue from sales	-0.00003	0.00005	-2.43	0.0
	Retail prices	0.86	0.32	2.74	0.0
	Wholesale price	-0.83	0.23	-3.62	0.0
	y	833.04	160.06	5.2	0.00
				R^2	0.92

The reason for the lack of significant marketing costs may be due to the low share of marketing and marketing costs and the short transportation routes to the market or the low share of sales of olives in the form of seeds (about 20% of the harvested product is sold or converted only in the form of seeds), which has a very small share in the marketing margin and the necessary changes to determine the effect It is not on the marketing margins. On the other hand, with the lack of significance of marketing costs, it can be realized that the distance of the farm and transportation costs to the olive markets, the low share of marketing and marketing costs, the cost of services performed, the costs of the place of business, and the absence of processing industries in the region have no effect on the marketing margin.

In the case of olive oil, all variables are significant in the spatial regression for this product. Marketing cost and retail price have a positive and significant effect on marketing margin and wholesale income and price have a negative and significant effect on olive oil production. The value of R^2 in the spatial regression model is higher than in the simple model, which indicates the superiority of the spatial model's fit compared to the simple regression. On the other hand, it can be said that the marketing margin for olive oil in Sistan, in addition to other factors affecting it in previous researches, also depends on the position of farmers in the adjacent areas, and this spatial location has a direct and significant effect on the adjacent samples in terms of marketing.

The high and significant effect of marketing costs on market margin is one of the most important results of spatial regression in olive oil production. So the greatest impact on marketing margin is through marketing costs. As shown, as the cost of marketing increases, the marketing margin increases. This indicates the high impact of marketing spending on market margins. Considering that this effect was significant in spatial regression but not significant in the simple model, it can be said that the cost of marketing and marketing has a high share of the costs in the marketing of olive oil and has a large share in the marketing margin. On the other hand, the effect of farm distance and transportation costs on the sales market is well evident in the spatial model. It can be said that the marketing margin has a significant and high relationship with the distance from the farm to the market, followed by transportation costs, with the marketing margin. The main marketing cost of olive oil is the cost of transportation and transportation, which is directly related to the size and distance to the market, which indicates the large and inappropriate distribution of farms to shopping centers.

The results in the above table indicate that the retail price has a positive and significant relationship with the market margin and this effect is positive. So one unit increase in retail prices can increase the market margin by 0.86. On the other hand, the wholesale price has an inverse and significant relationship with the market margin, and each unit increase in the wholesale price can reduce the market margin by 0.83. As the results show, the effect of wholesale prices is greater than that of retail. Considering the relationship between wholesale and retail prices with retail margins and the total market margin, it can be said that with the increase in production, the supply of products increases, this increase in supply decreases the price, but the wholesale price will decrease more than the retail price, so it will increase the retail margin and this factor will lead to an increase in the total margin. According to the above table, with an increase of one unit, the market margin of producers decreases by 0.0003 and this effect is significant. This coefficient shows that the income variable has an inverse relationship with the margin of the olive oil market. It can be said that even if the production of olive oil increases per unit, with the stability of prices, the income of producers will increase and the market margin will decrease.

4. Conclusion

One of the main issues in the agricultural sector, especially in the Sistan region, is the limitation of water resources at the present time (and in the past, the seasonality of water inflow to the region) and other environmental resources. At present, this restriction is the main factor in the production of horticultural products, especially stable production with economic value for gardeners. Focusing on this limitation as well as new developments in the production of horticultural products, the use of new methods of production of these products can be considered as a suitable solution to reduce the limitations and their impact on the production process of horticultural products. On the other hand, a significant part of the population in the Sistan region, which was engaged in agriculture and animal husbandry in the past, and this was required to receive sustainable water, is now changing the trend from the cultivation of crops to horticultural crops (which are both more economical and managed with less water and of course are compatible with the climate of the region). Accordingly, if the problem of water supply and the creation of infrastructure for downstream and conversion industries can be solved according to the mentioned limitations while helping the production industry, one of the main and fundamental concerns of the residents of the region, which is the issue of sustainable employment and income, will also be solved. Therefore, according to the presented materials, it can be said that the olive production system in Zabol, Nimroz and Zahak counties among other regions uses higher free environmental inputs and at the same time this system has less use of non-renewable free inputs and causes the least damage to non-renewable resources and the environment in the region.

The results of the economic sector show that there is a spatial and spatial relationship between olive oil producers. Due to the positive sign of marketing costs, it can be said that marketing cost has a positive effect on the marketing margin and with its increase, the marketing margin of these products will increase. The biggest impact on the marketing cost of this product was for olive oil. Access to transportation infrastructure for the transportation of products to the city center, the lack of active cooperatives in the field of product transportation, and the distance to Zabol city as the main market for the sale of these horticultural products are the important and main factors affecting the marketing cost index on the marketing margin. Since olive oil is considered a processed product and on the other hand, the environmental superiority of olive products in the cities of Zabol, Zahak and Nimroz can be seen compared to other regions, the processing of these products can help farmers in terms of economic empowerment and increase the profits from the sale of these products. Considering new technologies in the field of processing and processing industries can achieve two basic goals of sustainability and economic empowerment of users.

By implementing mechanization and industrial cultivation of olives in rural areas, it is possible to fill the gap of labor shortage, reduce costs, help increase cultivation and increase productivity in the region. Mechanical technologies, by overcoming technical and climatic constraints on the one hand and time constraints on the other hand, have led to the expansion of agricultural production in the region. Therefore, the level, appropriate selection and proper use of machine inputs in agriculture have a direct and significant effect on the achievable levels of land productivity, labor productivity, agricultural profitability, sustainability, environment and quality of life of people working in agricultural trade.

Conflict of interests

All authors declare no conflict of interest.

Ethics approval and consent to participate

No humans or animals were used in the present research. The authors have adhered to ethical standards, including avoiding plagiarism, data fabrication, and double publication.

Consent for publications

All authors read and approved the final manuscript for publication.

Availability of data and material

All the data are embedded in the manuscript.

Authors' contributions

All authors had an equal role in study design, work, statistical analysis and manuscript writing.

Informed consent

The authors declare not to use any patients in this research.

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