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OLIVAE

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IRAN

CARRYING TALES OF CENTURIES PAST:
IRAN'S MILLENNIAL OLIVE TREE

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OLIVAE

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EDITORIAL

DEAR READERS,

Welcome to the latest issue of Olivæ. Every year, the official magazine of the International Olive Council (IOC) is dedicated to a different country, at the request of its delegation to the Council of Members. The 2023 edition is devoted to the centuries-old olive groves of the Islamic Republic of Iran. Iran, which joined the International Agreement on Olive Oil and Table Olives in 2004, has dedicated a team of national experts who have worked hand in hand with the IOC Executive Secretariat to tell us the fascinating story of Iran's olive groves.

In the ancient tapestry of the Persian nation's landscape, the olive tree stands tall as a silent poet, its roots entwined with the echoes of time, carrying tales of centuries past. Iran, who has recently implemented numerous plans to boost its agricultural sector, has demonstrated a special devotion to the millennial olive tree. Within the framework of the fifth National Development Plan (2024-2028) and under the mandate of the Ministry of Agriculture Jihad, Iran has pushed a National Olive Development Plan which aims to foster a 150 thousand hectares olive garden, financed in part by the Ministry and other public and private entities of its agricultural sector. This is indeed a milestone for an IOC member country which falls very much in line with multiple objectives of the International Agreement.

In this edition of Olivæ, you will embark on an unparalleled journey through the Iranian olive germplasm and its characteristics, diving into the olive sector's environmental reality in a context of climate change and learning about a wide variety of aspects pertaining to the cultivation of olive orchards in the silk-woven heart of Persia. Upon finishing the reading of Olivæ, you will undoubtedly have acquired a deep understanding of where the olive trees stand in Iran, and where they are headed.

On behalf of the Executive Secretariat of the world's only intergovernmental organisation wholly devoted to the olive tree and representing almost all producing and consuming countries of this ageless crop, we sincerely hope that you enjoy this edition of our magazine as much as our team enjoyed putting it together. We wish to take this opportunity to thank the Iranian Ministry of Agriculture Jihad for their work and dedication, and also want to wish the nation good fortune and success as they endeavour to chair the IOC's Council of Members in 2024.

Mr. Abdellatif Ghedira
Executive Director of the International Olive Council

PREFACE

The olive tree is one of the oldest fruit trees and human food sources, which has been cultivated and used since ancient times. With the emergence of early human civilizations, its use has also become popular. In different religions, the olive is mentioned as a holy tree, auspicious and a symbol of peace. In the Torah and the Bible, including the Holy Qur'an, it mentions the olive eight times. The origin of this tree is considered by some to be in the Zagros region of Iran and others in Syria, Palestine and Asia Minor, which later reached Greece, Italy and Spain, in the 16th century to America and in the 20th century to China and Australia. Currently, olive cultivation centers are mainly around the Mediterranean Sea. It is believed that in ancient times, olives were cultivated for the first time by native people who lived in the region of "Iran and Turan" (Middle East). The latest archeological discoveries in Gole Warz Hill, Rostamabad, Gilan Province, indicate that olive cultivation in this area of Iran dates back to more than 2000 years ago.

Food security is one of the most important issues that mankind has faced in all times, and many wars and bloodsheds have been fought among different nations to increase the food security factor. Climate change is one of the atmospheric phenomena that has recently overshadowed food security in all societies. A greater productivity of water and soil under the conditions of climate change, in order to meet the food needs of families, especially vulnerable groups, is one of the strategies of governments. If this quantitative and qualitative improvement of production is not carried out in the countries where climate change is significant, insecurity and increasing treatment costs are social phenomena that will threaten the governments. Iran is also one of the countries where, due to being located in arid and semi-arid regions of the world, the phenomenon of global warming has had a significant effect on its agricultural production. The idea of introducing more cultivars to lands where they are more likely to be productive in these conditions is one of the ways to deal with and overcome this crisis to ensure food security.

One of the most important restrictions in the central, southern, western and eastern regions of Iran for the development of agriculture is the lack of water. Therefore, it is very important to select varieties that are less likely to dry out based on the amount of Leaf Water Potential (LWP) and the death rate of plants under water stress for cultivation in arid and semi-arid areas. The agricultural sector is one of the major consumers of water in our country. Due to the water crisis and the reduction of water resources, basic measures should be taken in order to reduce water and natural resource consumption in the agricultural sector. Cultivation of some products may not be very economical under the current conditions, so the development and production of products, such as olives that require less water, is very necessary and economical. Modifying the consumption pattern is the only way to overcome the water shortage crisis. In addition to being resistant to drought and consuming less water, the olive tree also has a good resistance to salinity. The production of about 40 tons per hectare in the 8.5-hectare orchard on the edge of the Semnan Desert with evaporation of about 3500 mm per year is one of the reasons for this claim. Therefore, the development of olive groves, as well as the proposal to replace some water-consuming crops with more drought-resistant varieties, can play an important role in controlling the very destructive effects of climate change and water scarcity. Olive oil has a high nutritional and medicinal value due to the presence of substances, such as tocopherols, polyphenols, antioxidants and fatty acids, like oleic, linoleic and linolenic. The plan of the Islamic Republic of Iran for using this valuable oil is to develop another 150 thousand hectares within a 10-year plan. The level of production standards of olive products has been upgraded to international standards. Given the membership and active role of the Islamic Republic of Iran in the International Olive Council, Iran is ready to transfer and exchange experiences with member countries. In continuation of this active role, it is planned to open a "Garden of Peace" composed of olive trees in the botanical garden in Tehran soon.

Dr. Mohammad Ali Nikbakht
Minister of Agriculture Jihad

PREFACE

Currently, the olive product in Iran has a special place due to its importance and direct role in providing food safety and health. Therefore, in the priorities of the Ministry under the Government, the olive has been declared as the only strategic horticultural product. Furthermore, in terms of its importance and role in the country's food security, it has been placed on the same level as wheat and corn. Considering the type of consumption of the olive product and the necessity of its processing, especially for the production of olive oil, creating an olive production chain is one of the goals and priorities of the Olive Design Office, Deputy Horticulture Affairs, in line with the policies and plans of the 20-year vision and with support from the domestic producer. In this way, we can see a significant and targeted increase in the production of olive oil and, as a result, a reduction in Iran's dependence on the import of this product. The creation of chain units in olives in the form of olive chains or olive clusters on a wide regional scale can be considered an effective step towards increasing product production and guaranteeing its final quality and, as a result, increasing per capita consumption and supporting domestic production.

According to the implementation of the programs and activities of the Olive Design Office to increase the cultivated area and make people more aware of olives, a significant increase in the consumption of canned food and olive oil has been observed. The consumption of olive oil per capita has increased from 30 grams to 200 grams and the consumption of canned food has increased from 30 grams to 650 grams. Currently, more than 40 categories of products are produced in the country's olive industry, some of which are exported.

According to the planning carried out in the Ministry of Agriculture Jihad and its extensive and wide-ranging activities in the framework of the improvement and development plan of the country's olive groves, the cultivation and development of olives was given attention to since 1993, which resulted in the increase of the cultivated area from 3500 hectares in the three provinces of Gilan, Zanjan and Qazvin, to about 90 thousand hectares of commercial orchards in 26 provinces of the country in 2022.

The long-term perspective of the sixth development plan:

- Increasing the food security factor in the country by producing healthy and useful oil.
- Achieving a positive food trade balance under the sixth development plan through increasing olive oil production.
- Ensuring the sustainable development of agriculture with the protection of basic natural resources.
- Improving water efficiency in the production of agricultural products and the optimal use of other production inputs.

Major goals:

- Increasing the economic level of the households and generating productive employment.
- Increasing the production and self-reliance factor of olive oil.
- Increasing the consumption of olive oil and improving nutrition and health in the community.
- Fostering self-sufficiency in the production of strategic products, including olives and their oil, and increasing food security for society by producing healthy olive oil.

Strategies:

- Optimizing olive orchards by developing early-yielding, high-quality and commercial cultivars.
- Improving the productivity of olive production factors (increasing yield per unit area of existing orchards).
- Improving the technical knowledge of managers and operators by using the opportunities available through the International Olive Council.
- Developing cultivated zones in susceptible areas, such as sloping lands, and optimal exploitation of basic resources and production bases, and the prevention of soil erosion.
- Using new technologies and upgrading, developing and expanding mechanization and improving quality.
- Improving the nutritional index and increasing the per capita consumption of olive products, preventing the import of low-quality products and improving the quality of domestic products.
- Developing and expanding the production of organic products.
- Developing and expanding the services related to the private sector.
- Educating and promoting technical knowledge.

Dr. Mohammad Mehdi Boroumandi
Horticultural Affairs Deputy Minister - Ministry of Agriculture Jihad

Introductory Olive Oil Organoleptic Assessment Course (Beski - Farshbaf Agricultural Complex, Minoodasht, Golestan, I.R.IRAN) Olive School Inauguration Ceremony (July 2023).

THE STATUS OF OLIVE DEVELOPMENT IN IRAN

1.Javad Mirarab Razi, 2.Anita Taherdoost, 3.Fakhte Alsadat Falah zade, 4.Somaye Nikfar, 5.Aydin Kamali zonoz, 6.Javad Mojtahed TabaTabaii

Olive Project Office | Ministry of Agricultural Jahad

Introduction

Iran is a country in the Middle East with an area of more than 1,600,000 Km^2. Its population is about 83 million. It borders 15 countries and is bound by the Gulf of Oman and the Persian Gulf to the south, and the Caspian Sea to its north. Given its varied climate, Iran enjoys great diversity in terms of animal and plant species, including the olive plant. Considering the interesting diversity of the Iranian olive germplasm, there are plans to significantly expand the country's olive cultivation area.

Among the thirteen chief climates in the world, Iran hosts a total of eleven climates, which creates a favorable opportunity for studying climatic diversity and how this affects the olive tree.

The history of the olive in Iran

Based on scientific evidence, olives have certainly been amongst Iran's major agricultural products throughout different historical periods.

The identification of several olive trees in different regions of Iran indicates the existence and the distribution of olive trees across the habitable microclimates of ancient Iran. These olive trees were distributed from west to east of the Zagros Mountains, and from the provinces of Kermanshah to Kerman. Moreover, some of the country's olive trees were also identified in Gelevarz in the city of Roudbar in the Gilan province, and the city of Maraveh Tappeh in the Golestan province.

In the ancient monuments that date back to the Achaemenid period (550-330 BC), representatives of western Iran are mainly characterized by having olive branches in their hands, proving the fact that the olive tree has been cultivated in that area.

In addition, Naser Khusraw (1004-1088) in his book "Safarnama", referred to some olive groves around the ancient city of Arrajan, now Behbahan, in the Khuzestan province. On top, according to documents belonging to the Finance Ministry during the period of the Qajar dynasty (1785-1925), the Qajar King borrowed 4000 tomans from the Russian government in order to finance a trip to Europe, in exchange of the product of olive groves from Rudbar city in the Gilan province over a four-year period.

Extension of the olive's diversity

The most important olive cultivars in the country are divided into two categories: domestic (native) and foreign cultivars.

The most important native cultivars are: Zard, Rowghani, Fishomi, Dezful, Mari, Shengeh, and Tokhm Kabki.

The Zard cultivar is one of Iran's most prime native olive cultivars. This cultivar is compatible with different climatic conditions and is cultivated broadly in the country. It is a dual-purpose and high-yield cultivar which produces olive oil and table olives of the upmost competitive quality. Another main variety, the Mari cultivar, is well-known as an excellent source for table olives. In addition, various Mediterranean olive cultivars are also grown in Iran. Amongst these, the Koroneiki, Arbequina, and Konservolia cultivars are the most cultivated.

Olive cultivation in Iran

Irrigated farming (ha)	Rainfed farming (ha)
98000	5000

Before 1992, and despite a long history of olive cultivation in Iran, olive oil was only used for cooking in the Rudbar and Tarom regions. In other parts of the country, this valuable oil was little known and was generally used for dressing salads or for medical purposes. Nowadays, however, and thanks to the work plan of the Olive Department of the Ministry of Agriculture, olive cultivated areas have reached approximately 84,000 hectares in 26 provinces of Iran. From these areas, 71,000 hectares of cultivated olive trees are bearing, producing more than 120,000 tons of olive fruit and over 5,000 tons of olive oil annually.

Olive production (table olives and olive oil)

Year	Production (tone)	Olive oil (tone)	Table olive (tone)
2021	120000	9500	64679
2022	157000	15500	81000

Total (ha)	Bearing (ha)	Nonbearing (ha)	~Added per year
103000	71000	32000	4000

The Iranian National Institute of Genetic Engineering and Biotechnology has devoted more than two decades of applied research to the olive sector. When the Institute began studying the Iranian olive, the extent of the diversity of the country's olive germplasm was unknown. In fact, given the proximity of the country to the Mediterranean basin, it was assumed that Iranian olive varieties would be quite similar to the Mediterranean ones. However, over time, research revealed an astounding degree of variation in Iranian olive genetic resources.

With the support of the Ministry of Agriculture, explorations of hard-to-reach locations in twenty-six provinces – from the highlands of the Zagros mountains (part of the ancient "Fertile Crescent") to the scorching plains of Baluchistan in southeastern Iran – took place with the aim of finding and sampling solitary feral and wild olive trees of both indeterminate and long age. Over time, more than 100 unique olive trees were identified and genetically analyzed.

Export and import of olive oil

About 1,700 tons of olive oil per year are exported to Iraq, Syria and Malaysia.

Conversely, in between 5,000 and 7,000 tons of olive oil are imported from Spain, Türkiye, Syria, Italy and Greece on a yearly basis.

Olive industry

In Iran, industries associated with olives are primarily situated in the production areas, facilitating the prompt processing of the fruit into olive oil. Conversely, a more suitable distribution of this matter could be achieved through government management of licenses.

Product	Amount
Extra virgin olive oil	6200
Virgin olive oil	5425
Refined olive oil	3425
Pomace olive oil	465
Lampante olive oil	300

Press and super press	Olive pomace oil extraction	Modern 2 & 3 Phases Mills	Olive oil refinery	Total sites
3	2	75	18	93

Olive laboratories

The establishment of the first laboratory for the sensorial analysis of olive oil recognized by the IOC in Iran in 2004 marked a significant milestone for the country's olive industry. This laboratory provides the possibility for standardized testing and quality control measures, ensuring the integrity of Iranian olive products. The number of official laboratories meeting the stringent IOC standards has seen a noteworthy increasing, reaching a total of five by 2022.

At present, these five official laboratories have employed a team that includes forty evaluators and five leaders. These professionals provide specialized knowledge and expertise in various aspects regarding olive testing, conducting a range of analyses to ensure the quality and authenticity of olive products. Through sensory evaluations, chemical composition analyses, and assessments of physical properties, they meticulously assess the characteristics and purity of Iranian olives and their derivatives. A chemical laboratory is also is in the final stages of evaluation in order for it to conduct tests adhering to the IOC's standards.

Local communities and associations

Local communities and associations play a vital role in the olive industry of Iran, where more than 45,000 households are directly or indirectly involved in various aspects of olive cultivation and production. Each province has an association working in the olive sector. These communities have recognized the immense potential of olives and have actively engaged in harnessing the economic and agricultural benefits offered by this crop.

To ensure effective coordination and representation of the olive sector, two prominent institutions have emerged as key players in Iran. The first one is the Association of Producers of Olive Oil and Salted Olives. This association brings together producers from different regions of the country, fostering collaboration and knowledge-sharing among its members. By promoting sustainable practices, quality standards, and technological advancements, the association aims to enhance the overall productivity and competitiveness of Iran's olive industry.

The second most influential organization is Iran's National Olive Council, in charge of monitoring and regulating activities related to olives in the country. This council has a similar structure throughout all of the olive producing provinces, based on a representative electoral system. It brings together experts, industry stakeholders and policy makers to formulate strategies and policies that promote the growth and development of the country's olive sector. By aligning its efforts with international standards and best practices, this council seeks to promote the reputation of Iranian olives and expand its presence in the global market.

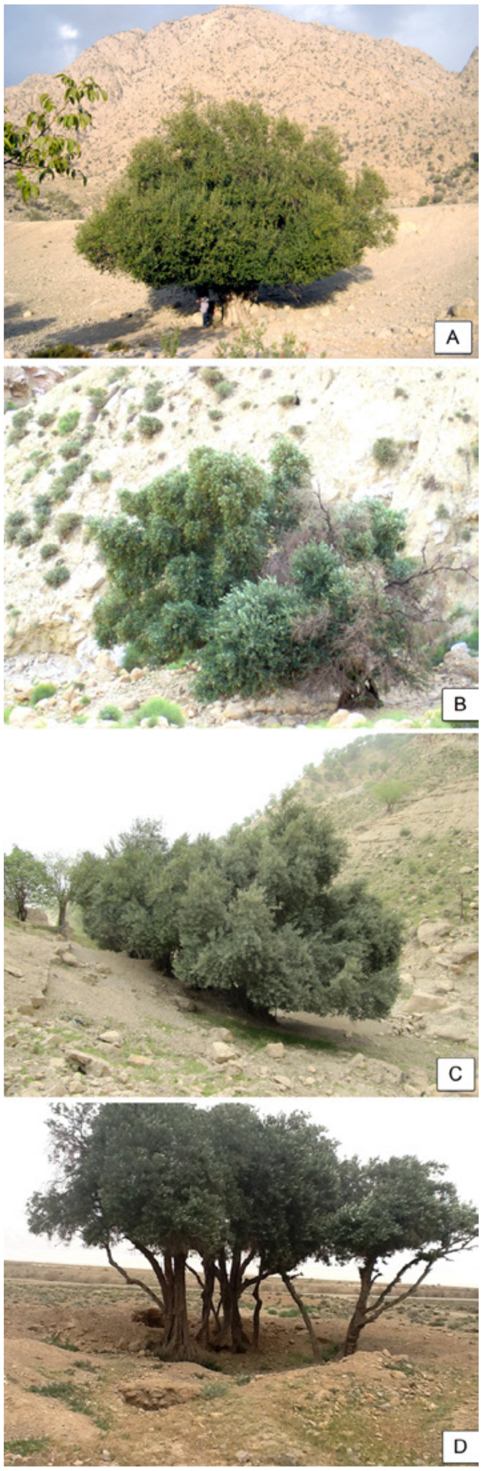
Both entities actively support research and development initiatives aimed at improving olive cultivation techniques, optimizing production processes, and exploring innovative uses of olives and olive-derived products. They also provide training programs, workshops, and educational resources to empower local farmers and producers with the latest knowledge and skills in the field.

Furthermore, they are committed to fostering sustainable practices in the olive industry by promoting responsible land management, water conservation, and environmentally friendly production methods to ensure the long-term viability of olive cultivation in Iran. By advocating for organic and sustainable farming practices, they also aim to meet the increasing demand for eco-friendly and socially responsible agricultural products.

In conclusion, the presence of vibrant local communities and dedicated associations, such as the Association of Olive Oil and Salted Olive Producers, along with the National Olive Council of Iran, highlights the important role of olives for Iran's agricultural landscape. Through their collective efforts, these organizations strive to promote the country's olive sector by embracing innovation, ensuring quality, and promoting sustainability, and ultimately contributing to the economic growth and well-being of local communities involved in olive production.

It is noteworthy mentioning that further to the aforementioned institutions, Iran is also home to numerous cooperatives of olive seedling producers and of olive growers, referred to as exploitation systems, acting as essential non-governmental sovereign actors that further enrichen the country's lively olive growing sector.

Examples of indigenous Iranian olive.



A) Torang cuspidata specimen, Kerman.

B) Mavi local ecotype, Khuzestan.

C) Gardineko local ecotype, Ilam.

D) Pirzeytun local ecotype, Fars.

LOCATING POTENTIAL AREAS FOR THE DEVELOPMENT OF OLIVE CULTIVATION IN IRAN

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An overview of the botanical characteristics and environmental requirements of the olive tree

The olive tree is an evergreen tree with the scientific name "*Olea europaea*". It belongs to the "Oleaceae" family, which belongs to the group of subtropical fruit trees. Olive tree leaves are near permanent, gradually falling once every three years. They have a relatively high resistance to drought and heat due to a waxy layer on their upper surface and fluff on their lower surface. Olive flowers usually bloom later than the flowers of other fruit trees. Olives have both complete (male and female) and incomplete (only male) flowers. The flowers are pollinated by wind and insects. The fruit of the olive is drupe and its shape can be oval, long or pointed depending on the cultivar. The olive tree also has a developed root system. The extension of the roots' expansion varies greatly depending on the type of climate, soil and variety that is cultivated.

The most important climatic, soil and physio-topographic needs of olive trees are presented in the three tables that follow:

Table 1 - Climatic requirements of olive trees

Species	Temperature (ºC)			Sum of temperature over than zero (degree-day)	Chilling requirements (hour)	Relative humidity (%)	Sunshine (hour)
	Absolute minimum	Absolute maximum	Average in the growth period				
Olive	-13	38-40	25-35	4000	200-1200	30-70	2000-2200

Table 2 - Soil requirements of olive trees

Species	Texture	Electrical conductivity (ds.-1)	pH	Content of Gypsum (%)	Content of lime (%)
Olive	Sandy-loam	<2	5.6-8	0-10	15

Table 3 - Physiographic and topographic needs of olive trees

Species	Latitude	Slope (%)	Altitude (meter above sea surface)
Olive	25-37	to 50	200-1500

The historical background of olive cultivation in Iran

The existence of centuries-old olive trees in many of the country's provinces, such as Golestan, Kerman, Sistan, Baluchistan and Fars, suggests that centuries ago, olive cultivation held a significant status in Iran and enjoyed widespread acceptance among the public. Despite there being no accurate data of how the olive tree reached Iran, it is believed that the plant may have been brought to the Persian country by the Arabs or the Greeks. Certain historians hold that the olive tree was in fact brought to Iran by Syrian refugees, while others attribute its arrival to the period corresponding to the Greek's presence in Iran. Nonetheless, most archaeologists and historians concur that the olive tree was brought to Iran from Mesopotamia.

Subject of the study

Since the early 21st century, the Ministry of Agricultural Jihad has devoted considerable efforts towards identifying the potential and practical aspects of developing the cultivation of Iranian olive trees across several regions and in eleven provinces in particular. A set of studies carried out by a group of qualified consulting engineers under the title "***Precise and detailed location-implementation of the development of olive cultivation"*** focused on identifying and prioritizing areas in Iran prone to olive cultivation, as well as identifying practical solutions for developing new olive gardens in different provinces.

Objectives of the development of olive cultivation in Iran

- Supplying a substantial portion of the country's required olive oil and achieving cost savings through a decrease in oil imports;
- Providing a productive employment environment;
- Creating suitable and permanent plant coverage in susceptible, low-yielding and non-cultivable areas;
- Preserving water and soil resources and encouraging sustainable development in areas prone to cultivation;

Geographical location of the study area

The studies were carried out in the provinces of **Kohkiluyeh va Boyer Ahmad, Fars, Kerman, Khuzestan, Ilam, Semnan, Tehran, Kermanshah, Sistan va Baluchistan, Lorestan and Ardabil**.

Methodology of the studies

The different study projects were broken down as follows:

A) Evaluation of the provinces' potential and capabilities in terms of their:

- Geographical situation;
- Political divisions;
- Climatic conditions;
- Watersheds and water basins;
- Water resources and water consumption;
- Current situation of orchards, especially olive groves (pure orchards with other trees);
- Production efficiency;
- Seedlings supply (Greenhouses, adaptation greenhouses and mother gardens);
- Oil extraction factories;
- Manpower;
- Investment capacities;
- Credits for water resource development projects.

B) Water supply

The diverse projects making up these studies were undertaken under the scope of irrigated water systems, meaning that water was supplied from the surface and from underground water sources. Taking this into account, the projects were classified in terms of their implementation priority, as explained below.

- B1) Projects with high implementation priority (3000)

  Areas under this category were given the identification code "3000", entailing:

  ✓ They are areas that have reliable water resources and water allocation permits have been obtained.

  ✓ In most cases, transmission lines, irrigation and drainage networks are ready for operation or are about to be finalized.

  ✓ In general terms, there are no apparent issues regarding public, economic and social participation.

- B2) Projects with medium implementation priority (2000)

  Areas under this category were given the identification code "2000", entailing:

  ✓ Water supply studies from surface streams or underground water sources are about to enter their second phase or are in their final stages.

  ✓ The continuation of studies and planning, with a particular emphasis on public participation, economic factors and social conditions, have been confirmed.

- B3) Projects with low implementation priority (1000)

  Areas under this category were given the identification code "1000", entailing:

  ✓ The potential water capacity and the necessary water supply for establishing olive groves in these areas are uncertain. The feasibility of water supply through surface flows (dam-pumping station) or underground sources is not likely in the near future.

C) Evaluation of areas prone to olive cultivation at the national level

The most important factors and indicators assessed at this stage are:

- Climatic factors;
- Physiographic characteristics (height, percentage and slope direction);
- Land use and crop coverage;
- Soil resources;
- Maintaining the status and capability of the provincial zones resulting from "National Spatial Planning".

D) Identifying and classifying priority projects

In this segment, the determination of project priorities for entering the implementation phase in the short, medium, and long term was achieved through the application of a relative importance index. The degrees of importance utilized include:

Table 4 – Degrees of importance index

Row	Index	Degrees of importance
1	Compatibility with environmental factors and climate	10
2	Land resources, soil science, land use and olive cultivation area	6
3	Water sources, including water quantity and quality	10
4	The possibility and system of water supply	7
5	Irrigation, efficiency and percentage of water supply	3
6	Compatibility of cultivars and supply of seedlings	5
7	Infrastructure facilities and characteristics of olive growers	3
8	Position of the project in zoning (or micro zone)	6
9	The level of olive cultivation in the base year, the stage of the studies, and the harvest peak	10
10	Yield and production of olives and olive oil in the base year, along with their marketing	8
11	Processing and oil extraction industries	5
12	Economic analysis	5
13	Manpower, employment creation, and the effect of the project on the sustainable development of the province and its components	5
14	Points of strengths and weaknesses	8
15	Recommendations and comments of the Jihad Keshavarzi Organization and provincial authorities	3
16	Comments of the expert team; synthesis of studies	3
17	Provincial rankings based on olive cultivation development capabilities	3
	Sum	**100**

E) Methodology for determining a project's ranking

The approach employed for determining project rank involved calculating a value derived from multiplying the ranking factors' values by the degree of relative importance of the index and then summing up the resulting numbers.

Zoning of suitable areas for olive cultivation at the national level

At this stage, the screening method, aimed at removing unsuitable ranges, was employed.

A) Primary zoning

Two key factors, namely climate and altitude level from the sea, were used for separating the suitable areas from the unsuitable ones and thus determining the initial zoning areas.

- **Temperature**

  Table 5 presents the temperature factor (annual average and minimum temperature average), in terms of the suitability of degree ranges for the cultivation of olive trees. In summary, olive trees are better grown under an average annual temperature between 16ºC and 18ºC, and an average minimum temperature between 0ºC and -2ºC.

Table 5 - Prioritizing adaptation of olive trees to temperature

Degree of priority Environmental factors	(1) Very suitable	(2) Suitable	(3) Semi suitable	(4) Low suitable	(5) Not suitable
Average of annual temperature (° C)	16-18	15-16 18-20	14-15 20-22	13-14 22-24	<13 >24
Average of minimum temperature (° C)	-2 to -1 -1 to 0	-4 to -2 0-2	-6 to -4 2-4	-8 to -6 4-6	<-8 >6

- **Rainfall**

Table 6 represents ranges of rainfall in terms of their suitability for growing olive orchards. In summary, olive cultivation in areas with less than 500 mm of rainfall should be accompanied by a water supply by irrigation. Conversely, areas with an annual rainfall of 700 to 800 mm are the most suitable areas for the development of olive orchards.

Table 6 - Prioritizing adaptation of olive trees to rainfall

Degree of priority Environmental factors	(1) Very suitable	(2) Suitable	(3) Semi suitable	(4) Low suitable	(5) Not suitable
Annual Precipitation (mm)	700-750 750-800	600-700 800-1000	550-600 1000-1200	500-550 1200-1400	<500 (for dry faming) >1400

- **Altitude**

Olive trees can be grown at an altitude of 700 to 1,400 meters above sea level. While height alone cannot may not be the sole limiting factor for the cultivating olive trees, it is generally observed that regions with elevations of up to 700 meters above sea level are mot conducive for olive cultivation. In areas exceeding 1,400 meters above sea level, more attention should be given to the careful planning and establishment of olive groves (refer to Table 7).

Table 7 - Prioritizing adaptation of olive trees to altitude

Degree of priority Environmental factors	(1) Very suitable	(2) Suitable	(3) Semi suitable	(4) Low suitable	(5) Not suitable
Altitude from sea level (m)	to 700	700-1000	1000-1200	1200-1400	>1400

B) Secondary zoning

After delineating susceptible areas and establishing the initial zoning range, the suitability of areas for olive cultivation was assessed. This evaluation, based on factors like class and slope percentage, as well as considerations of land resources and land use, led to the identification of suitable and unsuitable areas (refer to Table 8).

Table 8 - Prioritizing adaptation of olive trees to environmental factors

Degree of priority Environmental factors	(1) Very suitable	(2) Suitable	(3) Semi suitable	(4) Low suitable	(5) Not suitable
Soil depth (m)	1.5	1.2	0.8	0.7	<0.7
Slope (percentage)	0-10	20-Oct	20-30	30-50	>50
Underground water level (m)	180	150	110	100	<100
pH	7-7.2 7.2-7.5	6-7 7.5-8	5.5-6 8-8.2	5-5.5 8.2-8.5	<5 >8.5
EC (ds.m-1)	to 2.8	2.8-3.8	3.8-5.5	5.5-8	>8

C) Final zoning

Following the separation of vulnerable areas and defining the scope of secondary zoning, unsuitable regions were excluded through consideration of hydrological structure, water resources, and the biological environment. The tables (Tables 9, 10) were then utilized to pinpoint the susceptible areas for olive cultivation.

Table 9 - Area of zoning based on the results of the studies conducted in the study provinces (Ha)

Province		Area of provinces	Zoning		
			Primary	Secondary	Final
Kohkiluyeh and Boyer Ahmad	Area (Ha)	1,549,794	676,908	407,345	82,638
	Percent	100	44	26	5
Fars	Area	12,240,000	3,253,700	1,377,145	163,993
	Percent	100	27	11	1
Kerman	Area	17,919,103	7,418,400	4,374,115	4,261,000
	Percent	100	41	24	24
Khuzestan	Area	6,474,600	1,836,000	105,900	63,500
	Percent	100	28	2	1
Ilam	Area	2,003,950	1,545,000	1,377,200	852,439
	Percent	100	77	69	43
Semnan	Area	9,734,000	7,350,000	1,795,000	479,390
	Percent	100	76	18	5

Province		Area of provinces	Zoning		
			Primary	Secondary	Final
Tehran	Area	1,870,300	880,000	578,000	557,000
	Percent	100	47	31	30
Kermanshah	Area	2,486,729	1,004,130	763,390	127,824
	Percent	100	40	31	5
Sistan and Baluchistan	Area	18,750,200	5,478,890	1,397,185	20,120
	Percent	100	29	7	0
Lorestan	Area	2,800,000	991,510	144,580	37,000
	Percent	100	35	5	1
Ardabil	Area	1,788,300	389,630	115,630	38,857
	Percent	100	22	6	2
Sum	Area	77,616,976	30,824,168	12,435,490	6,683,761
	Percent	100	40	16	9

According to the results displayed in Table 9, out of the total area analyzed in the eleven Iranian regions, more than 30.8 million hectares were identified as suitable for olive cultivation under the initial zoning stage. Following the secondary zoning stage, this area was reduced to approximately 12.43 million hectares. Subsequent to the final zoning stage, and based on the aforementioned methodological indices, around 6.7 million hectares of land within the studied areas were determined as suitable for the cultivation of olive trees.

It is noteworthy to mention that upon completion of the first zoning stage, the province of Semnan displayed the largest area with the potential for cultivating olive trees. Nonetheless, following the successive zoning stages, Kerman province turned out to be the region with the most suitable land for olive cultivation.

Table 10 - Number and area of prominent projects by province

Province	Prominent Projects		Code 3000		Code 2000		Code 1000	
	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
Kohkiluyeh and Boyer Ahmad	10	11,318.6	3	3,637.6	4	3,786.0	3	3,895.0
Fars	16	33,650.0	3	9,850.0	13	23,800.0	0	0.0
Kerman	16	229,674.0	0	0.0	2	13,400.0	14	216,274.0
Khuzestan	35	22,676.0	0	0.0	20	9,880.0	15	12,796.0
Ilam	16	13,480.0	0	0.0	16	13,480.0	0	0.0
Semnan	12	2,287.9	0	0.0	5	1,244.5	7	1,043.4
Tehran	7	14,016.0	0	0.0	2	11,320.0	5	2,696.0
Kermanshah	28	33,474.0	4	1,551.0	10	13,990.0	14	17,933.0
Sistan and Baluchistan	8	3,775.0	1	1,750.0	1	375.0	6	1,650.0
Lorestan	7	10,442.4	0	0.0	7	10,442.4	0	0.0
Ardabil	9	2,684.4	2	402.7	5	1,342.2	2	939.5
Sum with Arabil Province	**164**	**377,478.3**	**13**	**17,191.3**	**85**	**103,060.1**	**66**	**257,226.9**
Sum without Arabil Province	**155**	**374,793.9**	**11**	**16,788.6**	**80**	**101,717.9**	**64**	**256,287.4**

The executive operations of prominent projects in Ardabil province will start and continue in the second five-year period.

According to Table 10, the study identified a total of approximately 377.5 thousand hectares dedicated to significant projects for establishing olive orchards in the examined regions. Among the studied provinces, Kerman stands out with the largest area of significant projects, totaling about 230,000 hectares. Notably, this province accounts for 61% of the entire noteworthy project area in the study regions. It is also important to note that within Kerman, over 216 thousand hectares (equivalent to 94%) of the identified significant projects are in the land area coded as 1000, while the remainder are in the land area with identification code 2000.

Table 11 - Planning the development of olive orchard cultivation and olive oil production at the national level

Description		Year 1	2	3	4	5	6	7	8	9	10	11	12	13
Cultivation area (ha)	Code 3000	2,000	2,500	3,000	3,500	5,800								
	Code 2000					5,000	6,000	8,000	12,000	15,000	16,000	18,000	22,000	
	Code 1000										27,500	32,500	49,000	65,000
	Ardabil Province						300	300	300	300	300	300	300	300
	Sum	**2,000**	**2,500**	**3,000**	**3,500**	**10,800**	**6,300**	**8,300**	**12,300**	**15,300**	**43,800**	**50,800**	**71,300**	**65,300**
Production	Oil cultivars						3,600	8,100	13,500	19,800	39,240	54,540	74,430	102,510
	Canned cultivars						400	900	1,500	2,200	4,360	6,060	8,270	11,390
	sum	**0**	**0**	**0**	**0**	**0**	**4,000**	**9,000**	**15,000**	**22,000**	**43,600**	**60,600**	**82,700**	**113,900**
Olive oli production							792	1,782	297	4,356	8,633	11,999	16,375	22,552
Number of olive olive pressing indusries (nominated capacity 5000 ton)											8			

Description		Year 14	15	16	17	18	19	20	21	22	23	24	25	Sum
Cultivation area (ha)	Code 3000													16,800
	Code 2000													102,000
	Code 1000	82,000												256,000
	Ardabil Province	300												2,700
	Sum	**82,300**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**377,500**
Production	Oil cultivars	136,980	203,004	266,418	349,992	410,886	486,720	535,824	591,858	665,712	705,906	756,000	756,000	6,181,020
	Canned cultivars	15,220	22,556	29,602	38,888	45,654	54,080	59,536	65,762	73,968	78,434	84,000	84,000	686,780
	sum	**152,200**	**225,560**	**296,020**	**388,880**	**456,540**	**540,800**	**595,360**	**657,620**	**739,680**	**784,340**	**840,000**	**840,000**	**6,867,800**
Olive oli production		30,136	44,661	58,612	76,998	90,395	107,078	117,881	130,209	146,457	155,299	166,320	166,320	1,357,152
Number of olive olive pressing indusries (nominated capacity 5000 ton)			32					67						67

Conclusion

Based on the results of these studies that focused on the adaptation of the olive tree's physiological needs to the environmental conditions present in the study areas, approximately 377.5 thousand hectares of Iran's land were prioritized for the establishment of olive orchards, within the framework of selected prominent projects. In summary, about 5% of these projects are in the scope of code 3000, around 27% are in the scope of code 2000, and approximately 68% are in the scope of code 1000. This means that, taking into account the olive tree's physiological requirements, as well as the country's environmental conditions and existing infrastructure (particularly in terms of available water sources), approximately 32% of the area studied under the identified prominent projects – in other words, around 119 thousand hectares – could potentially be devoted to the cultivation of the olive tree with minimum technical and social difficulties. Conversely, the findings indicate that leveraging the country's environmental potential for establishing olive orchards demands urgent measures to ensure the timely provision of necessary water resources and to address the social challenges faced by beneficiaries in susceptible areas.

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THE IMPACT OF IMPROVING THE VALUE CHAIN ON THE ASSETS OF OLIVE FARMERS WITH A SUSTAINABLE LIVELIHOOD APPROACH (IRAN CASE STUDY)

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Introduction

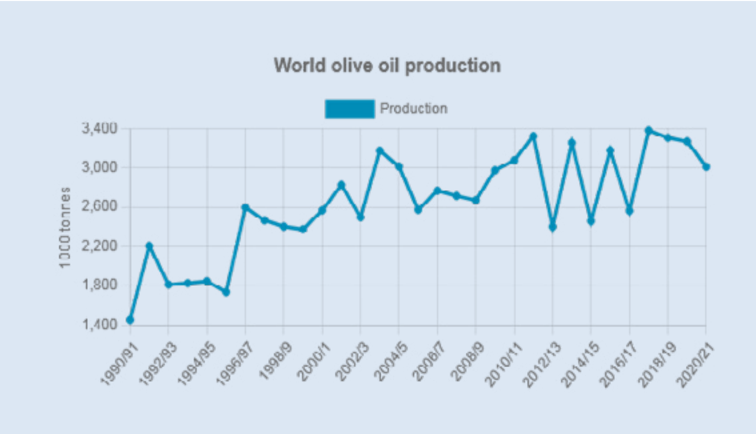
Today, the concept of a sustainable livelihood goes far beyond a purely economic dimension, affecting the stability and welfare of families as a whole. The formation of an economic structure in rural areas has entailed certain issues, namely: lower flexibility against short-term climatic fluctuations, volatility of crop prices at harvest time, crop marketing constraints, users› dependence on off-village factors, overt and covert unemployment, the decline in capital return, the degradation of basic natural resources, the vulnerability of rural economy and instability of income sources, the lack of job security, the low level of life quality, and finally, unsustainable rural livelihood (Azizi et al., 2004). Achievement of a sustainable livelihood requires adopting a strategy at different planning periods considering the internal and external conditions of rural communities, given that sustainable livelihood is a process-based activity that is made possible through the interaction and cooperation of institutions in charge of rural development and the establishment of coordinated connections among different components that are influential on sustainable livelihood in the long run. For this, strategic planning and the identification of appropriate strategies is essential (Badko et al., 2016).

Capital and assets are among the most important components of a sustainable livelihood framework. In this way, livelihood is supported by investment in the capabilities of the sustainable livelihood asset (Azizi et al., 2011). According to Chambers, livelihood will be sustainable when it is resistant to stresses and shocks, and when capabilities and assets are maintained not only for the present but also for the future, and net benefits are created for the livelihood of others at the national and local levels in the short and long run (Department for International Development, 2008).

As a starting point, the livelihood approach can complement the value chain by providing a full image of the dynamics that influence people's lives directly or indirectly. Therefore, the value chain analysis has been accompanied by the analysis of the livelihood approach, which is selected not only in terms of perspective but also in terms of methodology (Azami, 2018). The value chain refers to a series of factors and related markets, which converts inputs and services to products with the features that consumers would like to buy (Azizi, 2008).

The value chain is a general description of all activities performed for a crop, from the initial input step to processing, delivery to the final market, and post-consumption disposal. For example, the value chain of crops includes activities performed at the farm or rural level, including input resources, activities on inputs, processing, storage, packaging, and distribution. The product moves at different steps, transactions occur among various stakeholders of the chain, money and information are exchanged, and added value is gradually generated (IOC, 2020).

Table 1- World Olive Oil Production from 1990 to 2021 (IOC Statistic).



The value chain analysis can also be used as a precious instrument to investigate the role of the value chain in accomplishing certain political goals, e.g., poverty alleviation, sustainable growth, and injustice reduction (Azizi, 2005). This analysis extensively uses social, human, natural, and financial capital to analyze how social relations are expanded in value chains. The assets of players also influence their ability to take advantage of the value chain, secure their livelihood, and reduce their vulnerability. Any changes in the agricultural value chain have implications on the livelihood of farmers and their vulnerability (Fournier, 2019).

Through the appropriate and strategic division of relevant activities and loops, the value chain understands the behavior of production costs and the difference between actual and potential resources, and increases the final added value of crops by adding a superior value in each loop, thereby escalating the farmers' share from the final price of the crop purchased by the consumers. Based on the livelihood approach, livelihood capitals (physical, natural, human, financial and social) are the basis for rural people's capability and capacity for intervention in their social and personal destiny. These capitals determine and orient people's and families' perceptions, expectations, and activities in rural areas (Fournier, 2019).

The development of the value chain of the agricultural sector is of crucial significance owing to global considerations, presence in regional and international markets, and membership in the World Trade Organization. This is a higher priority in some provinces of Iran due to their rates of production and the expansion of their cultivated areas.

The olive is a crop that is conventionally sold in both raw and processed forms. This economically important and highly valuable crop can be produced in different regions of Iran, making it a strategic crop for some provinces.

Given that Iran is among the ten top countries in terms of horticultural production and ranks third in terms of crop diversity, the horticultural sub-sector is specifically important. This sub-sector accounts for 25 percent of the added value, 30 percent of employment, and 80 percent of the exports of the agricultural sector (Azizi, 2008). One of these crops is the olive. The global cultivated area of olive orchards, distributed among 47 countries on five continents, amounts to over 11 million ha. Over 6.7 million families in the world possess olive trees – an average of 1.67 ha of olive orchard per family. However, 98 percent of the global olive harvest is related to the Mediterranean region (IOC, 2023).

The IOC (2023) reports that Spain is the leading olive producer in the world with a production rate of 6,559,000 tons per year. Next in line are Greece and Italy whose production rates are 2.3 million and 2 million tons, respectively (Askarie Bezaye and et al, 2019).

Olive trees have a long history in Iran, but there is a difference of opinion as to when exactly its cultivation flourished. Considering the importance of olives, the improvement and development plan of olive groves has been implemented since 2003 based on government policies in the field of self-reliance of agricultural products, with the aim of providing a part of the country's edible oil needs. In 2018, olives were cultivated in 26 provinces of the country. Zanjan province has the highest production rate in the country with 25,000 tons. Next in line we find Qazvin, Fars and Guilan provinces with the largest area under cultivation and production. In 2018, about 75% of the country's total olive production was related to the provinces of Zanjan, Qazvin, Fars and Guilan (Azizi, 2005).

Table - 1 Information on the cultivation area, production rate, and yield of olives in Iran 2018-2019.

Total cultivated area including dispersed trees (ha)												
Non-fertile			Fertile				Production rate (t)			Yield	
Irrigated	Rain-fed	Total	Irrigated	Rain-fed	Total	Total area	Irrigated	Rain-fed	Total	Irrigated	Rainfed
15934	1215	17148	55961	1872	57833	74981	120052	2098	122150	2145	1121

Source: ITC Center, Deputy of Planning and Economy, Ministry of Agriculture Jahad, 2021.

Since the olive crop needs processing before its marketing, it is regarded as a valuable industrial plant with an added value. In addition to crop production in the farm, all marketing steps – including harvesting, transportation, oil extraction, sales, and financial and credit institutions – are somewhat involved in creating value for this crop (Chegini et al., 2015; Kheiri, 2007, Azizi, 2008).

These conditions highlight the country's exponential agricultural capacity, especially regarding olive production. However, the olive value chain is short and incomplete in Iran. In this regard, orchard owners are struggling with various issues, such as the sale of olives without processing, olive purchase by middlemen at low prices, the orchard owners' deprivation from the profits of post-production steps, crop marketing issues, price fluctuations, lack of olive grower associations to enhance farmers' knowledge regarding the added value of the crop, lack of motivation to increase efficiency and expand cultivation areas, the lack of mechanized irrigation systems, lack of infrastructure for crop export, etc. Conversely, by expanding the value chain, byproducts can be produced from the olive within the country and provide farmers with more added value. Therefore, given the role of the olive tree in Iran's agricultural economy, it seems necessary to develop the value chain of this crop. In this respect, the olive tree's value chain can be enhanced by adopting proper strategies and policies (Azizi and et al, 2004).

The agricultural development programs in Iran show that goals like increasing crop production and processing have always been attended by development policymakers, where the supply of rural households' livelihood has always been a priority (Azizi and et al, 2011). Given the sensitivity of the topic regarding the influence of the olive's value chain on livelihood sustainability in Iran, as well as the ambiguity of indices and criteria regarding livelihood sustainability, particularly regarding olive orchard farmers in Iran, it is necessary to design a paradigm for the livelihood sustainability of olive orchards. With such a paradigm, a planning system can be developed for making the livelihood of orchard owners sustainable and preventing the consequences of livelihood unsustainability, in other terms, immigration, unemployment, poverty, and food insecurity. Also, indices and criteria should be developed for the livelihood sustainability of olive orchard owners (Azizi, 2005).

Methodology

The research at hand is an applied study conducted descriptively and analytically in which data were collected with a survey using a quantitative approach (Azizi, 2008).

The statistical population was composed of all olive orchard owners in Iran who were registered in the Comprehensive Zonation System of Agriculture Jahad Organization and were available to online users. In the questionnaire, the Likert scale was used to measure the research variables. For the validity of the questionnaire, a panel of experts in agricultural development, extension and horticulture was engaged. Cronbach's alpha was used to determine the reliability of the questionnaire. Data analysis was performed using SPSS24 and Smart PLS software, as well as confirmatory factor analysis. The sample size for the studied villages was estimated in proportion to the population size using the proportional allocation method. Finally, the participants were selected by simple randomization.

Results

The main data collection instrument was a self-designed questionnaire that was composed of items to assess the olive value chain as the independent variable with five dimensions, livelihood assets as the mediating variable with five dimensions, and livelihood sustainability as the dependent variable with four dimensions.

A total of 604 people filled out the research instrument, among which 97.7 percent (590 people) were male, and 2.3 percent (14 people) were female. Their average age was 47.95 years. The highest frequency was 160 people (26.5%) for the age range of 51-60 years. In terms of their educational level, 10.4 percent were illiterate, and only 13.9 percent had a bachelor's degree or higher. According to the results, the average number of family members employed in the orchard (76.8%) was one person, and in only 3.8 percent of the families, three members or more were working in their respective orchard. Regarding the history of orchard establishment and olive tree production and cultivation, the studied olive orchard owners had 3-50 years of experience. The highest frequency was of 11-20 years and 21-30 years (169 people, 28%) and the lowest for the range of >41 years with a frequency of 10 people (1.7%). It was also found that the mean experience was 22.12 years with a median of 20 years, a mode of 30 years, and a standard deviation of 11.05 years.

The model derived from the literature shows that the olive value chain and livelihood assets are composed of five components, and the sustainable livelihood is composed of four components. Data analysis shows that the following components were all directly influential on the olive value chain: (1) the technical factor with a factor loading of 0.908 and t-statistic of 136.7; (2) the economic factor with a factor loading of 0.88 and t-statistic of 97.7; (3) the infrastructural factor with a factor loading of 0.885 and t-statistic of 84.1; (4) the marketing factor with a factor loading of 0.886 and t-statistic of 105.4; (5) and the policymaking factor with a factor loading of 0.911 and t-statistic of 135.7. The technical factor had the greatest impact on this chain.

It was also found that capital assets are most strongly influenced by the components of natural capital with a factor loading of 0.899 and t-statistic of 115.9; human capital with a factor loading of 0.895 and t-statistic of 105.02; social capital with a factor loading of 0.924 and t-statistic of 143.3; physical capital with a factor loading of 0.909 and t-statistic of 93.7; and financial capital with a factor loading of 0.896 and t-statistic of 103.8. In summary, the social capital is the most effective factor. According to these results, livelihood results were directly affected by the following components: (1) family welfare with a factor loading of 0.898 and t-statistic of 98.73; (2) income generation with a factor loading of 0.901 and t-statistic of 109.7; (3) food security with a factor loading of 0.912 and t-statistic of 121.1; (4) sustainable use of natural resources with a factor loading of 0.901 and t-statistic of 114.16. Food security was the strongest factor in influencing the livelihood of olive orchard owners.

Conclusions and recommendations

Optimal use of resources and facilities to meet human needs, including increasing production, income, employment, and welfare, is one of the most important development goals in all countries.

The livelihood status of the olive orchard owners was studied in Iran from the perspective of the questionnaire respondents. The results show that the promotion and development of value chain activities can increase livelihood assets and, subsequently, livelihood outcomes. According to the results, the indicators selected for the research exhibited their significant effect on measuring capital assets (natural, human, social, physical, and financial) and the olive value chain in Iran. Hence, the model has an appropriate structure given the significance of all dimensions of capital assets and their measurement indicators, acceptably the theoretical foundation of the research. This means that the component of capital assets has a positive effect on the livelihood of olive orchard owners.

Based on the results, olive production and processing create financial capital and improve the income of those employed in this work. This in turn is a positive way to improve livelihood, increase assets, enhance the welfare of olive orchard owners, and increase crop security and production. To increase income and further boost this activity, it is recommended to reduce power and water tariffs, subsidize inputs, help crop marketing, reduce wastage, and grant low-interest bank facilities.

The development of the business environment through the use of technologies required for the production and supply of new olive products in new and diverse packaging is one of the value chain needs.

It is suggested that the necessary infrastructure be provided so that the crop can be marketed rapidly. Moreover, the profession should be supported by providing facilities so that the physical capital of households is improved. Example measures include purchasing transportation and processing equipment, creating a suitable road to access the gardens, providing suitable housing, and providing more access to media and communication networks.

According to the results, it is suggested that by equipping olive processing plants and constructing processing plants for oil extraction waste, waste management strategies should be enhanced in order to protect the environment and increase productivity in the field of olive processing industries.

Based on the results, the factors underpinning the olive value chain positively influence the components of the capital assets. Thus, given the positive and significant relationship of the assets and factors influencing the olive value chain with the livelihood of orchard owners and the valuable advantages of this activity, including increased income, increased production, higher per capita consumption, etc., it is recommended to resolve the barriers hindering the development of this economic activity as much as possible.

Despite the health benefits of olives, they are not a staple product in Iran and our per capita consumption of olives is low compared to European countries. Considering that the use of the oil of this high-quality and nutritionally valuable product will improve health, it is suggested to take measures to include this crop in the food basket of Iranians. The research focused on the effect of the olive value chain on the livelihood of olive orchard owners whereas their livelihood is influenced by numerous factors. Thus, it is recommended to scrutinize the research literature to derive and study the tools equivalent to other factors.

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INVESTIGATING THE COMPARATIVE ADVANTAGE OF OLIVES AND ECONOMIC ANALYSIS OF FACTORS AFFECTING IT IN IRAN

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Introduction

Agriculture is one of the oldest forms of production and economy in every human society. The first and most important task of the Ministry of Agriculture is to provide food security for the growing population of the country. Therefore, one of the most important goals of policy makers at the macro level is to achieve self-sufficiency in the production of agricultural products (Mahmoudi, 2013).

The olive is one of the important products of the agricultural field, which has been classified as a basic commodity in Iran due to its importance. In this regard, the Ministry of Agricultural Jihad has made this product a priority in its development plan through which it aims to boost production to 200 thousand tons of olive oil. The area under olive cultivation in 2022 is equal to 84 000 hectares and its production is estimated to be 113 thousand tons of olive oil and olives.

In order to achieve self-sufficiency and develop exports in any country, one of the necessary measures is to identify comparative advantages and invest in the development of products with comparative advantages. A comparative advantage represents the profit obtained from trade, which lies at the heart of economic planning for more efficient allocation of resources (Arbab,2004). In other words, today's world is an economic competition, and every country is obliged to be precise and comprehensive in designing economic programs in order to maintain its political and economic independence. Identifying the comparative advantages of various economic sectors in the regions and provinces of the country is useful and necessary for economic planning. Comparative advantage is a principle that has a wide application and is essential in both production and commercial planning (Mahmoudi, 2013).

In the production process, economists emphasize production efficiency over other factors. Studies of comparative advantage have been proposed in the international economy, undergoing many stages. In general, its calculation method is based on the cost of internal resources and the cost of social benefit. These two methods are based on the famous foundations of Ricardo and Heckscher-Ohlin. Ricardo's theories of comparative advantage are based on relative costs, especially labor. On the other hand, Heckscher-Ohlin's theory looks at comparative advantage from another point of view: the abundance of production factors. However, the abundance of factors also infinitely affects advantages by affecting the relative costs. Mcintire & Delgado (1985) investigated the comparative advantage of crops in Burkina Faso and Nigeria using the effective support indices, effective support coefficient, net profitability and domestic resource cost (DRC). The results showed that in Burkina Faso, the average of DRCs for each of their products, with the exception of traditional corn, in different production methods is more than one. Their results indicated that in a country where 90% of the population earned a living through agriculture, most of the products were in a situation of no comparative advantage. On the other hand, all DRCs in Nigeria are less than one, emphasizing the comparative advantage in all products.

Leonardo et al. (1993) investigated the comparative advantage of five major Indonesian agricultural products, namely rice, corn, soy, sugar, and cassava flour, using the cost criteria of domestic resources, nominal and effective support rates, and social profitability. The results showed that the production of rice and corn has a comparative advantage compared to their import, but the comparative advantage of corn is greater than rice. This is mainly due to the government's support strategies, such as the implementation of protective prices and import restrictions for soybeans. Calculations related to sugar showed that sugar production has no economic efficiency compared to imports.

Nelson and Panggabin (1993), using the policy analysis matrix method, investigated the policies adopted in the production of sugar in Indonesia. The results showed that from the private and social point of view, sugar production in Indonesia is not profitable. The social loss of production, the loss of consumers and the loss of the government due to sugar production were estimated at 465, 263 and 112 million rupees, respectively. Yao (1997) investigated the production status and comparative advantage of soybeans, green peas and rice using the modified policy analysis matrix method. In this study, two regions from the north of Thailand were selected in 1992-1993. The results showed that, in both regions, rice is socially more profitable than other two competing products, namely soy and green peas. However, due to the use of subsidies for inputs and the high prices of soybeans and green peas, farmers intended to reduce rice cultivation and substitute it with competing products.

Sai (2010), using the policy analysis matrix, researched the main Jalizi products from the Jiroft region, specifically, potatoes, cucumbers and tomatoes. Using comparative advantage indices, it was shown that cucumber and tomato have a comparative advantage. Kazemnejad et al. (2009), in the book *Comparative Advantage and Supporting Indicators of Sugarcane-related Cultivation and Industries in Iran*, paid attention to the country's plan to increase sugar production, focusing on the development of sugarcane and the quantitative and qualitative improvement of production. This book includes discussions about sugarcane and related industries, regarding their strengths and weaknesses, challenges and opportunities in the sugarcane industry and related industries, with a focus on the performance in the production process. They calculated DRC based on their results and analyzed the factors affecting comparative advantage in the matrix method of policy making.

Joulii and Kazemnejad (2013), studied the comparative advantage and support policies on the production of raisins in Qazvin province. In this study, the policy analytical matrix (PAM) method and the DRC index were used to calculate the comparative advantage. To examine the policies supporting this product, the calculation indices of the policy analysis matrix were used. The geographical area was the major raisin producing cities in Qazvin province. A two-stage cluster method was used for implementing a field study and questionnaires. The DRC index showed a value of 0.78 for raisins, which indicates the comparative advantage of this product. The supporting indicators show that the internal policies were not aimed at supporting this product. Pakrovan et al. (2012), in the study of the comparative advantage of crops in Sari city, using the information collected from the crop year of 2008-2009, calculated the indicators of the comparative advantage of crops in Sari city. The results of the study show that barley does not have an advantage among the studied crops and its DRC index value is 2.03, ranking third, however, among the studied crops in terms of cultivated area. Therefore, they suggested the implementation of policies to create a comparative advantage for this product or to replace some of the cultivated areas of this product with advantageous products, such as wheat and canola. Moreover, wheat, at the lowest value of the exchange rate in terms of Rials, has a DRC index of one, and this shows that the high social profitability of this product encourages farmers to produce this product even at the lowest levels of social income. Currently, it ranks second in the city in terms of cultivated area.

Hosseini et al. (2017), using the PAM index of domestic resource cost indicators, nominal product support, nominal input support, effective support and social profitability index for the years 2010-2014, calculated the comparative advantage for the corn crop of Kermanshah province. Over the four years investigated, the DRC index of corn production for ordinary farmers was smaller than one only for the crop year 2010-2011, which shows the existence of an advantage. However, for professional farmers, the DRC index for two years 2011-2012 and 2012-2013 was smaller than one, which indicates the existence of an advantage.

Research materials and methods

In this study, using the information on the production cost of olive products in 2022 and by applying the PAM method, the calculation of the comparative advantage and the analysis of the factors affecting this index was done for olive products. Calculations were done using excel.

Certain key concepts must be kept in mind, namely that the PAM method is a double-entry bookkeeping technique that provides budgeting information for on-farm activities. Its theoretical background derives from the studies of cost analysis, social benefit and the theory of international trade originating in economics (Kazemnejad, 2019).

This method is based on the union defined on the profit axis and shows the difference between cost and income, i.e. cost - income - profit. According to PAM, costs are divided into two tradable parts (inputs that can be exchanged in the international market, such as chemical fertilizers, modified seeds, fuel, etc.) and domestic resources (such as land, labor and capital). PAM is calculated with two types of prices: private prices and social prices.

Private price – also known as real, market or financial price – is the price based on which goods and services are exchanged in practice and used for budgeting (such as sugarcane price, diesel cost, wage rate, etc.). These prices are determined in the domestic market and affected by government policies and interventions, or by market inefficiency.

Social price refers to the price that arises from private prices by removing political deviations, such as subsidies and taxes, or market failures, such as monopoly. These prices reflect the social value for the country, instead of individual private values, and they are the prices that are used in economic analyses with the aim of maximizing national income. These values are at times referred to as shadow price, efficiency value, and opportunity cost.

Calculation of the social or shadow price of manufactured products:

Global prices are the backbone for calculating social valuation and carrying out efficiency analyses in the agricultural system. They are the basis of social valuation for manufactured products. The social price of an agricultural commodity is the price at the border of that commodity at which the foreign suppliers deliver that commodity to the domestic market, or the price that foreign consumers pay to domestic suppliers. These prices are the opportunity cost of that product. Since the product can be imported or exported, the way of calculating their shadow prices varies.

Import products:

The shadow price of imported products is the price of their cost, insurance and transportation to the border of Iran (cost, insurance and freight - CIF) in addition to all the costs related to their transportation from the border to the farm.

Export products:

The shadow price of exported products is the price of the product itself with its free movement (free on board - FOB) to the border of Iran (minus all the costs of transporting them from the farm to the border).

Shadow price of inputs and resources:

Inputs and resources are divided into tradable and non-tradable categories. Tradable inputs are inputs such as poisons, chemical fertilizers and seeds that can be moved in the international market. Non-tradable inputs or internal resources are inputs such as land, water, labor and capital, that cannot be sold in international markets.

Shadow price of tradable inputs:

Their CIF price at the border of Iran is in addition to all the costs of their transportation to the domestic market. In fact, it is the price at which foreign suppliers deliver the desired input to the domestic market at this price.

Since internal resources do not have a global price, the criterion for determining the shadow price of internal resources is based on their market price. Taking into account the deviations of the domestic competitive market, their shadow price is equal to their internal price plus all deviations. It is positive or negative in terms of the market price. These deviations come from taxes and subsidies paid to these inputs. If these resources do not have a competitive market, like water, all the cost of its recovery should be considered and its shadow price should be calculated. Of course, other methods, such as the final production value using linear programming, are also used to determine the shadow price.

Calculating the shadow price of the currency:

Given that the exchange rate is used in the calculation of product prices and global and international inputs, as well as in the calculation of the PAM and the conversion of international prices into domestic prices, the exchange rate is of the utmost importance. Therefore, the official exchange rate cannot be used in this case given that this rate is controlled using government levers and will cause deviation in the results.

To calculate the exchange rate, a method called the elasticity approach was introduced by Krueger, Schiff and Valdez (1991), which is based on the simultaneous estimation of the import demand and export supply functions, through which the estimation of the relevant price elasticities is done.

Another method is presented based on the theory of purchasing power, which is mainly calculated from the ratio of the price of one ounce of gold in the domestic market (Rials) and the world market (Dollars). However, the method used by most economic researchers is called the standard conversion method (SCF), which has been used in the studies of the World Bank and FAO in African and Central Asian countries. This factor converts the official exchange rate into a shadow exchange rate:

CF=(M+X)/(M(1+TM)+X(1-TX))

CF is the conversion factor, M is the CIF value of total imports, X is the FOB value of total exports, TM is the average import tariff rate, and TX is the average export tariff rate.

After calculating the conversion factor, the shadow currency is obtained from the following relationship:

SER=OER/CF

where SER is the shadow exchange rate, CF is the conversion factor, and OER is the official exchange rate.

In this research, the standard transformation factor method has been used.

Policy Analysis Matrix (PAM):

The PAM was originally developed by Munk and Pearson in 1989. This technique was first used by Pangabin in 1991 in the analysis of sugar support policies in Indonesia. The methods provides researchers with three important analytical tools:

- Measuring the efficiency of input consumption in the production process (based on market and social profitability)
- Measuring comparative advantage
- Measuring the degree of government involvement in production

This matrix fully shows the extent of the government's involvement in production and creating deviations. The first line of this matrix shows the market profitability, the second line shows the social profitability, and the third line shows the difference between the two, which actually shows the government's interference.

	Cost			
Income	tradable inputs	internal factors	Profit	
A	B	C	D	Market prices
E	F	G	H	Shadow Prices
I	J	K	L	Deviation

As mentioned, the first line shows profitability at market prices, where profit is obtained from the difference between income and expenses:

D=A-B-C

In the second row of the matrix, social profitability is obtained from the difference between income and expenses at the shadow price:

H=E-F-G

In the third line, it shows the number of deviations of market and domestic prices from global and shadow prices: if I is positive and greater than zero, that is, E<A, this means that the government subsidized the product in question.

I=A-E

If A = E, it means that the government did not intervene, and if E > A, it means that the market price of the product is lower than the shadow price, and an indirect tax has been imposed on it.

If K and G are both positive, it indicates the application of a tax policy on inputs, and if they are equal to zero, it indicates that the market price does not differ from the shadow price, meaning that the government does not interfere. If they are negative, it indicates that the government receives direct taxes.

PAM is more effective than other indicators because it shows the effects of deviation at once. The indicators used include internal resource cost (DRC), net social profitability (NSP), effective protection coefficient (EPC), cost-to-social benefit index (SCB), and nominal product protection coefficient (NPC).

Internal Resource Cost (DRC)

In the PAM method, the value (DRC) is calculated from the following equation:

DRC=G/(E-F)

This index states how many resources are consumed in terms of shadow prices to obtain one unit of foreign currency. That is, it shows the ratio of the price of domestic resources to the difference in income and expenses to the shadow price. If this index is less than one, it indicates the existence of a comparative advantage. If it is equal to one, it indicates that there is no difference in the cost of internal resources inside and outside the country. If it is greater than one, it indicates the absence of a relative advantage.

In this article, due to the focus on the calculation of a comparative advantage, the description of other indicators was disregarded.

Results and discussion

Based on the statistics and information used, it can be seen that the DRC index calculated for the olive is equal to 0.65, which indicates that it has a comparative advantage in the production of this product in Iran.

According to the PAM methodology calculated based on the production cost information of 2022, it can be seen that with a 10% increase in yield per hectare, the comparative advantage index will improve by 32%. In addition, with every 10% change (decreasing the value of the national currency) in the exchange rate, the comparative advantage index will improve by 7%. Moreover, with a 10% increase in the world price of the product, the comparative advantage index will improve by 3.5%. Finally, the result shows that with every 10% increase in the world price, fertilizer and poison inputs will reduce the comparative advantage index by 53%.

Considering the above results and the policy analysis, it is observed that, in order to maintain the comparative advantage of olives, it is necessary to always increase the yield per hectare of this product by using appropriate technologies and, particularly, by using high-yielding seedlings. Farmers must act according to the climate of each region. Moreover, stability in certain macro policies, such as currency policies, enhanced communication, membership in relevant global organizations and the use of international consultations, including the International Olive Council, can be used to ensure the continuity and stability of the comparative advantage of production. As an end goal, the business of this product will be strengthened.

In addition, other related issues in the establishment, continuity and sustainability of the comparative advantage of this product are the attention to the oiling extraction process and the use of relevant new technologies, as well as the appropriate use of by-products from the olive product, which requires a wider study. Finally, in order to develop olives at the international level, it is suggested to apply the PAM methodology for other countries with the potential of olive production.

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OLIVAE
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INVESTIGATION OF TECHNOLOGICAL CHANGES IN IRAN'S OLIVE INDUSTRY

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Introduction

Olea europea is certainly one of the oldest plants in the regions of the Mediterranean and Middle Easte, and perhaps one of the oldest worldwide. Globally, there exist about 11.5 million ha of olive trees around the world. Today, Iran is a significant country in terms of olive production. With a cultivated area of about 84,000 ha of olive trees, this country produces about 61,000 tons of olive oil. In recent years, the domestic demand for olive oil and related products augmented due to an increase in consumption per capita and the promotion of advertisements regarding olive consumption. However, olive oil production decreased due to alternate bearing and pests like the olive fly, which led to an exponential increase in domestic prices. The development of olive planted groves in Iran has also led to a quantitative growth of olive dependent industries. Agricultural economists point out two main criticisms concerning this industry type, namely that end products of olive trees are more expensive than other similar foreign products, and that there are non-economic aspects of this industry's activities to take into account.

The study at hand deals with an assessment of the level of productivity of Iran's olive sector. Taking into account the considerable investments made in this sector over recent years, it is essential to analyze these resources in order to guarantee the most profitable outcomes. The study aims to evaluate the efficiency and technological trends of this industry, as well as its strengths and weaknesses.

The objectives of this research were:

1. Determining the efficiency level of olive related industrial units
2. Measuring technological changes in olive industries

The following hypotheses were tested:

1. The efficiency level of olive related industrial units.
2. The trend of technological changes in olive related industrial units is incremental.

Background

Chandrase Karan (1995) studied the productivity of production factors in India's cotton industry. In this nation's industrial sector, the cotton textiles industry holds a prominent position, being recognized as one of the primary industries based on factors such as size, employment rates, exports, contribution to the national product, and overall consumption. The study calculated partial and total factor productivity. Results suggested that the work force productivity index had an incremental trend from 1974 to 1983, except for the year 1982. Moreover, the annual growth rate of capital investment was estimated at 1.3 percent per annum.

Combhakar (1994) used sectional data from 227 western Bengal farmers in India and the Tran-Slog production function. Results led him to conclude that the technical efficiency mean of the studied units was 75.46 percent, with the maximum technical efficiency being 85.87 percent.

Ali and Flin (1989) used the random frontier Tran-Slog interest function area to calculate the interest efficiency of rice cultivators in Pakistan's Punjab province. Their data analysis focused on 110 randomly chosen rice cultivators. They used the Cols and ML methods to calculate their efficiency. They then determined the frontier function of interest, efficiency and its effective social-economic factors. Results indicated that the mean inefficiency value of rice cultivators was 28 percent. Level of education was found to be an important factor in reducing efficiency. In fact, farmers who had a higher level of official education showed less interest in reduction.

Najafi and Zibaei (1994) estimated the technical efficiency of wheat cultivators in the Iranian Fars province between 1987 and 1992 by using the C-D model and the random frontier function. The ML method was employed to estimate parameters, revealing an upward trend in technical efficiency from an average of 67.6 to 79.7. The findings indicated that by enhancing this efficiency and adjusting agricultural practices, wheat production could potentially see a 20 percent increase.

Torkamani and Shirvanian (1998) studied the productivity of new farming technologies by applying the random frontier method in the province of Fars. Results showed that, overall, creating and employing suitable technology is one of the key factors leading to the development of agriculture. In this study, data collection involved completing 82 cross-sectional questionnaires, employing a multistage cluster sampling method among cotton cultivators in Fasa town, Fars province. The researchers subsequently categorized farmers into less homogenous and more mechanized groups to compare their productivity and efficiency. The results revealed a statistically significant difference between these groups, particularly concerning the utilization of mechanized services per unit of surface.

Finally, Hassanpour (1997) calculated the efficiency of growers in Estahban, Kazeroon and Neireez towns by estimating transdental and translog random frontier production function through the application of the ML method. Results showed mean technical efficiencies of 65.7 80.2 and 63.7 percent, respectively.

Materials and methods

Productivity substantially dominates the relationship between a system's inputs and outputs at the micro-sector and macro-levels of a society (7). Thus, changes in productivity from one period to another, or the existence of gaps in units' productivity in a time period, would indicate changes and differences across a number of factors, such as technical potential, management levels, organizational structure, sectoral and para-sectoral dynamics, and even the environmental and natural influences shaping the transformation of inputs into goods and services within a unit, sector, or the broader economy.

Productivity is divided into two general categories: Partial Productivity (PP) and Total Factor Productivity (TFP). In the context of PP, the mean production level is determined by dividing the output by the consumption values of each input, excluding the consumption values of other inputs. This calculation yields the partial productivity index, a measure that illuminates the efficiency of utilizing production factors and resources during a specific time period (6). On the other hand, TFP is measured in two ways, either by applying (1) the parametric approach (econometrics), or (2) the growth accounting or the index number approach. In the parametric approach, measuring the productivity index depends on econometric techniques for estimating production, casts, the input demand equation, and supplying outputs derived from interest functions.

The central idea behind the growth calculation or index number method is the notion that in the presence of technological progress, the growth of input consumption values and production resources alone cannot account for growth in total production. In other words, the residual of production growth, which does not result from consuming production factors, is tied to productivity growth (12). The application of the growth calculation method (index number) requires the aggregation of productions and heterogeneous inputs. Several numerical indices mirroring different production technologies have been introduced for this purpose. Among the most common are the Divisia Index (11) and the Divisia Input Index (9), which can be applied to continuous data. Additionally, the Laseyres Index, aligning with the linear production function or Leontief, and the Geometric Index, corresponding to Cab Douglas product, stand out. For discrete data, the Tornqvist Index, analogous to the translog product function, can also be considered.

The study at hand used the Malmquist Productivity Index to assess industrial productivity, given its advantages in terms of it being unlimited in providing situations, such as perfect competition in inputs and the product market, not changing technical efficiency, its constant yield proportional to the scale, and the specific form of the production function. Data related to the present study have been collected from questionnaires distributed across olive industries and relevant organizations.

Results and discussion

It is essential to bear in mind that, prior to 1993, olive groves were dispersed across Iran, and were only a prominent crop in the provinces of Guilan, Zanjan and Fars. In 2000, the Ministry of Agriculture approved and enforced the Olive Groves Development Plan. At that time, the total olive grove area in Iran was 5385 ha. The total area currently spans across an approximate 84,000 ha, which demonstrates a significant increasing trend. According to the Ministry of Agricultural Jihad's plan, it is estimated that the area of the country's olive groves will increase to 220000 ha by the end of the fourth development plan in 2025. Currently, olive trees are cultivated in almost 27 provinces, including: Fars, with a cultured area of 16681 ha which is 17.5% of the country's total olive groves; Golestan, with 12.548 ha or 13.2% of the country's total; and Zanjan, with 9.902 ha or 10.4%.

Increasing the productivity of newly created groves, along with improving and reconstructing the older ones, has entailed an exponential growth in Iran's olive production over the last decade. According to statistics presented by the Ministry of Agriculture, 7.684 olive tons were produced in the year 2000. By 2021, this number multiplied by eight, reaching 62.385 tons. A general incremental trend in olive production is observed, despite annual fluctuations due to the yielding tear phenomenon. However, since 2004,

the presence of the olive fly has reduced the rate of production. In terms of ranking, the Zanjan province stands first with an annual production of 22.960 tons, or 37.4% of the country's total olive production. It is followed by Ghazvin and Gilan provinces with 15.200 ton (24.8%) and 14.181 ton (23.1%), respectively. It is important to take into account that a considerable portion of newly created groves have not yet reached their productivity stage, which is expected by the end of the fourth development plan.

By 2025, the rate of olive production rate is expected to be septuple, reaching 461883 ton compared with the current rate. It is worth highlighting that the significant surge in production is attributed to both governmental and private sector investments in regions conducive to olive tree cultivation. These initiatives encompass not only the development of new olive groves but also the revitalization of aging and dilapidated groves, resulting in a notable boost in productivity.

With regard to the cultivated areas and olive production development plan, as outlined in the Ministry of Agricultural Jihad's Olive Plan Office report, it is noted that prior to 1993, the nominal capacity of the existing factories stood at 12,700 tons per year, assuming a daily operational span of 12 hours. Due to the plan aimed at developing the country's olive production, which focused on the establishment and operation of new factories, production capacity reached 19200 ton a year. Moreover, through operating additional oil mills, the nominal capacity of factories reached 30500 ton a year. In fact, the trend observed until 2021 displayed that the nominal capacity of the country's active oil mills was 52600 ton per annum, showing a quadruple increase. By the end of the fourth development plan in 2025, it is predicted that this capacity will reach 61400 ton a year.

The Ministry's Olive Plan Office also stated that the capacity of olive packaging and processing factories at the moment stands at 810 tons of canned olives and 2409 tons of olive oil. The recent appearance of new companies in Iran has increased the packaging of canned olives and olive oil. It is important to consider that there are still many traditional, small-scale units that process olives in plastic containers for their sale. In fact, the sale of bulk processed olives in domestic markets is more than that of packaged olives. Hence, to understand the efficiency of industrial units, the periods under analysis must first be divided into three parts, accounting for the change of approach to olive production and processing: part 1 refers to the period before the implementation of the olive plan; part 2 represents the period between 2000 and 2021, focusing on when government and private sector investments began; and part 3 accounts for the 2000-2021 competition period. In this study, following the outlined research methodology, data and statistics pertaining to provinces with olive groves, as well as operational oil mills and processing-packaging factories, were utilized.

Part 1: Traditional production period (from 1985 to 2000)

Before the year 2000, olive factories were primordially located in the Gilan and Zanjan provinces which hosted the most amount of olive trees. The total existing capacity in this time interval was 12700 ton a year. During that period, there were only a handful of production units exclusively dedicated to packaging olive oil. Notably, there were no licensed factory units specifically designated for packaging, and the processing of olives was predominantly carried out through traditional methods, involving manual labor in workshops and barns. Moreover, the existing oil mills worked to their maximum capacity. Under such conditions, the following values were calculated for said period (refer to Table 1): technical efficiency change ($\Delta M^{\wedge}Eff$); scale efficiency change ($\Delta M^{\wedge}SEff$); frontier function efficiency change ($\Delta M^{\wedge}SForn$); scale efficiency changes at frontier function ($\Delta M^{\wedge}SForn$) and Malmquist index ($M^{min1, nt2}$).

Table 1 - Estimation of technical efficiency changes and the scale of olive industrial units during 1985 – 2000.

Deciles	$M^{m,nt1,nt2}$	$\Delta M^{\wedge}Eff$	$\Delta M^{\wedge}SEff$	$\Delta M^{\wedge}Fron$	$\Delta M^{\wedge}SFron$
1	0.994	1.013	1.015	0.972	0.955
2	1.007^{***}	0.884^{**}	1.173^{***}	1.117^{***}	0.869^{***}
3	1.021^{***}	1.011	1.038	1.036	0.941^{**}
4	1.001	0.954^{**}	1.077^{**}	1.020	0.955^{*}
5	1.003	0.942	1.089^{**}	1.011	0.968
6	1.003	0.944^{**}	1.082^{**}	1.016	0.966
7	1.024^{**}	0.949^{**}	1.070^{***}	1.034^{*}	0.964
8	0.987	1.026	0.919^{**}	1.091^{***}	0.959^{**}

Reference: Research findings

NOTE: Note that the presence of one, two, or three asterisks signifies the distinction between an estimate and one (indicating no change), with statistical significance levels set at 0.10, 0.05, or 0.01, respectively.

These results show that the Malmquist index for the periods 2, 3 and 7 was significant, displaying an incremental trend. These data indicate that the technical efficiency index had an increasing trend, along with a 1.2% growth rate of technological changes.

B) Part 2: Boom and investment period (2000 – 2021)

In this period, by enforcing the Olive Culture Plan, the Ministry of Agriculture increased the national olive production rate from 7684 ton to nearly 32000 ton. It also provided the private sector with licenses for establishing and operating oil mills, as well as processing and packaging units, further to economic incentives. Considering that the production of the initial raw material (olives) production increased, the overall level of grove productivity also increased. Overall, the Iranian olive industry has boomed, thanks to increased industry investments, a higher production capacity, the technological renewal of old units, and the establishment of new units equipped with the latest technology. Data in Table 2 below confirms this technological growth.

Table 2 - Estimation of technical efficiency changes and the scale of olive related industrial units during 2000 – 2021.

Deciles	$M^{m,nt1,nt2}$	$\Delta \hat{M} Eff$	$\Delta \hat{M} SEff$	$\Delta \hat{M} Fron$	$\Delta \hat{M} SFron$
1	1.032^{***}	1.025^{***}	0.862^{**}	0.817^{**}	1.012^{***}
2	1.008^{***}	1.092	0.925	1.014	0.984
3	0.982	0.939	0.991^{**}	0.957	1.043
4	1.014^{**}	1.046	0.973^{**}	0.977	1.032^{***}
5	1.021^{***}	1.076	0.944	0.964	1.034
6	1.024^{***}	1.075^{***}	0.962^{**}	0.960^{***}	1.022^{**}
7	1.139^{***}	0.986	1.035	0.968	1.022
8	1.145^{***}	1.113	0.974	0.975	1.025

Reference: Research findings

Taking the Malmquist index into account, a technological growth of 8.9 percent is observed. This can be considered a technological leap for Iran's olive industry. Moreover, an enhanced use of available resources has also led to the sustainable growth of technical efficiency.

C) Part 3: Competition period (2000 – 2021)

During this period, numerous olive-related industrial units commenced operations with a fresh approach, focusing on the supply of initial input, cost pricing, processing technology, and marketing strategies. In essence, each unit endeavored to carve out a unique identity for its products, aiming for a larger market share. The nominal capacity of industrial units exceeding the available raw materials (olives) intensified the competition for increased efficiency. In this competitive landscape, efficiency and technological changes were estimated as follows.

Table 3 - Estimation of technical efficiency changes and the scale of olive related industrial units during 2000-2021.

Deciles	$M^{m,nt1,nt2}$	$\Delta \hat{M} Eff$	$\Delta \hat{M} SEff$	$\Delta \hat{M} Fron$	$\Delta \hat{M} SFron$
1	1.038^{***}	1.007	1.002	1.093	1.071
2	1.169^{***}	0.998	1.085	1.072^{**}	1.097
3	1.128^{***}	1.059^{**}	1.028^{***}	1.041	1.054^{***}
4	1.089^{**}	0.954^{**}	0.984	0.986	1.106
5	0.991^{**}	1.057	1.063^{*}	1.046^{***}	1.010
6	1.005^{**}	0.989	1.028^{***}	0.973	1.054^{**}
7	1.056^{*}	1.214^{***}	1.062^{***}	1.066^{**}	0.937^{***}
8	1.276^{***}	1.301	0.985	1.235	0.960

Reference: Research findings

During this period, technical and technological efficiencies displayed a suitable growth – albeit not as significant as during the boom period – at a rate of 5.8% and 1.1%, respectively.

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COMPARISON OF OLIVE CULTIVATION WITH WHEAT CULTIVATION UNDER RAINFED AND IRRIGATED CONDITIONS IN IRAN

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Introduction

The significance of land as a crucial factor in agriculture cannot be overlooked. Taking into account the escalating concerns surrounding food security in the face of a burgeoning population, the efficiency of land use becomes paramount. Moreover, the intricate relationship between climate change and the impending water crisis further underscores the urgency of these issues.

In the quest to address these challenges, strategies are being formulated to achieve the target of producing 4.5 kilograms of crops per cubic meter of water, or, alternatively, ensuring an income for farmers of $2.5 per each cubic meter. This emphasizes the need to boost land productivity, operational efficiency, and yield per hectare.

Presently, Iran's national average yield of agricultural products lags behind global standards. As the population continues to grow, ensuring an adequate and readily available supply of nutritious food necessitates a significant surge in productivity, potentially doubling current yields per hectare.

Moreover, an increased focus on environmental conservation and the improvement of living conditions requires enhancing productivity per unit area. With the aim of diminishing fossil fuel reliance, there's a push to introduce and cultivate crop varieties that are well-adapted to the region's climate. A case in point is the increased productivity observed in olive orchards following the introduction of new, climate-resilient varieties. Such initiatives not only increase the yield per hectare but also positively impact the employment rate within the agricultural sector, ultimately leading to heightened income levels for farmers. This financial advancement sets the stage for a resilient and sustainable livelihood framework in horticulture. As time progresses, this transition can guide farmers toward modern agricultural techniques, surpassing conventional subsistence farming approaches.

Over the span of a decade (2012-2022), two significant case studies were conducted.

Case study #1: Rainfed slope land cultivation in Minoodasht

Location: Minoodasht county (Golestan province).
Coordinates: 37.147389, 55.278389

Overview:

This study was carried out on rainfed slope lands, with a traditional method spanning a total area of 23 hectares in two adjacent plots.

Land topography: The study focused on two plots located on rainfed slope lands

Climate and geographical characteristics:

- Annual rainfall: The region experiences an average annual rainfall of 480mm, spread over 78 days (more than 5mm per day).
- Relative humidity: The prevalent relative humidity averages 65%.
- Cultivation methodology: The cultivation approach was aligned with the "Guidelines for orchard establishment on slope lands".

Project: Olive orchard management and optimization operations

Objective: Optimization of olive orchards in terms of water management, pruning, soil management, and varietal selection.

Findings:

1. Water management:

Over the past decade, as farmers enhanced their technical know-how, significant strides were made in the field of water management in olive orchards. Notably:

- The establishment of efficient water harvesting systems tailored to the area's rainfall patterns.
- Systems were initially put in place during tree planting and subsequently enhanced under tree canopies in the following years. This promoted rainwater harvesting, optimizing the use of "green irrigation", meaning utilizing water solely from rainfall.

2. Pruning operations:

- Formative and yield pruning were carried out, influenced by the physiological behavior, growth rate, and age of the trees.

3. Orchard weed management:

- Activities incorporated controlling weeds and close monitoring of pests and diseases.

4. Selected varieties for cultivation:

- Local olive varieties suitable for various microclimates within the province were chosen for plantation. Notable varieties included Zard, Roghani, and Shengeh.
- A noteworthy observation after a decade was that varieties like Picual, Mission, and Arbequina exhibited commendable resistance to low and chill temperatures. Hence, these varieties were chosen for plantation.

Economic impact:

For comparison, in regions like Minoodasht (Golestan), the average profitability from wheat cultivation annually stood at approximately 3000 kilograms per hectare. After transitioning to olive cultivation, the production elevated to 3400 kilograms of olive fruits, which translated to around 510 kg of olive oil per hectare using local varieties.

Table1: The comparison between olive and wheat yield and income, Minoodasht - Golestan Province

Olive	Average yield kg/ha	Oil extraction kg/ha	Oil price/kg in €	Total earning/ha in €
	3400	510	3.8	1938
Wheat	Average yield kg/ha	Wheat price/kg in €		Total earning/ha in €
	3000	0.3		900

Table 2: Average olive yields from 2012-2021 in Minoodasht, Golestan, following the orchard management practices adopted in the project's orchards.

year	Yield in tons
2012	2
2013	1
2014	0.5
2015	2
2016	4
2017	7
2018	3
2019	3
2020	1
2021	4
Average	3.75

Case study #2: Implementation on dry land with an irrigation system

Location: Siahpoosh (Kallaj) Village (Ghazvin province).
Coordinates: 36.727905, 49.311877

Overview:

This project was conducted on two adjacent plots, each equipped with an irrigation system. Both plots collectively spanned a total area of 20 hectares.

Climate and geographical characteristics:

- Annual rainfall: The area receives an average annual rainfall of 218 mm.
- Rainy days: The average of rainy days amounts to 81 rainy days per year.
- Relative humidity: The average relative humidity of the region is 57%.

Cultivation details:

The cultivation on these plots was performed using a dense planting method.

Project: High density olive orchard management in Siahpoosh

Location: Siahpoosh Village (Ghazvin Province)

Objective: To optimize olive orchard management using improved techniques tailored for sandy soils.

Findings:

1. Soil and water management:

Over the past decade, farmers have enhanced their technical expertise which has led to groundbreaking results, namely:

- The innovation in olive orchards was the introduction of a tailored canal system taking into consideration the region's sandy soil quality.
- These canal systems were implemented at the tree planting stage, strategically allowing for tree roots to further develop within them. This practice significantly bolstered water use efficiency for green irrigation.
- For high-density olive orchard planting, a canal of 80 cm in width and depth was dug. As the years progressed, tree roots extended into these canals, effectively harnessing moisture and nutrients.
- Implementing smart water management systems, the moisture zone around the well-developed canal roots was closely monitored. Whenever soil moisture levels depleted, the smart system activated irrigation, ensuring that trees received optimal water amounts without entailing wasteful runoff or leaking. This precise management not only maximized water use efficiency but also conserved energy, making a significant contribution to environmental sustainability.

2. Pruning operations:

- Implemented both formative and yield pruning.
- Tailored the pruning techniques based on the tree's physiological behavior, growth rate, and age.

3. Variety selection for high-density cultivation:

- Arbequina
- Koroneiki

4. Orchard soil management:

- Maintained strict weed control measures.
- Continuously monitored for pests and diseases to ensure orchard health.

Economic impacts:

Historically, wheat cultivation in Siahpoosh (Ghazvin) yielded an annual average of 3000 kg per hectare. After transitioning to olive tree planting using the high-density cultivation method, the yield soared to 16,400 kilograms of olive fruits per hectare, which translates to approximately 3,200 kg of olive oil per hectare.

Table 3 - The comparison between olive and wheat yield and income –Siahpoosh-Manjil.

Olive	Average yield kg/ha	Oil extraction kg/ha	Oil price/kg in €	Total earning/ha in €
	16400	3200	3.8	12160
Wheat	Average yield kg/ha	Wheat price/kg in €		Total earning/ha in €
	5000	0.3		1500

Table 4 - Average olive yields from 2018-2022, resulting from orchard management practices in the project's orchards.

yied/tone	year
16.7	2018
19.5	2019
8.3	2020
22	2021
31.4	2022
16.4	Avg

Results and discussion:

Soil conservation:

- In both case study projects, soil erosion was minimized significantly due to the reduced movement of sand and soil particles. This is the most environmentally commendable outcome of the projects.

Water management:

- The evaporation rate in the cultivated areas using the new method was reduced by at least 75% compared to conventional methods.
- For the olive orchards in Case Study 1 located in Minoodasht (Golestan), water harvesting systems were tailored to the region's rainfall pattern. In comparison, orchards using traditional methods relied solely on rainfed cultivation.

Recommendations:

- **Public awareness:** It is essential to increase public knowledge, especially among rural women, with a view to promoting the project's objectives, goals, and expected outcomes. This will enhance the project's visibility throughout its implementation phase.
- **Collaboration:** It is anticipated that international organizations, such as the IOC, the Food and Agriculture Organization (FAO), the United Nations Industrial Development Organization (UNIDO), and the Green Climate Fund (GCF), in collaboration with the Ministry of Jahad Agriculture, will spearhead efforts to expand technical know-how in horticulture, and supply primary olive varieties and quality olive seedlings.

Yield and economic value:

- Slope rainfed orchards in Case Study 1 had an average of 178 trees. The yield was 3,400 kilograms of olives per hectare, translating to approximately 510 kilograms of olive oil. This production has an annual economic value of 1938€.
- Densely cultivated orchards in Case Study 2 in Siahpoosh-Qazvin consumed an average of 5000 cubic meters of water per hectare. They produced 16,400 kilograms of olives, resulting in about 3,200 kilograms of olive oil with an annual economic value of €12,160.

Farmer response:

- The successful outcomes of the projects have instilled confidence in farmers regarding the proposed methods and the olive varieties that were introduced. The overall sentiment towards the cultivation process has been positive.

Potential for expansion:

- Iran has the potential to cultivate 125,000 hectares of olive orchards using the proposed method. Of these, 72,000 hectares in Golestan, Kermanshah, and Khoozestan would use conventional methods, while 53,000 hectares across provinces like Gilan, Ghazvin, Fars, Semnan, Ilam, Zanjan, Kermanshah, and Lorestan would adopt the dense cultivation method.

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OLIVE FRUIT FLY *BACTROCERA OLEAE* ROSSI. (DIP .TEPHRITIDAE) MANAGEMENT AND CONTROL IN IRAN

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Introduction

Bactrocera oleae Rossi (Dip: Tephritidae) is the most prominent olive pest worldwide reducing 15% of products in the Mediterranean region (Sharaf, 1980; Rice, 2000; Economopoulos, 2002; Basilios et al., 2002). This insect belongs to the Dacinae sub-family and the Dacini tribe. Most species of the Dacinae sub-family are dispersed in tropical regions. In fact, the *B. oleae* species is the only one found in the northern Mediterranean (Panayotis, 2000). In Iran, *B. oleae* was reported to have caused serious damages to olive producing areas during 2004, 2009 and 2012, including the Qazvin and Zanjan provinces, as well as in Roudbar in the northern province of Guilan (Rezaei and Gafari, 2004; Mojdehi et al., 2016) (Figure 1).

Figure 1: Olive orchards in northern Iran

A diversity of methods for controlling *B. oleae* have been developed, encompassing sticky yellow traps, sex pheromones, and food attractant traps (i.e. a combination of a protein hydrolysate solution with a pesticide) (Haniotakis and Skyrianos, 1981, Kolyaei, 2011).

A study on the efficiency of kaolin micronized powder showed that applying a 5% spray of this material had a great effect on the reduction of the infestation and damage caused by *B. oleae* (Mozhdehi and Keyhanian., 2014, Keyhanian et al., 2012). Pyridalyl could potentially be a desirable insecticide for decreasing the infesting population of *B. oleae* in Iran. A study showed that the Pyridalyl added into a protein hydrolyzate for adult flies resulted in a significant mortality of this pest with LC_{50} of 0.517 μg/mL. Despite that the fecundity of treated females was not affected, significant mortality was observed in the eggs laid by treated females (Abbasi-Mojdehi et al., 2019). Using copper hydroxide as an inhibitory compound for the olive fruit fly oviposition was studied by Tsolakis et al. (2011). They used the combination of lure and kill methods and copper hydroxide spray at a concentration of 0.3%. Their results showed that if these two methods are combined and used as an Integrated Pest Management (IPM) strategy, the infestation level of fruits can be reduced under the Economic Injury Level (EIL).

In another study, the efficacy of kaolin, bentonite, and copper compounds (copper hydroxide and copper oxychloride) was surveyed on the olive and Mediterranean fruit flies. The results showed that the effect of kaolin powder is more significant than that of bentonite, entailing also better control effects over olive fruit flies than Mediterranean fruit flies. The results also demonstrated that copper hydroxide is as effective as kaolin (Caleca et al., 2008). The oviposition inhibitory effects of kaolin powder and various copper compounds were evaluated on *B. oleae* under field conditions. Moreover, the combined effect of kaolin powder with copper hydroxide and copper oxychloride was positive, especially on the quality of olive oil, given that the acidity of olive oil was reported as 0.1 to 0.2 percent in experimental treatments, and 3 to 4 percent in peroxide value (Caleca et al., 2004).

The *B. oleae* female has displayed a special behavioral character. Following oviposition, it throws compounds (e.g. dihydroxyphenyl ethanol, pyrocatechol, benzaldehyde, and acetophenone) on the fruit, causing other *B. oleae* females to fly away and ultimately preventing their oviposition. Female olive fruit flies oviposit their eggs underneath the skin of ripening olive fruits. Usually, only one egg per fruit is laid (Fletcher, 1987).

Another study investigated the effect of dihydroxy-3,4-B-phenylethyl alcohol (Panayotis, 1992). Several studies were conducted on the olive chemical inhibitory matter for female *B. oleae,* in which diphenolic compounds play an important role. Female flies prevent the oviposition of other female flies by spraying chemical compounds (e.g., olive glucose, oleuropein, demethyloleuropein, and their derivatives) on the fruits after oviposition (Scalzo-Lo, 1994).

The review of literature and studies shows that the olive fruit fly hosts certain symbiotic bacteria that help insects with the digestion processes (Estes, 2009). Given that *B. oleae* larvae receive these bacteria from their surrounding environment at the onset of biological processes, the control and management of these bacteria is essential in the reduction of pest damage. The antibacterial properties of copper compounds will affect the symbiotic bacteria of the olive fruit fly (*Candidatus* Erwinia dacicola: Enterobacteriaceae) and reduce the bacteria on the surface of olive leaves and fruits. Copper has been proved to disturb the symbiosis among *B. oleae* females and larvae, as well as certain bacteria found on the olive phylloplane, provoking a high percentage of young *B. oleae* larvae mortality in the absence of these bacteria (Rosi et al., 2007).

History of research done in Iran

Until 2004, the olive fly was considered a quarantine pest for the Persian country. However, during this year, its damage was recorded in olive orchards, which confirms its entrance from neighboring countries. Using pheromone traps (sticky yellow traps), baited traps (dome and bottle) charged with hydrolyzed protein, and regular fruit samplings, its biology and development were studied from 2005 to 2007 in olive orchards present in Roudbar, Tarom, Loshan and Dezphol, located in the provinces of Gilan, Zanjan, Ghqzvin and Khozestan. Results demonstrated that infected fruits can be observed in late July.

Analyzing the gathered data, it was deduced that the fly exhibits a minimum of three overlapping generations across the studied areas. These generations span approximately 25.36 ± 1 days during the summer, while the autumn generation extends for 40.27 ± 0.2 days, as illustrated in Figure 2.

Figure 2: Egg holes at the end of November

Digestive a-amylase of *Bacterocera oleae* larvae was characterized and treated by an inhibitor to gain a better understanding of the degradation of nutritional molecules as a potential target for controlling the pest. The presence of a-amylase was confirmed in the gut of olive fruit flies using a negative control in dinitrosalicylic acid procedures. The use of enzyme inhibitors from different plant sources may serve as an important pest control strategy via plant breeding programs. Identification of the genes responsible for these inhibitor proteins could be a first step towards providing a resistant variety of olives.

Digestive proteolytic activity in larvae and adults of *Bactrocera oleae* was studied using specific substrates and inhibitors. Results demonstrated digestive proteolytic activities in *B. oleae* for the first time. This knowledge could be capitalized upon for finding a control procedure to decrease the damage of this destructive pest.

In a separate investigation, the digestive lipase activity was assessed and characterized in the third larval instars of the olive fruit fly, *Bactrocera oleae*. This marks the initial instance in the dipteran order, utilizing two sample fractions. Given that olive fruits are rich with various oils, digestive lipases of *B. oleae* larvae have a critical role in their digestion. Thus, these enzymes might also serve as promising targets for developing inhibitors and resistant varieties.

Another study is analyzing the effects of the two proteinaceous inhibitors on digestive ▯- amylase of *Bactrocera oleae* Gmelin. The two proteinaceous inhibitors were extracted from Phaseolus vulgaris L. (white bean) and Vigna unguiculata L. (cowpea) using 20, 40, 60 and 80% concentrations of ammonium sulfate precipitations. Understanding the enzymatic reactions in environments containing inhibitors could be useful to enhance existing knowledge regarding the control of agricultural pests through plant breeding programs.

An investigation on the efficiency of several oviposition deterrent compounds to reduce olive fruit fly damage was conducted in the Roudbar Olive Research Station in Iran's province of Guilan between 2010 and 2017. The treatments included kaolin 5%, kaolin 4%, kaolin 5% + copper hydroxide, kaolin 4% + copper hydroxide, copper hydroxide, and water as the control substance. The results showed that copper hydroxide alone or combined with kaolin 5% with at least two sprays is recommended for controlling *B. oleae* and reducing fruit damage (Figure 3).

Figure 3: Kaolin protected fruits against the olive fruit fly.

Utilizing the mentioned traps minimizes environmental pollution, and while their high efficiency is crucial, another research evaluated and compared the efficiency of a novel technique, "Lure and Kill," employing magnet-ol traps and comparing them with other traditional trap types.

The aim of performing this research was to determine the efficacy of products prepared from aquatic animal wastes in comparison to other attractants. Based on the results, marine animal wastes can be considered a suitable compound for attracting and monitoring the olive fruit fly population.

Deployment of resistant varieties and detection of resistance mechanisms are useful strategies for pest management programs. Considering that traditional farmers do not apply cultural or chemical methods to control this pest, deploying resistant varieties is likely to be a more acceptable strategy from farmers' viewpoints. In another research, ten promising olive varieties hosted in the Roudbar Olive Research Station were studied in order to determine the infestation rate of olive fruit fly and the chemical compounds of olive drupes. The olive varieties analyzed were Arbequina, Manzanilla, Leccino, Zard, Konservalia, Amigdalifolia, Kalamata, Roghani, Mari and Fishomi. Arbequina and Kalamata varieties demonstrated a low yearly infestation rate from 8% to 11%, entailing that they can be taken into account for the development of resistant olive varieties. The study showed no correlation between infestation rate and both morphological traits and chemical compounds in olive oil. However, oleuropein can be considered amongst the factors resistant to the olive fruit fly.

Regarding the 2010 experiment conducted in the Roudbar Olive Research Station in northern Iran, kaolin powder was applied as one of the methods for the control and decrease of the damage caused by the olive fruit fly. The application of kaolin powder proved highly useful for the control of olive fruit flies, and will therefore be one of the methods included in the IPM.

Finally, another study carried out between 2014 and 2016 investigated the seasonal fluctuations, bio-ecology characteristics, and olive orchard infestation in the orchards located in Tarom Sofla in the Ghazvin province. The larval parasitism rate by Cyrtoptyx latipes was considerably low (0.71%) during this study.

The environmentally friendly management of the olive fruit fly involves employing strategies such as lure and kill or mass trapping to mitigate fruit damage. This study aims to assess the effectiveness of various attractive traps in luring and capturing the olive fruit fly.

It is hoped that, through the adoption of novel methods and IPM for the olive fruit fly in the future, effective control measures can be implemented in olive groves, thereby minimizing damage to Iran olive trees. Ongoing studies include the exploration of olive oil mill wastewater, novel attractants, biological insecticides, and the application of hormones to influence fruit growth and reduce susceptibility to the olive fruit fly. Additionally, research is being conducted on botanical insecticides targeting the symbiotic bacteria associated with the olive fly.

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ADVANCEMENTS IN OLIVE OIL QUALITY CONTROL MANAGEMENT THROUGH SENSORY ANALYSIS IN IRAN

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Introduction

The olive tree has a rich history in Iran, as evidenced by inscriptions and historical sources. The northern and western regions of Iran are traditionally the most acquainted with olive oil, where trees with a history of around a thousand years can be found. However, over the past century, most of Iran's olive cultivation has taken place in the northern regions near the Caspian Sea, notably in the city of Roudbar, -in the Gilan province. This region has a semi-Mediterranean climate, favorable for olive cultivation.

Locals from this area have shown a greater interest in consuming olive oil than any other area in Iran, naturally forming a significant part of their dietary scheme. The residents of Roudbar have traditionally used olive oil in their cuisine, making it a recurrent ingredient in their recipes. Nevertheless, other parts of Iran were not as familiar with olive oil, possibly due to the prevalence of locally produced fats, such as butter and animal fats.

Olive oil consumption plays a crucial role in promoting healthy nutrition and preventing various diseases. However, Iran has recently observed an increase of diseases related to improper nutrition, such as cancer, diabetes, cardiovascular diseases like high blood pressure and high cholesterol, as well as gastrointestinal diseases. To address these issues, Iran's Ministry of Agriculture Jihad launched the Olive Project. This initiative aimed to develop olive cultivation, improve the quality of olive oil, and raise public awareness about the importance of healthy unsaturated oils, particularly extra virgin olive oil.

The need for quality improvement

Before 2004, the consumption of olive oil in Iran was dominated by low-quality oils, with approximately 90% of consumed olive oils being ordinary and lampante oils. The lack of familiarity among experts and consumers with the chemical and sensory evaluation of olive oil hindered effective quality control. Furthermore, the cost of purchasing olive oil did not play a significant role in consumer choices due to a lack of awareness. With an average consumption of 30 grams per capita, olive oil had no important role in people's tables.

There were two primary reasons for the limited consumption of olive oil in Iranian households. Firstly, unfamiliarity with the special odors of virgin olive oil potentially deterred its consumption. Secondly, there was a lack of trust in the production process of olive oil due to suspicions about possible adulteration. These factors, combined with the relatively higher cost of olive oil, resulted in its lower consumption, particularly in lower-income households. These factors highlighted the need for advancements with regard to olive oil quality control management in Iran.

Several efforts have been put in place to improve the quality of olive oil in Iran, including:

- Implementation of a 10-year research program
- Training courses and international collaboration
- Establishment of sensory evaluation laboratories
- Public education and awareness
- Promotion of olive oil consumption

These combined efforts have contributed to an increase in the production of high-quality extra virgin olive oil in the Persian country, ultimately benefiting consumer health and the olive industry as a whole.

Implementation of a research program

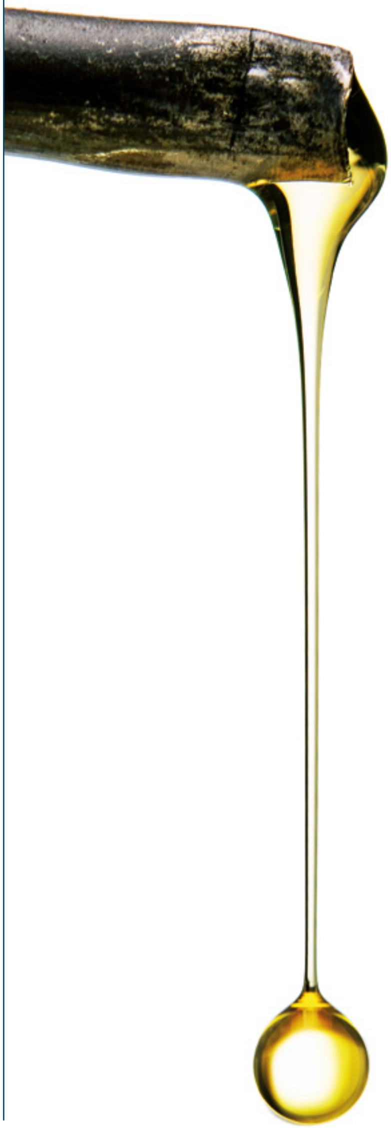
Over the past two decades, more than twenty scholarly investigations have been conducted by specialists and researchers. The overall aim of these studies was to explain the physico-chemical and sensory evaluation properties of olive oil produced in Iran. Furthermore, they sought to determine the optimal harvesting period for olives, the most efficient harvesting techniques, and the ideal temperature settings for implementing extraction systems, ensuring superior sensory qualities across various olive cultivars.

In response to the need for quality improvement, a 10-year research program was implemented in Iran. The program aimed to enhance the knowledge and skills of professionals involved in processing units, orchards, and trading companies regarding the sensory evaluation and physicochemical assessment of olive oil. The IOC played a crucial role in providing support and training courses on the sensory evaluation of olive oil. Iranian experts were trained both nationally and abroad, with some attending short-term training courses in Spain, Italy, and Greece.

Establishment of sensory evaluation laboratories

In line with the requisites of Iran's National Standard Organization and the directives of the Food and Drug Organization within Iran's Ministry of Health and Medical Education, all olive processing facilities are required to establish laboratories. The personnel operating these receive appropriate training, facilitated by the Ministry of Agricultural Jihad in collaboration with the IOC. These trainings encompass methodologies for both physico-chemical and sensory evaluation analyses and have proved instrumental towards increasing the overall quality of olive products.

To ensure the production of high-quality extra virgin olive oil, five sensory evaluation laboratories were established in Iran, adhering to the standards set by the IOC. These efforts have proved successful, leading to a significant increase in the proportion of extra virgin olive oil production, reaching 55% in 2022. The quality control units, equipped with relevant knowledge regarding sensory evaluation, have played a vital role in managing and maintaining the quality of olive oil. Currently, olive oil consumption in Iran has increased from 30 grams in 2004 to 200 grams in 2022 per capita, a promising datum for future actions.



Public education and awareness

Over the past two decades, substantial efforts have been made in order to enhance public awareness regarding the physico-chemical and sensory evaluation properties of olive oil. This initiative has witnessed the organization of five national and fifteen provincial festivals annually, accompanied by five distinct radio and television broadcasts in each province.

Public education and awareness have been key factors in improving the quality of olive oil in Iran. To this end, continuous efforts based on physico-chemical analyses and sensory evaluations of olive products were developed. Mass media, including radio and television, have been utilized to disseminate information and educate consumers about the significance of sensory evaluation. Additionally, promotional seminars have been organized in various olive-growing regions, accompanied by extensive coverage from media outlets.

In collaboration with the IOC, Iran has hosted three national promotional campaigns, five regional olive seminars, nine sensory evaluation training courses, and two physico-chemical evaluation courses. All of these events were attended by IOC experts. Additionally, six Iranian students obtained IOC scholarships for physico-chemical evaluation trainings in Spain and Tunisia, including the trainings offered at the prestigious University of Jaén's campus in Spain. Moreover, four sensory analysis laboratories have been recognized by the IOC, and a fifth one is pending recognition, spread out across Tehran, Qazvin, Gilan and Golestan provinces. These facilities analyze an average of 90 oil samples annually.

Conclusion

The advancements in olive oil quality control management through sensory analysis have significantly contributed to improving the quality of olive oil in Iran and promoting consumer health. Several factors have contributed to the enhanced assessment of this product's quality. The establishment of dedicated physico-chemical and sensory evaluation laboratories within processing units, coupled with the augmented expertise of laboratory professionals and a heightened awareness among the public, especially consumers, have proved to be primary drivers for the improvement in the quality of olive products. The implementation of the research program and public education initiatives has also contributed to the increase in the production of high-quality extra virgin olive oil. The success of these efforts is apparent in the significant increase in the proportion of extra virgin olive oil production, reaching 55% in 2022. As a result, this has benefited consumer health and integrally supported the growth and development of Iran's olive sector. The Ministry of Agriculture Jihad and the IOC's support is essential to further enhance the nation's culture of olive oil consumption, as well as to encourage the consumption of healthy and organic foods on a broader scale.

OLIVAE
№ 130

CAPABILITIES OF IMPROVING AGRICULTURAL WATER PRODUCTIVITY IN HIGH DENSITY OLIVE ORCHARDS

Mr. Afshin Gomrokchi

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Introduction

The development of olive orchards began in Iran in 1972. To this day, olive trees are cultivated in 26 of Iran's provinces. The area under olive cultivation in 2018 was about 84000 hectares, and more than 70% of olive production took place in six main provinces: Zanjan, Qazvin, Gilan, Fars, Golestan and Semnan (Ahmadi *et al.*,2020). The production levels of olive orchards across various provinces indicate that, similar to other countries globally, the yield varies significantly among provinces engaged in olive cultivation. The Iranian average yield of olives is about 2083 kg/ha, which is above than the world average (1800 kg/ha)(Ahmadi *et al.*,2020).

Although the olive tree is a drought-resistant tree, irrigation management is necessary for economic production, as well as for increasing the quality and quantity of production. Hence, the limitation of water resources has reduced the quantitative and qualitative performance of the product in many cultivated areas. In recent years in Iran, the adoption of pressurized irrigation systems in olive orchards has contributed to a notable increase in agricultural water productivity. However, akin to other agricultural products, the rise in production per unit area is expected to result in enhanced water productivity. Nonetheless, a primary challenge in Iranian agricultural and horticultural production, including olive orchards, persists in the form of low yields.

With the availability of irrigation options, the new olive groves opted for higher planting density, surpassing traditional recommendations. This shift resulted in the widespread establishment of high-density (HD) olive orchards. (250–800 tree ha^{-1}). Nowadays, these HD orchards represent more than 2% of the Iran olive area, as is the case in other countries where olive production has expanded recently, such as Greece and Italy. In other countries like Spain, production intensification was carried out by increasing the tree density, including the development of super-high density (SHD) plantations of more than 1000 trees ha^{-1} (Pastor *et al.*, 2007, Connor *et al.*, 2014). Most of the new commercial plantations in Iran are drip irrigated, intensively managed, and relatively large (100–500 ha).

In situations where agricultural production is limited by water rather than land, the concept of water productivity (WP) becomes advantageous. Water productivity is defined as the ratio of production to water use, where production may be defined as yield or value, while water may be defined as that used or consumed (ET), or only that applied through irrigation (Kijne *et al.*, 2003). When water availability decreases and/or cost increases, it is important to determine the marginal WP in economic terms, which is defined as the return that the farmer would get for an additional unit of water used/consumed (Fernández et al., 2020).

However, the primary goal in the development of HD olive orchards in Iran was to increase production, early fruiting, and achieving economic efficiency in the least amount of time. After more than a decade since the introduction of high-density olive orchards in Iran, the significance of their impact on enhancing agricultural water productivity has become crucial, particularly in light of the severe constraints on water resources. In Iran, limited research has been carried out to determine the amount of water used in orchards, however, a number of studies have focused on determining the olive tree's water requirements in experimental plots. Yet, the assessment of present water resources management indicators, encompassing factors such as water volume consumption, is regarded as a pivotal component of agricultural planning across various regions globally. Numerous studies have delved into the analysis of water consumption as part of this ongoing scrutiny.

The aim of this research was to determine water productivity in an HD olive orchard in Siyaposh village, located in Qazvin province. The recorded values have been compared with other cultivation methods in 32 other orchards.

Methodology

In the present study, the volume of irrigation water for the production of olive crops was measured during one crop season without interfering with the operators' irrigation schedule. First, the discharge flow was measured with a suitable device (flume or ultrasonic flow meter) in each of the selected orchards (Figures 1 and 2). After determining the amount of discharge entering the orchards by carefully monitoring their irrigation schedule (irrigation time, number of irrigation times during the growth period, ...) and measuring the cultivated area, the volume of water consumed by the olive crop for each of the selected orchards was determined.

Fig. 1 - Discharge flow monitoring at the entrance of the central control station using an ultrasonic flow meter.

Fig. 2 - Measuring discharge flow at the pumping station using an ultrasonic flow meter (Khandan orchards).

Table 1 shows the general characteristics of HD olive orchards. The volume of water consumed and the yield values in 32 other olive orchards in the region were also monitored. Various factors were taken into account, such as the irrigation method, the size of orchards, the soil texture, the water and soil quality, the planting intervals and the level of education of the operators.

Table 1 - General characteristics of super-high-density olive orchards.

Cultivated area (ha)	Age of trees (years)	planting arrangement (m*m)	Variety	Soil Salinity (ds/m)	Irrigation method	Discharge (lit/sec)
50	5-8	4*1.5	Arbequina	5.4	Drip irrigation	37

Results

In the first stage, in order to analyze water productivity, the three-year yield values in an SHD olive orchard were compared with those of other orchards (Figure 3).

As shown in Figure 3, due to the super-high density of trees per unit area and the cultivars used in high-density olive orchards, the crop yield was higher than the average yield of other orchards in the region. The average yield in the studied orchards (4991 kg/ha) was higher than the national average (2083 kg/ha). Therefore, it can be concluded that the first major advantage of HD olive orchards is increasing the yield per unit area and improving the yield potential.

In addition to production, the volume of water consumed in olive orchard is also considered as an important and effective factor in determining water productivity. In this regard, as aforementioned, the volume of water consumed in the 2017-2018 crop year was measured for 33 orchards. According to the measurement of yield values and the volume of water consumed, the water productivity was calculated in the analyzed orchards (Figure 4).

The results show that the highest water productivity (3.58 kg/m^3) was recorded in HD olive orchards. In other words, an HD olive orchard improved the water productivity index.

Fig. 3- Comparison of the three-year yield of a super-high-density olive orchard with the average yield of another orchard.

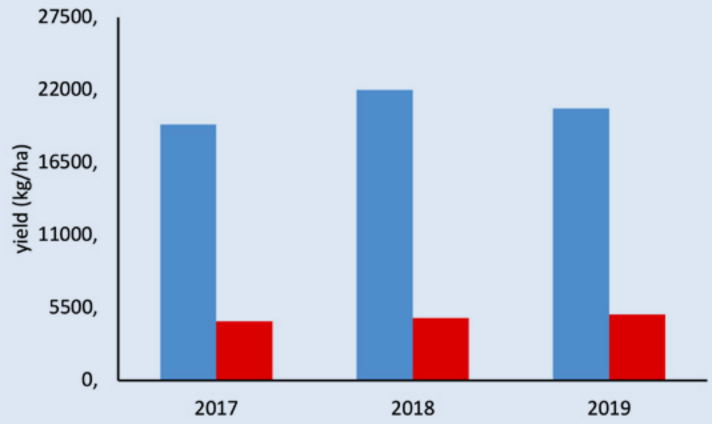
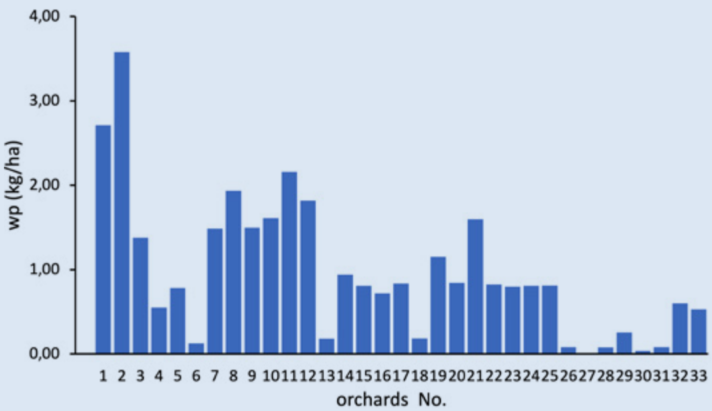


Fig. 4 - Comparison of the water productivity in studied olive orchards.



Given that the primary goal of high-density (HD) olive orchards is olive oil production, an approximate calculation of the olive oil production per unit volume of water consumed has been conducted based on the recorded yield and water consumption volume in the analyzed orchard (Table 2).

Table 2 - Yield, volume of water consumed and olive oil production in Khandan's orchard.

Olive Yield (kg/ha)	Volume of water consumed (m^3/ha)	W.P (kg/ m^3)	Oil production (kg/ ha)	Oil production per unit of water consumed (kg/m^3)
20600	5754	3.58	4120	0.72

Taking into account the yield and volume of water consumption, tending to SHD olive orchards is an efficient method to improve water productivity in the cultivation of olive crops. However, certain limitations to this method must also be taken into account, such as the high cost of the initial construction of the orchard, the high vulnerability of HD olive orchards to the invasion of pests and diseases, and the need for special harvesting machines, amongst others.

According to the Food and Agriculture Organization of the United Nations (FAO), a country is considered to be a leader in the water and agriculture sector if it can produce 4.5kg of produce from 1m^3 irrigation water while generating an income of 2.5 $. Based on the 2022 Iranian production report, SHD olive orchards yielded an average of 25 tons of olives per hectare. This translates to earning 5 kg of olives (equivalent to 1 kg of olive oil) valued at $5 per cubic meter of water.

OLIVE PLANTING SYSTEMS IN IRAN: A CASE STUDY

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Director of Gilan Agriculture and Industry, ETKA Organisation

Olive planting in Iran dates back to hundreds of years. According to certain studies, the country is even believed to be one of the places of origin of olive trees. The first olive planting area in Iran was Rudbar County, located in the Guilan province. The county, along with the rest of Iran, has an average annual precipitation of less than 250 millimeters. In comparison to other agricultural regions across the world, Iran's olive groves require irrigation throughout the year up to several months.

Due to the global increase in population, advancements in technology, and the rising public demand for healthy food, including olive products —especially olive oil— traditional orchards are no longer sufficient to meet local and global demands. Consequently, every facet of the olive industry, from planting and cultivation to harvesting, processing, and marketing, has undergone substantial changes.

Since 1996, which marks the beginning of Iran's "National Olive Plan", the country's olive cultivation area has increased significantly, reaching a total of 84,000hectares in 2023. This would not have been possible without the implementation of modern olive planting methods. Within the framework of an account of the history of Iran's olive planting, a case study is presented regarding the development of a 300-hectare orchard.

Olive planting systems in Iran

Traditional planting systems

In contrast to the conventional approach of planting olive trees with ample spacing (typically 50 to 150 trees per hectare), traditional olive orchards in Iran were established with much higher density under the misconception of optimizing land use. Unfortunately, this resulted in inadequate sunlight penetration, intensified light competition, and a subsequent increase in tree height. Consequently, this situation led to a notable decline in shoot growth, heightened vulnerability to pests and diseases, and impeded mechanization, causing a significant reduction in both production levels and economic efficiency. Furthermore, harvesting olives from tall trees posed safety concerns, often leaving a portion of the crops unharvested.

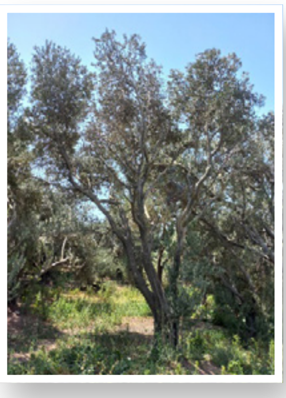
Traditional orchards were mostly planted in sloping lands. The lack of order when planting the trees resulted in semi-forest orchards. Furthermore, the orchards were established by planting suckers, leading to a prolonged period for economic fruit setting, sometimes extending up to 10 to 15 years. While suckers demonstrated ample resistance to environmental stress, including water stress, the act of planting a sucker resulted in damage to the mother tree.

Moreover, traditional fruit harvesting was also a slow process given that it was often family members who performed the harvest. Before being transferred to domestic workhouses for oiling, the fruits were stored until the entire harvest, resulting in poor-quality olive oil due to the prolonged storing time.

Traditional olive orchards could not be sprayed and tree nutrition was limited to the application of animal manure. On top, at the cultural level, pruning was considered taboo. In fact, there existed a common saying among farmers that said: "You can cut my hand, but not the olive branch!". Traditionally, supplemental irrigation was performed through a set of irrigation canals. Table olives were prepared by cracking the olives, soaking them in water for several days until their bitterness was removed, and, finally, soaking them in salt water. Although the crops were near entirely organic due to the lack of the use of chemicals throughout this process, this positive impact was lost with the post-harvest processes.

In summary, the traditional orchards were not in a desirable condition, leading to low production levels and low-quality crops. Therefore, these traditional methods are no longer in use in novel olive development projects in Iran.

Examples of traditional olive orchards.




High-density planting system

High-density planting systems entail the planting of about 150 to 500 trees per hectare. Due to the support of the Ministry of Agriculture and the positive impact of the National Olive Scheme, the state of high-density orchards is significantly different to that of traditional orchards.

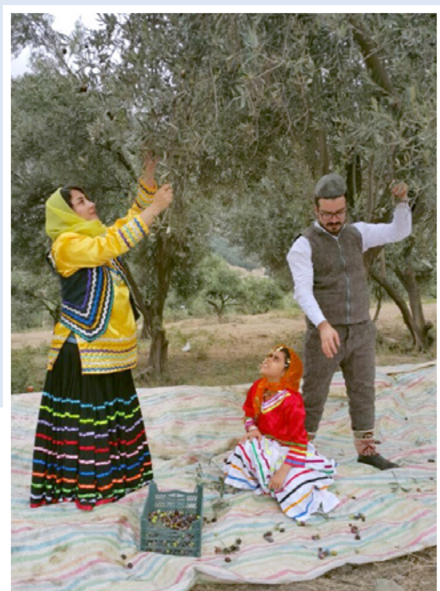
Target lands for this planting system are hilly. Generally, they are planted with seedlings from certain varieties that were reproduced in nurseries. The planting pattern is rectangular or squared. Planting distance is 7×7 or 6×8 given that most orchards plant Iranian varieties, such as the so-called yellow or oily varieties, which have a decent growth capacity. The possibility of mechanization is greatly improved since tractors can operate between plantation rows. Seedling planting is done according to international standards by digging proper-sized 60×60 holes using basic and animal manures. Orchard soil management is done mechanically. Weeds, pests and diseases are prevented through the application of pesticides.

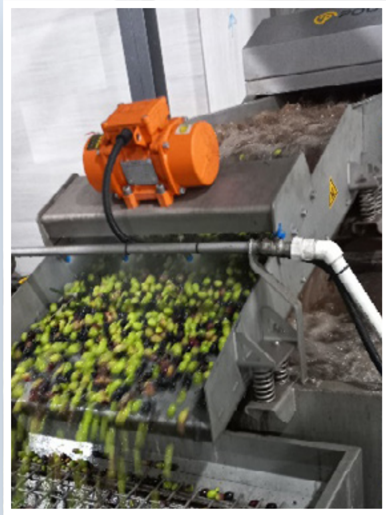
However, existing mechanical facilities are not suitable for the orchard's topography. Green fruits are harvested entirely manually in September and October, when factories begin processing table olives, mostly using the Spanish green olive method and employing proper equipment. Ripened black fruits are harvested using small rakes between November and January, depending on the year's production level, and rapidly transferred to oiling factories using the three-phase system in holed boxes. These advances have significantly improved the quality of olive oil and have substantially facilitated the production of extra virgin olive oil.

In order to support olive oil production in Iran, besides lands with an area of 30 to 50 hectares, the Ministry of Agriculture has offered grants to farmers for developing drip irrigation systems and supervising seedling distribution. The implementation of drip irrigation systems has made planting possible in sloping lands without causing water erosion. Moreover, spraying and injecting the required manures for trees has become easier, pruning is now a culturally accepted activity and has been integrated as an agricultural norm. Pruning waste is reused to make fuels and cattle feed, and oiling waste is also used for composting and cattle feed. A number of imported varieties, including Arbequina, Koroneiki, Manzanilla and Conservolia, have been used in several orchards in recent years. A considerable number of orchards have been constructed using modern methods. This study will dive into one of these.

Harvesting box.

Harvesting net.



Processing factory.




Irrigation system.

Fertilizer injection.

Pruning.

Harvesting rake for black fruits.

Super-high-density planting system

The importing of modified varieties over recent years has made constructing super-high-density orchards with a planting density of 1000 to 1500 trees per hectare more common. However, since constructing these orchards requires flat lands and fully mechanical agricultural methods, they are still low in number. The planting distance in these orchards is usually 4×5,1 meter. They are equipped with drip irrigation systems and pruned using mechanized tools. The planted varieties are Arbequina 18-I and Koroneiki 38-I. Recently, combined harvesting machines have been employed for harvesting. Nonetheless, this planting system also has its limitations, including the necessity for flat lands, the shorter life span of super-high-density orchards, and the heavy costs associated with the construction and maintenance of this type of plantations.

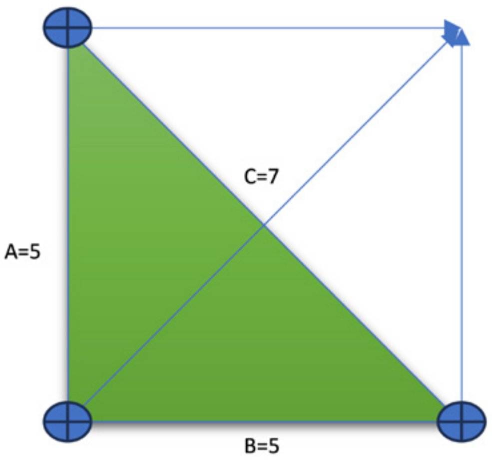
Super-high-density orchard.

Case study

In 2010, a 300-hectare olive orchard was constructed in Manjil city, in the Guilan province. Super-high-density varieties, including Arbequina I-18 and Koroneiki I-38, were chosen for plantation given a number of factors, namely: their compatibility with environmental conditions, the desirable quality of their oil, their high production yield and early fruiting, as well as their resistance to certain pests and diseases. However, due to the particular topography of the region which is characterized by sloping lands, super-high-density planting was not possible and the square planting pattern with a 5×5-meter-distance (400 trees per hectare) was chosen instead.

Thus, the orchard was constructed using the high-density method for the plantation of suitable varieties. A novel method was developed for implementing the planting pattern and the seedling planting spot. First, a large "plus" sign was drawn using a mapping camera and plaster. Then, a novel tool, referred to as "schablone", was employed to determine the exact location of planting spots. This tool was chosen given that point marking would lead to an almost 0.5-meter-error at the time of digging the planting holes. After determining the first planting spot on the plaster lines, the Pythagorean theorem ($A^2 + B^2 = C^2$) was used for subsequent marking. This novel method has a number of advantages, such as marking speed, a higher accuracy at the time of determining planting spots, enhanced ease for driving machinery, and an overall more pleasant view of the planted orchard.

Schablone.



High-density planting in an innovative way.

Schablone.

Holes measuring 60×60 centimeters were excavated, with the initial 30 centimeters of soil placed beside one side of the seedling root and the remaining 30 centimeters placed on the opposite side, to ensure that the seedling root is surrounded by suitable soil. The holes' soil was disposed of rubble and any kind of waste, and basic and animal manures were used to fill them.

Due to the windy climate of the region, 1.8-meter-tall bamboos were used as stocks. The entire orchard area was equipped with a drip irrigation system. The Ministry of Agriculture implemented grants and subsidies for seedlings. The specified 9 seedlings were sourced from an Italian seedling production company. Additionally, sections of the orchard were planted with the Manzanilla variety, locally produced in Iran.

Over the following years, Trifularlin (Treflan) pre-emergence herbicides were used in late winter to effectively prevent the emergence of weeds. To ensure an adequate mixing between the herbicide and the soil, the herbicide was fist sprayed on the soil, followed by the spreading of the organic matter (made from animal manure or compost) under the canopy. Farmers then proceeded with surface plowing.

Conclusion

Considering the local and worldwide demand for olive products, traditional orchard construction is no longer feasible due to low production levels and inferior product quality. On the other hand, the cost of construction and maintenance of super-high-density orchards is high and not affordable for many farmers. It is concluded that using high-density olive tree planting systems is the most appropriate mechanism for Iranian orchards, taking into account farmers' technological abilities, and Iran's topographical and climate conditions.

Recommendations

- Pay adequate attention to the planting spot. Performing soil examination and analyzing the topographic condition prevents substantial complications.
- Ensure the quality and quantity of water resources.
- Choosing the right variety is highly important in the construction of any fruit orchard, including olive orchards. The selected varieties should be self-fertile, early fruiting, productive, tolerable or resistant toward biotic and abiotic stresses, and should produce high-quality yield.
- Establishing NGOs can serve as a means to educate individuals on the optimal utilization of oil products, playing a crucial role in marketing and facilitating the exchange of information and equipment among farmers.
- Taking global warming into account and its consequent water resource limitations, and in order to preserve national germplasm varieties, it is essential to encourage the construction of compatibility orchards in order to recognize suitable varieties for high-density planting.

THE ROLE OF OLIVE DEVELOPMENT IN FACING SOCIAL DAMAGES

Faranak Nabipour

Social Research Unit, Arshia Olive

Payam Nabi

Social Research Unit, Arshia Olive

The Arshia Olive production brand belongs to an Iranian social enterprise founded in 2005 by Alireza Nabi.

The founder of the brand believed that involvement in olive processing and production could contribute to the economic development of underdeveloped areas and create jobs for the unskilled labor force, taking into account that the production process is relatively easy and safe and does not require advanced technological machinery. In fact, most activities pertaining to the process can be handled manually without the need for previously acquired skills or past experience. All individuals who received a brief training, regardless of their academic background, proved they were able to handle the job.

Olive production in Iran saw a surge between 2002 and 2004[1] when larger plots of land began to be dedicated to olive cultivation in many underdeveloped provinces. The surge in production paved the way for exports and the future of olive production seemed promising.

Moreover, studies suggested that the wholesome properties of olives and its high food value were set to make it a staple product of many households in Iran.

Alireza Nabi's innovative passion for problem solving and helping people in need, combined with the aforementioned factors, led him to launch a small company that specialized in table olives production, and gradually hire socially disadvantaged individuals who were unemployed due to lack of experience, knowledge and skills, as well as because of a prior conviction and/or a substance abuse record.

Initially, the company was established in the city of Mashhad in north-east Iran. It han an approximate olive production capacity of 50-ton, with a total of 15 rehabilitated drug addicts and vulnerable women on its payroll. However, production levels increased over the years, leading to the establishment of a new plant near Minudasht, in northern Iran, entailing the employment of an even higher number of unprivileged women and men. Its presence in rural areas of Minudasht has also created the opportunity to support local olive farmers by providing them with various types of training and making direct purchases from small-scale family farmers, which has replaced purchases from intermediaries.

Currently, Arshia's annual olive processing capacity stands at around 1,500 tons per year. Arshia's workforce is organized into six distinct categories, and the total number of full-time employees has reached approximately 200:

- Rehabilitated drug addicts
- Disadvantaged and at-risk women and single mothers
- Former inmates convicted of misdemeanors
- Former inmates convicted of felonies
- Inmates who are currently serving time
- Individuals from neighborhoods with high crime rates

Research question

Has Arshia been able to empower socially-harmed individuals and boost their social acceptance level through olive production?

As aforementioned, Arshia uses olive production and processing as a means to attain its principal mission of empowerment and entrepreneurship to benefit socially-harmed individuals and boost their social acceptance level. In addition to the common product-related Research and Development Unit, the company has recently set up a Social Research Department to thoroughly study its impact and further develop the business' social dimensions. By focusing on the challenging process of working with former offenders and socially-harmed individuals, this department strives to help sustain and expand Arshia Olive through the evaluation, measurement and improvement of its social impact. Below is an outline of the most important measures the Social Research Department has put in place since its establishment in 2022:

- Creating detailed files involving personality and social background information about 130 company employees, which encourages a better understanding of their mental and psychological state, as well as their needs.
- Reducing the impact of personality disorders of recovered addicts through Cognitive- Behavioral Group Therapy sessions and training in life skills.
- Organizing more than 50 group therapy sessions for former inmates and disadvantaged women.
- Organizing more than 10 training sessions to promote communication skills.
- Organizing around 300 individual counseling sessions for staff members who have requested such sessions.
- Drawing up a training and therapy plan, as well as an organizational social acceptance model for ex-offenders and recovered addicts.

(1) International Olive Council: GENERAL DESCRIPTION OF OLIVE GROWING IN IRAN(2012).

- Developing a first version of an employment protocol for socially-harmed individuals and employees with records of past misconduct.
- Using the SWOT matrix to identify the components that affect social businesses.
- Developing a strategic social research plan for the company through a SWOT analysis and the QSPM matrix.

Arshia's Social Research Department has several essential measures in the pipelines for 2024, namely:

- Measuring the *social impact* of the Arshia Olive company
- Creating a manual on how to deal with socially-harmed individuals
- Drawing up an Arshia social enterprise model and developing it for its use by other businesses with similar missions
- Developing a psychological-behavioral model with the involvement of successful Iranian social entrepreneurship and enterprise founders and releasing an article based on these findings

TRADITIONAL OLIVE BASED IRANIAN RECIPES

SHAMI RODBARI

Shahriar Azarakhshi

Research and development consultant, Arshia Olives Group, Dr. Nabi Charity Foundation

Zahra Yousefi

Assistant professor, Agricultural Engineering Research Group, Gilan Agricultural and Natural Resources Research and Education Center, AREEO (Rasht, Iran)

This dish is a meat patty cooked in tomato sauce that traditionally comes from the city of Rodbar in northern Iran.

Ingredients

- 500gram mince meat
- 2 large onions, grated
- 500gram pilled chopped tomato
- 2 teaspoons bee balm, chopped
- 1 teaspoon purple basil, chopped
- 1 teaspoon mint leaf, chopped
- ½ teaspoon angelica powder
- 1 cup extra virgin olive oil (EVOO)
- Salt, black pepper and turmeric powder

How it's made

Mix well all the herbs and the angelica powder with the minced meat. Add salt and pepper to enhance the taste.

Make small patties out of the mixture and fry them in EVOO.

In a separate pan, cook the tomato with a pinch of turmeric, and add salt and pepper to improve the taste.

Once the sauce has thickened, add the cooked patties to the sauce and let them simmer for 40 to 45 minutes on slow heat.

This dish normally is served with Persian style smoked rice.

TRADITIONAL OLIVE BASED IRANIAN RECIPES

ZEYTOON PARVARDEH

Shahriar Azarakhshi

Research and development consultant, Arshia Olives Group, Dr. Nabi Charity Foundation

Zahra Yousefi

Assistant professor, Agricultural Engineering Research Group, Gilan Agricultural and Natural Resources Research and Education Center, AREEO (Rasht, Iran)

This dish originated in northern Iran near the Caspian Sea Gillan province, where locals make it with a regional herb, *Eryngium planum*.

Ingredients

- 1 cup walnuts, grounded
- 1 cup fresh pepper mint leaves, finely chopped
- 1/3 cup fresh cilantro leaves, finely chopped
- 1 teaspoon dried angelica powder
- 4 cloves garlic, minced
- 1/2 cup olive oil
- 1/2 cup pomegranate molasses
- 1/4 teaspoon salt
- 2 cups green olives, pitted
- Pomegranate seeds (for garnish, optional)

How it's made

Use a food processor to finely ground the walnuts or, alternatively, employ a mortar and pestle to crush them. Transfer the grounded walnuts to a bowl, add the mint, cilantro, garlic and angelica powder (known as "Golpar" in Persian) and stir the ingredients to mix them. Add the olive oil, pomegranate molasses and 1/4 teaspoon of salt, and mix the ingredients to make a paste. Add the olives and give the mixture another good stir.

Transfer the mix to an air tied container and refrigerate for at least 4 hours and for a maximum of 24 hours. The longer the olives marinate, the better the flavour will be.

TRADITIONAL OLIVE BASED IRANIAN RECIPES

GREEN OLIVE AND LAMB STEW

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Ingredients

- 3 tablespoons olive oil
- 500 grams lamb shank
- 2 cups mushrooms, sliced
- 2 large carrots, roughly chopped
- 5 cloves garlic, smashed
- 2 large onions, roughly chopped
- 3 large potatoes, grated
- 4 cups lamb stock
- 2 bay leaves
- 2 cups green olive, pitted
- Salt and freshly ground black pepper
- 2 tablespoons garam masala powder
- ½ teaspoon saffron

How it's made

In a large pot over medium-high heat, add the olive oil and lamb and let the meat build a crust on all of its sides (about 3 minutes per side). Remove the meat and set it aside. Add the mushrooms, carrots, garlic and onions to the pot and stir. Mix in the potatoes. Add the beef stock, bay leaves and the lamb. Add salt, pepper and garam masala and cover the pot, but leave a vent for the steam to escape. Add the olives and bring the mixture to simmer until the meat is tender (about 2 hours). Add the saffron 20 minutes before serving the dish.

CONTENTS

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