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The Development of Agricultural Greenhouses in the Island of Crete, Greece. A SWOT Analysis

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ABSTRACT: The climate conditions in the island of Crete, Greece are favorable for the development of agricultural greenhouses. The island hosts nowadays almost one third of the Greek greenhouses used mainly for vegetables production. Although plastic covered greenhouses dominate in vegetable's production in Crete the use of modern technologies can increase the productivity and improve the quality of the products. The internal and external factors which affect the development of greenhouses in Greece have been analyzed focusing on the strengths, weaknesses, opportunities and threats according to SWOT methodology. The SWOT analysis helps in the development of a strategic plan for their development and indicates the competitive advantages of greenhouses in Crete. However, it gives subjective views and does not offer specific solutions. It has been found that greenhouse farming in Crete has many strengths. Although there are various weaknesses and threats regarding their growth in the island it has been found that there are several opportunities for their future development. The results could be helpful in the development of a strategic plan for the growth of agricultural greenhouses in Crete. They could be useful to policy makers, to greenhouses farmers and to the stakeholders of the agricultural sector in the island.

KEYWORDS: Agriculture, Crete-Greece, development, greenhouses, SWOT analysis

1. INTRODUCTION

The cultivation of several crops in greenhouses achieving high productivity is growing worldwide to meet the increasing food demand in the growing global population. The mild climate in Crete, Greece favors the cultivation of several crops, particularly vegetables, in greenhouses [1], [2], [3], [4].The island of Crete, Greece is hosting a large share of the Greek greenhouses used mainly for vegetables' cultivation. Vegetables are important ingredients of the traditional healthy Mediterranean diet which assist in the treatment of the current obesity pandemic[5], [6], [7].SWOT analysis is a methodology which helps organizations to assess their internal and external environment in the development of their strategic plans. It has been used in the agricultural sector in various countries [8], [9], [10], [11].

The aim of the current research is the implementation of SWOT analysis regarding the development of agricultural greenhouses in the island of Crete, Greece.

The text is structured as follows: After the literature survey the development of greenhouses in Crete is presented followed by a description of SWOT methodology. Next, the SWOT analysis of the development of agricultural greenhouses in Crete is conducted. The text ends with discussion of the findings, the conclusions drawn and the citation of the references used.

The current work is innovative since there are not many studies related with SWOT analysis in the Greek agricultural sector. It covers an existing gap regarding the factors affecting the development of a strategic plan for the growth of agricultural greenhouses in Crete. It could be useful to policy makers, to greenhouse growers as well as to several stakeholders of the agricultural industry in Crete.

2. LITERATURE SURVEY

The current situation in greenhouse farming in Greece has been studied [1]. The authors stated that the total greenhouse area in the country is estimated at around 5,600 ha while the majority of them is plastic covered. They also mentioned that only a small percentage, at around 17%, of the greenhouses used for vegetable production in Greece are heated. A climatic analysis for the rational development of crops under cover in Greece has been conducted [2]. The climagraphs can be used for the assessment of suitability for the development of crops under cover in a given area. The author stated that summer greenhouse crops can only be grown in Crete without evaporation cooling while winter cultivation in unheated greenhouses is only possible in Crete. The innovative training on smart greenhouse technologies has been explored [3]. The authors stated that advancements in new technologies have transformed the agricultural sector. They also mentioned that in Mediterranean greenhouses the small size of farms and the lack of qualified personnel does not facilitate the use of technological innovations. The use of renewable energies in greenhouses focusing on Crete has been assessed [4]. The author stated that the use of solid biomass and geothermal energy for heating greenhouses is cost-effective. The global problem of obesity and the Mediterranean diet has been

studied [5]. The authors stated that although Mediterranean diet is associated with numerous health benefits and is related with prevention of obesity its use is currently decreasing. They suggested that political actions towards the promotion of Mediterranean diet could help to tackle the obesity epidemic, especially in childhood. The impacts of a multi-disciplinary personalized lifestyle intervention program on the health of obese children and adolescents have been studied [6]. The authors stated that the implementation of a multidisciplinary personalized lifestyle intervention program in the management of childhood obesity is associated with the improvement of health in obese children. A national e-health program for the management of obesity in childhood and adolescence in Greece has been developed [7]. The authors stated that after following the e-health program for one year the prevalence of obesity decreased by 32.1%, the prevalence of overweigh decreased by 26.6% and the cardiometabolic risk factors improved significantly. A SWOT analysis regarding the intensification of sustainable agricultural systems in six African countries has been conducted in the framework of a HORIZON-2020 EU program [8]. It was found that the farming systems differ among the six countries while the food and nutrition problem has not been resolved. The study proposed that new ideas and innovations are necessary for the increase of the productivity in their agricultural systems. The strategies for urban agriculture development in Malaysia using SWOT analysis have been explored [9]. The authors interviewed 57 state stakeholders and prioritized strategies for urban agricultural development for achieving food security in urban areas. The development of renewable energies in agriculture in Vietnam using SWOT analysis has been studied [10]. The authors stated that the use of renewable energies has numerous strengths while they face several weaknesses and threats. They proposed several measures to promote agrivoltaic systems in the country. A SWOT analysis of agricultural improvement in countries with food imports has been conducted [11]. The authors used SWOT analysis to study the current problems and perspectives of developing agriculture in countries that import foods. The design challenges of agricultural greenhouses in hot and arid environments have been studied [12]. The authors stated that hot climate and water deficit are obstacles to all year-round cultivation while its microclimate should be adequately controlled. The irrigation management in EU greenhouses has been studied [13]. The authors stated that nutrient solutions are not recirculated in EU greenhouses while there is a large nitrate (NO_3^-) leaching loss. They also mentioned that irrigation management of greenhouse vegetable crops needs to be improved to reduce the nitrogen loss. The on-farm irrigation performance in Mediterranean greenhouses used for horticultural crops has been analyzed [14]. The authors stated that the mean irrigation water supply was in the range of 158 mm to 362 mm. They also mentioned that the mean irrigation water use efficiencies in greenhouses were in general higher that those found when these crops were grown outdoors in similar climate regions. The current trends in protected cultivation in Mediterranean climates have been examined [15]. The authors stated that new approaches have been developed to solve specific cultivation limitations and to reduce the environmental impacts of greenhouses. The sustainable and low input techniques in Mediterranean greenhouses used for vegetables production have been investigated [16]. The authors highlighted the need for efficient irrigation management, the use of solar energy for heating and of pad-and-fan systems for cooling stating that they are crucial for improving resource efficiency. The global trends on greenhouse technology have been analyzed [17]. The authors stated that the research is focused in optimizing the irrigation systems, in the optimum size of greenhouses, in soil conservation, in energy consumption and in controlling the climate within the facility. The input and output of energy in greenhouse crops in Crete, Greece have been studied [18]. The authors analyzed the energy efficiency in several greenhouse crops such as tomato, cucumbers, peppers and eggplants. They also estimated the share of energy inputs such as manpower, fertilizers, fossil fuels and electricity in the total energy balance in these crops. The environmental and economic performance of greenhouse crops in Mediterranean basin has been examined [19]. The authors analyzed commercial greenhouses located in Italy, Spain, Tunisia and Turkey. Their findings in commercial greenhouses revealed that they have higher environmental impacts and lower economic returns compared to similar EU greenhouses. The technology and the environment in greenhouse horticulture in Portugal have been overviewed [20]. The authors stated that the total greenhouse production area in Portugal is 3,000 ha with a tendency of expansion while there is a lack on relevant standards on performance indicators. They also presented a SWOT analysis for the most important greenhouse production areas in Portugal. The strategies for agricultural entrepreneurs' empowerment using SWOT analysis have been investigated [21]. The authors stated that important strengths were the increase of social responsibility, the increase of knowledge, attitudes and values and the reinforcement of social capital. They also mentioned that the main weaknesses were the lack of enough capital and the lack of entrepreneurial culture. The strategies to use pro-environmental technologies in producing greenhouse vegetables in Iran have been explored [22]. The study was conducted with questionnaires which were distributed to experts.The authors proposed the development of appropriate mechanisms to control the sale and use of pesticides and the reinforcement of the knowledge of greenhouse owners regarding biological control. The agriculture in India using SWOT analysis has been studied [23]. The authors stated that the main weaknesses of the Indian agricultural system are related with low yields, less value addition and food processing as well

as with large amounts of post-harvest losses. The strategy to increase the competitiveness of rice agriculture in Pamijahan district, Indonesia has been analyzed [24]. The authors stated that the main weaknesses in the district is the age of the farmers who are no longer productive. They also mentioned that the greatest strength is that all members receive direct guidance and supervision from the region's agricultural center. The development of sustainable agriculture in Ghana using SWOT analysis has been explored [25]. The authors stated that the main strength was the favorable environmental conditions followed by the availability of the agricultural land. They also mentioned that the main weaknesses were the inadequate financial services and the over-reliance on climatic conditions. The role of Mediterranean diet in health status has been examined [26]. The authors stated that the diet is characterized by high intakes of vegetables. They also mentioned that many studies have indicated that Mediterranean diet is related with lower risk of mortality, heart disease, metabolic disease and cancer. The regional distribution of greenhouses in Greece has been recorded in the census in 2021 [27]. The use of low and zero carbon energy technologies in agricultural greenhouses has been studied [28]. The author stated that solar energy, wind energy, biomass and geothermal energy can be used for heat and power generation in them. Additionally, he mentioned, several low-carbon emission technologies such as heat pumps, co-generation systems, fuel cells et cetera can be used in them.A study regarding the use of semi-transparent photovoltaics for agricultural applications has been conducted [29]. It was mentioned that semi-transparent solar photovoltaic panels coated with nano-materials can be used in greenhouses and in other agricultural crops combining energy generation with agricultural production.

3. THE DEVELOPMENT OF AGRICULTURAL GREENHOUSES IN CRETE, GREECE

Greenhouse agriculture has become a cornerstone of Crete's economy, transforming the island into a significant hub for horticultural production in Greece. This evolution is deeply rooted in the island's favorable climate, innovative agricultural practices, and strategic initiatives aimed at sustainable development.

3.1 Historical Development

The inception of greenhouse agriculture in Crete can be traced back to the mid-20th century. A pivotal figure in this transformation was Paul Kuypers, a Dutch agronomist who arrived in Ierapetra in 1966. Collaborating closely with local farmers, Kuypers introduced advanced greenhouse techniques that revolutionized traditional farming methods. His efforts led to a significant increase in agricultural productivity, particularly in the cultivation of vegetables. Today, Ierapetra stands as a testament to his legacy, with greenhouses covering approximately 15,500 acres, accounting for about 25% of Greece's total greenhouse area.

3.2 Geographical Distribution and Production

Crete's unique climatic conditions, characterized by a hot-summer Mediterranean climate with mild winters and abundant sunshine, make it an ideal location for greenhouse farming. The island boasts nearly half (45%) of Greece's greenhouse areas, with significant concentrations in regions like Ierapetra and the Messara Plain. These areas are particularly conducive to the cultivation of high-value crops such as tomatoes, cucumbers, and peppers. The extensive use of high tunnels and, to a lesser extent, low tunnels, has facilitated year-round production, ensuring a consistent supply to both domestic and international markets.

3.3 Technological Advancements and Sustainability

In recent years, there has been a concerted effort to integrate technology into greenhouse farming practices in Crete. The adoption of smart farming techniques, including controlled environment agriculture and precision farming, has optimized resource use and enhanced crop yields. Training programs, such as the "New Technologies for Sustainable Farming" initiative, have been instrumental in equipping farmers with the skills necessary to implement these modern practices.

Sustainability remains a focal point in the development of greenhouse agriculture on the island. Innovative projects exploring the co-production of vegetables and electricity through the integration of solar photovoltaics in greenhouses are underway. These initiatives aim to reduce carbon footprints and promote energy self-sufficiency within the agricultural sector. Additionally, the utilization of renewable energy sources, such as biomass and landfill gas, is being explored to establish zero CO_2 emission greenhouses, further underscoring Crete's commitment to environmentally friendly farming practices.

3.4 Economic Impact

The proliferation of greenhouse agriculture has had a profound impact on Crete's economy. The region around Ierapetra, for instance, has experienced substantial economic growth, with greenhouse farming serving as a primary source of income for many residents. The ability to produce a diverse array of vegetables throughout the year has not only satisfied local demand but also positioned Crete as a key exporter of horticultural products. This export-oriented approach has bolstered the island's economic resilience and contributed significantly to Greece's agricultural output.

3.5 Challenges and Future Prospects

Despite the successes, greenhouse agriculture in Crete faces several challenges. Water scarcity, exacerbated by climate change, poses a significant threat to sustainable farming. Agriculture accounts for a substantial portion of the island's freshwater consumption, necessitating the implementation of efficient water management systems. Projects aimed at improving irrigation infrastructure are underway to address these concerns and ensure the longevity of agricultural practices. The regional distribution of greenhouses in

Greeceare presented in table 1 and the characteristics of greenhouses in Greece in table 2.

Table 1. Regional distribution of greenhouses in Greece (census 2021)

	Region	Area of greenhouses (1,000 m^2)	%, total
1	Ipeiros	1,633	3.35
2	Ionian islands	193	0.40
3	Peloponnese	3,401	6.98
4	Crete	15,509	31.83
5	West Macedonia	167	0.34
6	Central Macedonia	5,334	10.95
7	North Aegean	451	0.93
8	South Aegean	778	1.60
9	West Greece	15,627	32.07
10	East Macedonia-Thrace	890	1.83
11	Attiki	2,534	5.20
12	Continental Greece	478	0.98
13	Thessaly	1,726	3.54
	Total	48,721	100

Source: www.statistics.gr

Table 2. Characteristics of greenhouses in Greece

1	Total area of greenhouses	5,600 ha
2	Greenhouses with vegetables	5,200 ha
3	Greenhouses with flowers	400 ha
4	%, Plastics covered greenhouses	96%
5	%, heated greenhouses	17%
6	Greenhouses with soilless culture	180 ha

Source: Savvas et al, 2016

4. SWOT ANALYSIS: A STRATEGIC PLANNING TOOL

SWOT analysis is a widely used strategic planning tool that helps organizations τoassess their internal and external environments. The acronym SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. By systematically evaluating these four aspects, organizations can make informed decisions, capitalize on advantages, mitigate risks, and improve overall performance.

4.1 Understanding SWOT Analysis

SWOT analysis is typically conducted in a structured framework, often presented in a matrix format. It divides factors into internal and external categories:

a) Strengths (Internal Factors): Strengths are the attributes or advantages that give an organization a competitive edge. These may include strong brand reputation, skilled employees, unique resources, financial stability, or technological expertise.

b) Weaknesses (Internal Factors): Weaknesses are areas that need improvement or create disadvantages. These could be a lack of expertise, limited resources, outdated technology, or inefficient processes. Recognizing weaknesses allows organizations to take corrective measures and strengthen their position.

c) Opportunities (External Factors): Opportunities are external factors that can be leveraged for growth and success. These may include emerging markets, technological advancements, regulatory changes, or shifts in consumer preferences. By identifying opportunities, organizations can strategically position themselves to take advantage of favorable trends.

d) Threats (External Factors): Threats are external challenges that could negatively impact an organization. These might include economic downturns, intense competition, changing market demands, regulatory restrictions, or cybersecurity risks. Organizations must proactively address threats to minimize potential disruptions.

4.2 Benefits and limitations of SWOT Analysis

Conducting a SWOT analysis offers several advantages including:

a) Strategic Decision-Making: It helps organizations set realistic goals and align strategies with their strengths while addressing weaknesses.

b) Resource Optimization: Organization can allocate resources efficiently by focusing on their competitive advantages.

c) Risk Management: Identifying threats in advance allows companies to develop contingency plans and mitigate potential risks.
d) Competitive Advantage: By leveraging strengths and seizing opportunities, organizations can optimize their performance

Despite its benefits, SWOT analysis has certain limitations. It provides a broad overview but does not offer specific solutions. Additionally, the analysis depends on subjective assessments, which may lead to biases. Moreover, external factors can change rapidly, requiring frequent updates to remain relevant.

5. A SWOT ANALYSIS REGARDING THE DEVELOPMENT OF GREENHOUSES IN CRETE

5.1 The Strengths of Developing Greenhouses in Crete, Greece

One of the primary strengths of developing greenhouses in Crete is its favorable Mediterranean climate. The island benefits from abundant sunshine and mild temperatures for most of the year, reducing the need for artificial lighting and heating. This natural advantage allows farmers to extend growing seasons and cultivate crops year-round, leading to increased yields and greater profitability. The ability to produce off-season crops also provides Crete with a competitive edge in both domestic and international markets.Another key strength is the island's fertile soil, which is rich in essential nutrients needed for high-quality crop production. Greenhouses allow for better soil management, reducing the risks of soil erosion and depletion commonly associated with open-field farming. Furthermore, controlled growing environments enable farmers to optimize nutrient supply, pest control, and irrigation, leading to improved crop health and higher productivity.Economic benefits also play a crucial role in the strengths of greenhouse farming. The agricultural sector is an essential component of Crete's economy, and greenhouses provide opportunities for job creation, increased agricultural exports, and overall economic growth. With improved infrastructure and investment, greenhouse farming can generate stable incomes for local farmers, reduce dependency on tourism, and boost the island's economy through agricultural exports. Additionally, greenhouses support diversification in agricultural production. Farmers can cultivate a wide variety of high-value crops, including vegetables, herbs, and flowers, which cater to both local and international markets. The ability to grow specialty crops, such as organic and exotic produce, can attract premium prices and increase revenue for farmers.The potential for integrating renewable energy solutions is another strength of greenhouse farming in Crete. The island has significant solar and wind energy resources that can be harnessed to power greenhouse operations, reducing reliance on fossil fuels. By adopting solar panels, geothermal heating, and other renewable technologies, greenhouse farming can become more sustainable and environmentally friendly.Furthermore, Crete's strategic location provides a logistical advantage for exporting greenhouse products to European and international markets. Its proximity to major shipping routes allows for efficient transportation of fresh produce, ensuring timely delivery and preserving product quality. This geographical advantage strengthens Crete's position as a key player in the agricultural trade. The strengths of developing agricultural greenhouses in Crete, Greece are presented in table 3.

Table 3. The strengths of developing agricultural greenhouses in Crete, Greece

1	The favorable Mediterranean climate in the island favors the growth of vegetables in greenhouses
2	The ability to produce off-season crops also provides Crete with a competitive edge in both domestic and international markets
3	The island's fertile soil, which is rich in essential nutrients, favors the high-quality crop production
4	Greenhouse farming can generate stable incomes for local farmers, reduce dependency on tourism, and boost the island's economy through agricultural exports
5	By adopting solar panels and other renewable technologies, greenhouse farming can become more sustainable and environmentally friendly
6	Crete's strategic location provides a logistical advantage for exporting greenhouse products to European and international markets

Source: own estimations

5.2 The Weaknesses of Developing Greenhouses in Crete, Greece

One of the primary weaknesses of developing greenhouses in Crete is the high cost of infrastructure and maintenance. Greenhouse farming requires substantial investment in materials such as glass or plastic coverings, irrigation systems, and temperature regulation equipment. Given the island's relatively small economy and dependence on tourism, many farmers struggle to secure the necessary funding to establish and maintain greenhouses. Additionally, the cost of importing specialized equipment and materials from mainland Greece or other countries further increases

expenses, making greenhouse farming less economically viable for small-scale farmers.Another significant issue is the limited availability of water resources. Crete has a semi-arid climate with hot, dry summers and relatively mild winters. Water scarcity is a persistent problem, exacerbated by increasing demand from both agriculture and tourism. Greenhouses require consistent and adequate irrigation, but limited freshwater availability makes sustainable water management a challenge. Over-extraction of groundwater for greenhouse farming has led to problems such as soil salinization and declining water tables, which can reduce long-term agricultural productivity.

Additionally, the island's vulnerability to extreme weather conditions presents a major weakness for greenhouse farming. Although Crete has a generally favorable Mediterranean climate, it is also prone to strong winds, heavy rains, and occasional heatwaves. These conditions can damage greenhouse structures, disrupt cultivation cycles, and lead to significant financial losses. The cost of repairing or reinforcing greenhouses to withstand these extreme weather events adds an extra financial burden on farmers.Soil degradation and land use conflicts also pose challenges to greenhouse development. Continuous cultivation in enclosed spaces can lead to soil depletion and a buildup of pests and diseases, necessitating frequent soil treatments and crop rotation strategies. Moreover, Crete has a limited amount of arable land, and expanding greenhouse farming often competes with other land uses, such as residential development, tourism, and traditional open-field agriculture. This competition can lead to higher land prices and make it difficult for new greenhouse operations to find suitable locations.

Furthermore, greenhouse farming in Crete faces difficulties related to energy consumption and sustainability. Greenhouses require a controlled environment with proper heating, cooling, and ventilation systems, all of which demand significant energy input. While renewable energy sources like solar power are available, their initial installation costs are high, making it difficult for small and medium-sized farmers to transition to more sustainable energy solutions. Additionally, the reliance on fossil fuels for heating during colder months contributes to greenhouse gas emissions, raising concerns about the environmental impact of greenhouse farming.Lastly, market limitations and logistical challenges hinder the growth of greenhouse farming in Crete. While greenhouse crops such as tomatoes, cucumbers, and peppers are in high demand, competition from other Mediterranean producers, such as Spain and Italy, makes it difficult for Cretan farmers to secure profitable export markets. Transportation costs and logistical issues, including shipping delays and limited access to major international markets, further reduce the competitiveness of greenhouse produce from Crete. The weaknesses of developing agricultural greenhouses in Crete, Greece are presented in table 4.

Table 4. The weaknesses of developing agricultural greenhouses in Crete, Greece

1	The high installation cost of greenhouses and their maintenance cost
2	The limited availability of water resources
3	The island's vulnerability to extreme weather conditions presents a major weakness for greenhouse farming
4	Soil degradation and land use conflicts also pose challenges to greenhouse development
5	Greenhouse farming in Crete faces difficulties related to energy consumption and sustainability
6	Market limitations and logistical challenges hinder the growth of greenhouse farming in Crete

Source: own estimations

5.3 The Opportunities of Developing Greenhouses in Crete, Greece

One of the key opportunities lies in the increasing global demand for fresh, high-quality produce. With greenhouses, Cretan farmers can cultivate vegetables, herbs, and fruits year-round, ensuring a stable supply to both local and international markets. As consumer preferences shift towards organic and sustainably grown produce, greenhouse farming can cater to these trends by adopting eco-friendly agricultural practices, such as integrated pest management and organic fertilization.Another significant opportunity is the potential for technological advancements in greenhouse farming. Innovations such as hydroponics, automated irrigation systems, and climate-controlled greenhouses allow for efficient resource management and higher yields. These technologies enable farmers to optimize water usage, reduce pesticide application, and increase productivity. Investing in precision agriculture and smart greenhouse systems can further enhance efficiency and sustainability, making Cretan greenhouse farming more competitive on a global scale.The tourism industry in Crete also presents an opportunity for greenhouse farmers to diversify their revenue streams. Agritourism, which combines agriculture with tourism, is gaining popularity, and greenhouse farms can be integrated into eco-tourism experiences. Visitors can engage in farm tours, participate in harvest activities, and learn about sustainable farming techniques. This not only generates additional income for farmers but also raises awareness about the importance of greenhouse agriculture.

Sustainability and renewable energy integration offer another avenue for growth in greenhouse farming. Crete has abundant solar and wind energy resources that can be

harnessed to power greenhouse operations, reducing reliance on conventional energy sources. The use of solar panels for heating and irrigation, as well as wind turbines for electricity generation, can lower production costs and enhance the environmental footprint of greenhouse farming. Moreover, adopting circular economy practices, such as using organic waste for composting or recycling water for irrigation, can further improve sustainability.Export opportunities also provide a significant incentive for expanding greenhouse farming in Crete. The island's strategic location near major European markets allows for the efficient transportation of fresh produce. By improving logistics and investing in modern packaging and cold storage facilities, Cretan farmers can strengthen their position in international agricultural trade. Expanding export capacity can lead to higher profitability and increased competitiveness in the global market.Additionally, government and EU support for sustainable agriculture presents funding opportunities for greenhouse development. Various grants and subsidies are available for farmers who adopt environmentally friendly practices, invest in technology, or expand their production. By leveraging these financial incentives, Cretan farmers can modernize their greenhouse operations and scale up production without facing excessive financial burdens. The opportunities of developing agricultural greenhouses in Crete, Greece are presented in table 5.

Table 5. The opportunities of developing agricultural greenhouses in Crete, Greece

1	The increasing global demand for fresh, high-quality produce including vegetables which are necessary ingredients of the healthy Mediterranean diet
2	Innovations such as hydroponics, automated irrigation systems, and climate-controlled greenhouses allow for efficient resource management and higher yields
3	The tourism industry in Crete presents an opportunity for greenhouse farmers to diversify their revenue streams
4	Sustainability and renewable energy integration offer another avenue for growth in greenhouse farming. Production of vegetables can be combined with electricity generation using semi-transparent solar photovoltaic systems
5	Export opportunities provide a significant incentive for expanding greenhouse farming in Crete
6	Government and EU support for sustainable agriculture presents funding opportunities for greenhouse development

Source: own estimations

5.4 The Threats of Developing Greenhouses in Crete, Greece

One of the primary threats to greenhouse farming in Crete is climate change. Rising temperatures, unpredictable weather patterns, and prolonged droughts pose serious risks to agricultural production. Increased heat stress can affect plant growth, while extreme weather events such as storms and heavy rainfall can damage greenhouse structures and crops. Additionally, prolonged droughts exacerbate water scarcity, a critical issue for an island that relies on limited freshwater resources.Water scarcity is another major threat to greenhouse farming in Crete. The island's semi-arid climate and increasing demand for water from both agriculture and tourism put significant pressure on available water resources. Over-extraction of groundwater for irrigation can lead to soil salinization and declining water tables, reducing long-term agricultural productivity. Without effective water management strategies, greenhouse farming may become unsustainable in the face of increasing water shortages.Economic challenges also pose a threat to the development of greenhouse farming. High initial investment costs for greenhouse construction, maintenance, and advanced technology can be prohibitive for small-scale farmers. Moreover, fluctuating market prices and competition from other Mediterranean countries, such as Spain and Italy, can make it difficult for Cretan greenhouse products to maintain profitability. Rising energy costs further contribute to financial strain, particularly for greenhouses that rely on artificial heating and lighting.

Pest and disease outbreaks represent another significant threat to greenhouse farming in Crete. The controlled environment of greenhouses can sometimes facilitate the rapid spread of pests and plant diseases, leading to reduced yields and increased production costs. The overuse of chemical pesticides to combat these issues can result in environmental and health concerns, making it crucial for farmers to adopt integrated pest management strategies.Land use conflicts also pose challenges to greenhouse development. With Crete's limited arable land, competition for space between agriculture, tourism, and urban development can drive up land prices and reduce available farmland. Expanding greenhouse farming may lead to environmental concerns, including habitat destruction and biodiversity loss, if not managed responsibly.Furthermore, logistical and market-related threats can hinder the growth of greenhouse farming in Crete. Transportation and distribution challenges, including limited access to major international markets and high shipping costs, can make it difficult for Cretan farmers to compete globally. Additionally, disruptions in supply chains, such as those caused by economic crises or geopolitical tensions, can negatively impact the export of greenhouse produce. The

threats of developing agricultural greenhouses in Crete, Greece are presented in table 6.

Table 6. The threats of developing agricultural greenhouses in Crete, Greece

1	A primary threat to greenhouse farming in Crete is climate change
2	Water scarcity is a major threat to greenhouse farming in Crete
3	Economic challenges also pose a threat to the development of greenhouse farming. High initial investment costs for greenhouse construction and competition from other Mediterranean countries, such as Spain and Italy, can make it difficult for Cretan greenhouse products to maintain profitability
4	Pest and disease outbreaks represent another significant threat to greenhouse farming in Crete
5	Land use conflicts between agriculture, tourism, and urban development can drive up land prices and reduce available farmland
6	Transportation and distribution challenges, including limited access to major international markets and high shipping costs, can make it difficult for Cretan farmers to compete globally

Source: own estimations

6. DISCUSSION

A SWOT analysis regarding the development of agricultural greenhouses in Crete, Greece has been conducted. The strengths, weaknesses, opportunities and threats have been identified. It has been indicated that there are several opportunities for further development of greenhouses in Crete while there are also various weaknesses and threats which hinder their growth. The threats depend on external parameters which may change rapidly. The identified opportunities indicate that the growth of agricultural greenhouses in Crete can be achieved with appropriate policies and mobilization of the local stakeholders. Our analysis has several limitations. It depends on subjective assessments, which may lead to biases. It provides a broad overview but does not offer specific solutions. Future work should be focused on the implementation of a PESTEL analysis regarding the development of agricultural greenhouses in Crete.

7. CONCLUSIONS

Looking ahead, the future of greenhouse development in Crete appears promising. Strategic planning that emphasizes technological integration, cross-sector collaboration, and a steadfast commitment to sustainability will be crucial. By continuing to embrace innovation and addressing environmental challenges proactively, Crete is well-positioned to maintain its status as a leader in greenhouse agriculture, contributing to food security and economic prosperity both locally and beyond.

Greenhouse farming in Crete offers several strengths that contribute to its viability and success. The island's favorable climate, fertile soil, water efficiency, economic benefits, agricultural diversification, renewable energy potential, and strategic location all support the expansion of greenhouse cultivation. By addressing existing challenges and maximizing these strengths, Crete can establish a robust and sustainable greenhouse farming industry that benefits both local farmers and the broader economy. However, greenhouse farming in Crete faces significant weaknesses. High costs, water scarcity, extreme weather, soil degradation, energy challenges, and market limitations all pose substantial barriers to the successful development of greenhouse agriculture on the island. Addressing these challenges requires strategic investments, sustainable practices, and improved infrastructure to ensure the long-term viability of greenhouse farming in Crete.

The development of greenhouses in Crete presents numerous opportunities for economic growth, sustainability, and technological innovation. By taking advantage of increasing market demand, technological advancements, agritourism potential, renewable energy integration, export opportunities, and government support, greenhouse farming can thrive on the island. With strategic planning and investment, Crete can become a leading hub for high-quality, sustainable greenhouse agriculture, benefiting both local farmers and the broader economy.While greenhouse farming in Crete presents promising opportunities, it also faces significant threats that must be addressed to ensure its long-term success. Climate change, water scarcity, economic challenges, pest outbreaks, land use conflicts, and logistical barriers all pose risks to the sustainability of greenhouse agriculture. By implementing effective water management strategies, investing in sustainable practices, and improving market access, Crete can mitigate these threats and establish a resilient and thriving greenhouse farming sector.

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