American Journal of Agricultural Science, Engineering, and Technology (AJASET)

ISSN: 2158-8104 (ONLINE), 2164-0920 (PRINT)

VOLUME 8 ISSUE 3 (2024)

PUBLISHED BY: E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Agricultural Science, Engineering, and Technology (AJASET)

Volume 9 Issue 1, Year 2025
ISSN: 2158-8104 (Online), 2164-0920 (Print)
DOI: https://doi.org/10.54536/ajaset.v9i1.3103
https://journals.e-palli.com/home/index.php/ajaset

Agribusiness in the UAE: Challenges and Technological Advancements, A Review

Mohamed A. Ateia Elhabib[1*]

Article Information

Received: April 30, 2024

Accepted: June 22, 2024

Published: January 27, 2025

Keywords

Agribusiness in UAE, Economic Diversification, Sustainable Agriculture, Vertical Farming, Water Scarcity Solutions

ABSTRACT

This review comprehensively analyses the agribusiness landscape in the United Arab Emirates (UAE), highlighting the challenges and strategic responses that shape the sector. The UAE's agribusiness is pivotal for economic diversification and reducing oil dependency. However, it faces significant obstacles due to the harsh desert climate, limited arable land, and freshwater scarcity. Soil salinity and water constraints necessitate innovative agricultural practices. Technological innovations such as vertical farming and hydroponics, alongside government initiatives like the 'National Food Security Strategy 2051', are crucial for sustainable agriculture. The paper examined the UAE's reliance on food imports and the associated risks, including supply chain disruptions and market volatility. It outlines resilience strategies such as crop diversification, supply chain improvements, and continuous innovation. Through case studies of pioneering enterprises like Pure Harvest Smart Farms and Al Dahra, the paper showcases successful applications of climate-resilient crops and advanced farming techniques. These firms demonstrate the potential for successful agribusiness despite environmental challenges. The paper concludes that addressing these challenges is vital for the UAE's food security, ensuring a stable food supply, and supporting a diversified, sustainable economy. Investment in AgriTech, research, innovation, and strategic policy implementation are key to the future of agriculture in the UAE.

INTRODUCTION

Evolution of Agribusiness

In the influential work "A Concept of Agribusiness," Davis and Goldberg (1957) challenged their time's prevailing agricultural economic policies. They critiqued the government's role, particularly targeting the New Deal policies, and argued for a shift towards privatization. They believed that the private sector, especially large corporations, was essential for the modernization and stabilization of the agricultural sector (Yadav, 2023).

The authors (Davis & Goldberg, 1957) expanded agribusiness's scope to include farming and the interconnected activities of processing, marketing, and distribution of agricultural products (Roche, 2019). This comprehensive view aimed to create a seamless value chain that would efficiently serve producers and consumers, revolutionizing the food and fibre economy.

Since Davis and Goldberg published "A Concept of Agribusiness" in 1957, the agribusiness sector has undergone significant evolution (Mrówczyńska-Kamińska & Bajan, 2019). According to Davis and Goldberg's (1957) definition, agribusiness initially included all activities related to farm supplies, farm production, storage, processing, and distribution of agricultural commodities and products manufactured from them (Gazdecki, 2018). The idea of agribusiness has been developed and improved over time. It now includes a wider range of upstream and downstream supply chain activities, offering products and services to worldwide customers (Davis & Goldberg, 1957; King *et al.*, 2010). The sector now involves the people and firms who provide inputs and process the output and those who manufacture the food products, transport them, and sell them to consumers (Barnard *et al.*, 2020).

The intensification of technologies, globalization of commercial foods, and financial increments in production and consumption have transformed the agricultural sector. The term "agribusiness," attributed to Davis and Goldberg, suggests cross-scale features of capitalist agriculture and hyper-modern farming. It involves several processes, including producing and distributing agricultural products and processing and storing agricultural commodities (Ioris, 2018). Agribusiness is a specific way of managing rural lands, mobilizing resources, financing, and commercializing production, and it extends to commercial agriculture as it is conducted on high-tech farms. Due to technical improvements, agricultural production and marketing have consistently been independently related; therefore, there has been a natural association between agribusiness and the value chain concept (Mac Clay & Feeney, 2019). Therefore, farmers must look not just at production on the farm but at the aggregate of all agricultural purchasing, production, and distribution operations.

Research Gap and Objective

Agribusiness in the UAE has faced unique challenges due to its arid climate, limited water resources, and reliance on food imports, necessitating innovative solutions to achieve sustainable agriculture. Despite significant investments and initiatives aimed at modernizing the agricultural sector, there remains a gap in comprehensive

[1] MAE Consultancy LLC, United Arab Emirates
[*] Corresponding author's email: mohamedeatiyaelhabib@outlook.com

evaluations of these efforts' effectiveness and the integration of advanced technologies. Previous studies have focused on individual aspects of agricultural advancements or specific case studies, leaving a broader, holistic understanding of the sector's progress and persistent hurdles underexplored.

This review aimed to address this gap by theoretically evaluating the challenges and technological advancements in UAE agribusiness. It aimed to assess the impact of recent innovations, such as controlled-environment agriculture, hydroponics, and precision farming, on overcoming existing barriers. Additionally, this review identified effective strategies and areas requiring further research to enhance sustainability and food security in the UAE's agricultural landscape.

LITERATURE REVIEW

Agribusiness in the UAE

Agribusiness in the United Arab Emirates (UAE) is a growing sector receiving significant attention due to the country's strategic initiatives to enhance food security and reduce reliance on food imports (Degefa, 2022). Despite the challenging arid environment, the UAE has invested in innovative agricultural technologies such as vertical farming and hydroponics to produce food locally. The government has also opened the sector to 100% foreign ownership, providing opportunities for investors and driving growth in food production and processing (Abdullah *et al.*, 2021; Antwi-Boateng & Al Jaberi, 2022). The UAE's National Food Security Strategy 2051 aims to streamline licensing and regulations for farming, fast-track approvals for ag-tech initiatives, and offer incentives for investment in the sector. With these efforts, the UAE is looking to secure its food supply and become a hub for food trade in the region (Al-Qodsi *et al.*, 2024; Degefa, 2022). Figure 1 represents the scholarly works that have been done in the past few years in the field of Agribusiness in UAE.

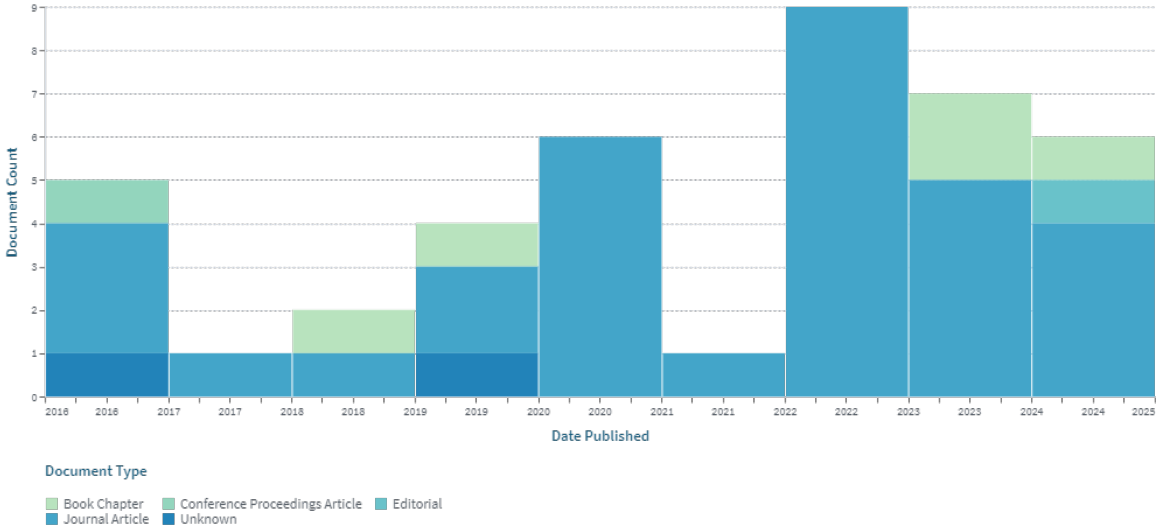

Figure 1: Scholarly works over time

Source: The image has been extracted from The Lens site with the specific keywords "UAE" and "Agribusiness".

The Importance of Agribusiness in the UAE

Agribusiness plays a significant role in the UAE's economy, contributing to its Gross Domestic Product (GDP) and supporting its strategic goal of economic diversification. The agricultural sector in the UAE is expected to contribute AED 19.3 billion to the GDP by 2025 (Agriculture sector in UAE to contribute AED 19.3 bn to GDP by 2025, 2022). This reflects the government's commitment to reducing the economy's reliance on oil by encouraging domestic and international investment and issuing "Agri-Tech" licenses to promote technology-based farming.

The UAE's efforts to diversify away from oil dependency are evident in its pursuit of economic diversification across various sectors, including agribusiness (Antwi-Boateng & Al Jaberi, 2022). The country has made significant progress in this area, aiming to break into high-tech manufacturing and other non-oil sectors. The government recognizes that hydrocarbon resources are finite and that oil prices and demand can fluctuate considerably. As a result, it has emphasized the importance of developing non-resource-based productive industries, such as agribusiness, to provide job opportunities, address unemployment, and facilitate technology transfers (Adnan Seric, 2019).

The transformation from an oil-based to a diversified economy has led to the UAE's integration into the global economic order, with consistent economic development being a priority for the nation's post-pandemic economic recovery (Bocanet *et al.*, 2021). The agricultural sector's growth, supported by innovative farming techniques and government initiatives, has been a testament to the UAE's commitment to reducing its economic dependence on oil and gas. This strategic shift was crucial for the long-term sustainability and resilience of the UAE's economy (Al Qubaisi *et al.*, 2018; Luomi, 2015).

Geographical and Climatic Challenges

The UAE is in an arid zone characterized by a desert environment covering more than three-quarters of the country's total area. The region faces harsh climatic conditions impacting agriculture, including extremely high temperatures, low rainfall, poor soil quality, and a lack of natural waterways (Sharaf, 2019). These factors present considerable challenges to traditional farming methods and have led to adoption of innovative technologies and solutions, such as hydroponics and aquaponics, to make agriculture viable (Sisodia *et al.*, 2021).

Additionally, the UAE's scarcity of arable land and freshwater resources is a critical concern. The country is one of the most water-scarce in the world, with limited natural freshwater sources and a high reliance on desalination and treated wastewater for irrigation purposes (Hussain *et al.*, 2019). The extraction of groundwater, mainly for agricultural use, has resulted in the depletion and salinization of aquifers, further exacerbating the scarcity of water suitable for farming (Fragaszy & McDonnell, 2016).

In response to these challenges, the United Arab Emirates (UAE) has implemented several types of strategies, such as promoting climate-smart and sustainable farming practices that prioritize efficient use of agricultural land and high-quality local products to improve the region's economic competitiveness (Brahimi & Bensaid, 2019). The government's proactive approach aims to ensure food diversity and contribute to the national economy while mitigating the impact of the harsh climatic conditions on the agricultural sector.

Soil and Water Concerns

In the context of the United Arab Emirates (UAE), the sustainability of agribusiness has been confronted with significant challenges, particularly in terms of soil quality and water availability (Manikas *et al.*, 2022). The soil in the UAE is predominantly of low fertility, with high salinity levels unfavourable for conventional crop cultivation. This condition necessitates the adoption of alternative agricultural practices tailored to the unique soil composition found in the region (Ismail *et al.*, 2019).

The UAE's green sector is divided into forestry and agriculture. The forestry sector is responsible for landscaping and crop production, while the agricultural sector uses water for crop production (Frenken, 2009). The forestry sector consumes around 709 million m3 annually, primarily from groundwater and treated domestic wastewater, contributing to 81.7% and 18.3% of irrigated watering amounts (Shahin & Salem, 2015). The agricultural sector uses around 1,489 million m3 annually, primarily from groundwater and desalinated sea water, contributing to 91.9% and 5.1% of irrigated watering amounts, respectively (Shahin & Salem, 2015). Furthermore, the scarcity of fresh groundwater reserves posed a critical challenge.

The main watering resource for the green sector in the UAE is groundwater, which irrigates 81.7% and 94.9% of the forestry and agricultural sectors, respectively (Shahin & Salem, 2015). The rate of groundwater extraction has historically surpassed the natural replenishment rate, leading to a concerning depletion of these reserves (Sherif *et al.*, 2023).

However, groundwater, a renewable energy resource, is expected to dry out in the next few years due to the higher expected consumption rate to meet the water requirements for basic needs and the agricultural sector. Additionally, the over-extraction of groundwater risks saltwater intrusion, which further increases the salinity of the groundwater (Mohamed & Elmahdy, 2015). This is due to the sharp population growth, expected to reach over 12 million by 2030, and the UAE's growing appeal for international events like Dubai EXPO 2020. As a result, the limited irrigation resources are under pressure, making sustainability a controversial topic and a critical challenge (Shahin & Salem, 2015).

These challenges underscored the need for innovative and sustainable agricultural practices that can adapt to the UAE's specific environmental conditions. Developing such practices is essential for ensuring the long-term viability of agribusiness in the region.

MATERIALS AND METHODS

The methodology for the review involved a comprehensive analysis of research papers and websites, ensuring the inclusion of information from 2017 onwards to maintain relevance and accuracy. Key databases used for this purpose were Google Scholar, Scopus, and The Lens, along with official UAE websites to gather region-specific data. The selection criteria for sources emphasized updated content, focusing on critical keywords such as "UAE agribusiness," "agricultural challenges UAE," "technology in UAE agriculture," "sustainable farming UAE," and "agribusiness advancements UAE." This approach facilitated the identification of significant literature and recent technological advancements, enabling a thorough understanding of the current state of agribusiness in the UAE. For graphical representation, The Lens database was utilized to visualize data trends and technological impacts. By synthesizing information from these varied and credible sources, the review provided an insightful overview of the challenges faced by the agribusiness sector in the UAE and the innovative solutions being implemented to address them.

RESULTS AND DISCUSSIONS

Technological Advancements

UAE has made significant strides in agricultural technology, adopting innovative solutions to overcome the challenges of its arid climate and limited water resources. Central to the country's strategy for food security and sustainability are technologies such as vertical farming and hydroponics (Fatnassi *et al.*, 2022).

Vertical farming in Dubai, for instance, has led to the establishment of what is claimed to be the world's largest vertical farm, projected to yield over 900 tons of leafy

greens each year. This method is highly water-efficient, using 95% less water compared to traditional field crops, and involves the indoor cultivation of plants in stacked layers with the aid of LED lighting and controlled systems for growth and nutrition (Despommier, 2020; Saraswat & Jain, 2021).

Hydroponics, another innovative approach, facilitates the cultivation of plants without soil, utilizing mineral nutrient solutions in a water solvent. This technique affords precise control over the use of nutrients and water, rendering it highly efficient and well-suited to the UAE's environmental conditions (Indira *et al.*, 2020; Sharma *et al.*, 2018).

The commitment of the UAE to agricultural innovation is further evidenced by substantial investments in AgriTech (Koch, 2019). The Abu Dhabi Investment Office (ADIO) has pledged at least $100 million in AgriTech companies, reinforcing the nation's food security strategy. Moreover, venture capital firms are anticipated to invest over USD 500 million in AgriTech startups by 2023 (National, 2020).

The importance of AgriTech for the future of farming in the UAE cannot be overstated. It is essential for enabling sustainable food production within the challenging local environment (Council, 2021). The COVID-19 pandemic has accelerated the digitization of traditional agricultural tools, underscoring the critical role of AgriTech in ensuring the resilience of the food supply chain (Goh, 2022). Beyond enhancing efficiency, AgriTech solutions also address labour shortages and support the UAE's transition to a knowledge-based economy (Alfaki & Ahmed, 2017).

In summary, the UAE's proactive investment in AgriTech demonstrates its commitment to addressing environmental challenges and securing its food supply for the future. The UAE is poised to become a regional leader in sustainable agriculture through these technological advancements.

Exemplar Firms in Innovation and Technology Adaptation

In agribusiness within the United Arab Emirates (UAE), several enterprises have emerged as exemplars of innovation and adaptation to the region's challenging environmental conditions, as shown in Table 1.

Table 1: Firms in UAE

Initiative/Company	Investment Amount	Year	Area of Investment
Abu Dhabi Agriculture and Food Safety Authority (ADAFSA)	AED 1 billion	2020	Agricultural innovation, food security
Al Dahra Agriculture	AED 1.2 billion	2018	Modern farming, water-efficient technologies
Pure Harvest Smart Farms	USD 100 million	2021	Controlled-environment agriculture (CEA)
International Center for Biosaline Agriculture (ICBA)	AED 100 million	2019	Saline agriculture, sustainable practices
Emirates Flight Catering - Vertical Farming	USD 40 million	2019	Hydroponic vertical farming
Elite Agro LLC	AED 500 million	2020	Fruit and vegetable production, organic farming
Ministry of Climate Change and Environment (MOCCAE)	AED 300 million	2019	Sustainable farming practices, agri-tech
Madar Farms	USD 10 million	2020	Hydroponics, indoor farming
Agthia Group	AED 200 million	2021	Agri-food products, innovative technologies
Emirates Bio Farm	AED 50 million	2022	Organic farming, educational programs
Crop One Holdings (Emirates Flight Catering partnership)	USD 40 million	2023	Largest vertical farm for leafy greens
Red Sea Farms	USD 16 million	2023	Sustainable farming technologies using saltwater

Pure Harvest Smart Farms, an enterprise based in Abu Dhabi, has been at the forefront of developing resilient food systems tailored to arid regions since its inception in 2018. The company has successfully cultivated various crops, including tomatoes, strawberries, and leafy greens, utilizing advanced technologies within the harsh climate of the Arabian desert. This endeavour has not only yielded high-quality, sustainable produce throughout the year but has also positioned Pure Harvest Smart Farms for rapid expansion across the Gulf Cooperation Council countries and into Asia (Ellis, 2021; Innovating for Impact: Creating Conditions for Growth with Pure Harvest Smart Farms, 2024).

Al Dahra, another prominent Emirati agribusiness, has been actively discussing acquiring additional agricultural land in Egypt. This strategic move aims to bolster Cairo's

agricultural self-sufficiency by reducing its reliance on imported staple crops. However, it also raises critical considerations regarding water usage and resource management in a region where water scarcity is a pressing concern (Dahan, 2023).

The Ollen Group offers another perspective on the agribusiness landscape in the UAE, providing consultancy services to companies seeking to navigate the complexities of the local and international markets. Their expertise assists in the planning and establishing new agribusiness ventures, thereby contributing to the sector's growth and dynamism (Agri-Tech in the UAE: Industry Landscape 2024-2025, 2024).

These case studies collectively underscore the UAE's dedication to overcoming the inherent environmental challenges through technological innovation and strategic business practices. The emphasis on sustainable methods and efficient resource utilization is a model for agribusiness development in arid and semiarid regions globally.

Government Initiatives: The 'National Food Security Strategy 2051'

The 'National Food Security Strategy 2051' represents the government's comprehensive and strategic initiative to revolutionize the food sector and ensure long-term food security. The strategy is based on several primary goals, such as acquiring UAE to the top of the Global Food Security Index by 2051, developing sustainable food production using contemporary technologies, supporting local production, forming international partnerships to diversify food sources, and passing laws and regulations to improve nutrition and decrease food waste (National Food Security Strategy 2051, 2024). A central ambition of the strategy is eradicating hunger ensuring consistent access to safe, nutritious, and sufficient food throughout the year.

The government has introduced a range of incentives and funding mechanisms to facilitate the realization of these objectives. Notably, the Abu Dhabi Investment Office has earmarked USD 100 million for AgriTech companies, with projections to generate a significant contribution to the GDP and create numerous jobs in the emirate by 2021 (ADIO allocates $100 million to four agritech companies, 2020). Initiatives are also in place to double the size of Dubai's agricultural sector by 2033, reinforcing its global leadership in agricultural technology and fortifying the food security sector (Sharma, 2023).

These concerted efforts indicate the UAE's commitment to fostering an innovative, technology-driven approach to food security, positioning the nation as a pioneering hub for sustainable agriculture. The strategy's focus on leveraging technology and international collaboration is designed to create a resilient food system capable of withstanding global challenges and ensuring the well-being of the UAE's population.

Market and Economic Challenges

The food security strategy of the UAE has been intricately linked to its reliance on food imports, a reliance that is necessitated by the country's challenging agricultural conditions (El-Dukheri & Amer, 2024). Despite progress in enhancing local food production, the UAE's dependence on imported food remains substantial due to the scarcity of arable land and water resources. This dependence introduces several risks to the nation's food security strategy (Manikas *et al.*, 2022).

Supply chain disruptions pose a significant threat, as global events such as pandemics, geopolitical tensions, or natural disasters can impede the flow of imported goods (Baldwin & Freeman, 2022). The UAE's food system is also vulnerable to economic fluctuations, particularly global market volatility and currency fluctuations, which can destabilize the food supply. Additionally, the country's status as a net food importer makes it sensitive to global price changes, potentially leading to increased costs for consumers and businesses (Hassen & El Bilali, 2019).

Market volatility and price fluctuations are further exacerbated by climate change, which can affect crop yields worldwide, leading to unpredictable supply and price swings (Dadhich *et al.*, 2023). Energy prices also play a role, as they can impact agricultural production costs, particularly for transportation and fertilizers, leading to changes in food prices (Hebebrand & Laborde Debucquet, 2023). Moreover, financial speculation in commodity markets can cause rapid price changes that do not always reflect supply and demand fundamentals (Knittel & Pindyck, 2016).

In response to these challenges, the UAE has undertaken measures to invest in technology-driven local production (Sharma *et al.*, 2024), diversify its import sources (Antwi-Boateng & Al Jaberi, 2022), and develop strategic food reserves (Hassen & El Bilali, 2019). These measures aim to enhance the resilience of the UAE's food system against external shocks and ensure a stable food supply for its population. The UAE government's proactive approach to addressing these challenges reflects its commitment to securing the nation's food supply in the face of global uncertainties.

Pathways to Resilience

A multifaceted strategy is essential in addressing the challenges that confront agribusiness in the UAE. This strategy encompasses the diversification of crops to include varieties that are resilient to the UAE's climatic conditions, such as those tolerant to salt and heat. It also involves the cultivation of high-value crops that can prosper within controlled environments like greenhouses and vertical farms.

Enhancements in Supply Chain Management

Enhancements in supply chain management are also critical, with investments in advanced logistics and

storage facilities to minimize post-harvest losses. Block chain technology could further improve traceability and transparency within the supply chain. For instance, Qatar, one of the six GCC countries, has significantly changed its food production strategies since 2017, focusing on locally sourced foods and supporting small farmers. This shift has led to a high proportion of Qatar's food production being local, even exporting some farm produce. However, this has led to the depletion of local groundwater, a problem that could be used as an example for other countries aiming to strengthen their food security, especially during transnational crises like COVID-19 (Amhamed *et al.*, 2023).

Innovation and Research

The role of innovation and research cannot be overstated, with the establishment of research centres dedicated to developing new agricultural technologies and practices suited to the UAE's unique environment. Collaboration with international institutions can facilitate the introducing of advanced AgriTech solutions to the region. The Arab Organization for Agricultural Development (AOAD) is a key player in promoting agricultural development and food security in the Arab world. Its role is significant in regional and global contexts, and it faces challenges in the region (El-Dukheri & Amer, 2024). Despite limited progress in digital agriculture, public actions in GCC countries encourage further adoption. Events like the FAO-KSA-UAE regional kickoff workshop and international conferences for agricultural technology innovation have facilitated knowledge exchange and investment in emerging technologies ("FoodTech Challenge. About FoodTech Challenge," 2021).

Government Incentives

Government incentives are pivotal in this strategy, providing subsidies and financial support for farmers who adopt sustainable and innovative farming practices. The UAE has implemented various investment policies and strategies to attract foreign investments, aiming to create an attractive investment climate. These policies include guarantees, incentives, business environment reforms, and economic diversification policies, fostering confidence and simplifying procedures for investors (Antwi-Boateng & Al Jaberi, 2022).

For instance, the nutrient film technique has been utilized for constructing a hydroponic farm by the Gulf region considering uncertainty, sustainability, and utility. The UAE government has launched funding initiatives to invest in such organizations, and the hydroponic system may help ensure food security and sustainability. The real options and net present value technique to examine five possible outcomes: business as usual; 50% subsidy via Khalifa funding; 4% premium; subsidy + premium; and installation of solar panels and a bore well. However, the result was a positive net present value, with the highest reported values for scenarios 4 and 5 (Sisodia *et al.*, 2021). Additionally, grants and funding for AgriTech startups and research initiatives can stimulate progress in the sector (Innovation and investment in agritech, 2024). A few of the advanced agricultural startups have been represented in Table 2.

Table 2: Modern Farms Startups

Startup	Focus Area	Investment Amount	Year of Implementation
Pure Harvest Smart Farms	Sustainable, high-tech indoor farming	Over $50 million in venture capital	2016
Badia Farms	Vertical farming and hydroponics	Received investment from Dubai Angel Investors	2017
Madar Farms	Urban farming and vertical agriculture	Secured funding from the Mohammed bin Rashid Innovation Fund	2018
Bustanica	Commercial-scale vertical farming	Backed by the Investment Corporation of Dubai	2021
Silal	Sustainable agriculture and food security	Subsidiary of Abu Dhabi Development Holding Company	2021

Education and Training

The UAE has declared 2023 as the "Year of Sustainability," focusing on sustainability in its development goals. The National Climate Change Plan focuses on air quality, water resources, clean energy infrastructure, and green growth initiatives. Education and training initiatives are equally important, aiming to equip farmers with modern agricultural techniques and promoting agribusiness as an attractive career path for the youth. The Ministry of Education aims to develop a knowledge-based, globally competitive educational system for all age groups. Higher Education Institutions (HEIs) are crucial in integrating sustainability into campus activities, teaching, and research. A transition-applied approach is proposed to enhance the sustainability culture in the UAE (Ahmed, 2023).

International Partnerships

International partnerships are instrumental in learning from the best practices of countries with advanced agricultural sectors, while knowledge exchange programs help to keep abreast of global agricultural trends. A few of the international partnerships of the UAE have been represented in Table 3.

Table 3: Sustainable Practices by UAE

Partner Country/Organization	Focus Area	Year of Partnership
International Center for Biosaline Agriculture (ICBA)	- Research and innovation in marginal land and saline agriculture - Developing salt-tolerant crop varieties	2002 onwards
Netherlands	- Knowledge exchange on high-tech, sustainable agriculture practices - Joint research and development projects	2015 onwards
Food and Agriculture Organization (FAO)	- Technical assistance and capacity building for UAE's agricultural sector - Promoting sustainable and climate-smart agriculture	2016 onwards
United States	- Sharing of best practices in precision farming and ag-tech - Education and training programs for Emirati farmers	2018 onwards
International Fund for Agricultural Development (IFAD)	- Supporting smallholder farmers and rural development projects in UAE - Knowledge sharing on best practices	2019 onwards
Israel	- Collaboration on water-efficient irrigation techniques - Joint development of advanced agricultural technologies	2020 onwards
European Union	- Collaboration on sustainable agriculture and farm-to-fork strategies - Joint research projects on climate-smart agriculture	2024 onwards

Sustainable Practices

Sustainable practices, including using renewable energy sources in farming operations and water conservation techniques, are encouraged to reduce the environmental impact. Renewable energy is a key achievement in Arab countries, with Egypt and Morocco having the highest installed renewable energy capacity in 2020. Djibouti is targeted to supply 100% of energy from renewable resources by 2035 (Dadashi *et al.*, 2022). A few of the sustainable practices adopted by the UAE have been represented in Table 4.

Table 4: Sustainable Practices in UAE

Sustainable Practice	Description
Solar-Powered Farms	- Several large-scale farms in the UAE, such as Madar Farms and Bustanica, are powered by solar energy - Solar panels are installed across the farms to generate clean, renewable electricity to power the operations
Water-Efficient Irrigation	- Advanced drip irrigation systems and hydroponics are widely adopted to minimize water usage - Farms utilize sensor-based technology and AI-driven analytics to optimize water consumption
Waste-to-Energy Conversion	- Agricultural waste from farms is converted into biogas or biofuel through anaerobic digestion - This renewable energy is then used to power farm equipment and facilities
Precision Farming Techniques	- Use of drones, sensors, and data analytics to monitor crop health soil conditions and optimize inputs - Minimizes resource waste and environmental impact through data-driven decision-making
Integrated Pest Management	- Adoption of biological pest control methods and natural pesticides to reduce chemical usage - Encourages beneficial insects and leverages natural ecosystem services to manage pests
Closed-Loop Aquaponics	- Combination of aquaculture (fish farming) and hydroponics in a closed-loop system - Fish waste provides nutrients for the hydroponic crops, reducing the need for fertilizers
Vertical Farming	- Growing crops in vertically stacked layers, often in controlled indoor environments - Maximizes land use efficiency and reduces water and energy consumption compared to traditional farming

Markets for Local Producers

Finally, developing markets for local producers to access domestic and international markets is crucial. Marketing campaigns emphasizing the quality and sustainability of locally produced food can enhance demand and reputation. By implementing these strategies, as shown in Figure 2, the UAE aims to enhance the resilience of its agribusiness sector, ensuring food security and contributing to the nation's economic diversification efforts. Continuous innovation and research are key to adapting to the evolving challenges and capitalizing on opportunities within the agricultural industry.

Figure 2: Pathways to Overcome UAE Agricultural Challenges

CONCLUSION

The UAE faces numerous challenges in agribusiness, including economic diversification, climatic and geographical obstacles to traditional farming, and soil salinity and water scarcity. To address these issues, the UAE is adopting innovative practices such as vertical farming, hydroponics, and AgriTech solutions. The 'National Food Security Strategy 2051' has accelerated the development of agricultural technology to mitigate risks associated with the country's heavy reliance on food imports. Strengthening resilience includes crop diversification, improved supply chain management, and a commitment to innovation and research. Case studies of UAE agribusinesses successfully using climate-resilient crops and advanced farming techniques demonstrate the potential for thriving agriculture despite environmental limitations. Addressing these challenges is crucial for the UAE's food security, ensuring a stable, self-reliant food supply, reducing vulnerability to global disruptions, and aligning with its aspirations for a diversified and sustainable economy.

REFERENCES

Abdullah, M. J., Zhang, Z., & Matsubae, K. (2021). Potential for food self-sufficiency improvements through indoor and vertical farming in the Gulf Cooperation Council: Challenges and opportunities from the case of Kuwait. *Sustainability, 13*(22), 12553.

ADIO allocates $100 million to four agritech companies. (2020). *The Arab Weekly*. https://english.aawsat.com/home/article/2226256/abu-dhabi-invest-100m-four-agricultural-tech-firms?_wrapper_format=html&page=1

Agri-Tech in the UAE: Industry landscape 2024-2025. (2024). *Ollen Group*. https://ollengroup.com/en/insights/article/agritech-industry

Agriculture sector in UAE to contribute AED 19.3 bn to GDP by 2025. (2022). *Economy Middle East*. https://economymiddleeast.com/news/agriculture-sector-in-uae-to-contribute-aed-19-3-bn-to-gdp-by-2025/

Ahmed, A. (2023). Developing strategy for integrating sustainability in UAE higher education institutions towards UAE strategic initiative net zero 2050. In *2023 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE)*.

Al-Qodsi, E. M., Jadalhaq, I. M., & El-Maknouzi, M. E. H. (2024). The place of UAE's food security in the national legislation and its role in supporting global food security. *Cogent Social Sciences, 10*(1), 2319379.

Al Qubaisi, A. A., Dol, S. S., Khan, M. S., & Azeez, A. A. (2018). Feasibility study and design of floating

offshore wind turbine farm in the United Arab Emirates. In *2018 Advances in Science and Engineering Technology International Conferences (ASET).*

Alfaki, I., & Ahmed, A. (2017). *From oil to knowledge: Transforming the United Arab Emirates into a knowledge-based economy.* Routledge.

Amhamed, A., Genidi, N., Abotaleb, A., Sodiq, A., Abdullatif, Y., Hushari, M., & Al-Kuwari, M. (2023). Food security strategy to enhance food self-sufficiency and overcome international food supply chain crisis: The state of Qatar as a case study. *Green Technology, Resilience, and Sustainability, 3*(1), 3.

Antwi-Boateng, O., & Al Jaberi, N. H. S. (2022). The post-oil strategy of the UAE: An examination of diversification strategies and challenges. *Politics & Policy, 50*(2), 380-407.

Baldwin, R., & Freeman, R. (2022). Risks and global supply chains: What we know and what we need to know. *Annual Review of Economics, 14,* 153-180.

Barnard, F. L., Foltz, J., Yeager, E. A., & Brewer, B. (2020). Agribusiness management. Routledge.

Bocanet, A., Alpenidze, O., & Badran, O. (2021). Business analysis in post-pandemic era. *Academy of Strategic Management Journal, 20*(4), 1-9.

Brahimi, T., & Bensaid, B. (2019). Smart villages and the GCC countries: Policies, strategies, and implications. In *Smart Villages in the EU and Beyond* (pp. 155-171). Emerald Publishing Limited.

Dadashi, Z., Mahmoudi, A., & Rashidi, S. (2022). Capacity and strategies of energy production from renewable sources in Arab countries until 2030: A review from renewable energy potentials to environmental issues. *Environmental Science and Pollution Research, 29*(32), 47837-47866.

Dadhich, S., Sharma, S., & Kumawat, S. (2023). Price volatility in agricultural market. In *Emerging Trends in Agricultural Economics and Agribusiness: An Edited Anthology* (p. 248).

Dahan, S. E. S., & El Maknouzi, M. E. H. (2023, October 17). Exclusive: UAE agribusiness in talks to acquire land in Egypt, sources say. *Reuters.* https://reuters.com/markets/commodities/uae-agribusiness-talks-acquire-land-egypt-sources-2023-10-17/#:~:text=Emirati%20agribusiness%20Al%20Dahra%20is,also%20reignite%20water%20use%20concerns

Davis, J. H., & Goldberg, R. A. (1957). *A concept of agribusiness.* Harvard University, Division of Research Graduate School of Business.

Degefa, B. (2022). Food security in the UAE. In *Facets of Security in the United Arab Emirates* (pp. 88-98). Routledge.

Despommier, D. (2020). Vertical farming systems for urban agriculture. In *Achieving Sustainable Urban Agriculture* (pp. 143-172). Burleigh Dodds Science Publishing.

El-Dukheri, I., & Amer, K. M. (2024). Role of the Arab Organization for Agricultural Development in promoting agricultural development and food security in the Arab region. In *Food and nutrition security in the Kingdom of Saudi Arabia, Vol. 1: National analysis of agricultural and food security* (pp. 29-64). Springer.

Ellis, J. (2021, July 28). Pure Harvest is not just a vertical farm, but a 'veridical' one, says CEO. *AgFunderNews.* https://agfundernews.com/pure-harvest-smart-farms-grows-veridically-as-well-as-vertically-in-middle-east

Fatnassi, H., Zaaboul, R., Elbattay, A., Molina-Aiz, F., & Valera, D. (2022). Protected agriculture systems in the UAE: Challenges and opportunities. In *XXXI International Horticultural Congress (IHC2022): International Symposium on Innovative Technologies and Production* (pp. 1377).

FoodTech Challenge. (2021). About FoodTech Challenge. *FoodTech Challenge.* https://foodtechchallenge.com/about-foodtech-challenge/

Fragaszy, S., & McDonnell, R. (2016). Oasis at a crossroads: Agriculture and groundwater in Liwa, United Arab Emirates. In *IWMI Project Publication—Groundwater Governance in the Arab World—Taking Stock and Addressing the Challenges* (USAID). IWMI.

Frenken, K. (2009). *Irrigation in the Middle East region in figures: AQUASTAT Survey–2008* (Water Reports No. 34). FAO.

Gazdecki, M. (2018). Factors of business relationships change in agribusiness input distribution channel: The case of Polish market. *IMP Journal, 12*(3), 567-582.

Goh, L. (2022). How agritech is transforming traditional agriculture in emerging markets. In *Breakthrough: The Promise of Frontier Technologies for Sustainable Development* (p. 125).

Hassen, T. B., & El Bilali, H. (2019). Food security in the Gulf Cooperation Council countries: Challenges and prospects. *Journal of Food Security, 7*(5), 159-169.

Hebebrand, C., & Laborde Debucquet, D. (2023). High fertilizer prices contribute to rising global food security concerns.

Hussain, M. I., Muscolo, A., Farooq, M., & Ahmad, W. (2019). Sustainable use and management of non-conventional water resources for rehabilitation of marginal lands in arid and semiarid environments. *Agricultural Water Management, 221,* 462-476.

Indira, D., Aruna, P., Kanthi, S. S., & Kumar, K. (2020). Hydroponics as an alternative fodder for sustainable livestock production. *World Journal of Advanced Research and Reviews, 5*(2), 87-92.

Innovating for Impact: Creating conditions for growth with Pure Harvest Smart Farms. (2024). Retrieved from https://blog.tranetechnologies.com/en/home/solutions-innovation/creating-conditions-for-growth-with-pure-harvest-smart-farms.html

Innovation and investment in agritech. (2024). Retrieved from https://www.visitdubai.com/en/invest-in-dubai/insights-and-resources/news-insights/food-agriculture-guide/innovation-investment-agritech

Ioris, A. A. (2018). The politics of agribusiness and the business of sustainability. *MDPI, 10*(1648).

Ismail, S., Rao, N. K., & Dagar, J. C. (2019). Identification, evaluation, and domestication of alternative crops for saline environments. In *Research Developments in Saline Agriculture* (pp. 505-536).

King, R. P., Boehlje, M., Cook, M. L., & Sonka, S. T. (2010). Agribusiness economics and management. *American Journal of Agricultural Economics, 92*(2), 554-570.

Knittel, C. R., & Pindyck, R. S. (2016). The simple economics of commodity price speculation. *American Economic Journal: Macroeconomics, 8*(2), 85-110.

Koch, N. (2019). AgTech in Arabia: 'Spectacular forgetting' and the technopolitics of greening the desert. *Journal of Political Ecology, 26*(1), 666-686.

Luomi, M. (2015). *The international relations of the green economy in the Gulf: Lessons from the UAE's state-led energy transition.*

Mac Clay, P., & Feeney, R. (2019). Analyzing agribusiness value chains: A literature review. *International Food and Agribusiness Management Review, 22*(1), 31-46.

Manikas, I., Sundarakani, B., Anastasiadis, F., & Ali, B. (2022). A framework for food security via resilient agri-food supply chains: The case of UAE. *Sustainability, 14*(10), 6375.

Mohamed, M. M., & Elmahdy, S. I. (2015). Natural and anthropogenic factors affecting groundwater quality in the eastern region of the United Arab Emirates. *Arabian Journal of Geosciences, 8,* 7409-7423.

Mrówczyńska-Kamińska, A., & Bajan, B. (2019). Importance and share of agribusiness in the Chinese economy (2000–2014). *Heliyon, 5*(11).

National Food Security Strategy 2051. (2024). *UAE Government.* https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/strategies-plans-and-visions/environment-and-energy/national-food-security-strategy-2051

National, T. (2020, April). ADIO allocates $100 million to four agritech companies. *Wamda.* https://www.wamda.com/2020/04/adio-allocates-100-million-agritech-companies

Roche, J. (2019). *Agribusiness: An International Perspective.* Routledge.

Saraswat, S., & Jain, M. (2021). Adoption of vertical farming technique for sustainable agriculture. In *Climate Resilience and Environmental Sustainability Approaches: Global Lessons and Local Challenges* (pp. 185-201).

Shahin, S. M., & Salem, M. A. (2015). The challenges of water scarcity and the future of food security in the United Arab Emirates (UAE). *Natural Resources and Conservation, 3*(1), 1-6.

Shahin, S. M., & Salem, M. A. M. (2015). Food security in the United Arab Emirates (UAE): The great competition between the agricultural and forestry sector on irrigation resources. *International Journal of Research in Science, 1*(1), 19-23.

Sharaf, A. (2019). Urban sprawl in arid environments: Contrasting master plans and land use changes in Al Ain City, United Arab Emirates.

Sharma, A. (2023, November 9). Sheikh Hamdan approves initiatives to boost Dubai's industrial and agriculture sectors. *The National.* https://www.thenationalnews.com/business/economy/2023/11/09/sheikh-hamdan-approves-initiatives-to-boost-dubais-industrial-and-agriculture-sectors/

Sharma, N., Acharya, S., Kumar, K., Singh, N., & Chaurasia, O. P. (2018). Hydroponics as an advanced technique for vegetable production: An overview. *Journal of Soil and Water Conservation, 17*(4), 364-371.

Sharma, R., Wahbeh, S., Sundarakani, B., Manikas, I., & Pachayappan, M. (2024). Enhancing domestic food supply in the UAE: A framework for technology-driven urban farming systems. *Journal of Cleaner Production, 434,* 139823.

Sherif, M., Sefelnasr, A., Al Rashed, M., Alshamsi, D., Zaidi, F. K., Alghafli, K., Baig, F., Al-Turbak, A., Alfaifi, H., & Loni, O. A. (2023). A review of managed aquifer recharge potential in the Middle East and North Africa Region with examples from the Kingdom of Saudi Arabia and the United Arab Emirates. *Water, 15*(4), 742.

Seric, A., & Tagliapietra, S. (2019). Progress and the future of economic diversification in UAE. *UNIDO.* https://iap.unido.org/articles/progress-and-future-economic-diversification-uae

Sisodia, G. S., Alshamsi, R., & Sergi, B. S. (2021). Business valuation strategy for new hydroponic farm development–A proposal towards sustainable agriculture development in United Arab Emirates. *British Food Journal, 123*(4), 1560-1577.

U.S.-U.A.E. Business Council. (2021). U.A.E. *AgTech sector.* https://usuaebusiness.org/wp-content/uploads/2021/02/Technology-Series-AgTech-Report-Draft-4.pdf

Yadav, G. (2023). Agriculture: Meaning, scope, and types. *International Journal on Advanced Science, Engineering and Information Technology, 10*(2), 1704. https://doi.org/10.18517/ijaseit.10.2.12984