Kurdish Studies
Feb 2024
Volume: 12, No: 2, pp.5490-5501
ISSN: 2051-4883 (Print) | ISSN 2051-4891 (Online)
www.KurdishStudies.net

Received: December 2023 Accepted: January 2024
DOI: https://doi.org/10.58262/ks.v12i2.406

The Future of Vertical Farming in Oman as a Vehicle for Boosting Entrepreneurship

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Abstract

According to World Bank reports released in 2021, Oman has only 4% of the total population employed in agriculture, resulting in only 2% of the country's GDP due to the country's high dependence on one source of income. To accommodate the rising demand for food production from the growing population and to reduce dependence on food imports, sustainably promoting agriculture is critical to the region. The study aims to understand the scope of vertical farming in Oman and assess the significance of vertical farming promotion in Oman, especially to remain self-dependent on food and to reduce imports. Oman with other GCC countries has recently embarked on vertical farming to explore the practice of cultivating vegetables and fruit crops to meet local food demands. The study identified key drivers, opportunities and frameworks for future growth of vertical farming in Oman and GCC countries. Central to these are common challenges the GCC region has to emphasize besides the benefits vertical farming can offer to the economy. Moreover, the government along with investors should identify sustainable strategies for creating demand for local farm produce to improve the self-sufficiency ratio and food security in the present scenario. Among those include making efforts to engage unemployed youth by offering technical and financial support to begin a career in vertical farming as entrepreneurship opportunities.

Keywords: *Farming, Oman, Weather, GCC, Population, Vertical, Agriculture.*

1.0 Introduction

Agriculture is an important sector that contributes to economic growth and development in every country. The share of this sector in global GDP % is different between developed and developing nations. According to World Bank reports in 2018, the sector accounted for 25% of GDP globally in some developing countries (World Bank 2022).

Currently, the world is facing socio-economic and environmental problems, which are major issues that require considerable attention. The effect of these concerns is profound in developing nations, mainly due to lack of proper food security and being less dependent on the agriculture sector, which by far are specific issues according to reports from the Food and Agriculture Organization of the United Nations (FAO). Among other problems surrounding these are global hunger, poverty, population rise, climate change, and food production, which can be reduced by proper planning in the agriculture and farming sectors. Furthermore, in the

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GCC region, significant risks such as population rise, urbanization, soil salinity, rising sea levels due to climate change, and demand for food production are crucial concerns that would have significant effects on economic growth in the future.

In the GCC, a policy brief document released by the Middle East Institute highlighted the current challenges of climate change in the agriculture sector and opportunities that can provide avenues for sustaining economic growth. According to World Bank reports released in 2021, Oman has only 4% of the total population employed in agriculture, resulting in only 2% of the country's GDP due to the country's high dependence on one source of income. In this context, to accommodate the rising food production demand from the growing population and reduce dependence on food imports, promoting sustainable agriculture is critical to the region. Therefore, to maximize the benefits in sustainable ways, farmers should adopt innovative techniques, approaches, and practices in agriculture because of the shortage of groundwater resources, dry weather, low rainfall, arid soils, salinity, and less arable land, and focus on improving agricultural technology in the coming decades.

In this context, one such innovative agricultural technique that is gaining momentum in many countries is the concept of vertical farming, which is more applicable for growing crops in countries that have less favourable conditions for farming. This innovative agriculture technique is gaining importance in Oman and other GCC countries, which have started to explore the practice of cultivating vegetables and fruit crops to meet local food demand. Globally, countries such as the USA, Japan, China, Singapore, South Korea, Taiwan, Germany, France, the UK, and the Netherlands are leading in the area of vertical farming.

In the GCC, vertical farming has already taken a substantial lead in Kuwait, Saudi Arabia, Qatar, Bahrain, and the UAE. Further to this, there is great potential towards vertical farming especially in Oman as it would provide great prospects for addressing local food insecurity, raising income levels through employment creation and increasing the share of agriculture in the national GDP. Therefore, it is imperative to examine the scope of vertical farming in Oman in the context of its significance, feasibility, potential, and effectiveness in meeting future challenges related to food production and security, as vertical farming appears to be a logical and feasible solution for contributing to the food sector, facilitating self-reliance and economic sustainability. Hence, this study aims to understand the growth of vertical farming as a potential development in agriculture, evaluate the feasibility of adopting the practice in a large-scale context among traditional farming communities to maximize production and assess the extent to which the concept of vertical farming can offer solutions to food production and security. Moreover, the present study believes that the food crisis brings enormous opportunities to use vertical farming for entrepreneurship, which will be explored in the current study as well.

2.0 Literature Background

Vertical farming is the practice of growing food in vertically stacked layers as well as vertically inclined surfaces, theoretically supporting the farming of every kind of crop, vegetable, herb, and fruit. In the modern arena, vertical farming harnesses technologies such as the artificial control of light, environmental control (temperature, gases, humidity, etc.), and fertigation. This technology is referred to as controlled-environment agriculture (CEA) technology in indoor farming techniques (Khan et al., 2020).

Vertical farming is possible in any type of closed structure, such as buildings, skyscrapers, warehouses, or structures. Organizations such as Aerofarm claim that in their vertical farming,

crops need 95% less water and no soil (The Guardian, 2016). Aero farms can achieve this through a root misting system; instead of soil, the crops are grown on reusable recycled plastic cloth (Khan et al., 2020). For photosynthesis, instead of the sun, there are rows of LED lighting; this, along with the climate control system, reduces the growth process by almost half (Rehman et al., 2021). The system makes the growing harvest happen Woat any time during the year, as the dependency on the weather conditions is almost zero (Khan et al., 2020).

Vertical farming in developing countries like Japan, the USA, and South Korea uses hydroponics which use 60-70% less water than traditional agriculture (Despommier, 2019), which could be more suitable for countries in the Middle East and GCC, which face a shortage of natural fresh water. Moreover, with the global population reaching 9.7 billion by 2050, every economy is bound to consider maintaining food security and production demand, which has the potential to increase productivity in a cleaner and more eco-friendly way without compromising the impacts of climate change (Benke and Tomkins, 2017). Success stories drawn from neighbouring countries, such as the UAE, have started practising large-scale vertical farming to grow tomatoes by integrating renewable sources to meet the energy requirements of these farms (Welle, 2022).

According to Kalantari et al. (2018), vertical farming in any economy undeniably offers environmental, economic, and social benefits that satisfy the three dimensions of sustainable development. On the other hand, farming technologies, such as vertical farming, can mitigate the effect of climate change by reducing greenhouse emissions from transport, machinery exhausts, water pumping systems, etc., which is more evident in traditional farming practices (Maheswari 2021). In the upfront of meeting the local food consumption demand, the vertical farming approach can play a critical role in producing perishable or speciality crops for local urban populations, facilitating efficient supply chain management and reducing the carbon footprint. (Solt n.d).

Oman is undergoing economic turbulence due to the global oil demand crisis. The Oil sultanate is striving to diversify its revenue sources and minimize the expenses or outflow of foreign exchange. The food sector is crucial to the economy of Oman, as the geography of the country does not support agriculture for many kinds of food items that otherwise have a high demand in the economy. According to the World Bank (2019) during the year 2018, Oman imported food products worth OMR 0.44 billion (USD 1.16 Billion) against a GDP of USD 79.28 Billion of the same year (World Bank, 2019). According to various forecasting agencies, the GDP of Oman is expected to fall to USD 70 billion and trend around USD 70-72 Billion for the next few years, whereas food consumption is expected to grow at an annual rate of 4.6% (Times of Oman, 2019). On the other hand, Oman has a good infrastructure for electricity generation, ample land area, and a strategic location on the world map.

This study proposes a model of vertical farming using the modern farming technique of controlled temperature. Considering all these issues, vertical farming appears to be a logical and feasible solution for contributing to the food sector and facilitating self-reliance. This study believes that a food crisis brings enormous opportunities for entrepreneurship. There is enough evidence from around the world that suggests that entrepreneurs harness the available opportunities and strengths and offer their products and services through different channels to meet new demands.

2.1 Research Gap and Study Objectives

Agriculture in the modern world is changing significantly with the discovery or invention of new ways, approaches, and techniques employed in farming. These have led to the

mechanization of farming and the improvisation of some of the traditional practices that maximize production, assuring food security and yields in developing nations (Emami et al., 2018). As the global population reached 8.0 billion currently Ritchie et al., (2023), increasing agricultural production sustainably and maximizing yields using sustainable methods by incorporating newer techniques is very much needed to meet the food production demand. In addition, the concept of Industry 4.0 has recently opened the scope for such advances in the agriculture sector through automation, artificial intelligence, etc. (Bernhardt et al., 2021), apart from other smart farming approaches currently being used in developed nations.

There are not sufficient empirical studies done in some cases only limited reports are available concerning the scope and significance of vertical farming in both developed and developing nations. While most of the studies related to sustainable technologies have been explored in areas such as harvesting, seeding, weeding, and mechanization, the concept of vertical farming contributing towards food production and security remains largely understudied globally in the context of GCC. With the United Nations (UN) Sustainable Development Goals (SDG) in place for every nation to achieve, Oman has a compelling scope to achieve food security, improve nutrition, and promote sustainable agriculture (goal 2 of the SDG) at the same time by taking measures to promote sustainable use of land resources to fight land degradation and arrest desertification (goal 15 of the SDG). In addition, vision 2040 of Oman aims to achieve food security by employing advanced technologies and exploiting available resources to make agriculture productive and sustainable in that way, contributing to the UN SDGs (FAO).

On the other hand, analysis shows, the future of food security and sufficiency are going to be very challenging for Oman to achieve, given the growth rate of population and the corresponding demand for food from the population. While the increasing population can sometimes be burden to the economy, but may also become opportunities for boosting the economy by engaging the umemployed youth into establishing own businesses. Consequently, the ways to meet the future challenge depends on the goverments plan and initiatives for achieving the food security and engaging the unemployed youth for sustaining the economy. With the current population of unemployed youth and amidst the growing concern of food insecurity, focus on innovative agriculture methods for increasing the food production requires more attention. Moreover considering the limitation and challenges existing for practicing traditional or conventional farming, modern methods like vertical farming are important approaches to explore and determine the signficance of promoting self employment through entreprenuership for unemployed youth. Recently, there has been an growing interest by the government which has allocated substantial budget amount to build vertical farming industry in Oman by announcing schemes, incentives to encourage the youth to start career in entreprenuership in vertical farming sector. Despite these promotions, preliminary studies are critically required to know the scope of vertical farming in Oman to ascertain its future prospects and at the same time realise the interests of entreprenuers, youth and consumers in accepting vertical farming as means to ensure food security and demand. Therefore, extensive studies and research are required to confirm the role of vertical farming in Oman in view of the challenges to understand the potential of the innovative farming technique for entreprenuership. In this background, the study is intended to examine the future prospects of vertical farming in Oman in light of the its role and importance as an agent of entreprenuerhip to boost the economy. Lastly the study will also uncover the potential scope of vertical farming as an innovative farming technique to meet the UN's sustainable development goals and propective vision 2040 of Oman.

Considering the importance and relevance of this concept to Oman, this study strives to

- To Analyse vertical farming as a potential opportunity for employment and entrepreneurship in the GCC region and Oman.
- To identify the key drivers, opportunities and significant considerations to boost the prospects of the vertical farming industry in GCC.
- Analyze the current agriculture profile, scope for investments and challenges that are impacting the vertical farming sector in Oman and other GCC countries.

3.0 Methodology

The proposed study is based on an explanatory research design to achieve the objectives of the study. This research design is chosen considering the nature of the information that is required to conduct the study and to reach succinct conclusions regarding the topic of study. Further, this will assist the researchers in gaining a broad understanding of the specific context of the study.

The study was conducted using preliminary surveys that were conducted locally among students, researchers, experts, entrepreneurs etc. on the study objectives. Information and data were also gathered from locally and regionally operating vertical farming projects by referring to websites, research studies, published information and private circulation material in the media. A few visits were also undertaken to agricultural departments of academic institutions to know and understand the current prospects of vertical farming in Oman and in the GCC region. All of these sources of information are reviewed and analyzed to present the observations from the study.

4.0 Results and Discussion

4.1 Agriculture Profile: GCC Vertical Farming Growth Potential Scenario

The vertical farming technique is an innovative farming method that has gained entry recently into the GCC agricultural system. This technique of farming involves growing crops in indoor environments in vertical stacks tiers by providing artificial light, without the requirement of soil substrate. Most of the crops grown under this technique are referred to as hydroponics as seeds grown in water medium. However, vertical farming is very new to the agriculture industry having started only two decades ago, which is not well established in the GCC, unlike advanced countries. This technique of growing crops completely indoors using different methods is much in the experimental phase in the region despite there being increases in funding, investments and uplift in the vertical farming units. Global research reports on the growth potential indicate the value of vertical farming in the GCC in the year was $144 million and is expected to reach around $472 million by the year 2028 (Infinium Global Research, 2023). Among the GCC countries, Saudi Arabia and UAE have the largest markets in terms of highest investment and projects, with other GCC countries joining the vertical farming industry more recently.

Prominently the growth prospects of this farming technique would be quite promising in the GCC region as vertical farming methods of growing crops are more suitable to the region's climatic and soil conditions, combined with less availability of groundwater resources. While indoor vertical farming is more appropriate than traditional agriculture, and in the context of GCC, the region offers plenty of opportunities for the vertical farming sector to flourish.

The growth potential for the vertical farming sector in the GCC has gained more prominence in the last five to ten years, where the first commercial vertical farming unit was established in the UAE sometime in 2018, while the current number of vertical farming units across GCC is not known. Certainly, there is a significant expansion of vertical farming units in the region which is visible through the drastic increase in the investments, and market value share of vertical farming in the GCC GDP. In addition, economic research reports that this innovative farming technique in the GCC would result in 22.0 % of CAGR during 2022-2028, with the largest vertical farming markets coming up in Saudi Arabia followed by UAE (Infinium Global Research, 2023). Some of the major farms in this field include Aero Farms, Madar Farms, Freight Farms, Crop One Holdings, and Intelligent growth solutions are operating the units.

In Oman, Thamra, Rakeeza, and iFarm are a few successful vertical farming operating companies, there are a few projects started in collaboration with NKK investments as joint ventures to establish vertical farming units (table 1). Further, the government of Oman through the Ministry of Agriculture are allocating a budget for investing in the promotion of vertical farming projects through entrepreneurship for local unemployed youth to encourage employment and self-reliance on food production.

Table 1: Key Players in the GCC Vertical Farming Market.

Company/investing venture	Crop One Holdings
A S Agri And Aqua LLP	Madar Farms
Sarya Holdings LLC	I.F.A.R.M. Inc.
NAAAS Holding Group	Sky Greens
YesHealth Agri-Biotechnology Co., Ltd	Naeem Farms
Pure Harvest Smart Farms	Aero farms
UNS vertical farms	

Recently ministry of Agriculture, fishery and Water Resources has signed an agreement with fertilizer companies to fund vertical farming projects for the production of leafy greens to be marketed locally to meet the demand. Currently, the vertical farms in GCC are tapping innovative technology applications to diversity and enhance production capacities by growing leafy greens in tier-level systems, through stack growing, and also microgreens. A variety of growing methods used by some of the farms operating in the GCC are considered to maximise resource conservation such as limiting water consumption and giving more yield per unit space.

The growth potential for vertical farming in the GCC including Oman, is likely to invite more farmers and entrepreneurs locally, due to the easy establishment and operations of farms which have become more effortless due to ready-to-use vertical farming systems promoted by major companies. Moreover, the companies from the project design to the installation, software support for digital marketing, hardware, and automation are all provided customized to the type of crops to be grown in the farms. These developments show a good scope for vertical farming as well as potential for employment through entrepruernship in the GCC region.

4.2 Vertical Farming Drivers and Key Signature Opportunities and Concerns- GCC

Innovative farming practices such as vertical farming are currently growing in the GCC, particularly in the UAE, and Saudi Arabia to the largest extent. Along with this growth, the Middle East and North Africa are also progressing to exploit the scope for vertical farming to meet the challenges in the region. Market studies indicate the revenue from vertical farming in the middle east and North Africa would be $6225.1 million by the year 2030, revealing that

there would be significant growth in the establishment of vertical farming projects in the region including the GCC countries, along with the increase in investments from governments and private business owners. There are both positive and negative factors for such an eventual growth in vertical farming, most prominently the drastic increase in urban population, climate change affecting global food shortages, disruption of food supply from the recent COVID pandemic, and geo-political issues have all combinedly leading to increase local food production. While achieving this objective in the Middle East, and North Africa, including the GCC countries is not feasible through traditional farming and agriculture systems due to unfavourable weather, and lack of resources, the only viable method to meet the food demand from the growing population is by exploring vertical farming.

Food production through vertical farming is likely to fulfil the future food consumption demand from 46.8 million tons in 2020 to 52.4 million tons in 2025 in the GCC. Besides the main factors mobilizing the growing popularity of vertical farming in the GCC are the abundant availability of sources of energy and capital investment in innovative farming technologies. Likewise, there is a high demand for locally produced food, including flexible economic conditions, low cost of electricity, and optimized energy production which are favouring increased prospects for vertical farming in the Gulf region.

Another significant reason behind compelling modern economies towards vertical farming technology is mainly the gradual decline of arable land in most countries because of urbanization and desertification, combined with global population growth which is mounting pressure on traditional farming methods. In such a challenging global scenario, viable options to meet the demand in food production would be possible by adopting innovative farming mechanisms like vertical farming systems, which can be established even in urban environments such as cities and small spaces, to bring down the production and purchase cost. Added to this, farming through such innovative techniques provides production throughout the year, and the ability to grow unseasonal crops without the intervention of natural climatic conditions. It is also noteworthy to highlight the major factors that are critically contributing to the popularity of the vertical farming industry in the GCC, which are presented in Table 2.

With the origin of innovative farming techniques, vertical farming is considered to be more feasible and best suited to countries with limited cultivable land or where climatic conditions do not support conventional farming systems. Despite the growing attempts to boost vertical farming in the region, particularly in the GCC, the rise in investments, and the global worth of vertical farming, there are certainly some key opportunities to review the fact that innovative farming techniques like vertical farming would be the future of agriculture in the GCC given the agro-climatic limitations not favouring traditional farming. Compared to conventional farming, vertical farming proves more beneficial in terms of yield per unit area of land, which implies increased food production with limited land resources.

Table 2: Reasons for Vertical Farming Impressive Growth in GCC.

Leading causes	Sustaining causes	Promoting causes
Rapid population growth	Flexible economic landscape	Preference for local produce food
Climate change	Low electricity costs	Employment to local youth
Increase food demand	Investment from governments	Reduction in cost of food, production, transport, losses and storage
Geopolitical crisis	Collaboration and partnership with global companies	Less land space for farming
Pandemic led shortages	Loca food security and sustainability	Utilize urban lands and spaces
High cost of imported food		
Less arable land for traditional agriculture		

In the UAE and Saudi Arabia, vertical farming units are increasing both in investments and the number of crops tested to grow through this technology is increasing due to the low cost of investment in electrical energy, while high interest from the governments is attracting vertical farming industry from US and Europe to GCC countries to expand their business. Furthermore, there is a growing interest among consumers shifting towards healthy diets preferring leafy greens, eventually adding more demand in the market for vertical farming. Though these are indicators for the upward trend of vertical farming in the region, the sizeable units of vertical farming projects in the GCC are considerably small and not rapidly explored due to specific concerns that exist regionally. The key factors and prospects contributing to the vertical farming industry among the GCC countries are summarized in Table 3.

Table 3: Summary of Key Drivers and Opportunities for Expanding Vertical Farming in Each GCC Country.

	Oman	KSA	UAE
Key drivers		Limited water supply	
		Predominant arid soils	
	Increase in urban population	Increase self-sufficiency	Socio-demographic factors
	Vast open land and urban spaces	Diversify imports	Growing urban population
	Low costs of energy inputs	Increase food security	Increase flow of foreign community
	Investments support from local government	Suitable economic conditions	Increase tourism and demand for fresh food
	International collaborations on investments	Reduce the cost of inputs	Public and private initiatives
			Boost in technology applications
Key interests	Consumer interest in local produce	Increasing awareness of healthy diets	Demand for leafy greens
	Scope for entrepreneurship	Importance to personal health and wellbeing	High demand for greens
		Increase flow of foreign population	Sustainable food economy
Key concerns	Slow economic growth and development over other GCC countries	High energy consumption- electricity	
	Not significant foreign company investments	Narrow diversity of crops	Technicalities in crop selection
	Poor marketing strategies		
	lack of consumer awareness of quality and freshness		

4.3 Innovative Farming- What Makes Oman Trail Behind in the GCC

Gulf Cooperation Council are an association of six countries in northern Asia, with a total land area of 2.57 million km² and a population of around 58.56 million. GCC accounts for 1.71 percent of the habitable area contributing 0.74 per of the global population, and represents 2.2 percent of the global economy. The Koppen Geiger climate classification for GCC is BWh falling under desert or arid climate comprising low latitude deserts. The annual precipitation is less than 50% of evaporation mostly hot weather conditions occasionally impacted with high hot winds carrying desert sand. Most of the land area in the six countries is sandy, low in organic matter, has poor water retention capacity and hence not suitable for growing large varieties of crops. The total land suitable for agriculture can be quantified as around 19.5% with little less than 1% as arable which is already under threat from desertification and salinization (Hassen and Bilali, 2019).

One of the future concerns posing a challenge to the GCC region is the growing population, the increase in food consumption rate, combined with the shortage of high imported food with no insignificant local food production. In contrast to the situation, the threat of climate change,

rise in annual average temperatures, low rainfall and unsupportive soil and weather conditions are all deterrents to the traditional agricultural systems. Therefore, innovative farming methods such as vertical farming systems are quite suitable to address the uncertainties of the region. Concerning this development, vertical farming in the GCC is gradually gaining momentum leading with Saudi Arabia and UAE. In comparison, Oman being the 2nd largest country in the GCC area and 3rd most populous is surprisingly lagging behind Saudi Arabia and UAE in vertical farming technology in investments and, the number of vertical farming units among other intermittent challenges.

Many factors can be attributed to the slow growth or ignorance of the potential scope of vertical farming in Oman, despite interest in locally produced food. Most of the challenges are very intricate to the country arising from the problems faced by the agriculture system which include, climate, weather, soil conditions, infrastructure support from the government, land availability, poor market support, misconceptions among consumers and farmers on vertical farming systems (Epoc et al., 2023). In addition, there are subsidiary causes for the slow growth of vertical farming such as lack of encouragement among local farmers, limited technical support and expertise to adopt innovative farming systems.

The local existing farmers are mostly reliant on traditional agricultural systems cultivating subsistence crops using limited water resources, while growing crops through vertical farming requires technical knowledge, expertise and willingness to adapt which are largely lacking among the farmers. Moreover, Oman still depends on food imports up to more than 70% limiting the scope for locally grown food and the prospects for meeting the local food demand are not been rightly recognised by the government in the last few years. Another important factor that needs emphasis to boost the vertical farming industry in Oman is motivation, encouragement and support to young entrepreneurs and also unemployed educated youth of the country to pursue their careers in innovative agriculture systems like vertical farming. Especially there are multiple sources of employment both upfront and downfront that can be explored locally and regionally in this sector. Considering this, the various challenges that are limiting the growth of the vertical farming industry in Oman have to be strengthened to be on par with other GCC countries in the region. A comparative account of vertical farming factors in Oman regarding other critical players in the GCC region is presented in Table 4.

Table 4. Comparative Analysis of Potential Factors Impacting Vertical Farming in Oman to Saudi Arabia and UAE.

Factor/s	Oman	KSA	UAE
Population in M	4.58	36.41	9.44
Land area km²	310, 000	2,150,000	84,000
The age group with the highest population	30-34	40-44	30-34
Percent in age group with the highest population	9%	7%	10%
Arable land (%)[3]	0.12	1.64	0.77
Extent of investments ($ million)	Low to medium	220	High
Vertical farming production volume (tons/year)	ND[4]	407,000	ND
Percent of self-sufficiency in food from local farms (including vertical farming)	40.3 (48.0)[5]	60 (36.1)	50 (16.6)
Employment in agriculture to % of total population (2021 statistics)	4.12	2.7	1.70

[3] Source: Zurayk, Rami & Chaaban, Jad & Sabra, Alia. (2011). Ensuring that potential Gulf farmland investments in developing countries are pro-poor and sustainable. Food Security. 3. 129-137. 10.1007/s12571-010-0107-y.
[4] ND: no data
[5] Brackets indicate excluding vertical farming

4.4 Future of Vertical Farming in GCC- Expected Challenges to Overcome

Though the future of vertical farming is going to be bright becoming the principal agriculture technology in the GCC, there are some inherent challenges surrounding the innovative farming system itself and how well the technology can substitute conventional farming will decide on the establishment and growth of the vertical farming in the GCC region. However, with the given climatic and unfavourable land characteristics for growing all types of crops in the GCC region, vertical farming would be the closest option to meet the food production demand of the growing population in the region. For the vertical farming technology to gain wider application, acceptance among prospective farmers, government interest in investment and finally consumer acceptance to hydroponic and indoor farm-grown crops, the present and expected challenges in adopting this technology should be given serious consideration to learn the success and future of vertical farming systems in the GCC region.

On the other hand, around 90% of the food is imported into GCC with less than 10% of crops grown locally, conversely, there is potential scope for locally grown crops in the GCC, vertical farming has to overcome its energy-intensive system, low profitability due to high cost of investment on resources and infrastructure facilities. Other significant aspects are competition between conventional-grown crops and indoor-grown crops that largely decide the consumer's preferences and market demand is very influential on the scope of the future of vertical farming systems. Apart from these, many technical, and operational risks and the selection of the range of crops grown in vertical farming canopy are some challenges decelerating the expansion in the region besides the positive aspects of this technology.

Indeed, there are difficulties involved in identifying the right kind and selection of crops for growing in a vertical farming system due to many determinant factors that decide the output, quality and demand in the market. Some of these require proper planning and resource analysis, technical collaboration on deciding the right amount of input resources such as light, water supply, ventilation management etc and finally evaluating the proper market value for the farm produce are key aspects that require essential focus for successful returns.

4.5 Principal Gains to Agriculture Landscape and Framework to Boost the Economy from Vertical Farming in Oman

Vertical farming certainly is going to change the agricultural landscape in the GCC region and will be the future of farming considering the demand for food production due to the increasing population and great interest among consumers in locally produced food. Despite the drawbacks the innovative farming system has, vertical farming is a more suitable, adaptable and conducive way of increasing food production in the GCC region.

There are huge investments from local governments, and leading foreign companies from Europe and the US are migrating to establish projects in the region knowing the potential growth and demand for food production. Highlighting the myriad benefits, this innovative farming technique will provide food security by reducing the greenhouse gas emissions from importing, transporting, storage and wastage of food. This will result in the overall reduction of carbon footprint in the farming sector being energy efficient and utilizing less water and land, unlike traditional agriculture. Moreover, the region would significantly gain from year-round produce, with the ability to maintain conducive crop conditions in the indoor farming systems without being affected by fluctuating natural weather conditions.

Globally, millions of tons of crop produce are subjected to wastage through transportation losses, and poor storage and most of them end up in landfill sites which directly leads to food shortages. However, vertical farming reduces losses by reducing the need for storage and transportation when grown locally and also protects from pests and insect infestation thus maximising the yield. However, the practice of growing crops in vertical farming systems should be meticulously planned and executed to avoid production losses, for that the local government support and inter-regional collaboration for market share and selling are very important to enhance the vertical farming industry in Oman.

The private and public sectors should be involved in creating demand for local farm produce, studying consumer behaviour, and offering incentive-based pricing for local farm food over imported food. Further, the government should seek local or regional investors to promote vertical farming projects to create employment opportunities for local youth and encourage unemployed educated youth to choose careers in the agricultural industry through entrepreneurship.

5.0 Conclusion

Agriculture is a very prominent sector in every country to meet its food security and production demands in addition to the role the sector plays in economic growth and GDP. With the global population rise expected to reach more than 9 billion, there would be greater pressure on agriculture and other farming operations to increase food production to meet the demand. Such a situation would be quite challenging in countries that are less dependent on agriculture. Moreover, in the GCC region where unfavourable conditions are predominantly characterized by low rainfall, prolonged dry weather, saline soils, low or no groundwater resources, high temperatures and occasional dust storms it is difficult for the agriculture sector and farming communities to cultivate.

To overcome such uncertainties in the current agriculture sector in Oman, vertical farming can be considered as a prospective technological approach to address the problems of food security, meet the food production demand, and provide employment opportunities to the Omani youth through entrepreneurship opportunities. However, this approach must be assessed for its significance, feasibility, and scope as a potential entrepreneurship opportunity by conducting in-depth research in terms of economic cost and profitability to local farmers over traditional farming methods.

References

1. Bernhardt, H.; Bozkurt, M.; Brunsch, R.; Colangelo, E.; Herrmann, A.; Horstmann, J.; Kraft, M.; Marquering, J.; Steckel, T.; Tapken, H.; et al. Challenges for Agriculture through Industry 4.0. Agronomy 2021, 11, 1935. https://doi.org/10.3390/ agronomy11101935
2. Deutsche Welle. (2022). Global ideas. Farming in the desert: are vertical farms the solution to saving water? https://www.dw.com/en/united-arab-emirates-vertical-farming/a-54252631
3. Dickson Despommier, "Vertical farms, building a viable indoor farming model for cities", Field Actions Science Reports [Online], Special Issue 20 | 2019, Online since 24 September 2019, connection on 23 November 2021. URL: http://journals.openedition.org/factsreports/5737.
4. Emami, M., Almassi, M., Bakhoda, H. *et al.* Agricultural mechanization, a key to food security in developing countries: strategy formulating for Iran. *Agric & Food Secur* **7,** 24 (2018). https://doi.org/10.1186/s40066-018-0176-2

5. Ferdinand J Epoc, Mallak Al-Siyabi, Reem Al-Kaabi, Khulood Al-Omairi, Al-Shima Al-Maqbali, and Zaynab Al-Rahbi. Issues and Challenges Faced by Omani Farmers: Evidence from Mahadha Oasis Area. DELHI BUSINESS REVIEW- An International Journal of SHTR. Vol. 24, No. 1, pp. 23-34.
6. Hannah Ritchie, Lucas Rodés-Guirao, Edouard Mathieu, Marcel Gerber, Esteban Ortiz-Ospina, Joe Hasell and Max Roser (2023) - "Population Growth". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/population-growth' [Online Resource]
7. Infinium global research. 2023. GCC vertical farming structure. https://www.infiniumglobalresearch.com/gcc/gcc-vertical-farming-market
8. Kalantari, Fatemeh, Tahir, Osman Mohd, Joni, Raheleh Akbari and Fatemi, Ezaz. "Opportunities and Challenges in Sustainability of Vertical Farming: A Review" Journal of Landscape Ecology, vol.11, no.1, 2018, pp.35-60. https://doi.org/10.1515/jlecol-2017-0016
9. Khan, S.A., Devi, T.P, & Sharma, P.P. (2020). Vertical farming: Why it matters for Bhutan. *Studies in Indian Place Names.*40 (01), 1323-1329. (ISSN 2394-3114)
10. Kurt Benke & Bruce Tomkins (2017) Future food-production systems: vertical farming and controlled-environment agriculture, Sustainability: Science, Practice and Policy, 13:1, 13-26, DOI: 10.1080/15487733.2017.1394054
11. Maheshwari, S. (2021). Vertical Farming: Resilience Towards Climate Change. In: Kateja, A., Jain, R. (eds) Urban Growth and Environmental Issues in India. Springer, Singapore. https://doi.org/10.1007/978-981-16-4273-9_13
12. Oman Vision 2040. Food and agriculture organization of the United Nations. https://isfu.gov.om; https://www.2040.om
13. Rahman, M.M.; Field, D.L.; Ahmed, S.M.; Hasan, M.T.; Basher, M.K.; Alameh, K. LED Illumination for High-Quality High-Yield Crop Growth in Protected Cropping Environments. Plants 2021, 10, 2470. https://doi.org/10.3390/plants10112470
14. Solt, C. n.d. What role will vertical farming play in the future of agriculture? The global advisory and accounting network. HLB. https://www.hlb.global/What-role-will-Vertical-Farming-play-in-the-Future-of-Agriculture%3F
15. Tarek Ben Hassen, and Hamid El Bilali, "Food Security in the Gulf Cooperation Council Countries: Challenges and Prospects." Journal of Food Security, vol. 7, no. 5 (2019): 159-169. doi: 10.12691/jfs-7-5-2.
16. The Guardian. (2016). World largest vertical farm New Ark green revolution. Retrieved from https://www.theguardian.com/environment/2016/aug/14/world-largest-vertical-farmnewark-green-revolution.
17. Times of Oman (September 10,2019). Retrieved from https://timesofoman.com/article/1900951/Business/Food-consumption-in-Oman-to-grow-46-annually-until-2023
18. World bank (2019). Oman Food Products Imports by country in US$ Thousand 2018. Retrieved from https://wits.worldbank.org/CountryProfile/en/Country/OMN/Year/LTST/TradeFlow/Import/Partner/by-country/Product/16-24_FoodProd
19. World bank. (2022). Agriculture and food. https://www.worldbank.org/en/topic/agriculture/overview#1
20. Zurayk, Rami & Chaaban, Jad & Sabra, Alia. (2011). Ensuring that potential Gulf farmland investments in developing countries are pro-poor and sustainable. Food Security. 3. 129-137. 10.1007/s12571-010-0107-y.