

Role of Urban Horticulture in Achieving Food Security –Present Scenario of Gulf Countries and Kuwait

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Abstract

Achieving food security has been a major challenge in all Gulf countries as the geographical and climate obstacles often hinder local food production. Even though traditional methods of agriculture and livestock production yield considerable quantity, it can't fulfill the existing food demand. Discovery of oil in the second half of 20th century not only generated revenue but also transformed the whole lifestyle of Gulf countries. Sooner, investing in food production such as agriculture, livestock, and poultry became rapid and turned out to be future oriented. Recruiting expert manpower along with technology adoption especially in agricultural and food production sector has become common. Government agencies provide huge funding for research and development. However, with the subsidized food production system and embracing westernized food culture, significant number of people became vulnerable to obesity and other food related illnesses. Present study reviews the status of prevailing food production system in Gulf countries with special emphasize on Kuwait. Topics such as use of water, wastewater treatment, desalinization costs, food import patterns, status of agricultural and livestock farms, present cropping trends etc. were covered. Major focus on agriculture production patterns and changes happened during the 21st century. Lot of high-tech farms started to implement various food production systems recently all over the Gulf. The study revealed that majority farm lands were not been used for agri-business and animal husbandry. Several farmers still depend on traditional method of farming and post-harvest handling; they seldom apply high quality crop production. Kuwait farmers are satisfied with their double income system, both from the government subsidy and from its selling by auction. Majority are not interested to invest more on advanced technology. So it needs to adopt massive changes to increase crop production in agricultural and livestock sectors, eventually to achieve food security.

Key words: *food security, hydroponics, vertical farming, protected horticulture, food import*

Introduction

Food security is one of the major concerns of every country. The cost of food imports to Arab states is expected to double over the next 20 years, if the region's farms do not become more efficient. The Middle East currently imports about \$35 billion of food annually, and this looks set to rise to \$70 billion in two decades as climate change impacts crop yields and the population rises. Increased dependence on food imports will likely mean higher prices for poor consumers, and thus more hunger and increased levels of strife and migration (Arabian Business, 2015). The need for sustainable food consumption in Arab countries has emerged from the regional concern for food and nutrition security that requires special consideration on multiple levels and disciplines.

In response to population growth and demand, the current Arab food system, characterized by intensive agricultural production as well as environmentally damaging, inefficient practices, is facing climate change and depleted land, energy, and water resources, making it no longer sustainable (Hwalla, 2015). In parallel, Arab countries are experiencing a nutrition transition marked by adoption of an unhealthy, 'westernized' diet, escalating obesity and diet-related issues. Fig. 1 represents food consumption percentage and its growth in GCC countries during 2012–2017 (Source, FAOSTAT). These challenges are negatively impacting the population's well-being and can be addressed by enhancing the sustainability of the food system. To date, Arab countries have fallen short of achieving food security, possibly due to efforts that have solely focused on increasing the food supply

while overlooking its quality and sustainability. This situation is impacted by a high burden of diet-related non-communicable diseases and micronutrient deficiencies,

even in resource-rich countries, which brings about the need to promote sustainable food consumption patterns to alleviate these challenges.

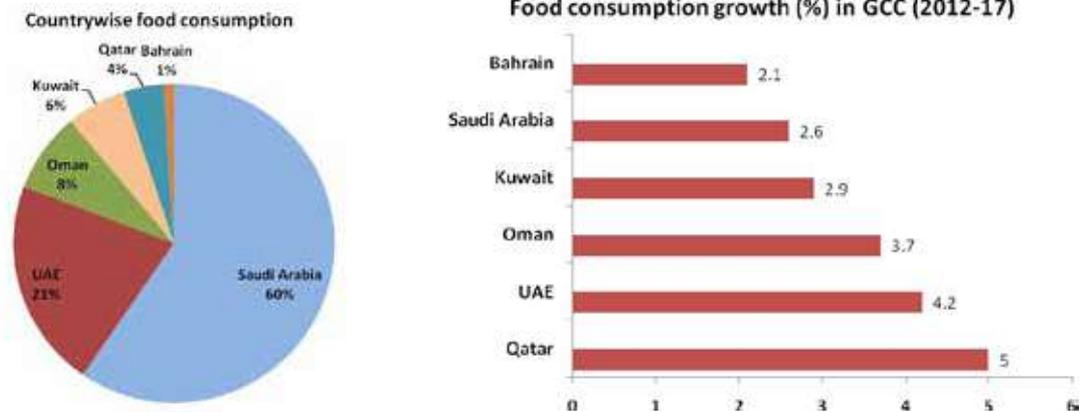


Fig: 1. Food consumption percentage and its growth in GCC countries (FAOSTAT)

Sadik *et al* (2015) pointed out that in their quest to enhance food self-sufficiency, Arab countries face serious challenges emanating from a backdrop of constraining factors, including aridity, limited cultivable land, scarce water resources and serious implications of climate change. Weak policies, insufficient investment in science and technology and agricultural development have contributed to the impoverished state of agricultural resources and to their inefficient use and low productivity. Population growth, rising demand for food, degradation of natural resources, and conversion of farmland to urban uses pose further challenges to the enhancement of the food security goal in the Arab region. The food deficit is underscored by a self-sufficiency ratio of about 46 % in cereals, 37 % in sugar, and 54 % in fats and oil. With this background this paper reviews the potential of increasing agricultural production using the modern state of art production technologies while conserving the limited natural resources by its responsible and most efficient use.

Methodology

The study was conducted by collecting primary and secondary data from different sources. The data sources include, FAOSTAT; SDG indicators (2012-16), Central statistical bureau, Kuwait; Arab Forum for Environment and Development; Arab News; Country specific statistical report and Annual Report of the Arab

Forum for Environment & Development pertaining to the Gulf Cooperation Council. The Gulf Cooperation Council countries (GCC) included in this study are Saudi Arabia, UAE, Oman, Kuwait, Qatar and Bahrain. The data was homogenized for units and base year, compiled and analyzed for required parameters using descriptive statistical tools.

Agriculture in GCC Countries

Gulf countries have reached significant level in agricultural development during the past decade, thanks to their high oil revenue. Depletion of agriculture land is a major constraint for GCC. Crops like Cereals were not produced in GCC, and due to lack of water resources other crops are also getting affected. Hydroponic systems are getting attention in GCC and companies also started using them for vegetable and fruits production as this process requires less quantity of water and less land, no soil. Increase in population and advancements in food industry are reasons for increase in consumption. GCC is a net importer of cereals like Wheat, Barley, Millet, Maize and Sorghum (Analysis of the Agricultural Sector in GCC Countries: 2020 - 2025). GCC is one of the largest importers of food products too. Low ground and surface water availability, limited rainfall, limited arable land and low production are the biggest restraints for agriculture production in GCC (Anonymous, 2019a).

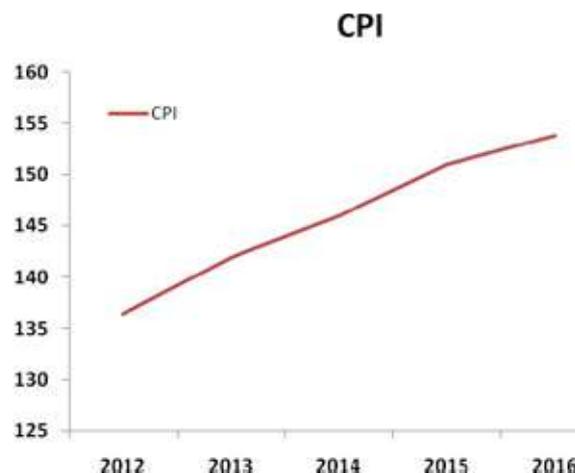
Across the Middle East and North Africa (MENA) region, their environments are at a huge disadvantage when it comes to producing food due to soil-fertility decline, salinization of soil and water resources, population growth, and climate change. The good news is that geography is not destiny. GCC countries are pioneering and leveraging agricultural technology to overcome the handicap of their desert ecosystem and increase their domestic supplies of food. With the increasing incorporation of technology in agriculture, the hope is that these environments will one day be able to produce high food yields with minimal resources (Arab News, 2021).

Kuwait Scenario

Food and Nutrition

Kuwait has the highest level of food security among Gulf States. It is currently among the highest water and

food consumers in the world too. In an attempt to enhance food security, Kuwait is aiming to reclaim more land through irrigation. With support from the government for large-scale food production, Kuwait is steadily increasing the domestic production of some food items, including poultry, eggs, fruit and vegetables subsidies are given to farmers which lower the price on produce. High affluence and low food prices have led to overconsumption and food wastage. In 2008, the WHO stated that Kuwait was one of the Arab countries that were exposed the most to obesity and overweight, with prevalence reaching up to 42% of the whole population (Alzaman and Ali, 2016). As many Kuwaitis say they prepare more food than they require (Ismail, 2015). Following table explains the significant growth of consumer price index during the past 5 years (Fig. 2).



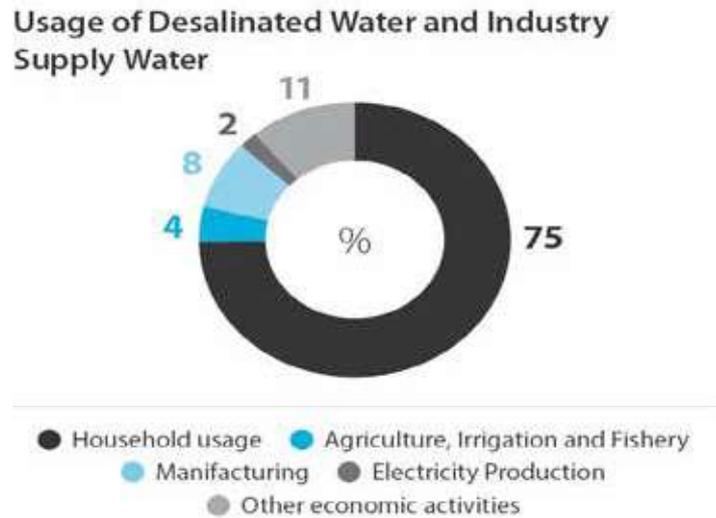
(Source: SDG indicators (2012-16), Central statistical bureau, Kuwait)

Fig. 2: Consumer Price Index per year

Water Consumption

Kuwait’s water consumption is among the highest in the world with per capita consumption averaging 447 liters every day. The groundwater withdrawal rate is 255 million m³ per year, 12 times its annual groundwater inflow. Of total water withdrawn annually, 54 per cent is used for agriculture, 44 per cent for municipal purposes and 2 per cent for industrial purposes (Ismail, 2015). Kuwait’s desalination costs US\$1.2billion each year with this figure likely to grow with increased population and

food production (Ismail, 2015). According to Kuwait Voluntary National Review 2019 (Anonymous, 2019d) in 2016, Kuwait’s main water resources revolves around 117.9 million m³/year of rain water, 634.9 million from desalinated water, and 643.342 million from water supply industry. Out of this, 9.5 million evaporate and 27.503 million are lost during transportation, leaving Kuwait with an average of 1,368.739 million m³/year of fresh water. The 634.9 million m³/year of desalinated water and 643.342 million from water supply industry is consumed through several day-to-day activities (Fig. 3).



Source: Environment statistics for 2013, UNSD and UNEP

Fig. 3: Usage of desalinated water and industry supply water

Wastewater Treatment

According to Ismail (2015) at US\$3.4 billion, the majority of investment in water in Kuwait between 2005 and 2014 was spent in the construction of water treatment plants. The estimated annual volume of recycled wastewater produced is between 206 and 254 million m³. About 30 per cent of wastewater is currently discharged into the sea. Kuwait plans to increase its water resources by utilizing 100 per cent of its wastewater for use in agricultural irrigation, greenery landscaping and the development of forested areas. This will assist in reserving freshwater and reducing the water resource deficit. Treated wastewater also costs less to produce than freshwater, and costs less for consumers to purchase.

Food Import

In 2019, food imports for Kuwait were 16.5 %. Though Kuwait food imports fluctuated substantially in recent years, it tended to increase through 1997 - 2019 period ending at 16.5 % in 2019 (World Data Atlas, World and regional statistics, national data, maps, rankings: Anonymous, 2019c). Kuwait’s reliance on food imports increases its risk of food insecurity as it faces the threat of supply disruptions. Kuwait’s geographical location introduces geopolitical considerations to continued food

security such as disturbances to Arabian Gulf shipping lines could hamper the delivery of food imports to Kuwait (Ismail, 2016). Improving food storage facilities in Kuwait would go some way towards mitigating the threat of supply disruptions by reducing import reliance and enabling Kuwait to better capture and utilize domestic production.

Agriculture and Livestock

Agriculture accounts for only 0.24 per cent of Kuwait’s gross domestic product and the reduction in productivity results in a declining agricultural labour force (Ismail, 2015). Recent data from the Public Authority for Agriculture and Fish Resources (PAAAFR) Kuwait, indicated that 23% of the owners of agricultural land or partners with rights in agricultural land are women (Anonymous, 2019a). Of relevance to food security, it is worth mentioning that a special area was dedicated for productive and sustainable agriculture during the period 2012 – 2016 (Fig. 4). The size of that area remained stable and consisted of around 96% of the total area dedicated for agriculture (Central Statistical Bureau, Kuwait). Only 0.6% of Kuwait’s land is arable, with 0.3% used for permanent crops and 7.6% for permanent pasture (Ismail, 2015). Arable land is declining at a rate of one

% per annum. Kuwait’s arable soils contain 80 to 90% sand and have very low water retention capacity and organic nutritional elements. Almost all of the cultivated

area relies on artificial irrigation. Of the water withdrawn annually from Kuwait’s groundwater supplies, 54% is used for agriculture.

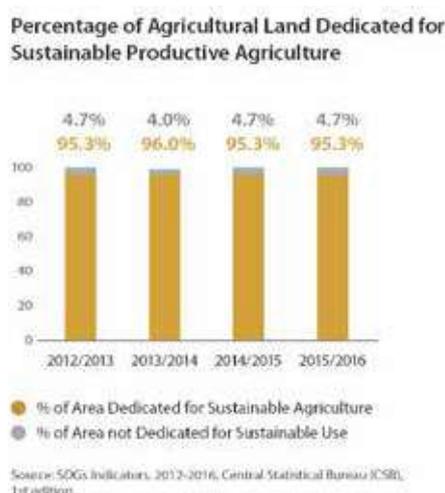


Fig. 4: Percentage of agricultural land dedicated for sustainable productive agriculture

Following data (Tables 1, 2 and 3) are collected from Annual Agricultural Statistics 2019 published by Central Statistical Bureau (Anonymous, 2019b).

Table 1: Number of various farm holdings in Kuwait (collected from Wafra, Abdali, Sulaibiya, and Kabd)

Sl. No.	Type of farm holding	Coverage (ha)
1	Vegetables and crops	3913
2	Livestock	42
3	Sheep and goats	4040
4	Poultry	38
5	Mixed	25
6	Landscaping	15
7	Bees	4
	Total	8077

Table 2: Total cultivated area (in hectares) with field crops (open field) and covered crops

Sl. No.	Type of land use	Total area (ha)
1	Vegetables and crops	3849
2	Semi-perennial crops	4696
3	Covered crops	1420
4	Landscaping	324
	Total	10289

Table 3: Total number of livestock quantity by type – pattern from 2015 to 2019

Sl. No.	Type	2015	2016	2017	2018	2019
1	Cows	29,263	24,246	30,630	29,077	34,746
2	Sheep	588,618	695,699	664,654	684,220	714,348
3	Goats	156,543	172,259	197,768	209,686	235,324
4	Camels	7,718	11,025	9,389	12,225	17,812
5	Poultry	50,237,673	49,680,504	53,011,577	53,530,147	51,359,503

Present Status of Agricultural Practices in Kuwait

Kuwait has never been an agricultural country due to its harsh weather, unproductive soil, unavailability of natural water and other nutrient resources. Water resources are very scarce in Kuwait due to the desert nature of the country. Therefore, Kuwait does not have any agricultural lands, which prevents any development of the agricultural sector. Even though, major activity of the country is related to fishing, cattle, and pearls, Kuwaitis have always an affinity to do agriculture since ancient times. Before the discovery of oil, several occupations contributed to the economy, nomads moving livestock to the sparse forage in the desert, pearling, and fishing, but none of these occupations provided much beyond subsistence (Anonymous, 2017). Once the government began receiving oil revenues, the contribution of other sectors to national income was reduced still further. Economic growth and welfare measures since World War II drew workers away from historical pursuits and lessened the role of agriculture. In the late 1980s, fewer than 10,000 people were employed in agriculture. The government invested some money in developing hydroponics to increase vegetable production. Kuwait's most important crops in 1989 were tomatoes (40,000 tons), dried onions (25,000 tons), melons (7,000 tons), dates (1,000 tons), and smaller amounts of cucumbers and eggplants (Anonymous, 2017). Some of these crops are grown hydroponically. At present farmers grow water melon, cantaloupe, cucumber, snake cucumber, squash, pumpkin, okra, eggplant, tomato, cauliflower, pepper - hot/sweet, strawberry, spinach, parsley, coriander, hibiscus, celery, cabbage, lettuce, peppermint, basil, radish, carrot, onion, garlic, potato etc. and so many leafy vegetables. Although Kuwait manages to export some vegetables, its agricultural potential remains limited. Generally, Kuwait's present vegetable growing can be

divided into three major types *viz.* Open Field Cropping, Protected Agriculture and Hydroponics. Current study choose *Al Faisaliya farm* as one of the high productive agricultural farms in Kuwait as an example.

Al Faisaliya Farm, Wafra, Kuwait

Al Faisaliya farm, *KFAS (Kuwait Foundation for the Advancement of Sciences) award winner for technological diversity, and the best farm by PAAAFR, is one of the high productive agricultural farms in Kuwait*, has also been renowned for its technical expertise in hydroponics, native plant production, desert restoration and mushroom production. The farm possesses large production facility for hydroponics, native plants, and state-of-the-art white button mushroom plant. With the scientific collaboration of Kuwait Institute of Scientific Research (KISR) and lead by prominent field specialists, Al Faisaliya farm has become the pioneer in desert restoration mission and native plants nursery in the whole Middle East private sector.

Open Field Cropping

Many marginal farmers still depend on seasonal crops that require normal desert soil and municipal fresh water. Majority farmers use drip system for fertigation which helps to fertilize the crops and also to reduce the use of irrigation water. Major constraints are harsh weather parameters and unexpected pest infestation. However, majority farmers are able to minimize the effects from those harsh situations by adopting indigenous methods. They produce huge quantity of vegetables such as potato, onion, tomato, eggplant, okra, squash, corn, cabbage, cauliflower, broccoli, carrot, radish, beet root, guards, melons, lettuce etc. Plates 1 a & b are those photos taken from Al Faisaliya farm in February 2021, showing existing method of open field cropping.



Plate 1: Open field a) potato b) field broccoli and cabbage

In addition to this a number of leaf vegetables are also grown in large scale such as spinach, coriander, basil, parsley, rosemary, thyme etc. These farmers generate decent amount of profit from the government sales outlet. The main input is manpower which is comparatively cheap (KD 60 per month to KD 150 per month) in the country and most of the major crops are subsidized.

Protected Agriculture (PA)

Due to the harsh climate, scarce water resources and poor-quality land resources, protected agriculture has a significant role in Kuwait’s agricultural development. The technology used in Kuwait’s PA ranges from simple uncooled and unheated plastic tunnels to very sophisticate computer-controlled, cooled and heated, metal-frame glasshouses. Approximately 85% of the PA is carried

out in uncooled (57%) and cooled (28%) plastic tunnels, with the remaining 15% in cooled greenhouses covered with fiberglass, glass or acrylic material (Nasser and Bhat, 1998). Cucumber and tomato are the two main crops grown in PA, accounting for approximately 90% of the total area. The production technology in Kuwaiti PA varies tremendously, but soil-based production using the native soil with or without organic-matter addition is still common. Drip irrigation systems with desalinated water are used. Inorganic fertilizers in the form of soluble compound fertilizers are applied through drip systems at a more or less fixed rate per day. Following photos taken from Al Faisaliya farm (plates 2 and 3) shows typical greenhouse production of cucumber and tomato, which are the major crops growing under greenhouse conditions in Kuwait.



Plate 2: Cucumber



Plate 3: Tomato

Hydroponics

The production of high value crops requires a certain quantity and quality of water that is practically impossible to obtain in desert agriculture such as the Arabian Peninsula. The present conventional growing system for vegetable crops involves a lot of water wastage due to evaporation too, run off and deep percolation. In arid countries like those in the Arabian Peninsula, rapid evaporation from the soil surface may also lead to salinity problems. Limited natural resources for fertilization and increased soil borne pathogens and salinity are limiting the agricultural development. These reasons lead to the adoption of soilless agricultural production such as hydroponics and aquaponics (rarely) in the country and which is well established during the post-Gulf war. Peat

moss, coco peat, volcanic soils, perlite, nutrient solution and a number of different soil substitutions are widely used. Greenhouse designs and growing technics are also changed. Computer controlled and less environment dependent growing systems have become common in the chief agricultural areas such as Wafra and Abdali.

Plate 4 explains a different way of growing strawberry in a hydroponics system (Al Faisaliya farm). This method saves space, manure, irrigation, and fertilizer. Media used was peat moss. Another method of hydroponics system installed in Al Faisaliya farm is based on floating raft system (plate 5). This method is ideal for raising fast-growing, leafy greens such as lettuce and spinach, and can provide with a constant source of fresh vegetables.



Plate 4: Hydroponics system - strawberry



Plate 5: Floating raft system - lettuce

New developments in Agriculture sector

Recently, Kuwaiti entrepreneurs have started to invest in European production systems which are completely controlled and guaranteed year round production. Two such examples of large scale investments are follow (source: regional news media);

- [Pure Harvest Smart Farms](#), a startup developing technology-enhanced greenhouses for agricultural developments across the Middle East, has received a commitment of up to \$100 million from Kuwait's Wafra International Investment Company (a wholly owned subsidiary of The Public Institution for Social Security).
- [The Sultan Center](#) (TSC), Kuwait's leading supermarket and general merchandise retailer has secured a strategic multi-year, commercial offtake agreement with Pure Harvest Smart Farms, the region's pioneer in controlled-environment agriculture. Through this first-of-its-kind partnership, Pure Harvest will build a dedicated high tech farm producing many varieties of locally grown, premium quality fresh fruits & vegetables, serving TSC's supermarkets across the country.

Vertical Farming

Kuwait growers started utilizing vertical growing systems since 2 decades at experimental level. Recently, due to the growing interests few Kuwaitis started integrated vertical farming system for growing leafy type vegetable. Most vertical farms are either hydroponic, where plants are grown in a bowl of water containing nutrients, or aeroponics, where the plants' roots are sprayed with a mist that includes water and the nutrients needed to support plant growth. Neither method requires soil for the plants to grow. Usually artificial grow lights are used, sometimes in conjunction with natural light.

Newly Opened Vertical Farm in Kuwait

The first commercial high tech vertical farm is recently opened in Kuwait City (Plate 6). **The opening of what is claimed to be the GCC region's first commercial indoor vertical farm in Kuwait aims to ease the country's dependence on imports of leafy greens and herbs.** The facility will soon produce fresh salad year-round in the middle of the Kuwaiti desert. The farm can grow up to 550 kilos of fresh greens and herbs a day and has faster growth cycles than traditional outdoor farms, which are dependent on the weather conditions (source: &ever: Sustainable Indoor Farming | SAP News Center).



Plate 6: Vertical growing system with automated controls – recent start up in Kuwait

Even food labelled as organic can contain different pesticides. Kuwait-based **& ever** Project Engineer Rami Safareni says that their products are “better than organic,” because the company can produce more than 250 different types of plants using:

- 90 % less water
- 60 % less fertilizer
- Zero pesticides

Mushrooms

Mushroom growing has been a new trend in Kuwait although commercial production started in the beginning of the 21st century. At present, a number of local farms has successfully established white button mushroom

plants with the technical collaboration of Dutch and Indian consultants. Demand for various mushrooms, both fresh and processed is increasing in the region day by day. White button and portabello are the most common varieties available locally.

Al Faisaliya farm is the first company to plan the concept of integrated, year round, climate controlled mushroom production to Kuwait. Present mushroom production focused on white button and portabella. The present aim is to produce as much of white button mushroom which is the most desired one in Kuwait, to meet domestic demand. It possesses both composting and growing facility in addition to its own spawn production lab. At present, the farm produces 200 tons of white button mushrooms annually. Following photos are taken from Al Faisaliya mushroom farm (plate 7).



Plate 7: Growing shelves of button mushroom plant

Poultry and Livestock

The poultry industry in Kuwait is one of the leading food industries in the country. It consists of several poultry companies that vary between large, medium and small size poultry producers. The majority of poultry production concentrates on chicken meat and eggs, due to consumers' demand. An estimated 60% of the local broiler production is marketed live, 5% chilled and the rest as frozen. The poultry industry in Kuwait is moving towards production of specialty food such as eggs enriched with omega-3-fatty acids which, it seems, will take part of the market share in the future. Per capita consumption of poultry meat in Kuwait reached 63.3, 61.2, and 60.8 Kg in the years 2004, 2005, and 2006 respectively (Nasser, 2007). However, per capita consumption in 2017 is 46.3 kg only, according to FAOSTAT. This is 0.879 % less than in the previous year. Since local producers supplied only part of the poultry meat and table eggs consumed and the remainder of the local poultry consumption imported from other countries.

Conclusions

Kuwait's urban horticultural system needs massive changes to achieve the country's goal of getting food security. Majority farmers are still depending on traditional cultivation systems and reluctant to invest more on innovative agriculture systems. Those who invest more and produce high quality crops do not get extra value. The government agricultural sales depot (Al Forda), established to support local farmers by providing maximum price to their products, is unable to guarantee an uninterrupted backing. Natural calamities are not uncommon in Kuwait which leads to huge loss to the farmers. Following recommendations seems to be significant to improve the farming sector in Kuwait;

1. The ideal agricultural system in the country shall be independent of climatic factors which guarantees assured quantity and quality crop.
2. The growing system has to be unique for a crop or group of similar crops. Presently, every greenhouse is made for growing any crops.

3. Use of natural soil has to be minimized or avoided for growing crops.
4. Utilization of farm lands shall be maximum, majority farms are barren and not in use.
5. Effective utilization of irrigation water; use of recycled water for farming shall be made mandatory. Uninterrupted supply is also inevitable.
6. Most of the existing greenhouses are not scientifically designed, need to transform into ideal systems. Solar power based greenhouses can be an effective alternative.
7. Lack of qualified technicians is a major concern in Kuwait, they are the back bone of any agricultural farms. The country need to think about investing more on manpower.
8. Timely technical assistance from government research authorities such as KISR (Kuwait Institute of Scientific Research) and Kuwait University is essential.
9. Financial assistance from Public Authority of Agriculture Affaires and Fish Resources (PAAAFR) is necessary whenever and wherever necessary.
10. Future plans to be implemented - reduce post-harvest loss by processing, compost from green waste, and production of value added foods.
11. Future trends to adopt - Indoor Vertical Farming, Farm Automation, Livestock Farming Technology, Modern Greenhouses, Blockchain, and Artificial Intelligence.

Acknowledgements

The author is highly thankful to the management of Al Faisaliya farm to conduct the study. He is also indebted to the owners of other local farms in Kuwait and the Government of Kuwait to use information and various statistical data.

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