

EVALUATION OF AGRICULTURAL MARKETING OF TOMATO AND CUCUMBER IN QATAR AGRO CLIMATIC ZONE

Abstract

There is a great demand of tomato and cucumber in Qatar than their production. Qatar has been categorized as BWh (B=Arid or Dry; W=Waste or Desert; h=hot) based on the Köppen's classification. In addition to having high summer temperatures, high humidity, intense sun radiation, poor soil, and strong winds, Qatar also has limited precipitation. As a result, the climate is no longer favorable for agricultural production. Furthermore, the conditions are made worse by the scarcity of cultivable agricultural land. Due to these unfavorable circumstances and the growing emphasis on self-sufficiency, Qatar has adopted protected farming methods including greenhouse farming. The current state of Qatar's agriculture production has been examined in this review by taking into account the amount of crop output, the amount of cultivated land, the reliance on imports, and the value of crop production with reference to two major vegetable crops identified as critical commodity by Qatar National Food Security Strategy Programme (QNFSS) *i.e.* Tomato and Cucumber.

Keywords: Tomato, Cucumber, Agricultural Marketing, Qatar, Agro-climatic zones.

INTRODUCTION

A wholesome, sustainable, and inclusive food system is essential for achieving the global sustainable development goals. To fight with extreme poverty by 2030, an increased shared prosperity with low income group countries, and to feed 10.0 billion people by 2050, the agricultural development is one of the most suitable solution. The expansion of the agricultural industry, is two to four times more effective than other industries to raise the earnings of the poorest people [1]. Economic expansion and gross domestic production (GDP) of any country also depends heavily on agriculture. It contributed 3.8% of the world's Gross Domestic Product (GDP) in 2019. India contributes 17% of total GDP while some developing countries including African continent have potential of over 25% from agriculture. Crop yields are declining throughout the world due to climate change, especially in the world's most food-insecure regions, further putting agriculture-driven growth, poverty reduction and food security at danger. As per

World Bank, 25% of greenhouse gas emissions is accounted by the agriculture, forestry, and land use change.

Because the current food systems produce unsustainable amounts of waste and pollution that could affect the environment, they pose a hazard to human health. A third of the food produced worldwide is thought to be lost or squandered. Therefore, reducing food loss and waste is essential for raising food and nutrition security and advancing efforts to reduce greenhouse gas emissions. Food insecurity can degrade diet quality and raise the danger of obesity and malnutrition [2].

A little peninsula in the Arabian Gulf known as Qatar is a highly urbanized nation. In urban regions, 99.1% of the population resides. With a GDP per capita of Qatari Riyal (QR) 224,926 (constant prices) in 2020, it is one of the richest nations in the world. To feed its population of 2.88 million (in 2020), Qatar is highly dependent on food imports which is over 90% of its total import of food and food products [3]. A land, sea, and air blockade was implemented in 2017 by surrounding Arab nations and their allies. This sparked national concerns about food security and prompted the nation to look for new supply-side tactics and sources to meet the demand for food [4]. In response, food production in Qatar significantly rose, and it soon became clear that agricultural production was a sustainable and economically viable means of reducing the dangers associated with international geopolitics.

2. OVERVIEW OF THE WORLD PRODUCTION OF VEGETABLES

Between 2000 and 2020, the world's main crop production rose by 52%, reaching 9.3 billion tonnes. In comparison to 2000, this is an increase of 3.2 billion tonnes. Cereals made up the majority of the crops grown in 2020, accounting for just under one-third of the total, followed by sugarcane (23 percent), vegetables, and oil crops (12 percent each). Fruit, roots, and tubers made up 9–10% of the overall yield, respectively. The fastest rise in output between 2000 and 2020, from 0.5 billion tonnes to 1.1 billion tonnes, was seen in oil crops. In contrast, roots and tubers saw the least growth between 2000 and 2020, growing by only 22%.

2021 was declared by the UN General Assembly to be the International Year of Fruits and Vegetables. It began in December 2020 and ended in March 2022. Between 2000 and 2020, the global output of vegetables increased more quickly, rising by 65 percent, or 446 million tonnes,

to 1 128 million tonnes (Figure 6). The five major vegetable species—tomato (16 percent in 2020), onions (9 percent), cucumbers (including gherkins) (8 percent), cabbages (6 percent), and eggplants (5 percent)—accounted for 42–45 percent of the total throughout that time. Onions, cucumbers (including gherkins), and eggplants had a gain in share, whereas tomatoes and cabbage saw no change. China produced the most tomatoes (35 percent of the world's total), cucumbers (including gherkins) (80%), cabbage (48 percent), and eggplants (65 percent) in 2020. India produced the most onions (26 percent of the world's production) [21].

3. OVERVIEW OF THE QATAR AGRICULTURE SECTOR

3.1 Economic contribution

Since 2014, the oil and gas industry has continuously provided at least 80% of the government's revenue, showing how heavily Qatar depends on utilizing its hydrocarbon resources [5]. Thus, changes in the price of energy on the international market might also affect its economic growth. For instance, since 2015, the GDP has decreased twice. The Covid-19 pandemic-related inactivity in the oil and natural gas sector is what led to the most recent decrease [5]. With the Qatar National Vision 2030, which is considered as a roadmap for investing resources in people and infrastructure and promoting increased participation from the private sector, the State of Qatar tried to diversify its economy in order to mitigate this impact. Despite the fact that the country's agriculture sector is very small and heavily dependent on imports, promoting domestic production is crucial for achieving food security goals as well as protecting against major world events like the recent blockade and worldwide pandemic [6]. The Qatari government's policy initiatives and assistance have led to the sector's modest growth over the past few years.

From 2015 to 2020, the Value of Agriculture Production (the total of Cereals, Green Fodder, Fruits and Dates, and Vegetables) grew at a compound annual growth rate (CAGR) of 7.33%. Furthermore, from 0.16% in 2015 to 0.29% in 2020, the value added by agriculture has increased (nearly doubling). As a result, agriculture in Qatar is an emerging sector. [7].

3.2 Qatar Agriculture market

Agriculture market net consumption, or local production plus net trade, increased at a CAGR of 6.9% from 2017 to 20. Two key factors—high and rising disposable income (highest in the GCC region) and population growth with an increase in expatriates—are driving up food consumption

[8]. To provide the local demand for both fruits and vegetables, Qatar has been dependent on imports. The government is now considering strategies to localize the production of fruits and (particularly) vegetables as a result of worries about global food security. In addition, alternative agricultural methods like hydroponics, organic farming, and greenhouse farming can help with the effective production of fruits and vegetables.

Recognizing this, the government is supporting local production through both legislative efforts (such as increased private sector participation, the "Daman" Guarantee Programme), as well as financial incentives (such as 100% financing by banks for greenhouse installation). By the end of year 2023 [10], it also hopes to reach a 70% vegetable self-sufficiency target. In certainty, locally grown veggies increased from 53,600 tonnes to 103,694 tonnes between 2016 and 2020 (CAGR of 17.93%).

There are 67,000 hectares of cultivable land in Qatar, which can be classified into two categories: (i) uncultivated land and (ii) cultivated land. Over the past five years, the amount of cultivated land has increased from 11,805 hectares in 2015 to 13,646 hectares in 2020, with a significant increase in 2018. This rise can be ascribed to the government's emphasis on encouraging regional production in order to solve issues with food security through initiatives like QNFSS 2018-23 [10]. The largest component of the land is planted for green fodder; throughout time, its area expanded from 6,670 hectares to 7,990 hectares. This rise also explains the 38.4% annual growth in the production of green fodder.

Similar to this, the area used for growing vegetables expanded 1.35 times between 2015 and 20; this area accounts for the second-highest share of all cultivated land, rising from 19.4% (2,339 hectares) to 21.9% (3,135 hectares) over time (including greenhouse cultivation).

3.3 Prioritization framework of Qatar development Bank

Despite being in its infancy, the agriculture market in Qatar is a growing industry. The sector has benefited from the government's recent shift in emphasis towards achieving self-sufficiency. There is a tonne of evidence demonstrating that the employment of newly introduced modern agricultural practices, such as greenhouse farming, has considerably increased agricultural productivity, particularly that of vegetables. This section identifies those product categories that

are not only desirable from a consumer standpoint but also have room for future expansion, which will further influence the amount of investment the category draws [11].

For the purposes of this review, a prioritization framework created by the Qatar Development Bank was taken into consideration. It includes important factors and determines the most attractive segments by applying a weighted score approach. These two crop categories, tomatoes and cucumbers, were determined using a prioritization framework that takes into account three main criteria: production for human consumption, suitability for Qatari conditions and greenhouse technology, and a weighted average score of seven different parameters, including (i) the quantity of demand for consumption, (ii) self-sufficiency, (iii) average yield, (iv) the CAGR for demand for consumption, (v) the proportion of produce produced in greenhouses, (vi) the focus of research activities, (vii) Existence of downstream industry [12].

4. Production of Tomato and Cucumber in Qatar

4.1 Tomatoes

The most widely grown and eaten vegetable crop worldwide is tomatoes. Its great nutritional content and variety of consumption options make it an essential component of Qatari households' food supply. In accordance with the Qatar National Food Security Strategy Programme (QNFSS) 2018-23, the crop has been identified as an essential commodity [12]. Additionally, funding has been provided for research into initiatives that might boost the crop's domestic output in Qatar.

4.1.1 Domestic Consumption

In Qatar, there has always been a considerable demand for tomatoes. at actuality, it will make up 24% of all the veggies sold at the Doha Central market in 2023. Tomato consumption per person has also steadily increased over time, rising from 17.7 kg year in 2017 to 33.3 kg annually in 2021 [13]. The demand for tomatoes in Qatar was further aided by the development of a few processing businesses (such as Al Manal Food Factory) that produce processed foods, juices, and beverages. Tomato consumption as a whole has increased over the previous few years, rising at a CAGR of 17.46% from 48,221 tonnes in 2017 to 91,802 tonnes in 2021 (**Fig. 1**).

Imports, which contribute 57% of the consumption demand in 2021, have largely contented this need. Local production, which has been expanding over time, has satisfied the remaining

demand. Future tomato demand is anticipated to increase steadily, with consumption estimated to reach 155,455 tonnes by 2027 [13, 14]. By supplying a significant share of domestic tomato consumption, local farmers will contribute significantly to the achievement of self-sufficiency standards as a result of the anticipated increase in demand.

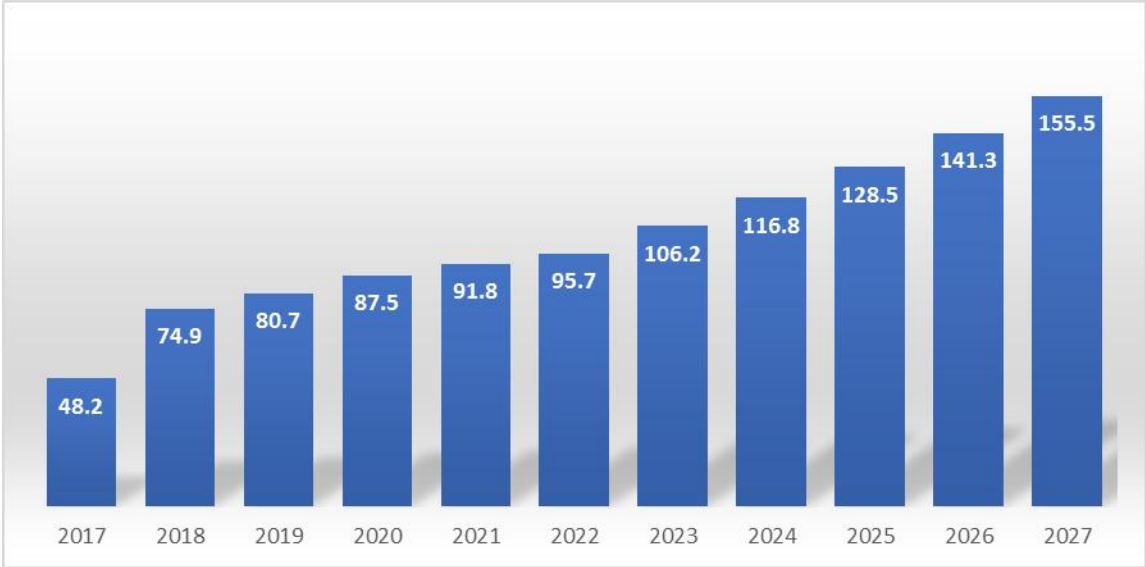


Figure 1: Domestic consumption of Tomatoes in Qatar (1000 Tonnes) projected till 2027 (*Source: [11, 12])

4.1.2 Analysis of Tomato Imports

At a CAGR of 11.35 percent, tomato imports climbed from 34,022 tonnes in 2017 to 52,300 tonnes in 2021. However, due to a renewed emphasis on meeting demand through domestic production, the pace of increase of imports has been steadily dropping over time. As a result, the dependency on tomato imports decreased from 70.55% in 2017 to 56.97% in 2021 [15].

Around 95.7% of tomatoes imported in 2020 came from three nations: Iran, India, and Turkey. Iran contributes the most to this trade, accounting for 79.5% of the tomatoes imported. Comparatively to other imports of the crop from more industrialized nations like Spain and the Netherlands, the average price of these imports is cheap. Tomatoes imported from the three main partners, however, are of worse quality than their local or European counterparts.

Tomato imports fell for the second year in a row in 2022, by -4.1% to 49K tonnes, following two years of growth. Imports generally experienced a noticeable decline. With an increase of 6.6% in

2020, the growth rate seemed to be at its fastest. The outcome was that imports peaked at 56K tonnes. The growth of imports stayed at a lower level from 2021 to 2022 (**Table 1**). Tomato imports decreased in value to \$22M in 2022 [15].

Table 1: Import of Tomatoes in Qatar (Million USD) (*Source: [12])

Import of Tomato in Qatar (Million USD)					
COUNTRY	2019	2020	2021	2022	CAGR, 2019-2022
Iran	10.6	13.5	14.4	11.0	1.2%
Morocco	4.5	2.0	2.5	2.4	-18.9%
Jordan	0.1	0.1	0.1	2.0	171.4%
India	4.2	3.0	1.9	1.3	-32.4%
Turkey	3.3	2.0	0.4	0.7	-40.4%
Others	3.8	4.8	5.1	4.4	5.0%
Total	26.5	25.4	24.4	21.8	-6.3%

The amount of imports from the top 3 nations has climbed from 73.5 in 2017 to 95.7 in 2020, despite the government's emphasis on diversifying trade ties to reduce geopolitical and supply chain risks. On a value basis, during the same time period, the growth went from 58.8 to 73.9. This suggests a consistent flow of tomatoes from nations that grow the crop at a price that is competitive; yet, local production is replacing some of the more expensive supply coming from industrialized markets.

4.1.3 Analyzing the Local Production of Tomatoes

The government's assistance in enhancing agricultural activities has significantly increased local tomato production. The area under cultivation expanded from 303 Ha in 2017 to 424 Ha in 2021 at a CAGR of 8.76%.

Local production of tomatoes expanded at an even quicker rate throughout this time, with a CAGR of 28.33%, from 14,563 tonnes in 2017 to 39,502 tonnes in 2021. Indicating an increase in yield and a shift from open field farming to greenhouse farming, which is regarded as more productive, the pace of production growth is more than quadruple the growth rate of land cultivated under tomatoes [12, 16].

Increased production factors can be linked to an increase in tomato output. Qatar imports fertilisers (nitrogen, phosphorus, and potassium), hybrid seeds, and urea for soil preparation. Additionally, the agricultural industry has earned a great deal of expertise and experience to enhance the production process for regional conditions. Additionally, the switch from outdoor to indoor tomato cultivation, which accounted for 82.41% of regional production in 2021, has helped to boost yield from 48.1 tonnes/ha in 2017 to 93.17 tonnes/ha in 2021 (**Fig. 2**).

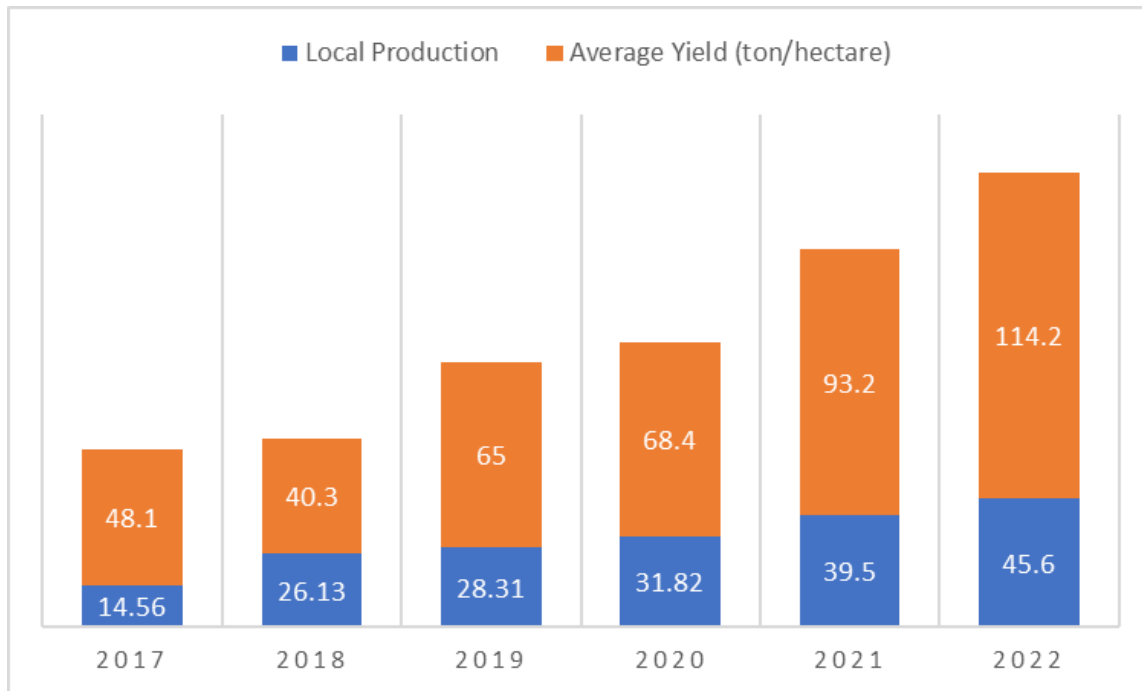


Figure 2: Local Production (1000 Tonnes) and Average Yield of tomatoes in Qatar (*Source: [16])

In Qatar, the sowing season for local tomatoes starts in August-September. The harvest season begins in late December and lasts until March, with a total cycle of 6–8 months. The figure below makes this clear by demonstrating how the local supply began to gradually expand in December and picked up speed in January. The local supply reaches its peak in March or April. From January to April, prices tend to decline as supply rises. Due to price rivalry with imports that local farmers are experiencing, prices have remained range-bound and on the lower side since July despite the extremely low supply. Farmers may experience lower local prices during the slow summer months because they plan to make money during the busy autumn and winter months when demand and prices are favorable [15,16].

Considering the scale of demand, majority of the farms operating in Qatar produce tomatoes. However, only a few large farms such as AGRICO, Al Safwa, SAIC, and Global Farm, are able to supply large supermarkets directly due to the fragmented nature of the industry (supermarkets prefer to buy in bulk from a single source). The majority of other farms depend on the government and wholesalers to sell their tomato products since they lack the production output necessary to satisfy the demands of large outlets. A greater relative preference for producing tomatoes in greenhouses and open fields is indicated by an increase in the area of farmed land under tomatoes. The Qatari population's growing preference for locally grown fresh and organic products has resulted in high demand (and, as a result, high output) for locally produced tomatoes, particularly those grown in greenhouses [15].

In 2021, 45.28% (192 Ha) of the tomato produce was grown in greenhouses, which is significantly more than from 16.43% (49.8 Ha) in 2017. This was accompanied by a rise in greenhouse yield, which went from 140.12 tonnes per hectare in 2017 to 169.56 tonnes per hectare in 2021. The cultivated land in open field declined from 253.2 Ha in 2017 to 232 Ha in 2021, while the yield stayed constant at 30 tons/Ha. This depicts that greenhouse farming was the primary factor in the overall rise in yield and production.

4.1.4 Price Competitiveness

Locally grown tomatoes must be able to compete with imported tomatoes on price and quality in order to establish a sustainable tomato agriculture sector. According to FAO data, the price per/kg for locally produced tomatoes in 2020 was QR 2.5. Due to inexpensive supply from Iran, the average price of imported tomatoes was only QR 1.64 per kg. However, supply from other international markets including India, Turkey, Morocco, and the Netherlands are more expensive than the typical cost of tomatoes made domestically. Local producers have been gaining market share in various nations during the past few years. The preference of Qatari consumers for locally produced fresh organic tomatoes over imported ones has helped local producers gain a foothold in the market [16].

4.1.5 Production Cycle, Costs, and Profitability

Depending on whether they are grown in greenhouses or open fields, tomatoes typically take 8 to 5 months to produce. Due to open field farming's lack of protection, the harvest season is shorter than in greenhouse farming [8].

In comparison to open field farming, the cost of production in greenhouses is much higher. However, the higher price those greenhouse tomatoes bring in makes up for this distinction. In addition, tomatoes grown in greenhouses are more profitable than tomatoes grown in open fields (**Table 2**). The switch to greenhouse farming for tomatoes is explained by higher profitability and sufficient demand [9].

Table 2: Average Production Costs and Net Return in Tomato production (*Source: [16])

ITEMS	GREENHOUSE	OPEN FIELD
Return on Investment (%)	23%	15%
Net Return (QR)	332	139
Average Sale Price (QR/ton)	2,255	1,359
Productivity (tons/acre)	8.6	5.6
Production Cost (QR/ton)	1923	1220

4.2 Cucumbers

Another prioritized vegetable crop with high demand in Qatar is cucumber. It is responsible for 3.11% of Qatar's overall agricultural imports and 29.42% of the nation's vegetable crop production in 2022. On account of rising consumer demand and favorable conditions for growing it using contemporary greenhouse farming techniques, local production activity for the vegetable has been continuously rising.

4.2.1 Domestic Consumption

The populace of Qatar is rapidly favoring cucumbers, a vegetable crop that QNFSS has categorized as a critical commodity. The consumption of cucumbers per capita has increased from 7.04 kg per year in 2017 to 11.9 kg per year in 2021, demonstrating the crop's significance. Cucumber consumption increased from 19,184 tonnes to 32,749 tonnes overall over this time at a

14.3% CAGR [12]. Importantly, indigenous production, which supplied 66.7% of the total consumption in 2021, has largely satisfied this demand. Although cucumber imports are crucial for filling the output shortfall, their significance has been declining recently. By 2027, the domestic demand is anticipated to reach 72,502 tonnes, which could spur an increase in local cucumber output during the next several years (**Fig. 3**).

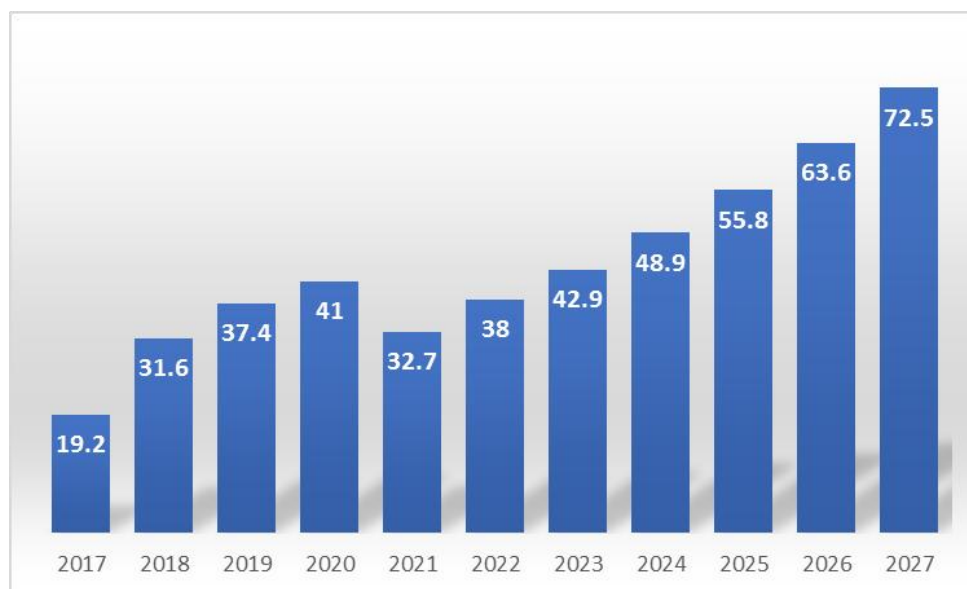


Figure 3: Domestic consumption of Cucumbers in Qatar (1000 Tonnes) projected till 2027

(*Source: [11, 12])

4.2.2 Analysis of Imports

Cucumber imports increased overall, growing at a CAGR of 10.64% from 7,273 tonnes in 2017 to 10,900 tonnes in 2021. However, over time, the rate of import increase has gradually slowed. In actuality, imports dropped by 13.3% from 2020 and 2021. This is partly because Qatari manufacturers have begun to meet local demand [12, 13] .

Iran, the world's second-largest cucumber grower, is the main trading partner, accounting for 90.6% of all imports. However, it only made up 58.76% of the import value in 2020, showing a low import price that enables them to control the country's imports. The average import prices from the top 7 trading partners for 2022 are displayed below (**Table 3**).

Produce costs in India are 6.12 times more expensive than those in Iran. At QR 17.68/Kg and QR 16.87/Kg, respectively, the prices of cucumbers from wealthy nations like the Netherlands and Spain are significantly higher [15].

Table 3: Import of Cucumbers in Qatar (*Source: [12])

Rank	Name	Quantity (Tonnes)	Volume share (%)	Value (1000 QR)	Value share (%)	Average Import Prices (QR per Kg)
1	Iran	11,394.48	90.63	12,030.91	58.76	1.06
2	India	1,021.34	8.12	6,626.23	32.36	6.49
3	Bangladesh	56.80	0.45	385.69	1.88	6.79
4	Lebanon	56.74	0.45	716.12	3.50	12.62
5	Netherlands	30.96	0.25	547.41	2.67	17.68
6	Sri Lanka	6.53	0.05	63.51	0.31	9.73
7	Spain	6.25	0.05	105.43	0.51	16.87

As a result, there is a significant degree of concentration in the import of cucumbers into Qatar, with the top 3 partners, led by Iran, accounting for 99.2% of all imports in 2020, up from 87.9% in 2017. In terms of value, the top 3 trading partners' share climbed from 62.92% to 93% between 2017 and 20. Although Iranian prices are quite competitive, indigenous producers have been able to replace the flow of imports from other nations by providing the local population with fresh and high-quality goods. As a result, the import proportion of high-priced nations has decreased over time [16].

4.2.3 Local Production of Cucumber

Cucumber purchases by Qatari households have been steadily rising, which has led to local farms allocating more resources to meet the rising demand. Cucumber cultivation area increased from 123 Ha in 2017 to 185 Ha in 2021 at a CAGR of 10.74% over the 2017–20 timeframe. Over time, greenhouse farming for cucumbers significantly increased as a result of the government's efforts to localize agriculture; today, greenhouse farms occupy nearly all of the land that is used for agriculture [8].

Due to advancements in knowledge and sophistication for greenhouse agriculture, this has also been accompanied by a constant increase in production. Additionally, government organizations have supported research on enhancing cucumber productivity. Additionally, the local production of cucumbers in greenhouses has been aided by the availability of crucial inputs including seeds and fertilizers that are imported from Europe as well as local supplies of urea and organic manure. Overall, from 97.5 tonnes per hectare in 2017 to 118.1 tonnes per hectare in 2021, the yield increased (**Fig. 4**).

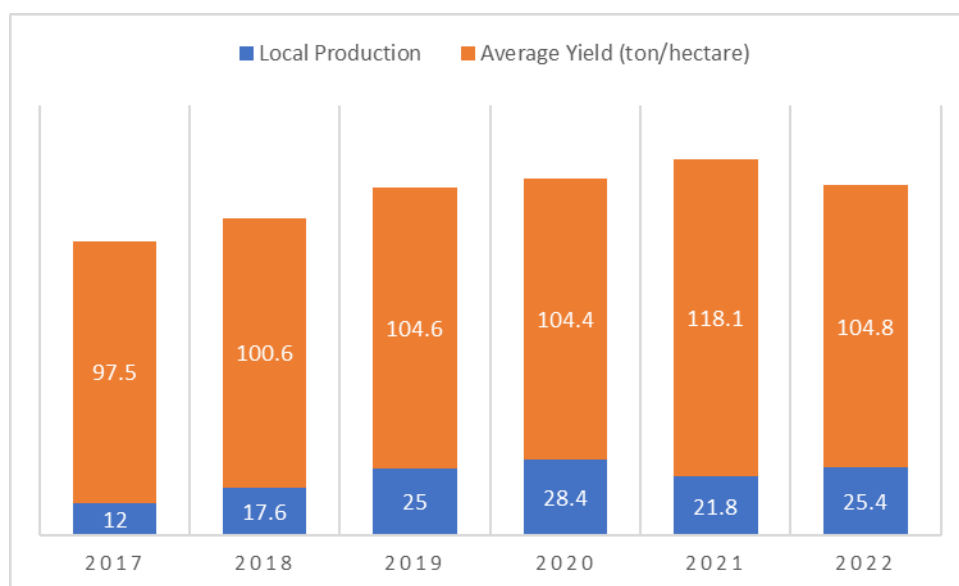


Figure 4: Local Production (1000 Tonnes) and Average Yield of Cucumbers in Qatar (*Source: [16])

Although technically cucumber may be produced all year long and is only grown in greenhouses in Qatar, the summertime climate has a considerable impact on productivity even in greenhouses. Almost all of the production of cucumbers in Qatar is through greenhouse farming. Cucumber prices in the local market are still variable. The local supply grows during the harvesting seasons, which lowers local pricing. After that, from April on, the local supply decline drives up prices until the local supply starts to increase in October.

Cucumber cultivation in open fields has actually decreased over time as a result of productivity and market competition difficulties. In 2021, 98.59% (182 Ha) of the area was covered by greenhouses, which is higher than from 97.07% (119.4 Ha) in 2017. This was complemented by a rise in greenhouse yield, which went from 99.99 tonnes per hectare in 2017 to 120 tonnes per

hectare in 2021. The cultivated land in open field decreased from 3.6 Ha in 2017 to 3 Ha in 2021, and the yield stayed essentially constant at just over 14 tonnes/Ha. This proposes that greenhouses were the sole source of the rise in yield and production [9].

4.2.4 Price Competitiveness

Qatar is at a disadvantage when compared to Iran, which can supply cucumbers for just QR 1.06/kg. However, it has been successful in holding both price and quality parity with other partners. This is particularly true for the share of imports coming from developed nations, which has decreased from 1.31% in 2018 to 0.75% in 2020 (**Table 4**). The average cucumber production cycle in Qatar lasts between 3-4 months. Cucumbers grown in greenhouses may be produced at QR2540/tonne, which is a 20% return on investment [15].

Table 4: Average Production Costs and Net Return in Cucumber production (*Source: [16])

ITEMS	GREENHOUSE
Return on Investment (%)	20%
Net Return (QR)	328
Average Sale Price (QR/ton)	2540
Productivity (tons/acre)	6.9
Production Cost (QR/ton)	2,212

5. STRATEGIES FOR ROBUST FOOD SECURITY SYSTEM IN QATAR [20]

i. International Trade and Logistics

To lessen Qatar's sensitivity to external variables, geographically diversify trading partners for vital commodities by having 3-5 partners per critical commodity. Put emergency plans in place proactively to lessen the effects of trade shocks or other exogenous disruptions.

ii. Domestic Self sufficiency

To increase vegetable production and achieve 70% self-sufficiency on greenhouse crops (such as tomatoes and cucumbers), create a hydroponic greenhouse cluster. Increase and enhance the production of red meat (fattening units and sheep and goat breeding farms) and fisheries (fish farms). Reduce the production of groundwater-based fodder by using TSE.

iii. Strategic Reserves

Utilize the private sector to stockpile a variety of goods to serve as a long-term short-term buffer against system shocks. As insurance against probable trade and production disruptions, establish strategic stockpiles of perishables and choose non-perishables. To protect against potential crisis situations, increase potable water reserves while balancing risk exposure and "insurance" costs. By maximizing water use in agriculture, the Aquifer's net depletion can be reduced.

iv. Domestic Markets

Streamline the domestic "farm gate to retail" model to ensure price fixing is transparent and to help farmers increase their output and product quality. Create a comprehensive food waste management programme that includes the collection, treatment, and disposal of organic waste. To more efficiently oversee quality certification, monitor food safety across the nation, and optimize and simplify Qatar's governance of food standards

6. RECOMMENDATION TO REDUCE LOSSES IN AGRICULTURAL MARKETING

- Increase the contribution of agricultural extension to the marketing of vegetable crops with the goal of transferring post-harvest technologies to farm owners.
- Accuracy in carrying out sorting, grading, and packaging procedures, and making sure the farmer does these tasks.
- Promote direct communication between the production and the final customer to help find a quick marketing path.
- Promote vegetable cultivation under protected conditions.
- Make sure to be informed of the precise fertilizer needs necessary for the crop being cultivated and to make an effort to prevent fertilizer application deficiencies.
- To hire enough staff with the necessary abilities to handle all farm tasks, the farmer should.

- Use the study's findings in statistical computations, especially those that involve food balance.
- Expand the choices for producers, entire sellers, and importers to obtain simple financing for the construction of cooled storage facilities and cutting-edge ways of delivering agricultural goods to markets.
- Create and set up various markets (wholesaling and retailing).
- Utilize current sorting, grading, packaging, and marketing methods in light of their clear contribution to lowering the percentage of losses.
- Give marketing operations more attention, and focus on studies and practical research that address marketing-related topics.
- Encourage farm owners and farm leasers (renters) to hire agricultural engineers and technicians, improve the technical proficiency of farm workers, and hire qualified employees from nations with comparable resources and environments.
- A contribution from the government in the form of a modern center for grading and sorting.
- Stress the need of establishing a specialized marketing firm that will purchase goods from farm owners and handle the marketing in an effective way.
- Suggest the creation of a market for temporary workers to supply an adequate quantity at high need places, similar to what is done for cleaning and home service providers.

7. CONCLUSION AND FUTURE PERSPECTIVES

The agricultural industry in Qatar is still in its infancy. Although there have been numerous laws and programmes in place for well over a decade to assist the operations of local farms, the majority of the vegetables and fruits that Qatari households consume still come from imports. However, the 2017 blockade gave the administration additional motivation to focus on speeding the development of the local agricultural industry in order to achieve self-sufficiency for important agricultural crops. In order to do this, the government has taken a number of actions, such as providing financing for the construction of greenhouses and the adoption of modern farming methods, defraying a percentage of the running costs of farms, and providing procurement guarantees to lessen any market risks that farms may face.

Key fruit and vegetable crops have seen an increase in local production thanks to these programmes. The QNFSS's plan for diversification and contingency focuses on a number of essential commodities, including various fruits, vegetables, dairy and meat products, cereals, and legumes. By 2023, the QNFSS wants to see 70% of its vegetables self-sufficient. In Qatar, a lot of the nominated crop segments, including tomato, cucumber, lettuce, and green/sweet pepper, are consumed. These items are significant components of Qatar's diet because in 2020 they made up about 33% of all vegetable intake. The QNFSS's food security goals will be significantly impacted by the production of these veggies.

The most popular vegetable crop, tomatoes, continue to see solid demand growth. To reach the goal of 70% vegetable self-sufficiency, increasing local tomato production would be essential given its significance in the food basket. Cucumber is another significant item that continues to experience high local demand. Importantly, greenhouses are where the majority of the cucumbers cultivated locally are grown. The development of agricultural technology to boost productivity and even introduce sophisticated procedures would give local produce a boost.

It will be simple to understand the importance of studying the main barriers and factors that influence these elements and what this implies for knowledge production and exchange consequently innovation once it is known that improving local food production requires innovation, technology adoption, and close collaboration between the different stakeholders. However, data on the various innovations adopted by Qatari farmers to boost food production are scarce, and little is known about the adoption of technology in the agricultural [3]. A major issue facing Qatari agriculture is innovation. A significant and alarming awareness gap exists in the body of knowledge required to develop effective policies due to the paucity of recent research on the dynamics of innovation and technology adoption in Qatar's agriculture sector and their relationship to food security and sustainability.

Tomato and cucumber cultivation are selected for many studies due to their importance. Tomato and cucumber play an important role in human nutrition because of the low fat and carbohydrate, but high content of vitamins, minerals, antioxidants, and dietary fibers. Numerous research studies try to find out the challenges faced by tomato farmers in the production, marketing and the marketing mechanisms for surplus production [17]. Tomato is the largest vegetable crop produced in the world, and is known as protective food due to its unique nutritional value and

wide distribution. Thus, different strategies to overcome the climatic changes should be developed [19]. Especially, tomato plant is one of the most broadly cultivated plant crops in the world. Challenges and innovation to face climate change issues with crops should include: *a)* more efforts and management of different strategies to overcome the climatic change and to protect plants from diverse diseases and insects to get a high yield and quality [17]; *b)* development of crop varieties to increase tolerance to moisture pressure, salinity, high temperature and elevated CO₂ levels in order to overcome climatic change issues and increase climate-resilience of the agriculture system; *c)* overcome the major barriers to the farmers such as lack of knowledge, lack of awareness of the modern technology, *i.e.*, application of bio-herbicides, bio-pesticide, bio-fertilizers, and improved seeds [18]. Relevant agricultural system should take imitative steps to spread the knowledge about the modern technology usage, which is the biggest challenge faced by the farmers.

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