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Backyard Urban Agriculture in Qatar: Challenges & Recommendations

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1. Abstract

The last decade witnessed a return to traditional ways of farming that were, for decades, braced by technological advancement. Along with many countries around the world, Qatar manifests an interest in urban farming, encouraged by a strong political will to achieve food security. The plans set and implemented by the Qatari government, on both micro and macro levels, raised awareness around urban farming and inspired many urban households. In this study, a survey of 70 households practising backyard farming was performed to explore their particular challenges. A thorough literature review winds up with national scale challenges, raising issues common to urban farming in hot-arid regions. The research design follows a mixed qualitative method, which includes a literature review and semi-structured interviews. The synthesized data, shaped by an understanding of the national scale challenges and drawn from the interviews and surveys' conclusions, is categorized into 4 themes: environmental, economic, regulative and social. The results showed that many macro-level challenges cascade down to the household/micro level. Under the environmental category, key findings include climatic challenges, non-viable organic farming problems, soil scarcity, and pollution. Economic challenges include the low return on investment in rent and labour, soil, fertilizers, and water costs. The public policy appeared to lag in areas of urban-farming subsidy, land-use policy, and food safety. Recommendations to abate challenges include national strategies to mitigate water and soil scarcity, land use policy upgrades, public health policies, suitable selections of agricultural systems, and farmers' support.

Keywords: *urban farming, food security, Qatar, backyard farming, home-grown food, household-farmers, challenges, recommendations, urban planning, land use planning, public policy*

2. Introduction

A major driver of rural impoverishment is the lack of opportunities and basic services in rural areas, undermining people's ability to support their livelihoods (Bebbington, 1999). The lack of clean and affordable energy is a major underpinning factor to such issues (Guta et al., 2019). Although Latin America has some of the world's best renewable energy conditions, 17 million people lack energy access due to living in rural off-grid locations in hard-to-reach areas and thus face energy, water, and food insecurity

Home-grown food was traditionally a naturalized way of life, especially in Asian and European countries. It made highly nutritional foods available in times of slow and expensive transport systems (Horticultural Crops Group, 2005). In contrast, recent technological advancement in both production and transport made any type of food available to any region and within hours or days. This eventually led to a high dependency of urban areas on imported foods (Veolia Institute, 2019). Regrettably, the fast, ample, and low-cost supply of imported agricultural produce compromised the public appreciation of the environmental, economic, and social benefits that locally and self-grown food brings.

Fortunately, the last decade witnessed a return to making urban farming a priority, given its benefits in supporting the ever-growing need for food in an increasingly growing urban population. In particular, neighborhood and household farming became increasingly seen as a solution to food insecurities and a valuable resource to underprivileged households in developing countries (Stewart, et al., 2013). They are also seen as promoters of both real-estate values and social capital in developed countries (Duchemin et al., 2008).

The general agreement around the benefits of urban agriculture encouraged many cities, such as Chicago, Vancouver, Berlin, Toronto and Montreal to name a few, to draw policies that promote urban agricultural practices (The Peninsula, 2019). Qatari cities are no different. Parallel to the fast pace of urbanization that they went through (Shandas et al., 2017), a considerable community of appreciators for locally and self-grown food is rapidly emerging, together with a strong political will to resolve food insecurity. Coupled with the community's willingness, a strong political will to alleviate food insecurity fueled a range of plans

to mitigate Qatar's vulnerability to food imports (Ministry of Municipality and Environment, 2020). Currently, many agricultural systems are being deployed, including greenhouse production using hydroponics, aquaponics, and vertical farming (The Peninsula, 2019; Karanisa et al., 2021). Plans are also set to promote the use of these agricultural production systems in urban areas. A noticeable example is a program by Qatar Development Bank (QBD) where greenhouses are subsidized for local households in urban areas. QBD currently provides both support and training for the home production of vegetables using the hydroponic method (Qatar Development Bank, 2020).

This paper explores the noticeable and inspiring experiences of individual households practising backyard urban farming in Qatar. It starts by clarifying the national challenges faced by agriculture in Qatar. Then, based on a survey of 70 households practising backyard urban farming, it elaborates on the micro-level challenges that they face and attempts at devising solutions through several recommendations.

In the context of this paper, backyard urban farming and gardening are used interchangeably and defined as the individual households' exercise of growing fruits, herbs and vegetables in open-air, on-grade, and within their homes' backyards, side-yards, or front-yards, balconies and terraces.

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3. Context: Food Security in Qatar, Public Policy and Community Involvement

Qatar, a strategically located peninsula in Western Asia and surrounded by the Persian Gulf, covers 11,600 km^2 mostly consisting of unfertile plains and deserts (Qatar Planning and Statistics Authority, 2019). In 2017, a political air, sea, and land blockade was imposed on Qatar by several countries and lasted 3.5 years (mid-2017 till early 2021). Since 90% of Qatar's consumed food until 2017 was imported (The World Bank, 2019), mostly by land from the Kingdom of Saudi Arabia, food security rose to a national priority.

Since the 2017 Gulf Rift, Qatar has seriously started strengthening food security by setting up a variety of agricultural industries (Market Intelligence, 2020). The enactment of Qatar's National Food Security Strategy (2018–2023) took a major role. The four-pillar strategy included international trade and logistics (diversifying the importing countries), enhancing food self-sufficiency (increasing domestic production and using water-saving techniques), ensuring strategic reserves of food items and production inputs (water, seeds, and fertilizers), and finally, ensuring domestic markets warrant the high quality and fair prices while mitigating food waste (Sheila Golden, 2013; Qatar Ministry of Municipality and Environment, 2020).

Efforts have also been mobilized towards promoting the "Made in Qatar" food and agriculture, both locally and globally. Local food production increased, and the sources of food imports diversified. Consequently, during the COVID-19 pandemic, Qatar proved to be one of the most food-secured countries (Ben-Hamadou & Bello, 2021). Since 2017, the total local food production and monetary value clearly showed an increasing trend (Table 1).

Year	Local Production (Ton)	Value of Production (thousand QR)
2012	176,256	788,358
2013	212,495	1,028,357
2014	242,161	1,353,129
2015	260,129	1,376,428
2016	249,545	1,393,002
2017	244,038	1,905,147
2018	446,467	2,110,897
2019	380,604	2,574,119

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Table 1: Total local production (ton) and value of production (QR) of major food groups (cereals, green fodder, fruits, dates, vegetables, meat, milk, milk products, eggs and fish) in Qatar between 2012 – 2019 (Planning and Statistics Authority, 2019).

After becoming self-sufficient for fresh dairy products and poultry in 2019 (> 100%), the Ministry of Municipality and Environment (MME) in Qatar has set up aspiring goals for 2023, where a 70% self-sufficiency in vegetables and eggs is anticipated and planned for, as well as a 63% self-sufficiency in fodder production (Figure 2).

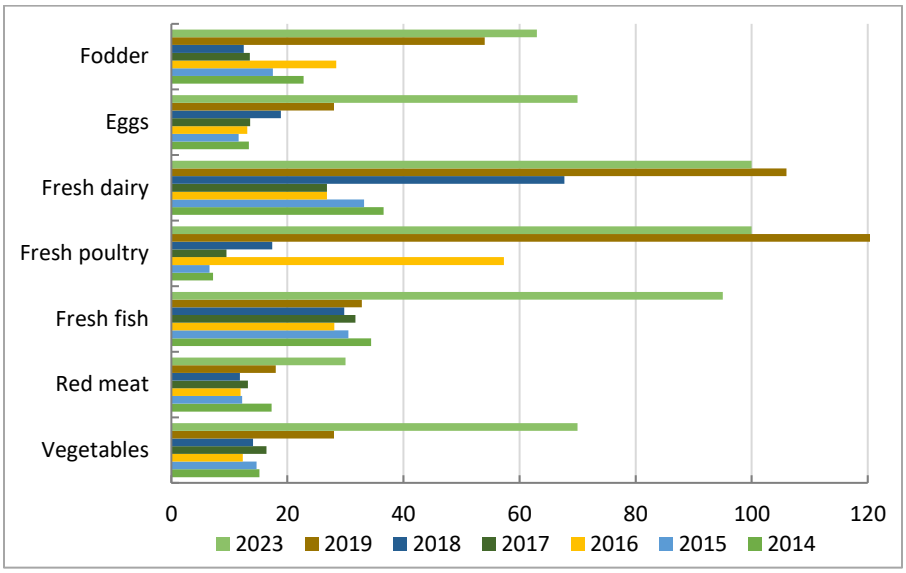

Figure 2: Self-sufficiency of major food types (vegetables, red meat, fresh fish, fresh poultry, fresh dairy, eggs and fodder) in Qatar for the period from 2014 to 2023. (self-sufficiency = local production/available for consumption %) (Qatar Planning and Statistics Authority, 2017; Qatar Planning and Statistics Authority, 2019).

In parallel to the enacted public policies, a noticeably diverse community of promoters of urban farming is growing in Qatar. Social networks like the ''Krishiyidam urban farming community'' (an Indian gardening community of 14,300 members) and the ''Gardening Club-Qatar'' (8,000 members) have been remarkably active in exchanging knowledge on plant protection products, seeds, homemade fertilizers, and gardening supplies. ''Wahab'', a volunteer community mitigates waste management problems by redistributing

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surplus food and converting food waste into compost (Wahab, 2020). The ''Torba Farm and Market'' (Torba, 2017) offers stalls to small businesses with handcrafts and homemade products and hosts educational workshops and events. Additionally, some other entities like the Quranic Botanic Garden as well as some private companies organize training workshops around home farming.

Recent newspaper articles report growing trends of residents willingly adopting homegrown food. Kitchen, backyard, and balcony gardens are becoming popular (Abusin & Mandikiana, 2020). Correspondence with the Facebook group "Krishiyidam Qatar" identified an increase of 40% in the population interested in backyard gardening as a result of the slow-down brought by the COVID-19 pandemic and during lockdowns between 2020 until mid-2021.

Pictures 1 & 2: Kitchen Garden in a villa at Al Waab (Source: authors).

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Pictures 3 & 4: Backyard Garden in a villa at Al Khor (Source: authors).

Pictures 5 & 6: Backyard Garden in a villa at Al Duhail (Source: authors).

Public awareness of food security and environmental awareness has grown as well. According to a report by the Boston Consulting Group (BCG), 55% of the population in Qatar express their willingness to

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consume more eco-friendly goods and services, adopt a sustainable lifestyle and invest in green infrastructures. The report also highlights that although 74% of the population is aware of climate change and the degrading environment, the primary challenge of transforming plans into actions remains the greatest shortcoming (Hildebrandt et al., 2021).

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4. Research Methodology

4.1 Research Questions and Stages

The title of the study reflects the composite aspect of the question raised: challenges and solutions. To answer the research question: "What are the challenges of home-farming in Qatar, and how to mitigate them?", the study adopted a multi-stage methodology as represented by the chart below (Figure 3).

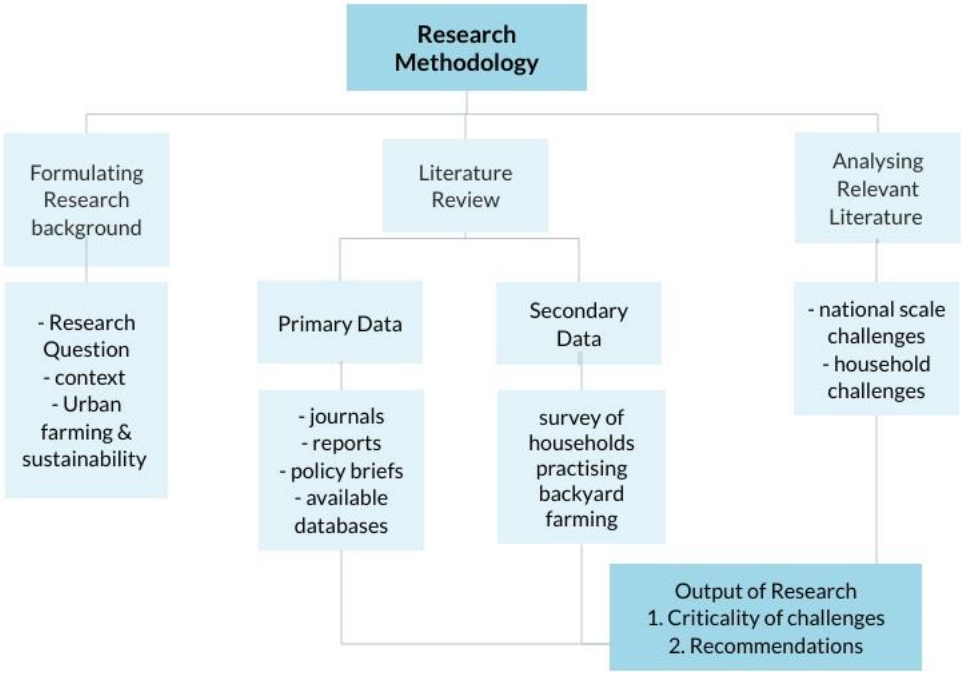

Figure 3: Followed semi-systematic methodology scheme.

While the explored challenges and solutions directly related to the hot and arid climate that characterizes Qatar, solutions were not customized to fit any specific neighborhoods.

4.2 Sourcing Relevant Literature

The study adopted a semi-systematic review method of scholarly literature, available databases, and grey literature. Grey literature includes reports from private and government organizations, discussions from

conferences and workshops published online news articles and discussions from conferences and policy briefs. The methodology of the literature review is inspired by Hassen et al. (Hassen et al., 2020). However, some of the data was filtered based on the number of citations of individual studies. This step ensures that the references of this study are highly authentic and validated all over the world.

4.3 Analyzing Relevant Literature

A search was performed to collect research papers of Clarivate Analytics—Web of Science and Scopus ranked journals. The search was conducted based on only the relevance of the topic, with keywords such as *''sustainable neighborhoods'', ''urban farming'', ''community farming''* and *''hot-arid climates''*, and concerning each other. No material was excluded based on the publication date or the time frame of the study. However, it was found necessary to exclude the criteria of referring to the latest publications, since backyard farming is similar in many ways to the traditional self-help and on-site at-home farming, developing at times when transportation of goods, especially perishable goods, was expensive and not practical.

4.4 Data Synthesis

The last stage of the methodology covered synthesizing data: co-relating the challenges of traditional farming to the experience of backyard farming communities in Qatar.

An informal interview of 70 active home farmers took place between 1st March 2021 to 15th April 2021. The interviews were intended to gain first-hand clarity on challenges and were carried out from 1st April 2021 to 15th April 2021. Responses were collected through emails, social media groups and in-person interviews. The participants, targeted based on their interest and activeness in public forums, consisted of all ages, gender and ethnicities. The collected 70 responses in total emanated from various neighbourhoods and cities in Qatar. Those covered: AlKhor, AlWakra, AlSadd, West-Bay, The Pearl, New-Salata, Ain-Khalid, AlMansoura, AlDafna, Mesaieed, AlWaab, Lusail, Najma and AlGharaffa. The diversification of neighbourhoods allowed a comprehensive understanding of gardeners' perceptions, experiences, and challenges, irrespective of location.

Interviews revealed key information about the respondents' characteristics and attitudes towards backyard farming. Noticeably, all collected responses were from expat households, but the respondents' gender was not given consideration when analyzing the survey. One person per household usually leads the gardening exercise; other family members contribute occasionally to taking care of plants. In some cases (14.3% of respondents), a gardener either on an hourly or full-time basis is hired. As for the employment status, almost a third of respondents (31.7%) were unemployed. The best timing to work in gardening was not revealed; however, 43.3% of the total surveyed sample made time for farming during weekends and evenings of weekdays.

The exploration covered the totality of the process of growing: preparing the soil, planting, seeding, manuring, maintaining, and harvesting.

The deduced challenges were categorized into 4 themes: environmental, economic, policy/regulative, and social. The conclusions are made from a clear understanding of the collected data and the residents' responses, while the recommendations are based on benchmarking and selecting policy measures adopted for similar conditions.

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5. Research Findings

5.1 Challenges to Urban Agriculture at National-Level

According to a report by Haus consultants in 2020, the major weaknesses and threats to urban agriculture in Qatar are water-related constraints; water is limited and hence, expensive and limited groundwater with high levels of salt, harsh weather conditions, and fluctuations in funding by the government due to oil price fluctuations (Mathew, 2020).

5.1.1 Water Scarcity

Qatar is an arid country with limited natural water resources and very low or no annual rainfall, marking a long-term average of 92.9 mm for the years from 1962 to 2019 (Planning and Statistics Authority, 2019). Most of the water in Qatar is desalinated from seawater, which apart from being an expensive process, is not environmentally friendly as it emits high greenhouse gases (Mannana et al., 2019). Moreover, the concentrated brine with elevated temperature is discharged to the sea while the marine ecosystem is affected (Rahman & Zaidi, 2018). In specific, 61% of the total water is produced through desalinization of ocean water whereas aquifers supply approximately 24% of the country's water production and 14% comes from treated wastewater for 2019 (Planning and Statistics Authority, 2019). The salinization of groundwater resulting from over-pumping and seawater intrusion is also a challenge (Ahmad & Al-Ghouti, 2020). It is noteworthy that 92% of the abstracted freshwater is consumed by the agricultural sector, as shown in **Figure 4**. This amount comes up to 230 million m^3 out of a total of 250 million m^3 abstracted groundwater and only 20% of this is used for other economic activities in the country, making water resource management a critical issue. According to experts, Qatar is undergoing an acute water shortage. However, this crisis-like situation remains silent since the supply chain is not disrupted and there is no direct dissatisfaction from the public (Hussein & Lambert, 2020).

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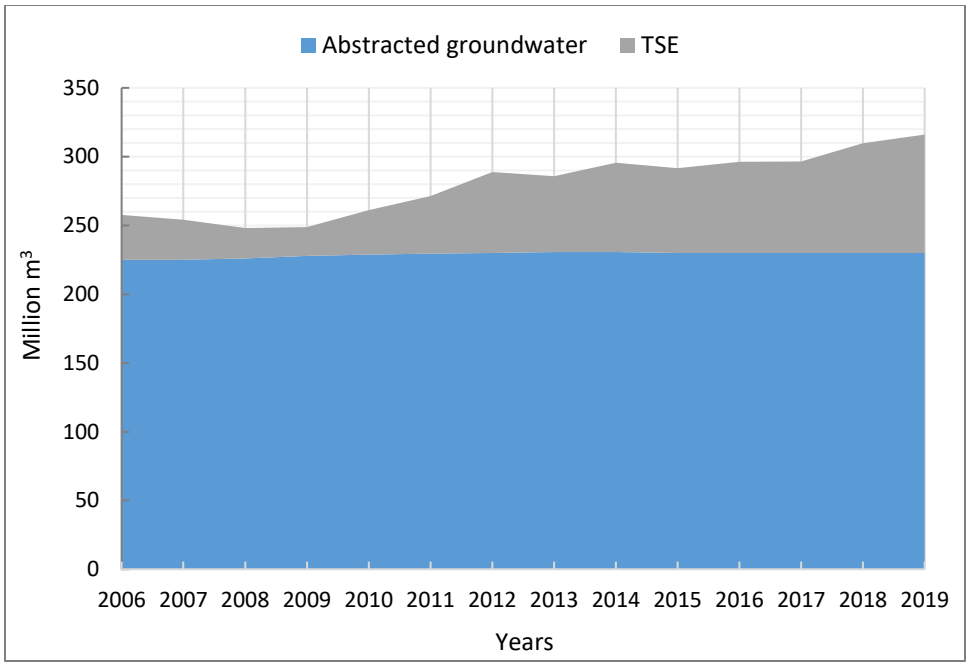

Figure 4: Agricultural water sources for Qatar from 2006 to 2019. TSE: Treated Sewage Effluent (Planning and Statistics Authority, 2017).

5.1.2 Scarcity of Arable Lands

According to the United Nations Convention to Combat Drought and Desertification (UNCCD), land degradation occurs due to various reasons including harsh climates and human activities. The same applies to Qatar which faces the challenge of scarcity of arable lands coupled with low soil fertility. Qatar is a rocky desert area by 82.4%, therefore soils are mainly coarse, shallow, with low water holding capacity. According to FAO, the total arable land in Qatar is limited and estimated to be 65,000 hectares while constituting 5.6% of the total country area (FAO, 2008). The main agricultural soils are locally known as ''rodah'' and are scattered in 850 depressions all over Qatar. ''Rodah'' soils are fertile and arable while constituting only 2.44% of the total country area (27,620 ha). Other soil types in Qatar like the ''sabkha'' (6.6%) which are highly saline, or the hilly outcrops (5.4%) are non-arable and unsuitable for traditional agriculture (Yousef et al., 2020).

5.1.3 Noncomprehensive and Softly-Enforced Spatial Development Policy

Qatar outlays its development goals through several statutory documents. Almost every regulation is led by The Qatar National Vision 2030 (QNV), issued in 2008 by the General Secretariat for Development Planning (General Secretariat for Development Planning, July 2008). Central to QNV is regulating urban growth, maintaining social equilibrium between Qataris and expatriates, and engaging in good environmental governance. The National Development Strategy (NDS1, 2011-2016 and NDS2, 2018-2022; Hildebrandt et al., 2021) developed by the Ministry of Development Planning and Statistics in Qatar focuses on setting implementation plans that are informed by proper stakeholders' engagement. While sustaining economic development is central to QNDS2 (Qatar General Secretariat for Development Planning, 2011), it also aims at achieving proper management of natural resources. More sector-specific strategic frameworks – such as the National Health Strategy and the Qatar National Food Security Program (QNFSP) – were subsequently developed (Qatar Ministry of Municipality and Environment, 2020). The Qatar National Master Plan (QNMP) initiated and implemented by the Ministry of Municipality and Environment (MME) is a spatial representation of the goals and vision in QNV 2030. The plan consists of both The Qatar National Development Framework (QNDF) and the Municipal Spatial Development Plans (MSDPs), spanning till the year 2035. Published relatively recently (2014, updated in 2016), the QNDF aims at creating "a role model for sustainable urban living and the most liveable towns and cities in the 21st Century." MSDPs comprise vision and development strategies and zoning regulations. Central to this national-level spatial plan is the designation of a "Green Belt Zone" to contain sprawl. Unfortunately, large areas of the green belt are already developed. The aforementioned overarching sustainability goals drawn in every enacted comprehensive national strategy and statutory document, coupled to the context-specific food insecurity, warrant substantial attention and regulations to empower urban agriculture. Unfortunately, there is still no clear-cut enforceable regulatory land use and spatial controls in Qatar that acknowledge urban farming as an essential means to promote sustainable cities.

Land-use plans, a component of the spatial development strategy, are implemented through zoning regulations. Among the many controls that Zoning provides, it regulates both the compatibility of uses (across plots and within set separating distances) and the allowed quantum for each use. It, therefore, decides on where urban farming is allowable, which type, and in which volume. Large tract farming and major agricultural industries are usually developed based on an exemption from enacted zoning (a variance). On the micro-level (individual plots and gardens), farmers are expected to abide by zoning.

Luckily, the conceptual shift from a preference for single-uses to multi-functional and mixed land-uses frees the way for introducing urban agriculture to almost all regulated areas, conditional to controlling externalities. Multifunctionality resolves the high competition among land-uses and saves on land (Lovell, 2010), a scarce natural resource, especially in Qatar. Zoning can also be tailored to decrease a plot's building coverage in favour of larger backyards, balconies, and gardens while providing the same buildable area (vertically). As a regulatory tool, zoning allows for many zero-cost incentives (Pollans & Roberts, 2014). To the least, additional gross floor area (GFA) or floor to area ratio (FAR) can be mobilised in exchange for introducing all necessary equipment and space for farming by developers. Through zoning, green walls, elevations or fences can be required as a precondition to granting a permit. This becomes very significant on the level of megaprojects where facilitating urban farming can be imposed in exchange for the required variances. Aside from zoning, land-use planning decides on types of community facilities. To date, farmers' markets, garden sheds, produce storage, and other farming-related facilities did not yet make their way into the statutorily required list, nor into the spatial plan, except for large scale national level needs.

Despite the many possibilities that zoning can provide to promote urban agriculture including backyard farming, Qatar's zoning regulations are not currently redacted as such. In almost all zones, urban agriculture is neither mentioned as an "Allowed Use" (as of right) nor as a "Conditional Use". This deprives farmers of private gardens of a necessary legitimization of their activity and leaves them vulnerable to nuisance complaints by neighbors.

Zooming into the spatial characteristics of home gardens, it is clear that the available areas for farming are tight and limited within tight setbacks. These are in most cases – and as seen in photos by the survey respondents – covered with tiles: a clear deviation from the minimum landscape area regulated by zoning. The weak enforcement and lack of awareness around this smallest element of zoning – the maximum impervious cover – not only makes the backyard prone to flooding and water run-off but also leaves little space for open-air planting and no possibility to plant large and deep-rooted plants.

All in all, by failing to provide legitimacy and assurance, space, and water-permeable grounds, current land use zoning laws contribute to depriving backyard farmers of an opportunity to flourish.

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5.1.4 Partially Deployed Agricultural Systems

Keeping up with the Qatar National Vision 2030 and the Qatar National Food Security Strategy 2018-2023, the agriculture sector is projected to grow by 6.3% by 2025 (Ben-Hamadou & Bello, 2021) all the while mobilizing technology and non-traditional methods. Hydroponics and aquaponics, coupled with smart greenhouse technology and resource-saving techniques (Karanisa, et al., 2021) have made their way into commercial agriculture practices, changing the ways of food production in Qatar. Though aquaponics is one of the most sustainable solutions of urban farming, as it enables the reuse of water and is non-soil-based (Mordor Intelligence, 2020), its deployment is still not enough to meet the country's total food demand. As a result, alternative strategies, such as creating new routes to import foods, foreign land acquisition and investments in research and development are considered as well.

5.2 Challenges to Urban Agriculture at Home-Grown Backyard-Level

The survey analysis identified the possible categorization of the challenges to urban agriculture at the backyard level into four (4) themes: environmental, economic, public policy, and social.

5.2.1 Environmental Challenges

Environmental challenges were seldom given light in traditional farming, which took place mostly in the countryside or farmlands away from the city. In contrast, urban farming faces an array of challenges, with the scarcity of water and land being the most pronounced (Veolia Institute, 2019). The survey responses allowed the identification of factors like climate, the difficulty of organic farming, deficient agricultural soil, and pollution as major environmental challenges.

A. Climatic Conditions: Backyard farmers reported finding Qatar's climate as a major challenge to grow crops locally. The growing season has been traditionally limited to the months between October and April. Interviewed farmers revealed that it is extremely difficult to grow or maintain plants in summertime, June, July, and August. Also, little (or no) rainfall, frequent sandstorms and extreme humidity are seen as a threat to gardening. 78.3% of people said harsh temperatures are a major obstacle, and 41.7% responded that staying out and gardening is challenging due to the weather. 35% of people identified pest attacks as a

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disturbing consequence. When asked about the worst effects of climate, the common response was "*pest attack due to extreme temperatures*". And when asked about how they manage pest attacks, the common response was to scrape out the affected plant, so that it does not affect other plants. This is quite an impractical solution for larger-scale farming.

B. The difficulty of Organic Farming and Need for Pesticides: Organic farming was reported to be extremely difficult unless done on a very small scale. Farmers use some amount of chemicals and pesticides to maintain the plants: 31.7% of the surveyed farmers buy conventional commercial chemicals and pesticides; 21.7% of people make their homemade plant protection products and only 4% population buy organic plant protection products (which are relatively more expensive).

C. Deficient Agricultural Soil: Qatar has poor agricultural soil as it is mostly arid, shallow, and coarse. When asked about the soil for their kitchen and backyard gardens, most respondents affirmed that they buy and transport the soil and soil amendments from nurseries, which is an undeniably impractical and tiring step to add to the farming process. Repeatedly cultivating lands, especially urban lands that are not meant for farming, quickly degrades and at times, even contaminates the land (Kanianska, 2016). This is more critical in arid climates. Undoubtedly, backyard gardeners would have reported the inadequacy of land if it was available in a large area for them; however, as the area cultivated is narrow, and as most use small vegetable beds or pots for gardening, land degradation was not reported as the main factor.

D. Pollution: Soil, water and air pollution from chemicals and pesticides used for farming is also a challenge with no mitigation strategies yet. Respondents reported that there is no segregation of gardening waste from other waste. Moreover, most respondents were not aware of composting methods.

The criticality of environmental challenges facing backyard agriculture in Qatar is shown in **Figure 5**.

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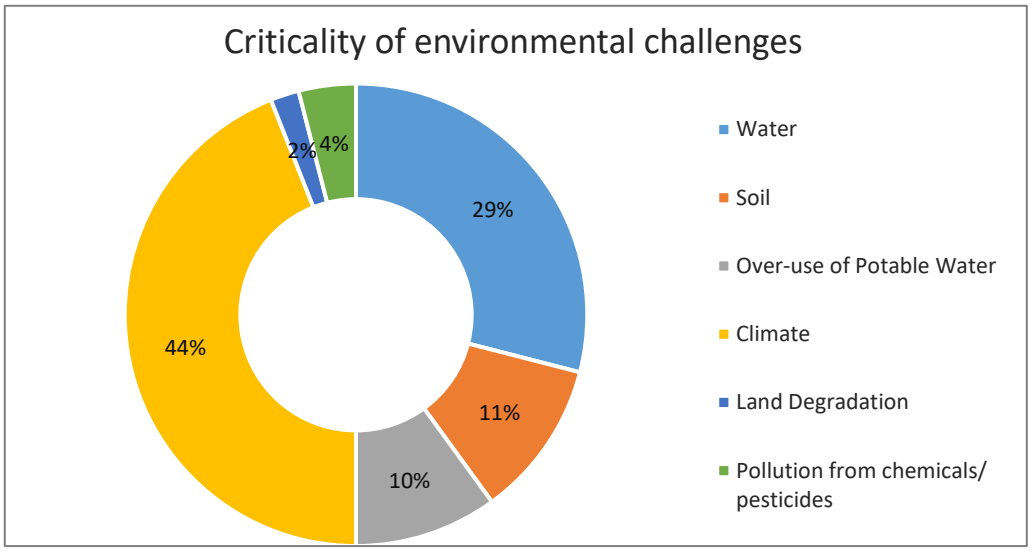

Figure 5: Criticality of environmental challenges based on informal interviews from residents of Qatar's neighborhoods.

5.2.2 Economic Challenges

Economic challenges that were identified by the survey responses include the low return on investment, the low opportunity for job creation in light of the instability, and the elevated costs of inputs like soil, fertilizers, and water, as shown in Figure 6.

A. Non-Feasibility of Investment, Low Revenue to Cost Ratio: Based on the survey, it is clear that backyard farming offers so far little or no guarantee of return. Respondents reported that, besides being time-consuming, it involves several upfront investment costs. When asked about reducing the amount of buying fresh foods from the commercial market, residents stated a reduction of approximately 12 to 15% in expenditures incurred on the same product. Noticeably, only a few fresh foods, such as tomatoes, green chillies, and eggplants, grow sufficiently in the respondents' home gardens. Water, soil, seeds, and pesticide costs add up to labour. Employed respondents reported certain needs to hire gardeners on hourly rates and subject to the garden area. For reference purposes, it is noted that the hourly rate costs 25 - 30 QR, and an area of 50 m^2 requires 3 hours to maintain, subject to the condition of plants.

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B. Low Return Threatens Opportunities for Job Creation: While it is argued that neighbourhood farming would further create instability on the employment front (Barioni, et al., 2019), this is unlikely to be the case in Qatar. Interviews revealed that the majority of home-farming is undertaken during free time or by stay-at-home family members. It is therefore improbable for residents of Qatar to compromise their jobs for backyard farming given the insufficient volume of home-grown produce. On a positive note, backyard farmers will not cause other devoted urban farmers to run out of jobs.

C. Elevated Costs of Soil and Fertilizers: 80% of people responded that they buy soil and/or soil amendments from a nearby nursery and 28.3% people said they buy from supermarkets, especially during discount periods. For reference purposes, a bag of 10 litres of potting soil costs 50 QR (~15 US$). It is undeniably costly to buy soil for farming. Buying manure or other soil amendments and fertilizers adds to the incurred costs. Very few respondents are aware of home-composting processes. To wrap up, 55% of respondents agreed that the cost of gardening is a major impediment.

D. Elevated Cost of Water: The water used for backyard farming is potable. Not only this is environmentally unsustainable and economically costly on the national level, but it also adds to the many costs incurred by backyard farmers. One m^3 of water costs around 5 QR (~1.5 US$). Additionally, in February 2021, Kahramaa, the public water and electricity authority of Qatar, implemented a 20% rise in the water bill to cover the costs of infrastructure projects (Abdallah, 2020).

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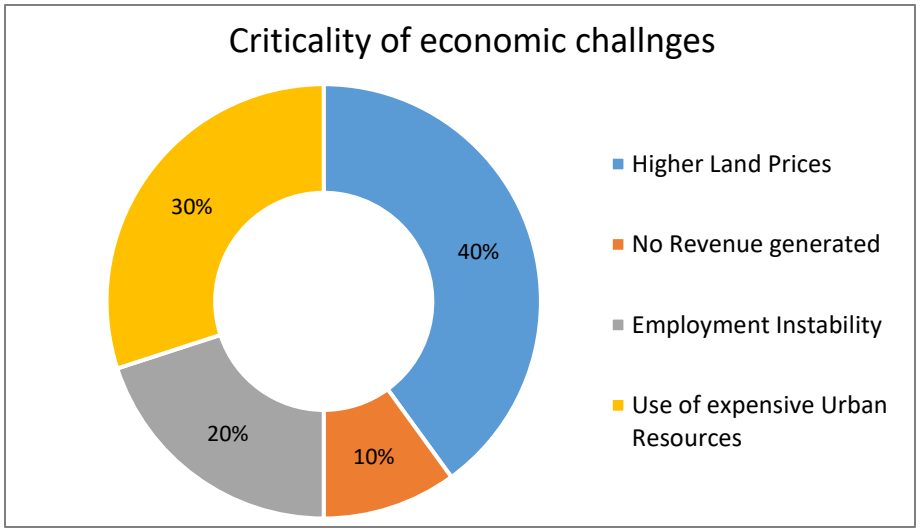

Figure 6: Criticality of economic challenges based on informal interviews from residents of Qatar's neighbourhoods.

5.2.3 Public Policy Challenges

With the attention that urban agriculture has gained through international organizations, media and sustainability policies (United Nations, 2008), self-sustaining communities and self-grown food are becoming major subjects of public policy strategizing, setting, implementation, and monitoring. The research revealed that incomprehensive food safety monitoring challenges backyard farmers, among other factors (Figure 7).

A. Limited Farming-Areas Covered by Food Safety Monitoring: It is proved that chemicals, pesticides, and herbicides can cause harm or discomfort to live organisms and affect the environment as a whole (Arzu Özkara, 2016). The increasing use of these chemicals poses a considerable threat to both residents and crops if not all precautionary measures are taken, and good agricultural practices are not followed. Policies geared towards monitoring the self-grown-food environments are still embryonic. While registered farmlands around Qatar are regularly monitored by the Ministry of Public Health, Qatar does not have any monitoring or food inspecting policy for small-scale farming as of now (2021). Correspondence with local stakeholders revealed that the health inspectors examine the quality of soil and produce every 15 days on average. However, the survey exposed that 99% of the respondents are not aware of if their home produce is consumable or not (Hassen et al., 2020). Many respondents are unfortunately unaware of the high possibility for disease transmission and its rare yet life-threatening aptitudes.

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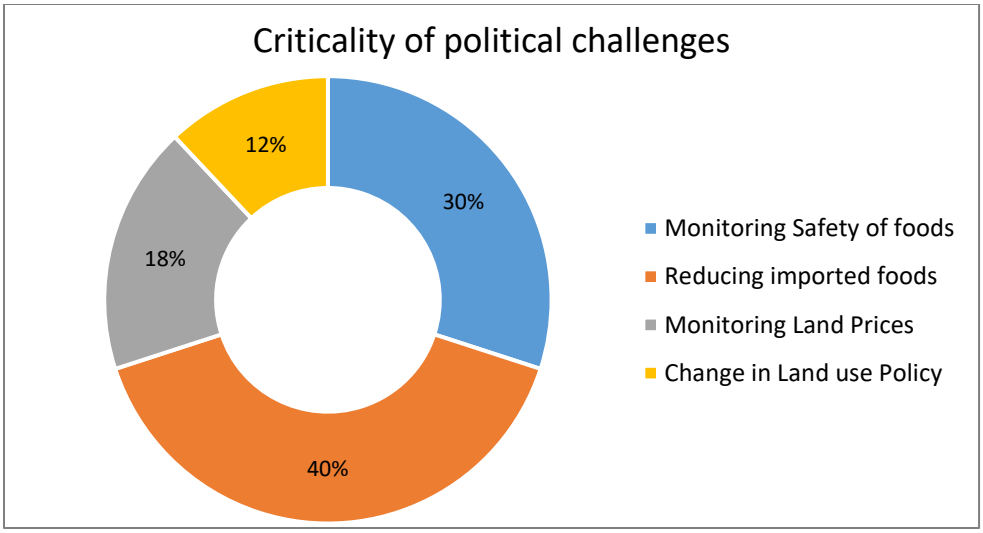

Figure 7: Criticality of political challenges based on informal interviews from residents of Qatar's neighbourhoods.

5.2.4 Challenges to Social Wellbeing

Respondents revealed a positive impact from backyard agriculture on their social wellbeing, however, the effect of climate on the outlook of plants was seen as disincentivizing.

They also reported that socializing, exchanging ideas and individual experiences with peer backyard farmers was important motivators. In specific, when asked if they feel more connected to other backyard farmers, 48.3% of people responded positively, and 28.3% of people responded negatively.

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A. Enhanced Societal Interactions: It is argued that social interaction around a common purpose improves communal mental health, especially for isolated expats (Tulane University, 2020). This is agreeable with the responses of many informally interviewed gardeners who responded that they connect better to neighbours interested in gardening, and on many occasions, they exchange plants, seeds or other plant materials. It is also argued that there is a scope for theft and vandalism (Pitt, 2013). However, vandalism is not particularly seen as an issue among respondents, who benefit from a safe environment in Qatar, and well-fenced private farming areas. In specific, when asked if they feel more connected to other backyard farmers, 48.3% of people responded positively, and 28.3% of people responded negatively.

B. Garden Aesthetics: As in most hot and arid regions, sandstorms and days of high dryness occur frequently in Qatar. The effect on crops is not only physical but also aesthetic. The respondents attested that the appearance of their gardens at such time is unpleasing and psychologically disturbing to residents. For the focus group of this research, gardening is more about passion and self-motivation, therefore many reported being demotivated if plants die or get attacked by pests and therefore should be discarded (Figure 8).

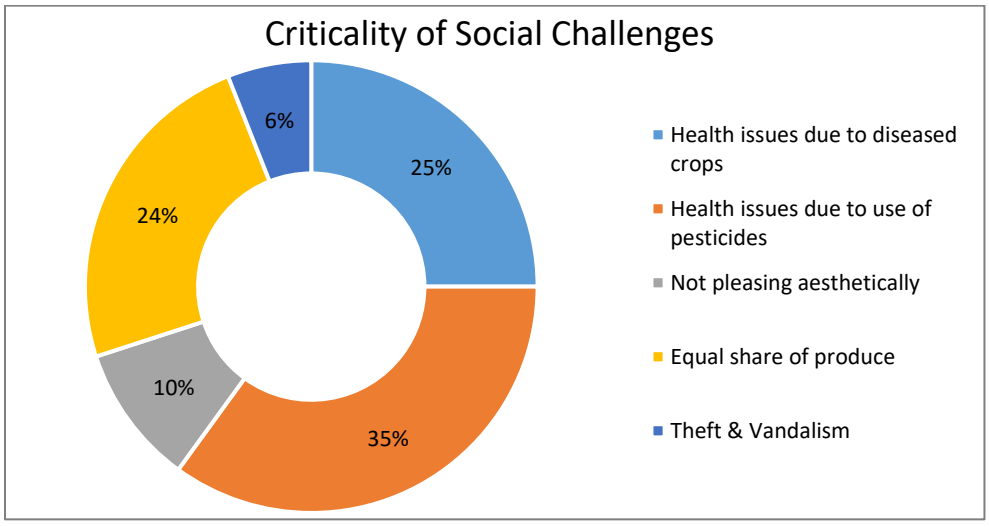

Figure 8: Criticality of social challenges based on informal interviews from residents of Qatar's neighbourhoods.

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6. Recommendations and Policy Implications

Several solutions can be deployed to mitigate the aforementioned national-level challenges namely: soil, arable land and water scarcity, incomplete spatial development policies, and lag in the deployment of proper agricultural systems. And while mitigating the scarcity of arable land is not directly related to the promotion of backyard farming, addressing water and soil scarcity directly and positively impacts backyard farming. Solutions addressing the challenges brought by an incomplete spatial policy framework and a lagging deployment of agricultural systems vary across levels, and what might seem suitable nationally, can be of irrelevance at the backyard level. Therefore, context-specific solutions based on an extensive analysis of local conditions are needed (Gulyas & Edmondson, 2021).

6.1 Mitigation of Water Scarcity

A. Robust Water Resource Management Policies: The use of abstracted freshwater should be done carefully and sustainably avoiding depleting the existing renewable water resources, the aquifers.

B. Water-Saving Food Growing Systems: The use of hydroponics and aquaponics should be raised, as the first one is proved to be a successful strategy in Qatar for growing vegetables and is already practised by local greenhouse farms saving water and input resources (McClintock et al., 2010). Aquaponics incorporates aquaculture into hydroponics to produce both plants and aquatic species, therefore the benefits are bigger in terms of food diversification than practising aquaculture or hydroponics separately. Moreover, aquaponics produces nearly half the environmental impacts compared to hydroponics due to the higher total value of its products (Chen et al., 2020). Therefore, according to experts, aquaponics could respond to the challenge of sustainable food production in an arid country, like Qatar (Abusin & Mandikiana, 2020).

C. Alternative Water Sources for Irrigation: The use of TSE in agriculture and landscaping is an alternative solution for irrigation purposes conserving the country's natural water resources. Other alternative water sources such as water produced from air conditioning units, greywater, and saline water could be utilized as well. After the proper treatment, these water sources could be used in the agricultural sector, in landscaping, and for irrigation of salt-tolerant crops such as halophyte plants. Indeed, Qatar has already started using TSE since 2004 with 25 million m^3 (Planning and Statistics Authority, 2017) and this amount has been increased by about 3 times from 32.69 m^3 in 2006 to 88.6 million m^3 in 2019 (Figure 4).

D. Water-Saving Agronomic Practices: Farmers should be encouraged to adopt water-efficient irrigation methods such as sprinkler and drip irrigation systems and choose to grow water-efficient crops than water-intensive crops.

6.2 Mitigation of Soil Scarcity

A. Soilless Cultivation Techniques: Cultivation in growth bags using soil substitutes like cocopeat, rock wool, vermiculite, and perlite could potentially overcome the limitation of non-productive or marginal land unsuitable for soil cultivation (Mustafa, 2010; Karanisa et al., 2021). These methods can be extended to support backyard farmers.

6.3 Integrating Urban Agriculture in Land use Planning

Incorporating urban agriculture in land use policies is an important step towards developing more food-secure cities (Wooten & Ackerman, 2011). To do so, land-use policymakers are encouraged to undertake the following actions:

A. Urban Agriculture Sites: Incorporate urban agriculture sites, community facilities (storage, sheds, markets), community gardens, urban farms, and home gardens in spatial mapping and regulations.
B. Landscape Requirements: Reconcile landscape requirements with produces that enable food security, not only aesthetic and shading plants.

C. Integrate Urban Agriculture into Comprehensive Spatial Planning: Regulate externalities and conflicting uses in a way to minimize insecurity from nuisance complaints.

D. Integrate Urban Agriculture into Zoning Regulations: Set land use policies where urban agriculture is either allowed or conditional, based on the local context, and set zoning bonuses to subsidize developers for pro-agriculture developments.

E. Community Participation: Seek stakeholders' participation in policy-setting.

6.4 Deploying Suitable Agricultural Systems and Facilities

A. Development of the Greenhouse Sector: During the years 2019 and 2020, the Ministry of Municipality and Environment in Qatar imported 350 greenhouses and allocated them to 85 local farms to lay a strong foundation of agricultural production in the state (Ministry of Municipality and Environment, 2019). This volume is not yet enough and proper policies shall be deployed to support the demand for greenhouse products. Qatar would largely benefit from the further development of the local greenhouse sector as the use of smart technologies in greenhouse cultivation would optimize the use of resources and inputs, reduce the production cost while maximizing the potential crop yield (Ouammi et al., 2020). It is also important that the greenhouse design and employed technologies are suitable for the Qatari geo-climatic conditions for optimal performance under a hot arid climate and unique resource availability (Ghani, et al., 2019).

B. Composting: Urban agriculture, as well as backyard farmers, can greatly benefit from organic compost. It is recommended to treat household waste, including food and green waste, and convert it to compost. This offers an opportunity to enhance the fertility of the on-site available soil while reducing the amount of generated waste and the cost of its disposal.

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6.5 Recommendations to Relieve Economic Challenges

A. Farming Subsidies and Financial Support: Farm operating costs such as water consumption could be subsidized for farmers to encourage more residents to garden in their backyards while installing a specific water meter for the garden. Besides, agricultural supplies can be subsidized and monitored to ensure there is no supply shortage and price instability.

B. Strengthen Farmers and Agri-Business Relationships: It is essential to integrate community urban farming initiatives with agri-business by establishing a collaboration model that is self-sustaining over the long term, especially financially. Local markets can facilitate the supply chain and generate revenue for the farmers. Garden markets can sell resources, necessary equipment, and seeds.

6.6 Recommendations to Relieve Social Challenges

A. NGOs and Local Entities' Assistance: NGOs and local entities can assist in spreading the culture of home gardening among the communities as well as providing general resources.

B. Farmers' Social Networks: Social media is a successful way towards networking. Group members can support each other and share knowledge on successful gardening techniques. For groups based on proximity, members can also exchange seeds and other plant supplies. Authorities can leverage the existing members of social media groups, as they are managed by private accounts. Besides, experts can be called to join the group imparting their knowledge, making backyard gardening more efficient.

C. Promotion of Awareness Programs: Awareness events can highlight the benefits and spread the culture of urban farming among communities while facilitating practical issues as the resources access. Training workshops are vital for those practising or who wish to start farming as basic knowledge is required for the maintenance of the production systems.

7. Conclusion

The paper explores the challenges of backyard self-grown food in neighborhoods of Qatar, where a considerable community of appreciators is burgeoning. The conclusions that were drawn based on interviews and surveys, showed that the macro-level challenges cascade down to the household/micro level in many instances. Based on the reported answers, backyard urban farmers in Qatar face a large spectrum of challenges, distributed over four categories: environmental, economic, regulative, and social. On the environmental level, farmers complained of harsh climatic conditions, leading them to use chemicals and pesticides, deficient agricultural soil, land degradation, and pollution. On the economic level, complaints included low feasibility of their investment in time, labour, soil, water, and products compared to the little financial returns. Land use policy did not yet catch up with food security and urban agriculture requirements. Respondents also wondered about the adverse health effects of increased use of chemicals and air pollution, neither could they affirm the safety of their backyard-produced food. Furthermore, the effect of sandstorms, heat, and dryness on both the aesthetics and quality of produce disincentivized farmers.

The sample size for this research is limited to responses from 70 households in Qatar. While the conclusions are drawn based on these responses, the proposed recommendations are drawn from authors' understanding based on benchmarking and selecting policy measures adopted for similar conditions. The authors suggest to expound the size of samples for future research.

The paper demonstrated that urban farming in Qatar should urge policymakers to develop policies for urban farming at different levels, ranging from national to backyards and gardens. The sector has the potential to increase even more in the future and might put extra pressure on both the arid ecosystem of Qatar and the limited capacities of urban households. The recommended measures on urban land use, sustainable resource management, increased awareness together with the support to urban growers will help to overcome these challenges and make urban farming in Qatar both viable and sustainable.

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