# Food self-sufficiency of urban areas—lessons from the metropolitan area of Barcelona

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## Preface

Increasing regional food self-sufficiency has been recognized as a strategy by movements such as degrowth to advance multiple urban sustainability goals. However, particular socio-ecological configurations need to be examined to understand the role local food production has in city. To better understand the current and potential food self-sufficiency of urban areas, this TFM project evaluated the food self-sufficiency of the Metropolitan area of Barcelona as well as strategies to improve food self-sufficiency through urban agriculture. While the research design of the project followed similarly to an academic format, the final output is a non-academic output in the form of two essays. This was done mainly as an attempt to disseminate the research findings and main arguments in a clear and appropriate manner to a larger audience.

The first essay in this two-part series looks to describe the current food self-sufficiency level of the AMB building on the work Dr. Gara Villalba's research group. For more information on the research methodology, please see the annex. The second essay reads as a complement to the first in that it explores urban agricultural strategies being proposed as a means to improve local food self-sufficiency, something spoken about frequently in our courses throughout the year, described as local food provisioning. This essay was mainly built on a thorough literature review, concepts disseminated throughout the master's course, and personal experiences I have had participating in an urban garden for the past 8 months in Barcelona.

**What role does food self-sufficiency have in metropolitan areas? Lessons from the metropolitan area of Barcelona.**
By: Haley Parzonko

In the wake of calls for urban resilience and sustainability, one strategy increasingly found on the urban agenda is enhancing local food self-sufficiency, understood here as the extent to which a given region, city, or other geographic scale can fulfill its food demand from domestic production.

The metropolitan area of Barcelona (henceforth AMB) is a microcosm of the movement both politically and socially towards food self-sufficiency. Since Barcelona signed the Milan Food Policy Act in 2015, bolstering local food production under the banner of 0 km food has been at the forefront of local food policies culminating in Barcelona being named the Sustainable Food Capital of 2021. Despite this rather recent policy awakening, social movements and farmer's unions have been advocating for the protection of farmland and fighting for the right to produce in the AMB for decades.

Nonetheless, on the ground, the food production potential of the AMB has deteriorated as a result of continuous processes of urbanization. So, where does this leave us today? This post looks to take a deep dive into the current food self-sufficiency levels (SSL) in the AMB building on new data released from URBAG, a research group focused on urban agriculture. The purpose of this post is to provide a more nuanced picture of the SSL at the metropolitan scale using data from 2015.

SSL assessments include three main parts: current production on available agricultural land, current diets, and agricultural productivity. These will serve as the main sections of the post to highlight the SSL of three main food categories in the AMB: fruits, vegetables, and fresh meat.

**Agricultural Land & Current Production**
As noted above, the production of food in and around the AMB has seen major reductions as a result of waves of urban development. In one study, researchers found the agricultural land in the AMB has decreased significantly since 1956, from 24,713 hectares to 5,728 hectares in 2000. Whereas, the urban built-area made up of residential, commercial, and infrastructure projects went from 10,000 hectares to 59,300 hectares in the same time period.

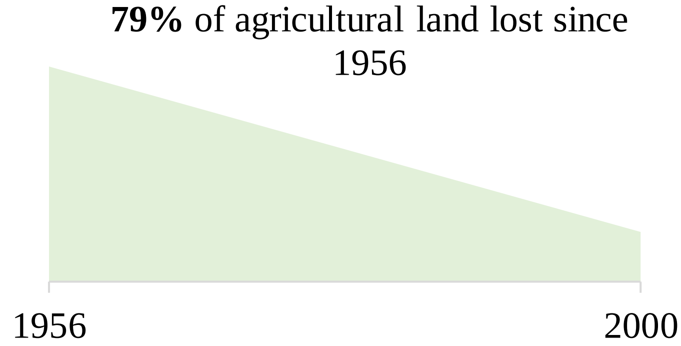

**Figure 1**. Decrease in agricultural land from 1956 until 2000. Source: Own elaboration based on this study.

According to researchers Angelica Mendoza-Beltran and colleagues, approximately 9% of the land in the AMB is used for agriculture. Mostly concentrated in the one county, that hosts the Baix Llobregat Agricultural Park (BLAP), a protected peri-urban agriculture zone on the outskirts of Barcelona.

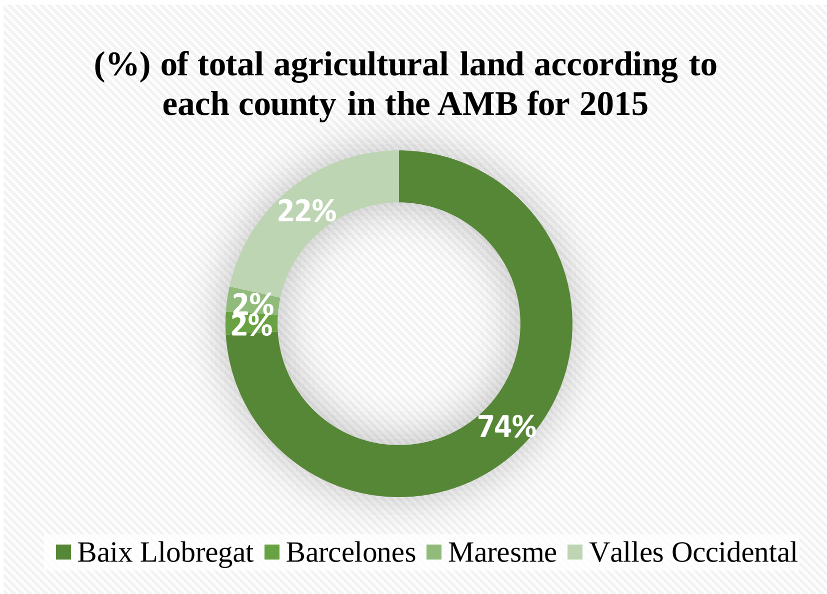


**Figure 2**. The percentage of agricultural land disaggregated according to the different counties in the AMB. Source: Own elaboration based on the study of researchers Angelica Mendoza-Beltran and colleagues.

The lion's share of remaining agricultural land in the AMB is dominated by vegetables and fruits (54%) and cereal grains (34%). However, the crop categories with the highest agricultural output are vegetables (38,836 tons), fruits (13,186 tons), and forage crops, more commonly known as animal feed, (12,859 tons). This marks a shift in the local landscape from producing the Mediterranean trilogy (i.e., wine, olive oil, and cereal grains). Olives and vineyards still occupy agricultural land, however to a significantly lesser extent then their historical presence.

Away from vast fields focused on one crop (i.e., monocultures) the production of fruits and vegetables contributes an important level of diversification to the food productive landscape in the AMB, producing more than 35 different crops (listed in the table below).

**Table 1**. All of the fruits and vegetables produced in the AMB according to different categories. Source: Own elaboration based on the study of researchers Angelica Mendoza-Beltran and colleagues.

| Dried Fruits | Fruits | Stone fruits | Stem Vegetables | Fruit Vegetables | Other Vegetables |
|---|---|---|---|---|---|
| Almonds | Apples | Apricots | Asparagus | Chilies | Artichoke |
| Hazelnuts | Figs | Cherries | Celery | Cucumber | Broad Beans |
| Walnuts | Kiwi | Nectarines | Chard | Eggplant | Cabbage |
| | Melon | Quince | Leafy vegetables | Peppers | Carrot |
| | Pears | Peach | | Pumpkin | Cauliflower |
| | Persimmon | Plum | | Tomato | Garlic |
| | Watermelon | | | | Green beans |
| | | | | | Peas |
| | | | | | Radish |

For livestock production in the AMB, according to a forthcoming study by researchers_Angelica Mendoza and colleagues titled, *Regionalized impact of nutrients and water of peri-urban agriculture*, *case study of AMB*, there is a variety of livestock animals being raised in the AMB, including chicken, dairy cows, laying hens, cattle, rabbits, sheep, and goats. The crops grown to feed animals in the AMB, is primarily alfalfa and rye-grass. These two types of feed are usually for grazing animals like sheep, goats, and cattle.

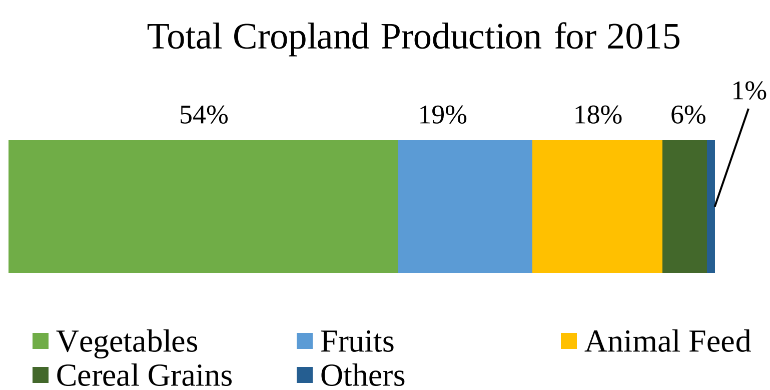


**Figure 3.** Total agricultural production in the AMB for 2015. The category labelled as 'Others' includes olives, vineyards, legumes, industrial crops and other woody crops which all had minimal production less than 200 tons. Source: Own elaboration based on the study of researchers Angelica Mendoza-Beltran and colleagues.

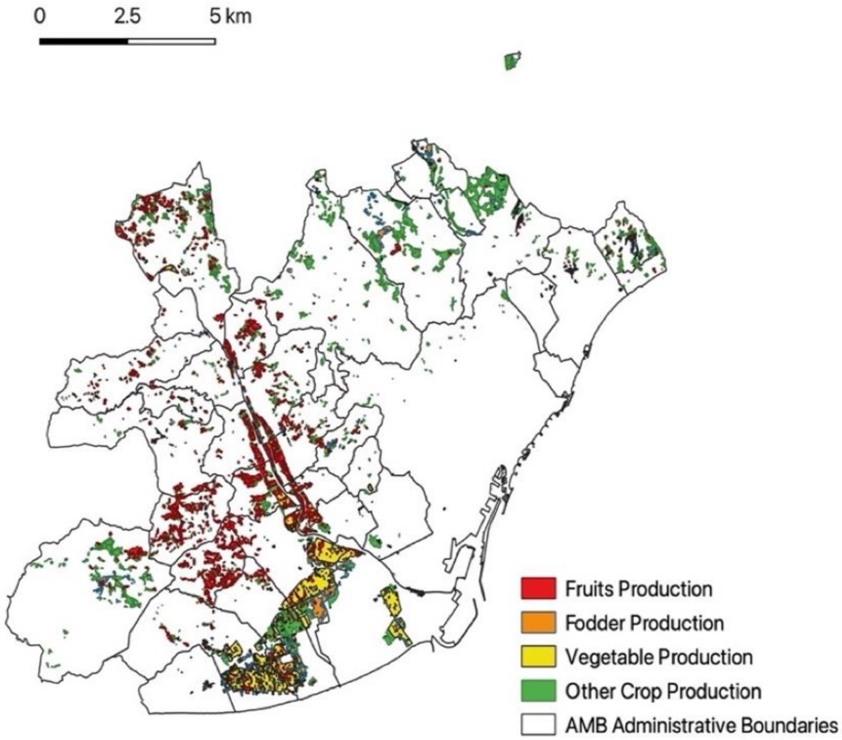


**Figure 4**. A more detailed picture of all the crops produced in the AMB for 2015 mapped used Geographic Information Systems (GIS). Source: Own elaboration based on the study of researchers Angelica Mendoza-Beltran and colleagues.

**Agricultural Productivity**

The level of productivity in agriculture often relies on the production system in practice. Since the mid-20th century a rapid transition occurred in Catalan agricultural practices, in which mechanization (i.e., substituting manual labor for machinery), farm size consolidation, and increased usage of agrochemicals like synthetic fertilizers, increased agricultural output. In the AMB, despite the ecological degradation connected to these agricultural practices, the majority of farms still rely on them, oftentimes to make agriculture economically viable.

**Consumption Demand**

Since the mid-20th century, Catalan diets have changed dramatically, expanding beyond the spatial and temporal dimensions of food productivity from the local landscape. One main difference is the substitution of the traditional role of legumes and tuber consumption for livestock products. However, fruits and vegetables still make up a large share of the overall Catalan diet.

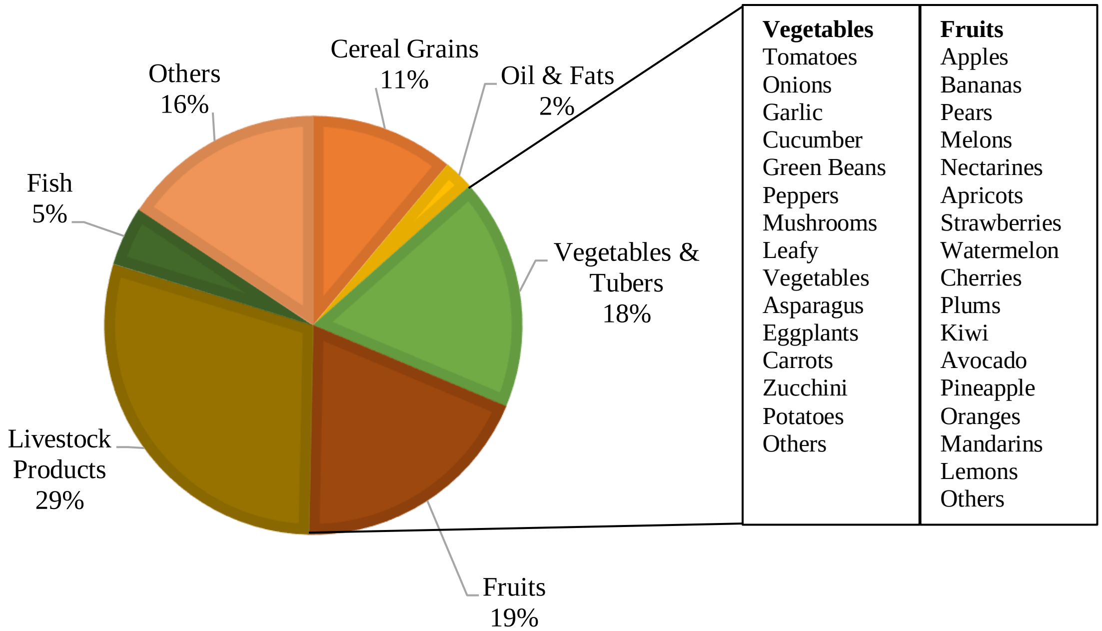


**Figure 6.** Estimate of total food consumption of the AMB population based on consumption surveys. Other products include processed and prepared fruits and vegetables, beverages, chocolate products, olives, and legumes. Source: Own elaboration based on data from Ministerio de Agricultura, Pesca, and Alimentacion.

**Food self-sufficiency ratio**

The current self-sufficiency level in the AMB is 13.7% for vegetables and 3.5% for fruits (see figure below). Most of these products are seasonal, hence the current food self-sufficiency would cover a portion of the harvesting season, but not necessarily the whole year. Similar to other metropolitan areas, in Europe and globally, there is a discrepancy between a densely populated area and the available agricultural land to feed this population, resulting in a high dependency on other geographies for food supply.

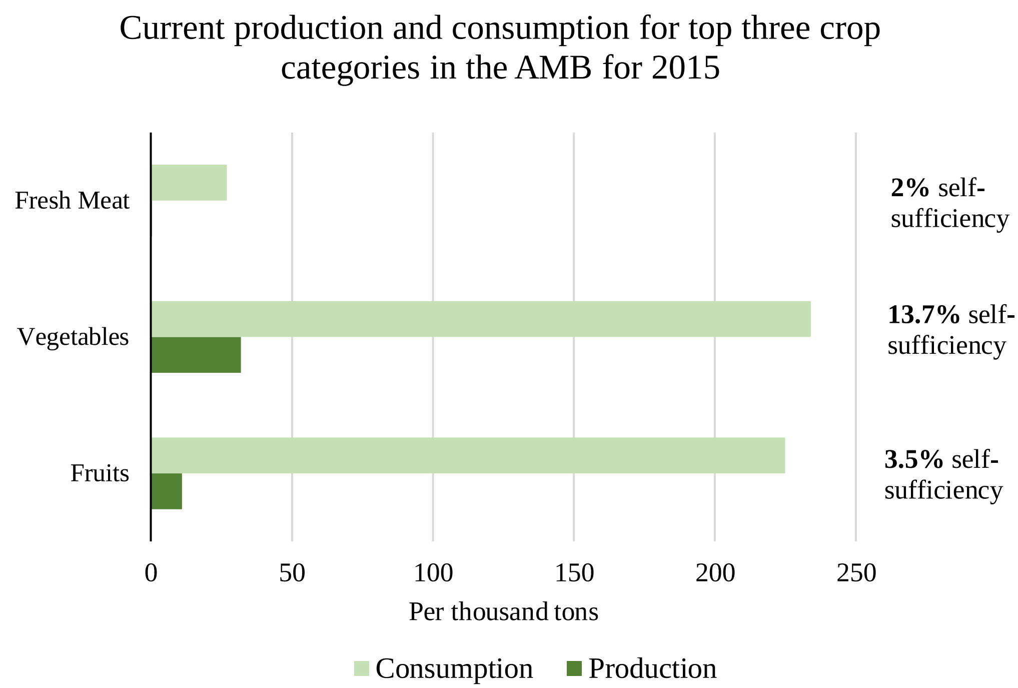


**Figure 7.** Self-sufficiency ratio for three main production categories in the AMB. Source: Own elaboration

For livestock products, while current fodder production can cover 75% of the feed demand for goats, sheep, and cattle in the AMB (see figure below). For human consumption, this livestock population converts into supplying a mere 2% the total dietary intake of fresh meat.

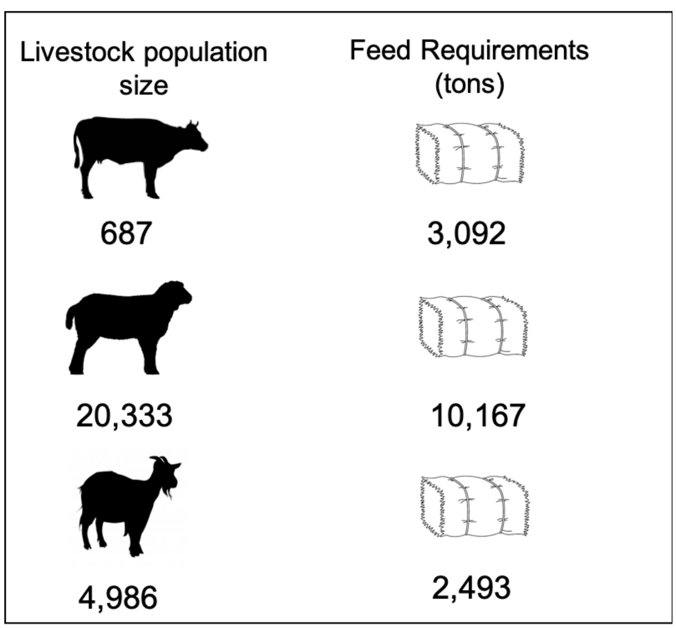


**Figure 5.** Livestock population representing the assumption of those which could be fed what is produced in the AMB. Source: Own elaboration based on data and methods from Eurostat to calculate the feed requirements and livestock population size taken from a forthcoming study,

Angelica Mendoza, et al. Regionalized impact of nutrients and water of peri-urban agriculture, case study of AMB. Submitted to the journal STOTEN April 2022.

**Do current diets and local landscapes match?**

Besides the major reduction in agricultural land, the mismatch between the dietary patterns in the AMB and the local landscape impact current food self-sufficiency levels. For instance, 30% of fruit consumption is from bananas and oranges, currently non-existent in local production. Currently, livestock products make up close to a third of the overall diet, with fresh meat being the highest consumed product per capita. The 'meatification' of the Catalan diet comes backpack of extensive land requirements weakening the self-sufficiency potential of the AMB landscape.

On the other hand, some key food products that have remained in the diet have disappeared from the landscape. olive oil and wine still represent core parts of the diet, but they have disappeared almost entirely from the AMB landscape. There are some efforts to recover these traditions within the AMB, such as the agricultural cooperative L'Olivera. Interestingly, one food category that has lost its role in both the landscape and the local diet is legumes. Legumes functioned as a natural fertilizer providing nitrogen to the soil, largely replaced now by chemical inputs. At the same time, it was an integral part of the Catalan diet providing energy and protein to the population.

In short, there have been historical transitions both in the landscape of the AMB and the diet of its population, both of which have traces of Mediterranean influence. There is a clear divergence between what and how much the landscape can grow and a food metabolism stretching beyond the spatial and temporal dimensions of the AMB landscape.

**What does this all mean?**

On its own, as demonstrated above, city-scale food production is a marginal contributor to food self-sufficiency levels. Importantly, increasing local self-sufficiency is not meant to reverse the over-reliance cities have on the global-scale to then complete self-reliance. Rather, what food system scholars advocate for is a diversification of the scales of production to find a balance in what urban food security relies on. What role cities have in this, remains an open question.

There have been some general recommendations for what is most appropriate for city-scale food production, or also known as urban and peri-urban agriculture. Some argue the potential of urban agriculture in supporting more resilient food systems lies in the focus on producing nutrient rich, perishable foods like fruits and vegetables. While others highlight that the potential of urban agriculture is in its ability to provide services to the urban environment and actualize social and health benefits for its residents. Others have argued for the development of city-region food systems, expanding the idea of self-sufficiency beyond a city's administrative boundaries. A study done by BCN Smart Rural in 2021, found that for Catalonia, the broader region where the AMB rests, the self-sufficiency rises to around 44% for the complete diet. Other city-regions show better potential, almost complete self-sufficiency, such as Lisbon.

Most critically, city-scale food production needs to not only rest on potential production capacity, but also the political ecologies of the local landscape. To avoid what scholars, some scholars have called 'the local trap', decoupling local from inherently more sustainable will provide a more honest picture of re-localizing food systems alongside the inevitable compromises and tradeoffs involved. To close, I will end with some questions in order to put the idea of food self-sufficiency into conversation with questions of social and environmental justice.

Who gets to choose which tradeoffs are we willing to accept for city-scale food production? Who owns and has access to the means of food production, like land and resources? How are different values and visions for urban agriculture reconciled? Whose interests prevail and who loses from enhancing food self-sufficiency?

**To what extent can urban agriculture improve food self-sufficiency of a city?**
By: Haley Parzonko

Globally, urban agricultural strategies are being explored as a means to improve food self-sufficiency of cities. In the metropolitan area of Barcelona (henceforth AMB), there is a rich heterogeneous environment of urban agriculture in both policy and practice. In the AMB, using urban agriculture as a mechanism to improve food self-sufficiency has increasingly been recognized as part of the solution to transform urban food systems within a broader framework of urban sustainability. Urban agriculture is often defined as the cultivation and processing of food in and around cities.

However, urban agriculture can represent a wide variety of practices and visions within the food system, leading to divergent outcomes. Furthermore, the socio-ecological configurations of cities shape the potential of urban agriculture in particular ways. Hence, this post will broadly explore 1) urban agricultural strategies to improve local food self-sufficiency, 2) look at how do these contributions implicate other goals such as lowering the environmental impact and improving social equity in urban food systems, and 3) address the opportunities and challenges for each strategy in relation to the context of the AMB.

To note, some peri-urban and urban agricultural practices have already been quantified in their local food contribution, these mainly include peri-urban and urban farms. Thus, the purpose of this post will look at other popular urban agricultural strategies being considered as contributors to local food self-sufficiency.

**Why do we need to improve local food self-sufficiency?**
Before discussing the urban agricultural strategies, it is helpful to understand why food self-sufficiency has become increasingly popular. The need to improve food self-sufficiency falls under two main critiques to the current food system. First, the heavy reliance on international trade for urban food security decreases the resilience of urban food systems. The second is the current functioning of urban food security relies heavily on unequally shifting the costs of production, also understood as environmental burdens to other countries.

Besides the critiques, authors have noted a wide list of potential positive outcomes bringing agriculture back into the city for its residents and urban ecosystem. Some outcomes for the city include, helping to cool the city and increase biodiversity and green space (for a more comprehensive review see this study). While some outcomes for urban residents include health and social benefits related to access to healthy food, building social cohesion among participants, and educational opportunities (for a more comprehensive review see this study).

**Urban agricultural strategies**
One main way urban agriculture is practiced is through urban gardens. Urban gardens allow for a wide variety of fruits and vegetables to be produced through a practice called polyculture. Urban gardens are often thought of as a potential strategy to improve food self-sufficiency due to historical examples where during economic crises they contributed significantly to urban food security. For instance, the urban garden network formed in Havana, Cuba with the collapse of the

Soviet Union underpinned the city's food security. Closer to home, urban gardens played a central role in supporting urban food security of Barcelona during the Spanish Civil War.

*Image: Cheeses, an urban vegetable garden part of Havana's organop*ónicos, a system of urban agriculture using organic gardens. *Flickr, CC BY-SA 2.0*

Urban gardens take many forms, such as private backyards, vacant lots, individual allotments, on rooftops, squatter gardens, or community gardens. They are almost always non-commercial, and at times purposefully kept as examples to alternative, non-capitalistic food provisioning. Following this alternative path often means, most urban gardens are seen as a space of alternative practices to the dominant food system, striving for environmental sustainability despite the amateur status of most participants. This results in attempts at regenerative or agroecological farming where practices such as cover cropping, organic composting, and biological pest control are practiced.

Studies have shown urban gardens produce average yields that are found to be higher than rural farm counterparts per square meter of land but less than high-tech production systems, like rooftop greenhouses. At the same time, there can be a large variance in reported productivity levels, resulting in a lack of uniform production across urban garden sites. Furthermore, urban gardens abide by the seasonality of produce, unlike greenhouses, for instance, where food can be grown all year long in a more controlled environment.

Some of the more revolutionary practices of urban gardens are attempting to transform food production practices that are in their control, realizing the little influence they have over the transformation of conventional food systems. As most urban gardens are communally or individually managed, they embody principles of food sovereignty, like granting access to environmental resources and being in control of the means of production. Food sovereignty is also a goal outlined in food policies for the AMB. Furthermore, given most urban gardens are open-access there is potential to empower urban residents through the transfer knowledge unlike most high-tech production systems that often require licenses to operate, capital assets to purchase, and dependency on experts who hold the knowledge.

Urban gardens represent different values to the community, which means food production may not always be the primary function of the garden. For instance, urban gardens in Barcelona are used as mechanisms of social inclusion for people with disabilities or as educational tools for young school children. Or another common practice is for urban gardens to be places of political struggle against gentrification of a neighborhood for instance.

Production in urban gardens often has low costs and is based on low-tech systems. This requires more labor, that is voluntary or on a leisurely basis. On average, one study found gardeners required between 2.79 to 3.03 hours per square meter of land in community and home gardens while another study found an average of 6 hours of labor per square meter of land. Critics point out the inefficiency in labor or resources required for small-scale production. Even though input costs are generally low, finding access to land is one of the largest challenges for non-private urban gardens due to high land prices and limited subsidies for public land.

*Image: Examples of different urban garden typologies. Top left represents a home garden, bottom left is a community garden and on the right is a group of individual allotment gardens, Own photographs*

In contrast, there is another side of urban agriculture based on more innovative practices, like high-tech high yield technology. The usage of these production practices usually happens through indoor farming, greenhouses or open-air hydroponic systems, mostly on rooftops. High yields characterize these production systems but are usually limited to a small variety of crops such as tomatoes or lettuce. However, one study found rooftop farming in Bologna, Italy was estimated to potentially supply 77% of the vegetable requirements for the city.

These practices have been criticized for the heavy material requirements embodied in the infrastructure but praised for the optimization of resources, particularly waste. For example, one study found for a closed-loop hydroponic system that recycled water from the system allows for 40% reduction of daily irrigated water, but had a larger environmental impact in other environmental categories due to the added infrastructure. Similar to conventional production systems, high-tech systems usually rely on creating a highly controlled growing environment to maximize food production. This can take the form of using synthetic fertilizers and pesticides, or usage of artificial lighting. Although, one study found in a review of 79 global cases of rooftop agriculture that 66% practiced chemical-free production.

The infrastructure for these forms of urban agriculture incur a large financial investment, often dictating the goal of the project to be commercial. Costs for installation can be as high as 880 € $m^2$. For rooftops further costs can be incurred such as building structural support for the rooftop according to legislative building codes. Some projects have found it difficult to compensate these costs as market acceptance is low and prices are high. Furthermore, commercial interests are interested in profitability for the company and its shareholders. Hence, the competitive advantage in business results in exclusionary practices like patents or high market prices. Socially, high-tech systems are often restricted in their community involvement such as for hygienic reasons and are limited in their social acceptance as an acceptable food source similar to indoor farming.

*Image: Alvin Kho, Indoor vertical farm at Chicago O'Hare Airport*. Flickr, CC BY-SA 2.0

In sum, both low-tech urban gardens and high-tech urban agriculture offer an opportunity to increase the local self-sufficiency of primarily healthy food, but each have their tradeoffs when it comes to improving food self-sufficiency while achieving environmental and social goals.

**Opportunities for urban agricultural strategies in the AMB**

*Environmental*
The different forms of urban sprawl in the AMB provide opportunities for underused or abandoned land or rooftops. The compact, dense urban core makes the utilization of rooftops a prime opportunity. It was estimated by Barcelona City Council's Environmental Department in 2010, the potential available space for rooftop farming was 1,764 hectares for the city of Barcelona. While, undeveloped, vacant land sporadically spread throughout the AMB alongside the street verges and vacant spaces fragmented by low-density urban sprawl open the chance for urban gardens to take root. For instance, in the neighborhood of Vallcarca, urban residents have transformed two plots of vacant, speculative land into urban gardens under the project name Desenruna. Furthermore, according to a study carried out in 2018 by the Barcelona Provincial Council, there is approximately 911 vacant lots throughout the AMB.

The material resources available from urban waste streams to become new inputs for urban agriculture in the AMB offers a second opportunity, especially given the heightened awareness both in policy and research in the AMB. This can be in the form of organic matter from municipal waste transformed into compost. For example, at the AMB, is actively promoting composting initiatives through community compost sites and educational materials for home composting. Alternatively, for practicing agriculture in or on buildings, it has been found by utilizing rainwater harvesting systems on roofs can significantly reduce water inputs or improve energy efficiency with recycling of thermal energy coming from buildings.

*Economic*
In the AMB, a 2019 survey from Omnibus municipal confirms there is a popular movement towards consuming more local food production. This can be a strong customer base for urban agriculture projects to develop closer producer-consumer relations. Especially given the rise of agri-food cooperatives in the AMB over the past decade.

On another note, as urban gardens cannot sell products in the local market, they often rely on public grants or fundraising efforts by the community for financial support. In the AMB, local authorities have promoted small-scale programs that subsidize publically owned land such as municipal allotment gardening programs or vacant lot strategies which grant a short-term land tenure of three to five years for a minimal fee. Given the high demand for these programs, opens the opportunity for expansion to be considered.

*Social*
In the AMB, there is a strong cultural acceptance and participation in urban gardens. Researchers Laura Calvet-Mir and Hug March, described in their study the movement towards urban gardening in Barcelona over the past few decades as a rebirth, particularly as a form of political expression.

While rooftop agriculture has been generally limited in the AMB, there is movement towards their implementation. For example, InstaGreenHouse and UrbanFresh are indoor vertical commercial farms in the heart of Barcelona growing microgreens, vegetables and herbs. Furthermore, the integrated rooftop greenhouse hosted on the campus of the Autonomous University of Barcelona provides a base of technical knowledge and research development for future implementations of rooftop urban farming in the AMB.

## Challenges for urban agricultural strategies in the AMB

*Environmental*

Despite Barcelona being a landscape historically known for its fertile agricultural lands, urban agriculture faces new challenges within the built environment. Urban gardens in the AMB, are mostly unplanned in the sense that, their location is not necessarily chosen for the most optimal growing conditions (i.e., exposure to sunlight, soil quality, slope) but mostly to use vacant land. Compounding this, especially in the urban core is the challenge of potential soil contamination or other environmental pollutants impacting the safety of the food and growing conditions. Furthermore, in the semi-arid climate of the AMB, urban agriculture not using agricultural methods to increase soil humidity or efficient watering practices could place higher environmental pressure with rising temperatures and more frequent droughts. Finally, while high-tech production systems like rooftop greenhouses, might resolve the challenge of limiting land pressure in the AMB, other environmental impacts resulting such as energy use or more material requirements associated with infrastructure should be taken into consideration.

*Economic*

Access to land for long term tenure is a main challenge for urban gardens in the AMB due to high demand, limited land, and unaffordable prices. As noted above, the longest available lease for urban gardens in AMB programs is three to five years, these are given out in minimal amounts where demand is much higher than supply. According to a study by scholar Chiara Tornaghi, not having long-term land security can limit the incentives to invest in the land such as building soil fertility or growing perennial plants. Some urban gardens guarantee land through practices of squatting (i.e., occupying a piece of land informally), but this is also precarious as local authorities can reclaim the land at any point. In short, there is a mismatch with the permanence required of urban gardens to be a resilient food production source and the precariousness with which most urban gardens find themselves in the AMB.

Due to the high infrastructure costs of high-tech rooftop or indoor commercial farming, they require sizeable public subsidies or private investors. While innovation in the agri-food sector is a hallmark of the Catalan economy, the economic viability of rooftop farming might not pay-off in the short turnaround investors expect. According to one study, this is because of current regulatory barriers, a lack of guidelines for rooftop food production, and the high initial costs that do not have a guaranteed return on investment

*Social*

A main social challenge that the AMB faces, similar to other studies is the unintended consequences of urban agricultural projects implicated in acts of social injustice, like the gentrification of a neighborhood. What this means is that as a previously devalued neighborhood gets redeveloped, including the greening of the space, which in turn raises prices in the area displacing those are low-income. This has been demonstrated in the case of Barcelona.

A second challenge for urban agricultural projects in the AMB is the mismatch between what local authorities and urban residents consider ‘appropriate’ use or appearance of urban nature. The former, has a particularly strict, tamed version of urban nature that is contradicted by the informal gardening practices and informal gardens in the AMB. An example of this is documented in one study focused on informal gardens located in the outskirts of Barcelona. This tension can limit the potential of grassroots initiatives who do not comply with the local authority’s directive.

**Conclusion**

As exemplified above, both strategies can contribute to improving local food self-sufficiency but to varying degrees and with different sets of trade-offs. Urban gardens can offer a low-input, average-yield production system focusing on healthy, culturally appropriate foods but lacks access to long-term land tenure, relies on volunteerism, and has competing goals for its main usage. High-tech urban agricultural offers a high level of production on minimal land, efficient use of resources during operations, but faces many legal barriers that hinder it from being economically viable, a social mismatch with the values of urban residents in the AMB as well as potential of incurring other larger environmental impacts embodied in infrastructure.

The way to improve food self-sufficiency through urban agriculture especially when considering the opportunities and challenges in cities does not have a one-size fits all answer. In this article, I hoped to show that urban agriculture is interconnected to many other goals and processes happening within the AMB that result in inevitable tradeoffs. These tradeoffs need to be considered within the policy framework heading towards increasing local food production within the AMB in the coming decade. Mainly keeping in mind that solely focusing on achieving higher local food production can limit the ability for urban agriculture to fulfill other necessary transformations such as ecological sustainability and social equity.

# Annex

**Research Methodology**

The methodological flow as shown in figure 1 guided the study to describe the current metropolitan foodshed according to data from 2015.

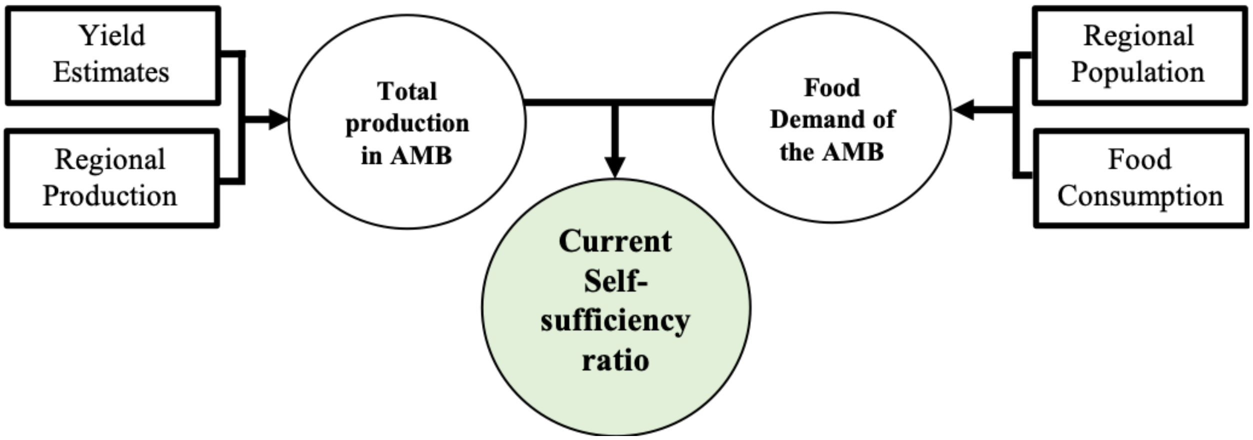


**Figure 1.** Methodological flow chart for the self-sufficiency assessment. The rectangle shape equates to data inputs taken from the scholarly literature or regional government statistics, while the circle shape equates to a calculation made.

To estimate agricultural production, data was taken from Mendoza-Beltran et al., (2022) who mapped the total AMB crop production for 2015 with Geographic Information System (GIS) technology. Then, to calculate the total production this study combined the total area and crop category from Mendoza-Beltran et al., (2022) with county level productivity estimates (kg/ha) reported by the Generalitat de Catalunya (2015). Table 1 provides a list of the components of each crop category studied. For forage crops, some land was assumed this was being directed for animal feed instead of human consumption from the crop map of Mendoza-Beltran et al., (2022).

**Table 1**. Complete list of the estimated production the different fruits, vegetables, and fodder which make up the three main crop categories in the AMB. Sources: (Mendoza-Beltran et al., 2022) and (Ministerio de Agricultura, Pesca, and Alimentacion, 2015).

| | |
|---|---|
| Fruits | almonds, apples, apricots, cherry, figs, hazelnut, kiwi, melon, nectarine, quince, peach, pears, persimmon, plum, walnut, and watermelon |
| Vegetables | artichoke, asparagus, broad bean, cabbage, carrot, cauliflower, celery, chilies, cucumber, eggplant, garlic, green beans, leafy vegetables, leek, peppers, peas, pumpkin, radish, tomato, and other vegetables |
| Fodder | Alfalfa and Ray-Grass |

The second step was to estimate the per capita food consumption of different categories. This study used regional household food consumption statistics reported by the Ministerio de Agricultura, Pesca, and Alimentacion (2015). Demand was calculated by taking per capita estimates from regional statistics and multiplying this by the total population of the AMB. However, due to the fact the study adopted a supply-restraint approach, tropical fruits such as bananas or avocados and other fruits including included strawberries, oranges, and lemons were not included in the self-sufficiency assessment.

For the fodder production consumption two calculations were made. The first estimate was to calculate self-sufficiency of fodder production to feed the current livestock population of goats, cattle, and sheep in the AMB based on data from Angelica Mendoza, et al., (2022) combined with average feed requirements reported by EW-MFA Compilation Guide (2013). The second estimate was to calculate the self-sufficiency of this animal livestock into a final consumable product, which was fresh meat in this study. This was done as shown in Table 2, by using the average carcass weights from (Alfonso et al., 2001; Guerrero et al., 2017; Holland, Loveday, & Ferguson, n.d.) and multiplying by the number of livestock animals to reach the self-sufficiency of three fresh meat products.

**Table 2.** Details and assumptions for self-sufficiency ratio of fodder production. Sources: (Angelica Mendoza, et al. Regionalized impact of nutrients and water of peri-urban agriculture, case study of AMB. Submitted to the journal STOTEN April 2022), (EW-MFA Compilation Guide (2013), and (Mendoza-Beltran et al., 2022).

| Livestock Type | Number livestock | Feed Requirements[a] (tons) | Feed produced (tons) | Self-Sufficiency Ratio |
|---|---|---|---|---|
| Cattle | 687 | 3,092 | - | |
| Sheep | 20,333 | 10,167 | - | |
| Goats | 4,986 | 2,493 | - | |
| Total | | 15,751 | 11,941 | 76% |

[a] Data to calculate the feed requirements used from table 6 of the EW-MFA Compilation Guide (2013) and then multiplied by the livestock population size.