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Prospects for Urban Agriculture in Greater Amman

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Abstract

Objectives: This research aims to assess the potential of urban agriculture within the Greater Amman Municipality (GAM) to achieve self-sufficiency in vegetable production by analyzing various neighbourhoods.

Methods: Census data, ortho-imagery, and spatial analysis using Geographic Information System (GIS) methods were employed to evaluate space allocation for vegetable production across the selected neighbourhoods. A mixed-methods approach was used with both quantitative and qualitative data. GIS analysis incorporated official documents such as urban land use plans, environmental and statistical reports to determine suitable locations for urban agriculture. Additionally, expert interviews, structured questionnaires targeting GAM residents, field observations, and photographic documentation were conducted to assess land use, site characteristics, and public perceptions. The analysis included scenarios using vacant spaces, private gardens, and rooftops with various gardening methods: open, protected, soil-based gardening, and hydroponics.

Results: The research revealed that neighbourhoods such as Jabal Al-Weibdeh could not meet vegetable production demand due to land use composition, despite lower operational costs. However, rooftop hydroponics could fulfill this demand, though it requires significant investment. In contrast, outer neighbourhoods like Al-Yadoodeh can efficiently meet vegetable needs without the use of hydroponics.

Conclusions: Urban agriculture holds the potential to significantly contribute to local agricultural production, particularly with supportive planning policies, agricultural training, and skill development. Neighbourhoods outside the urban core present a greater capacity for self-sufficiency, while those in the core could benefit from innovative methods like hydroponics to meet demand.

Keywords: Urban agriculture, food security, urban food systems, sustainable cities and communities.

الآفاق المحتملة للزراعة الحضرية في عمان الكبرى

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ملخّص

الأهداف: تهدف هذه الدراسة إلى تقييم إمكانيات الزراعة الحضرية في عمان لتحقيق الاكتفاء الذاتي من إنتاج الخضروات من خلال تحليل الأحياء المختلفة داخل حدود أمانة عمان الكبرى (GAM).

المنهجية: تم استخدام بيانات التعداد، الصور الجوية، والتحليل المكاني باستخدام أساليب نظم المعلومات الجغرافية (GIS) لتقييم تخصيص المساحات لإنتاج الخضروات في الأحياء المختارة. اعتمد البحث على نهج متعدد الأساليب يجمع بين البيانات الكمية والنوعية. شمل تحليل نظم المعلومات الجغرافية (GIS) الوثائق الرسمية مثل مخططات استخدام الأراضي الحضرية، والتقارير البيئية والإحصائية، لتحديد المواقع المناسبة للزراعة الحضرية. بالإضافة إلى ذلك، تم إجراء مقابلات مع الخبراء، واستبيانات موجهة لسكان أمانة عمان الكبرى، وملاحظات ميدانية، وتوثيق فوتوغرافي لتقييم استخدام الأراضي، وخصائص المواقع، ووجهات نظر العامة. تضمنت السيناريوهات المدروسة استغلال المساحات الفارغة، والحدائق الخاصة، والأسطح، مع استخدام أساليب زراعية مختلفة: الزراعة المفتوحة، والمحمية، والزراعة التقليدية المعتمدة على التربة، والزراعة المائية (الهيدروبونيك).

النتائج: تبين أن الأحياء المركزية في المناطق الحضرية مثل جبل اللويبدة غير قادرة على تلبية احتياجاتها من الخضروات بكفاءة بسبب تكوين استعمالات الأراضي فيها، على الرغم من انخفاض تكاليف التشغيل. ومع ذلك، يمكن للزراعة المائية على الأسطح تلبية هذا الطلب ولكنها تتطلب استثمارات كبيرة. في المقابل، يمكن للأحياء الخارجية مثل اليادودة تلبية احتياجاتها من الخضروات بكفاءة دون الحاجة إلى الزراعة المائية.

الخلاصة: تمتلك الزراعة الحضرية إمكانيات كبيرة للمساهمة في الإنتاج الزراعي المحلي، خاصة مع وجود سياسات تخطيط داعمة، وتدريب زراعي، وتطوير المهارات. تظهر الأحياء خارج النواة الحضرية قدرة أكبر على تحقيق الاكتفاء الذاتي، في حين أن الأحياء المركزية يمكن أن تستفيد من طرق مبتكرة مثل الزراعة المائية لتلبية الطلب.

الكلمات الدالة: الزراعة الحضرية، الأمن الغذائي، نظم الغذاء الحضرية، المدن والمجتمعات المستدامة.

Introduction

Urban agriculture is a highly prevalent part of human progress, dating back to the dawn of civilization. Historically, Jordan and the Levant had a lot of urban agriculture activities. Traditionally, fruits such as citrus, figs, pomegranates, grapes, and stone fruits(Peaches and apricots) were included in the plant palette. It was also popular to grow vegetables such as tomatoes, cucumbers, and radishes, as well as herbs such as mint, parsley, and basil (Al-Asad and Zureikat 2018). Changing attitudes toward gardens (from those that primarily feature edible plants to those that primarily feature ornamental plants), as well as increased urbanization and densification, have resulted in a decrease in the availability of open space for urban agriculture in the domestic and public realms.

This research aims to quantify the impact of urban agriculture on food security in the Greater Amman Municipality (GAM) using a GIS-based approach. It focuses on analyzing and quantifying available agricultural land, estimating the potential for converting land to urban agriculture to achieve vegetable self-sufficiency, and investigating the effects on household vegetable consumption. Additionally, it identifies key stakeholders and their contributions to urban agriculture and develops recommendations for promoting these practices. Figure 1 shows Amman city regions and districts.

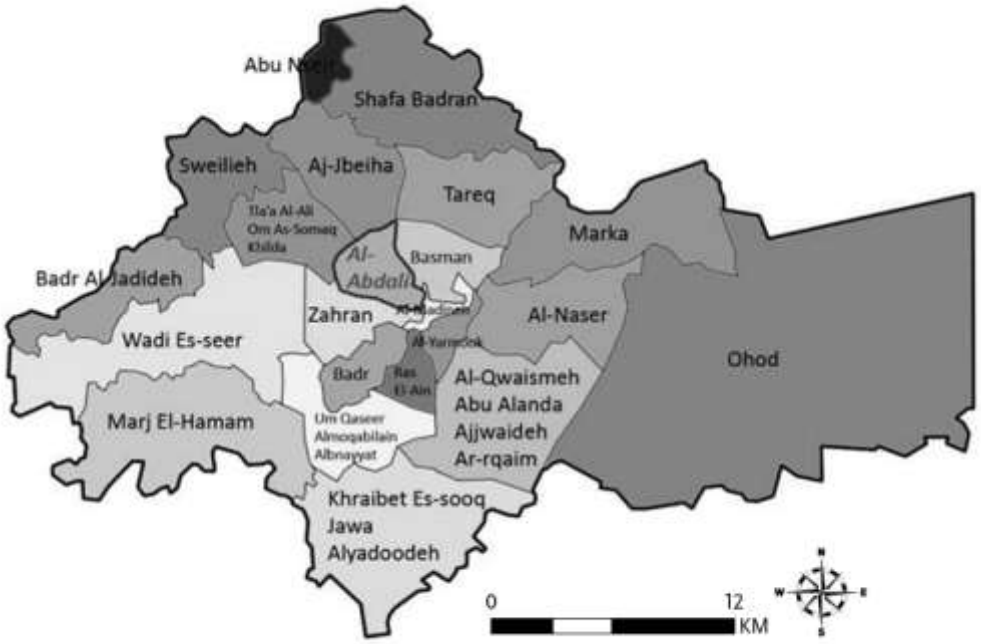


Figure 1: Amman city regions and districts. (Source: GAM, 2017).

Literature review

Urban Agriculture is not a recent phenomenon nor is it localized. Historically, UA was presented in the infrastructure of cities in a variety of forms. For example, the Inca citadel Machu Picchu, which dates from the 15th century (Mougeot, 2000). Urban Agriculture (UA) is described as any type of crop cultivation and production carried out in domestic or public settings in urban or peri-urban locations (Wyse et al. 1991). Globally, UA has arisen as a modern cultural manifestation and land-use trend, serving as a source of social solidarity, environmental education, and a leisure interest (Camps-Calvet et al. 2015). It was reintroduced to Europe years later as a response to the poverty and food insecurity caused by economic crises and protracted wars. Germany developed the concept of allotment gardens at the beginning of the nineteenth century, which fed millions of people throughout the Great Depression. (Urban Allotment Gardens in Europe 2016).

The difficulty in defining UA is that it must be comprehensive enough to cover a wide range of activities but narrow

enough to exclude unrelated fields. Agriculture in urban areas (UA) is defined by Sawio (1994) as "crop growing and livestock Keeping in both intra-urban and peri-urban settings." This definition is overly inclusive, as "growing" might include aesthetic gardens and "keeping" could include animals.

L. J. Mougeot (2000) provides a more thorough description of UA by defining it as:

"An industry located within, or on the fringes of a town, city, or metropolitan area, which grows and raises, processes and distributes a variety of food and non-food products, (re-) using largely human and material resources, products and services found in and around that urban area, and supplying largely to that urban area."

On the other hand, Nasr, Smit, and Annu (2001) define Urban agriculture as a substantial economic activity that is fundamental to the lives of tens of million s of people worldwide. It is a fast-expanding industry that is becoming increasingly vital to the economic and nutritional security of urban dwellers and has far-reaching economic, environmental, and health consequences. Urban agriculture encompasses any "industry that provides, practices, or markets groceries, on water and soil scattered all across urban and peri-urban areas", including gardens and community gardens, rooftops, construction greenhouses, and intelligent indoor plant factories.

Scale, typology, and growing system of Urban Agriculture

According to Pearson, Pearson, and Pearson (2011), there are three scales of Urban agriculture (UA) micro, meso, and macro. Its ownership is categorized as private, corporate and public entities (Table 1).

Table 1. Urban agriculture scale categorizations

Scale	Example of scale	Broad ownership categories
Micro	Green roofs, walls, courtyards Backyards Street verges	Private, corporate Private Public
Meso	• Community gardens • Individual collective gardens (allotments) • Urban parks	Private, on public land Private Public
Macro	• Commercial-scale farms, e.g., turf, dairy, orchard, grazing (e.g., horses) • Nurseries • Greenhouses: floriculture and vegetables	Private, corporate Private, corporate Private, corporate

Source: Pearson, Pearson, and Pearson (2011)

Globally, urban agriculture is found in different types and shapes, all of which are determined by the needs and preferences of the world's urban populations. According to (Payen et al. 2022), the U.A were categorized based on the urban space used to grow the crop, where two major categories were created: "gray spaces" and "green spaces," (Table 2). The term "grey space" refers to urban agricultural production placed upon artificialized land or utilizing zero-acreage farming technologies. While the term "green spaces" corresponds to urban food growing in urban vegetated areas, that is, vegetated spaces traditionally found within built-up areas (including such allotments, parks, community and private gardens, yards, and urban farms), and in "natural" environments, that is, areas of vegetation or bodies of water in an urban landscape, such as forests, coastal areas, riparian spaces, and wilderness areas (Thomaier et al. 2015; Taylor and Hochuli 2017).

Table 2. List of the Categories Used to Classify Observations per Urban Space.

Urban space		Definition	Includes
Gray spaces	**Façades**	Urban food production located on buildings' façades	Green walls, suspended balconies
	Ground	Urban food production taking place on ground-based urban	Brownfields, vacant lots, parking areas,

		land, which is to say land that is not located on or within a building and that is not classified as a green space	roadside and pathways, school and university grounds, religious spaces
	Indoor	Urban food production located within existing buildings	Plant factories, growth chambers, offices, private flats, and houses
	Rooftops	Urban food production is taking place on building's rooftops	Rooftop gardens, rooftop farms, rooftop-integrated greenhouses
Green spaces		Urban food production taking place in urban vegetated spaces traditionally located within built-up areas and in "natural" environments, which is to say areas of vegetation or bodies of water located in an urban landscape	Allotments, parks, community and private gardens, yards, urban farms, forests, coastal areas, riparian spaces, wilderness areas

Source:(Payen et al. 2022).

Urban agriculture system and methods

This research examines the impact of three factors on crop production within growing systems: whether agriculture is conducted on the ground or atop buildings, the type of cultivation medium used, and the level of environmental control applied. This study starts with conventional ground-based approaches (both open and protected) and then transitioning to rooftop agriculture, often termed Zero-acreage farming, which includes both soil-based and soilless methods. Table 3 summarizes the practices associated with typical urban agriculture typologies.

Table 3. Summary of practices for typical typologies of U.A.

U.A type	Products	U.A practices
Community garden	Horticultural crops (fruits and vegetables, leaf crops), Cereals crops	Soil-based: (open and protected)
Private gardens	Horticultural crops (fruits and vegetables, leaf crops), Cereals crops	Soil-based: (open and protected)
Urban farms	Horticultural crops (fruits and vegetables, leaf crops), Cereals crops	Soil-based: (open and protected)
Rooftop gardens	Horticultural crops (fruits and vegetables, leaf crops)	ZFarming: Soil-based/ Hydroponics

Source: Adapted by researcher, 2023

Potential Impacts of Urban agriculture

Urban agriculture helps meet local food needs and promoting environmental sustainability, health, nutrition, and social interaction; creating opportunities for locally controlled food enterprises and economic development . It enhances community engagement and empowerment. It is an important economic development issue (Hamilton et al. 2014). In developing countries, the sevre urbanization and the rapid population growth caused urban poverty; therefore, the implementation of UA policies will ensure the daily food supply of urban residents and improve their living standards (Nugent 2000b).

Research Methodology

A mixed-methods research strategy was used. Collected data was gathered using Geographic Information System (GIS), official documents, expert interviews, questionnaires, direct observation, and photo documentation. This research employed a geo-spatial land capability model using deep learning machine technique with several parameters to assess the best locations for urban agricultural interventions in Amman, considering the city's existing environmental and socioeconomic constraints.

The first step was of data collection such as maps, statistics, datasheets, and technical amd statisitacl manuals was ontained from official and internet sources. This data formed the standing point in determining the evaluation criteria for the selected sites. Additionally, it assisted in identifying software applications for the analysis approach. Step two included collecting qualitative data from experts and decision-makers through in-person interviews. The field study was conducted

to describe the vegetation cover, land use, land cover, site characteristics, and opportunities using observations, photographic documentation, and mapping. Afterwards, a structured questionnaire survey was conducted to facilitate public participation. The survey aimed to investigate the understanding of Urban agriculture's importance and evaluate the acceptability of implementing Urban agriculture techniques. Based on the preceding procedures, the collected data was analyzed and reported as recommendations for the usage and placement of urban agriculture within the GAM region. The results of each phase of research were utilized as input for the Analyzing model and as part of the future scenario planning that will be detailed later in this research. Step Three involved drafting the site selection criteria which followed a two-stage process. First, selecting five districts (North, East, West, South, and Central). Then, five neighborhoods were choosen within each district. The research methodology framework is illustrated in Figure 2.

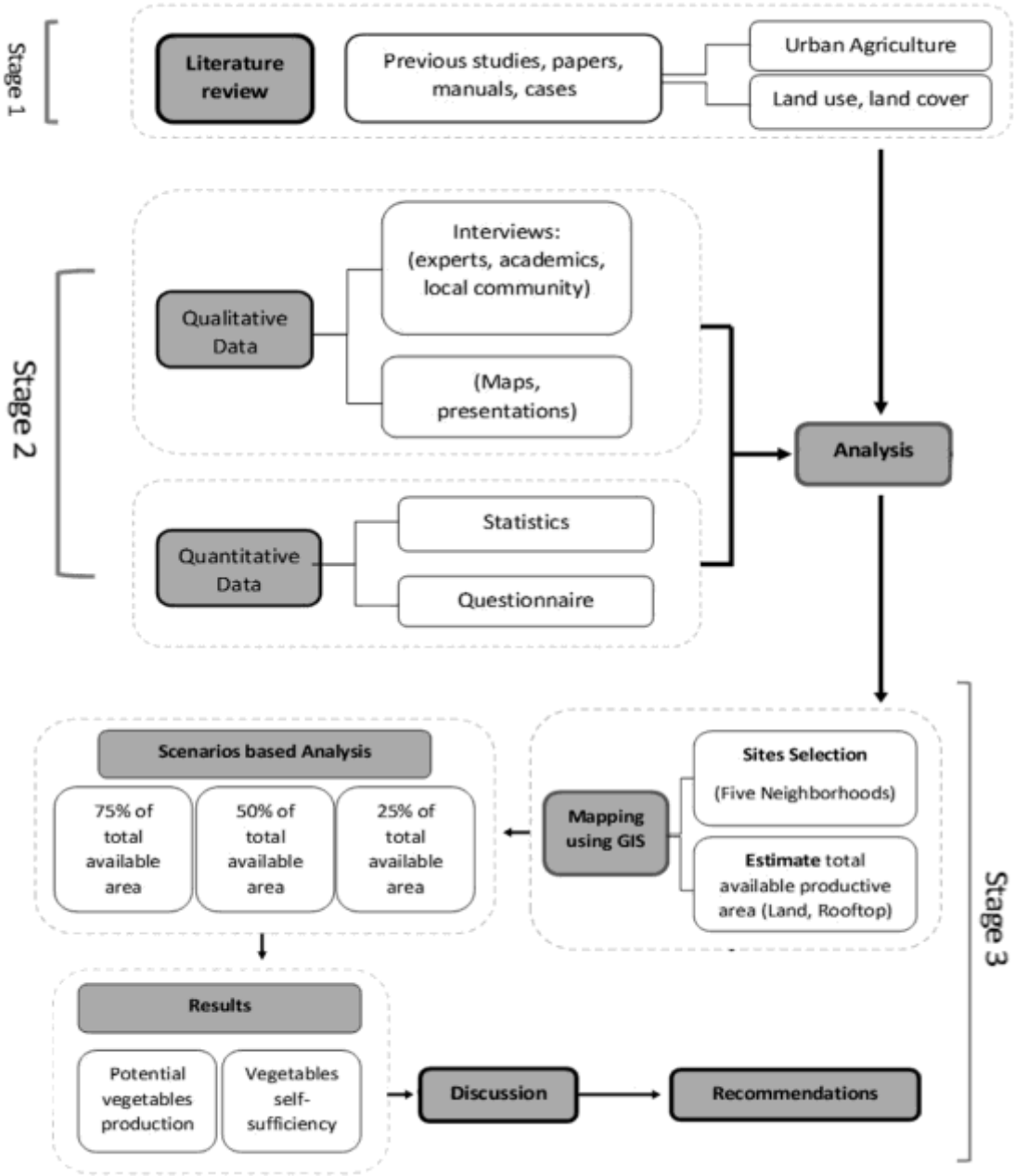


Figure 2 : Research Methodology framework. (Researcher 2022)

Research results and discussion

Rapid urbanization and population growth have significantly impacted GAM, causing major changes in the hydro system, land use, biodiversity, habitat structure, and species extinction (Grove and Burch, 1997). Over the past thirty years, the city's urban area has expanded by an average of 2.03% annually, primarily along transport corridors, leading to a 53.54% reduction in green spaces, from 35.22 km² in 1987 to 16.40 km² in 2017 (Al-Bilbisi, 2019).

The population of Amman has grown more than five hundred times since the early 20th century, making Amman an "immigrant city" (Abu-Dayyeh, 2004; Al Tal , 2006). Unchecked urbanization has negatively affected ecosystems and natural resources, contributing to 64% of the city's annual carbon emissions of 7.5 million tons of CO2. With an annual population growth of 2.2%, Amman is projected to reach 6.4 million residents by 2025, necessitating 1.3 million housing units (GAM, 2017).

Site selection

The preceding phases assisted in developing the selection criteria for the study areas, which would be exploited in two stages. The first stage will select five districts (North, East, West, South, and Central) depending on five factors: Location, urban development, land use type, and number of households, to identify areas within the GAM that reflect the general situation. The second stage involves selecting five neighbourhoods inside each of the districts selected in the first stage; Based on land use type and area around 1-3.5km. Figure 3 shows Amman map with the selected neighbourhoods. Table 4 shows the site selection criteria based on the literature review and experts' advice. The indicators are assessed by type, resource for information, and recommendations.

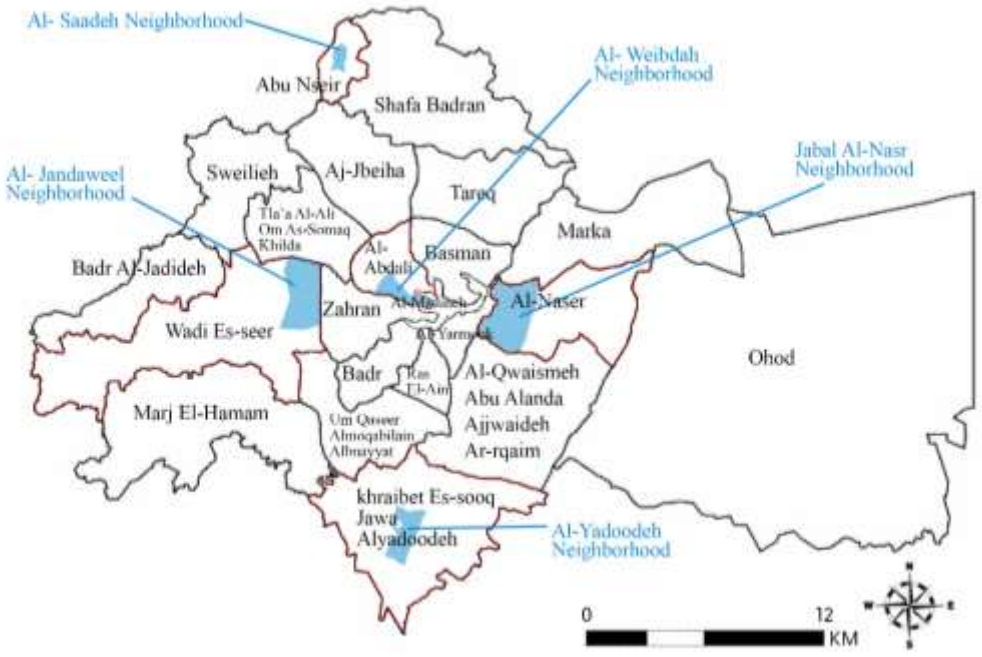


Figure 3: Amman map with the selected neighbourhoods. (Source: researcher, 2024)

Table 4: Site selection criteria based on the literature review and experts' advice.

Indicator	Source	Reference
Stage one		
Location	Official maps	GAM
Urbanization Rate	Official maps and documentation	Literature review.
Stage two		
Number of households	Official documents	Literature review.
Land use type	Official maps and documentation	Literature review, Expert advice.
Area around 1-3km	Official maps	Literature review, Expert advice.

Source: Adapted by researcher, 2023

Moreover, table 5 shows the characteristics of selected sites.

Table 5: Site selection criteria based on the literature review and experts' advice.
Source: (GAM, 2023) adapted by researcher, 2023

District level	Location	Urbanization Rate (%)	Neighborhood level	Num. of households	Land use type	Area (sq.km)
Al-Nasr	East	95%	Jabal Al-Nasr	6000	Residential 90% (C, D) Commercial 5%	1.0
Wadi As seir	West	90%	Al Jandaweel	6151	Residential 90% (B, C, D) Commercial 5%	1.5
Qasabt Amman (Abdali)	Center	90%	Al Weibdah	5484	Residential 62% (A, B, C,) Commercial 29%	1.0
Abu Nseir	North	70%	Al-Sa'adeh	3452	Residential 90% (special house code) Commercial 4.5%	1.0
Khrebet Es-sooq	south	55%	Yadoodeh	4105	Residential 90% (B, C, D) Commercial 6%	3.1

Data Analysis

The collected data was modified and reviewed, with ArcGIS Pro used for quantitative data entry and land cover analysis. Machine learning classification technique were employed to present the data analysis. The study's objectives were quantitatively analysed, and a deep learning technique was used to predict the amount of built-up and vacant land that could be converted into agricultural areas based on various independent variables.

Table 6 shows the potential production values of urban agriculture in Amman, estimating the amount of production in kilograms per square meter (kg/m^2). According to a study by Payen et al. (2022), 200 research studies were reviewed, extracting 2,062 observations of urban agriculture yield values. Most of these studies were published between 2014 and

early 2021, covering a wide range of towns and cities across Europe, North America, South Asia, Southeast Asia, the Middle East, Central America, Oceania, North Africa, the USA, Japan, China, Spain, India, Brazil, and Italy.

Table 6: Yields of primary vegetables cultivation per m2.

Urban area		Growing system	Yield (kg//yr.)
Gray spaces	Rooftops	Soil-based(open)	**3.24**
		Hydroponics(greenhouse)	**9.29**
Green spaces	Vacant lots Private gardens	Soil based (open)	**2.29**
		Soil based (protected)	**7.85**

Source: Payen et al. 2022

In order to address the study question regarding production, and self-sufficiency, the researchers have used an equation that depended on (Sanyé-Mengual et al. 2015) *: "Integrating horticulture into cities: A guide for assessing the implementation potential of rooftop greenhouses (RTGs) in industrial and logistics parks".*

The output of these equations is the annual agricultural production potential given in **(kg/yr.)** equation (1)**,** and the self-sufficiency potential **(kg/household/year)** equation (2).

Sanyé-Mengual et al. , 2015, have employed an overlaying of production practices on rooftops (RTG) solely, however the researcher used these equations to vacant lots and rooftop to determine the potential for vegetable production in GAM. Agricultural production potential was estimated in kilograms per year by multiplying the defined area of distinct land uses (vacant and rooftop areas) by the yield rates of a single production method (conventional urban agriculture and hydroponics).

In addition, it is unrealistic to assume that 100 percent of any land use can be cultivated for several reasons, including agriculture's competition from other land uses such as real estate and business development, soil pollution, geographical factors, and the need for auxiliary agricultural components such as shelter, walking paths, and storage. Each land use type was multiplied by each production area three times, taking 75%, 50%, and 25% of the land use area. The following equation is the primary calculation utilized to predict agricultural production potential in GAM:

$$Potential\ production\ (\frac{kg}{yr}) = Area\ (m^2))\ x\ Yield\ (\frac{kg}{m^2}/yr) \quad (1)$$

$$\text{Sufficiency(HH)} = \frac{\text{potential production } (\ kg/yr)}{Number\ of\ households} \quad (2)$$

$$\text{Percent demand} = \frac{\text{Sufficiency(HH)}}{average\ consumption\ \left(\frac{kg}{HH.yr}\right)} * 100 \quad (3)$$

Descriptive Statistics

- **Demographics:** 57% of the respondents were females, and 43% were males. Most of the respondents belonged to the age groups of (18-34 years), and (35-50 years). Most of the respondents are Responsible member in their families. 75% of them live in an apartment, while 25% live in detached houses. However, 54 % of the respondents Have BSc degree, 24% of them have MSc.

- **Vegetable consumption:** According to the respondents, the weekly budget is 10 JOD/week. With an average of **4.7** members per family in Jordan (DOS 2022), a typical family spends **480 JOD** on vegetables each year. In Addition, as indicated by the most recent data available from the Department of Statistics, the average annual vegetable consumption for each person in Amman is **106.12 Kg/yr**, consequently, the annual per capita vegetable expenditure in Amman is **102.1 JOD**.

- **Participants' motivations:** Seventy-five percent of respondents lived in apartments, compared to only twenty-five percent who lived in separate houses. They were asked if they owned any arable land, and (Figure 5.4) reveals that in the case of apartments, 59% said no and 41% responded yes, whereas in the case of private houses, 76% responded yes and 24% said no. Furthermore, responders were questioned if they cultivated the area. The percentage of apartment respondents who said yes or no was close, while 85 percent of private house respondents said yes. Whatever, this demonstrates the high willingness of the Amman people to participate in agricultural activities, regardless of if they live in a single house or an apartment.

Spatial analysis for five neighbourhoods to determine available productive areas.

In this section, spatial analysis of the five indicated areas was conducted to determine the total built-up area and total vacant land. Figures 4 and 5 is a sample the work done on the for Jabal Al-Naser Neighbourhood represents the patterns of LULC in a simplified form, where they are separated into categories relevant to each area to estimate the potential of implementing urban agriculture within the Greater Amman Municipality.

Using the classification tool in the remote sensing software ArcGIS pro and the ortho-imagery data or raster image of the Amman city, the land cover pattern and the percentage coverage of potential productive land area in each of the selected neighbourhoods, was estimated. Built-up areas (including outside buildings), roads, vegetation (including trees and shrubs), grass verge, and other uses, in addition to the productive land cover, were estimated by researcher.

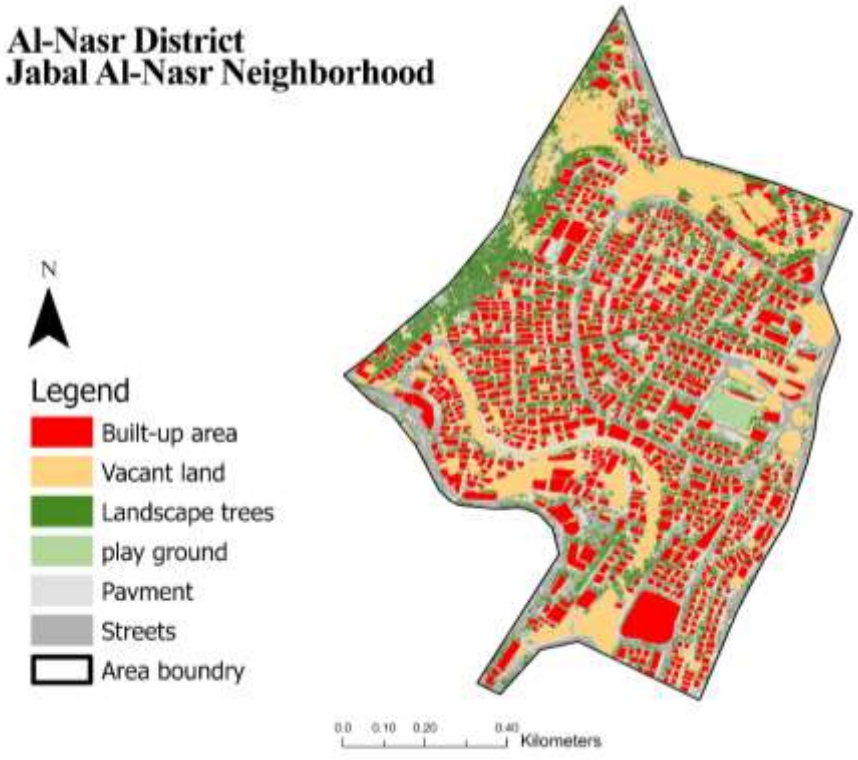


Figure 4: Land Cover Classifications of Jabal Al-Nasr neighbourhood. (Source: Researcher,2023)



Figure 5: Land Use Classifications of Jabal Al-Nasr neighbourhood. (Source: Researcher,2023)

Table 7 presents a summary of the land cover distribution across the different neighborhoods.

Table 7: Summary of the land cover distribution across the different neighborhoods

Neighborhood	Built-up Area	Vacant Land	Streets/ Pavement	Landscape Trees	Special Features	Building Area Range (sqM)	Vacant Lots Range (sqM)	Private Gardens Range (sqM)
Jabal Al-Nasr	50%	20%	25%	10%	Built-up areas concentrated in the center and southern borders; vacant land in minor zones, particularly in the northern boundaries.	[50- 400], [500-1100]	[150-16,000]	[80-800]
Al-Jandaweel	55%	15%	20%	5%	Homogeneous land use distribution with vacant land randomly scattered.	[50- 400], [500-1100]	[110-8000]	[50-1600]
Al-Weibdah	55%	7%	30%	8%	Built-up areas spread uniformly,	[50-400], [500-1100], [1200-7500]	[300-4200]	[90-700]

					with vacant land mainly in the eastern part.	(commercial /governmental)		
Al-Saadeh	40%	25%	25%	10%	Homogeneous building distribution in the northern part, less homogeneous in the southern part.	[50-400], [500-1100] (residential), larger for commercial/ educational	[150-35000]	[30-870]
Al-Yadoodeh	20%	30%	20%	5%	Higher vacant land percentage, with agricultural lands in the southwest and forests in the north; built-up area concentrated in the center and south.	[50-400], [500-1100] (residential), larger for commercial	[250-1800], [1900-3800], [14000-7200], [1500-25000]	N/A

Source: Researcher, 2024

Household yearly consumption of vegetables in GAM

This section demonstrates annual household vegetable consumption in the five previously selected neighborhoods. According to the questionnaire (2023) findings and information published by the Jordanian Department of Statistics 2022, indicates that the average of household is 4.7 persons Amman, and the average yearly consumption of vegetables by a GAM's household is **498.7 kg/year** (2017), which is the value used for estimations as indicated in Table 8.

Table8: Household yearly consumption of vegetables in GAM. Source:(DOS, 2022)

Neighbourhood	Household number	Consumptionkg /yr.
Jabal Al-Nasr	6,000	2,992,584
AL-Jandaweel	6,151	3,067,897
Al-Weibdah	5,484	2,735,222
Al-Saadeh	3,452	1,721,733
Al-Yadoodeh	4,105	2,047,426

Source: DOS, 2022

Potential production of UA in GAM

Tables 9 illustrate the quantity of vegetables that can be produced inside selected neighbourhoods (kilograms per year) using different land use types (vacant lots, private gardens, and rooftops), and agricultural production methods (soil-based and hydroponic). Percent (%) indicates the proportion of each land use area (m2) that is assigned to agricultural production. The study shows promising results for increasing local production in Amman's local food system.

Table 9: Potential production of primary vegetables as per neighbourhoods

Al-Naser Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr.**	**Total area m2**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	113,211	194,439	129,626	64,813
	Private garden			9,700	16,659	11,106	5,553
	Total			**122,911**	**211,099**	**140,733**	**70,366**
	Vacant lot	Protected	**7.85**	113,211	666529	444353	222176
	Private garden			9,700	57108	38072	19036
	Total			**122,911**	**723,638**	**482,425**	**241,212**
	Rooftop class	**Production Method**	**Yield Rate** kg/m2/yr	**Total area**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%**) kg/yr.	**Scenario 3 (25%**) kg/yr.
	50-400	Soil based	**3.24**	197,983	481,098	320,732	160,366
	500-1100			63,457	154,200	102,800	51,400
	1200-7500			41,735	101,416	67,610	33,805
	Total			**303,175**	**736,715**	**491,143**	**227,976**
	50-400	Hydroponics	**9.29**	197,983	1,379,446	919,631	459,815
	500-1100			63,457	442,136	294,757	147,378
	1200-7500			41,735	290,788	193,859	96,929
	Total			**303,175**	**2,112,371**	**1,408,247**	**704,123**
Al-Jandaweel Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr**	**Total area(m2)**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	219,430	376,871	251,247	125,623
	Private garden			27,478	47,193	31,462	15,731
	Total			**246,908**	**424,064**	**282,709**	**141,354**
	Vacant lot	protected	**7.85**	219,430	1,291,894	861,262	430,631
	Private garden			27,478	161,776	107,851	53,925
	Total			**246,908**	**1,453,670**	**969,113**	**484,556**
	Rooftop class	**Production Method**	**Yield Rate kg/m2/yr**	**Total area**	**Scenario 1 (75%) (kg/yr.)**	**Scenario 2 (50%) (kg/yr.)**	**Scenario 3 (25%) (kg/yr.)**
	50-400	Soil based.	**3.24**	278,805	677,496	451,664	225,832
	500-1100			229,840	558,511	372,340	186,170

Al-Naser Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr.**	**Total area m2**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	113,211	194,439	129,626	64,813
	Private garden			9,700	16,659	11,106	5,553
	Total			**122,911**	**211,099**	**140,733**	**70,366**
	Vacant lot	Protected	**7.85**	113,211	666529	444353	222176
	Private garden			9,700	57108	38072	19036
	Total			**122,911**	**723,638**	**482,425**	**241,212**
	Rooftop class	**Production Method**	**Yield Rate** kg/m2/yr	**Total area**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%**) kg/yr.	**Scenario 3 (25%**) kg/yr.
	50-400	Soil based	**3.24**	197,983	481,098	320,732	160,366
	500-1100			63,457	154,200	102,800	51,400
	1200-7500			41,735	101,416	67,610	33,805
	Total			**303,175**	**736,715**	**491,143**	**227,976**
	50-400	Hydroponics	**9.29**	197,983	1,379,446	919,631	459,815
	500-1100			63,457	442,136	294,757	147,378
	1200-7500			41,735	290,788	193,859	96,929
	Total			**303,175**	**2,112,371**	**1,408,247**	**704,123**
	1200-4000			29,000	70,470	46,980	23,490
	Total			**537,645**	**1,306,477**	**870,984**	**435,492**
	50-400	Hydroponics.	**9.29**	278,805	1,942,573	1,295,049	647,524
	500-1100			229,840	1,601,410	1,067,606	533,803
	1200-4000			29,000	202,057	134,705	67,352
	Total			**537,654**	**3,746,041**	**2,497,361**	**1,248,680**
Al-Weibdah Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate (kg/m2/yr.)**	**Total area(m2)**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	42,500	72,993	48,662	24,331
	Private garden			18,561	31,878	21,252	10,626
	Total			**61,061**	**104,872**	**69,914**	**34,957**
	Vacant lot	protected	**7.85**	42,500	250218	166812	83406
	Private garden			18,561	109277	72851	36425

Al-Naser Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr.**	**Total area m2**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	113,211	194,439	129,626	64,813
	Private garden			9,700	16,659	11,106	5,553
	Total			**122,911**	**211,099**	**140,733**	**70,366**
	Vacant lot	Protected	**7.85**	113,211	666529	444353	222176
	Private garden			9,700	57108	38072	19036
	Total			**122,911**	**723,638**	**482,425**	**241,212**
	Rooftop class	**Production Method**	**Yield Rate** kg/m2/yr	**Total area**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%**) kg/yr.	**Scenario 3 (25%**) kg/yr.
	50-400	Soil based	**3.24**	197,983	481,098	320,732	160,366
	500-1100			63,457	154,200	102,800	51,400
	1200-7500			41,735	101,416	67,610	33,805
	Total			**303,175**	**736,715**	**491,143**	**227,976**
	50-400	Hydroponics	**9.29**	197,983	1,379,446	919,631	459,815
	500-1100			63,457	442,136	294,757	147,378
	1200-7500			41,735	290,788	193,859	96,929
	Total			**303,175**	**2,112,371**	**1,408,247**	**704,123**
	Total			**61,061**	**359,496**	**239,664**	**119,832**
	Rooftop class	**Production Method**	**Yield Rate (kg/m2/yr.)**	**Total area(m2)**	**Scenario 1 (75%) kg/yr.**	**Scenario 2 (50%) kg/yr.**	**Scenario 3 (25%) kg/yr.**
	50-400	Soil based.	**3.24**	146,497	355,987	237,325	118,662
	500-1100			106,622	259,090	172,727	24,876
	1200-7500			30,711	74,628	49,752	24,876
	Total			**283,830**	**689,706**	**459,804**	**168,414**
	50-400	Hydroponics.	**9.29**	146,497	1,020,717	680,478	340,239
	500-1100			106,622	742,886	495,257	247,628
	1200-7500			30,711	213,981	142,654	71,327
	Total			**283,830**	**1,977,584**	**1,318,389**	**659,194**
Al-Saadeh Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate (kg/m2/yr.)**	**Total area(m2)**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	2.29	229,540	394,234	262,823	131,411

Al-Naser Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr.**	**Total area m2**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	113,211	194,439	129,626	64,813
	Private garden			9,700	16,659	11,106	5,553
	Total			**122,911**	**211,099**	**140,733**	**70,366**
	Vacant lot	Protected	**7.85**	113,211	666529	444353	222176
	Private garden			9,700	57108	38072	19036
	Total			**122,911**	**723,638**	**482,425**	**241,212**
	Rooftop class	**Production Method**	**Yield Rate** kg/m2/yr	**Total area**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%**) kg/yr.	**Scenario 3 (25%**) kg/yr.
	50-400	Soil based	**3.24**	197,983	481,098	320,732	160,366
	500-1100			63,457	154,200	102,800	51,400
	1200-7500			41,735	101,416	67,610	33,805
	Total			**303,175**	**736,715**	**491,143**	**227,976**
	50-400	Hydroponics	**9.29**	197,983	1,379,446	919,631	459,815
	500-1100			63,457	442,136	294,757	147,378
	1200-7500			41,735	290,788	193,859	96,929
	Total			**303,175**	**2,112,371**	**1,408,247**	**704,123**
	Private garden			8,820	15,148	10,098	5,049
	Total			**238,360**	**409,383**	**272,922**	**136,461**
	Vacant lot	protected	7.85	229,540	1,351,416	900,944	450,472
	Private garden			8,820	51,927	34,618	17,309
	Total			**238,360**	**1,403,344**	**935,563**	**467,781**
	Rooftop class	Production Method	Yield Rate (kg/m2/yr.)	**Total area(m2)**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%)** kg/yr.	**Scenario 3 (25%)** kg/yr.
	50-400	Soil based.	3.24	212,394	516,117	344,078	172,039
	500-1100			41,910	101,841	67,894	33,947
	1200-7500			12,900	31,347	20,898	10,449
	Total			**267,204**	**649,305**	**432,870**	**216,435**
	50-400	Hydroponics.	9.29	212,394	1,479,855	986,570	493,285.
	500-1100			41,910	292,007	194,671	97,335
	1200-7500			12,900	89,880	59,920	29,960

Al-Naser Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr.**	**Total area m2**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	113,211	194,439	129,626	64,813
	Private garden			9,700	16,659	11,106	5,553
	Total			**122,911**	**211,099**	**140,733**	**70,366**
	Vacant lot	Protected	**7.85**	113,211	666529	444353	222176
	Private garden			9,700	57108	38072	19036
	Total			**122,911**	**723,638**	**482,425**	**241,212**
	Rooftop class	**Production Method**	**Yield Rate** kg/m2/yr	**Total area**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%**) kg/yr.	**Scenario 3 (25%**) kg/yr.
	50-400	Soil based	**3.24**	197,983	481,098	320,732	160,366
	500-1100			63,457	154,200	102,800	51,400
	1200-7500			41,735	101,416	67,610	33,805
	Total			**303,175**	**736,715**	**491,143**	**227,976**
	50-400	Hydroponics	**9.29**	197,983	1,379,446	919,631	459,815
	500-1100			63,457	442,136	294,757	147,378
	1200-7500			41,735	290,788	193,859	96,929
	Total			**303,175**	**2,112,371**	**1,408,247**	**704,123**
	Total			**267,204**	**1,861,743**	**1,241,162**	**620,581**
Al-Yadoodeh Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate (kg/m2/yr.)**	**Total area(m2)**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	2.29	229,540	394,234	262,823	131,411
	Private garden			8,820	15,148	10,098	5,049
	Total			**238,360**	**409,383**	**272,922**	**136,461**
	Vacant lot	protected	7.85	229,540	1,351,416	900,944	450,472
	Private garden			8,820	51,927	34,618	17,309
	Total			**238,360**	**1,403,344**	**935,563**	**467,781**
	Rooftop class	Production Method	Yield Rate (kg/m2/yr.)	**Total area(m2)**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%)** kg/yr.	**Scenario 3 (25%)** kg/yr.
	50-400	Soil based.	3.24	212,394	516,117	344,078	172,039
	500-1100			41,910	101,841	67,894	33,947
	1200-			12,900	31,347	20,898	10,449

Al-Naser Neighbourhood	**Vacant area type**	**Production Method**	**Yield Rate kg/m2/yr.**	**Total area m2**	**Scenario 1 (75% of total area) (kg/yr.)**	**Scenario 2 (50% of total area) (kg/yr.)**	**Scenario 3 (25% of total area) (kg/yr.)**
	Vacant lot	Open	**2.29**	113,211	194,439	129,626	64,813
	Private garden			9,700	16,659	11,106	5,553
	Total			**122,911**	**211,099**	**140,733**	**70,366**
	Vacant lot	Protected	**7.85**	113,211	666529	444353	222176
	Private garden			9,700	57108	38072	19036
	Total			**122,911**	**723,638**	**482,425**	**241,212**
	Rooftop class	**Production Method**	**Yield Rate** kg/m2/yr	**Total area**	**Scenario 1 (75%)** kg/yr.	**Scenario 2 (50%**) kg/yr.	**Scenario 3 (25%**) kg/yr.
	50-400	Soil based	**3.24**	197,983	481,098	320,732	160,366
	500-1100			63,457	154,200	102,800	51,400
	1200-7500			41,735	101,416	67,610	33,805
	Total			**303,175**	**736,715**	**491,143**	**227,976**
	50-400	Hydroponics	**9.29**	197,983	1,379,446	919,631	459,815
	500-1100			63,457	442,136	294,757	147,378
	1200-7500			41,735	290,788	193,859	96,929
	Total			**303,175**	**2,112,371**	**1,408,247**	**704,123**
	7500						
	Total			**267,204**	**649,305**	**432,870**	**216,435**
	50-400	Hydroponics.	9.29	212,394	1,479,855	986,570	493,285.
	500-1100			41,910	292,007	194,671	97,335
	1200-7500			12,900	89,880	59,920	29,960
	Total			**460,323**	**3,207,301**	**2,138,200**	**1,069,100**

Source: Researcher, 2024

Potential Sufficiency and estimated percentage of demands

In this part, estimated the household's share to vegetable production in the previously mentioned neighbourhoods (in kg per household per year). These estimates were generated by applying Equation (2), to the Amman population statistics from the Jordan Census of 2022. The results contain the weight of vegetables obtainable to each household in each of the five neighbourhoods, assuming equitable distribution.

For setting, to provide a baseline for the estimates presented in the preceding section, we refer to per household annual vegetable consumption data. When vegetable consumption in GAM is linked to the potential for vegetable sufficiency in chosen neighbourhoods across different land use and yield rates scenarios, as shown below, these two parameters become related. Utilizing this correlation and applying Equation (3), researchers can begin to evaluate GAM's capacity to supply

urban vegetable demand with locally sourced produce. Table 10 shows neighbourhoods share per household (kg/HH/year) and Percentage (%) of demand covered by potential production.

Table 10: Neighborhoods share per household (kg/HH/year) and Percentage (%) of demand covered by potential production

	Vacant Area Type	**Production Method**	**Scenario 1 (75% of total area)**		**Scenario 2 (50% of total area)**		**Scenario 3 (25% of total area)**	
			kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%
	Vacant lot	Open	32.41	6.50%	21.60	4.33%	10.80	2.17%
	Private Garden		2.78	0.56%	1.85	0.37%	0.93	0.19%
	Total		**35.18**	**7.05%**	**23.46**	**4.70%**	**11.73**	**2.35%**
	Vacant lot	Protected	111.09	22.28%	74.06	14.85%	37.03	7.43%
	Private garden		9.52	1.91%	6.35	1.27%	3.17	0.64%
Al-Naser Neighbourhood	**Total**		**120.61**	**24.18%**	**80.40**	**16.12%**	**40.20**	**8.06%**
	Rooftop class	**Production Method**	kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%
	50-400	Soil based	80.18	16.08%	53.46	10.72%	26.73	5.36%
	500-1100		25.70	5.15%	17.13	3.44%	8.57	1.72%
	1200-7500		16.90	3.39%	11.27	2.26%	5.63	1.13%
	Total		**122.79**	**24.62%**	**81.86**	**16.41%**	**40.93**	**8.21%**
	50-400	Hydroponics	229.91	46.10%	153.27	30.73%	76.64	15.37%
	500-1100		73.69	14.78%	49.13	9.85%	24.56	4.93%
	1200-7500		48.46	9.72%	32.31	6.48%	16.15	3.24%
	Total		**352.06**	**70.60%**	**234.71**	**47.06%**	**117.35**	**23.53%**
Al-Jandaweel Neighbourhood	**Vacant Area Type**	**Production Method**	**Scenario 1 (75% of total area)**		**Scenario 2 (50% of total area)**		**Scenario 3 (25% of total area)**	
			kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%
	Vacant lot	Open	61.27	12.29%	40.85	8.19%	20.42	4.10%
	Private Garden		7.67	1.54%	5.11	1.03%	2.56	0.51%
	Total		**68.94**	**13.82%**	**45.96**	**9.22%**	**22.98**	**4.61%**
	Vacant lot	Protected	210.03	42.12%	140.02	28.08%	70.01	14.04%

	Private garden		26.30	5.27%	17.53	3.52%	8.77	1.76%
	Total		**236.33**	**47.39%**	**157.55**	**31.59%**	**78.78**	**15.80%**
	Rooftop class	**Production Method**	kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%	kg/HH/yr	percent of demand%
	50-400	Soil based	210.03	42.12%	140.02	28.08%	70.01	14.04%
	500-1100		26.30	5.27%	17.53	3.52%	8.77	1.76%
	1200-4000							
	Total		**236.33**	**47.39%**	**157.55**	**31.59%**	**78.78**	**15.80%**
	50-400	Hydroponics.	315.81	63.33%	210.54	42.22%	105.27	21.11%
	500-1100		260.35	52.21%	173.57	34.80%	86.78	17.40%
	1200-4000		32.85	6.59%	21.90	4.39%	10.95	2.20%
	Total		**609.01**	**122.12%**	**406.01**	**81.41%**	**203.00**	**40.71%**
Al-Weibdah Neighbourhood	**Vacant area type**	**Production Method**	**Scenario 1 (75% of total area)**		**Scenario 2 (50% of total area)**		**Scenario 3 (25% of total area)**	
			kg/HH/yr	Percent of demand (%)	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)
	Vacant lot	Open	13.31	2.67%	8.87	1.78%	4.44	0.89%
	Private garden		5.81	1.17%	3.88	0.78%	1.94	0.39%
	Total		**19.12**	**3.83%**	**12.75**	**2.56%**	**6.37**	**1.28%**
	Vacant lot	protected	45.63	9.15%	30.42	6.10%	15.21	3.05%
	Private garden		19.93	4.00%	13.28	2.66%	6.64	1.33%
	Total		**65.55**	**13.14%**	**43.70**	**8.76%**	**21.85**	**4.38%**
	Rooftop class	**Production Method**	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)
	50-400	Soil based	64.91	13.02%	43.28	8.68%	21.64	4.34%
	500-1100		47.24	9.47%	31.50	6.32%	15.75	3.16%
	1200-7500		13.61	2.73%	9.07	1.82%	4.54	0.91%
	Total		**125.77**	**25.22%**	**83.84**	**16.81%**	**41.92**	**8.41%**
	50-400	Hydroponics	186.13	37.32%	124.08	24.88%	62.04	12.44%
	500-		135.46	27.16%	90.31	18.11%	45.15	9.05%

	1100							
	1200-7500		39.02	7.82%	26.01	5.22%	13.01	2.61%
	Total		**360.61**	**72.31%**	**240.41**	**48.21%**	**120.20**	**24.10%**
Al-Saadeh Neighbourhood	**Vacant area type**	**Production Method**	**Scenario 1 (75% of total area)**		**Scenario 2 (50% of total area)**		**Scenario 3 (25% of total area)**	
			kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)
	Vacant lot	Open	114.20	22.90%	76.14	15.27%	38.07	7.63%
	Private garden		4.39	0.88%	2.93	0.59%	1.46	0.29%
	Total		**406.53**	**81.52%**	**271.02**	**54.35%**	**135.51**	**27.17%**
	Vacant lot	protected	391.49	78.50%	260.99	52.33%	130.50	26.17%
	Private garden		15.04	3.02%	10.03	2.01%	5.01	1.01%
	Total		**406.53**	**81.52%**	**271.02**	**54.35%**	**135.51**	**27.17%**
	Rooftop class	**Production Method**	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)
	50-400	Soil based.	149.51	29.98%	99.68	19.99%	49.84	9.99%
	500-1100		29.50	5.92%	19.67	3.94%	9.83	1.97%
	1200-7500		9.08	1.82%	6.05	1.21%	3.03	0.61%
	Total		**188.10**	**37.72%**	**125.40**	**25.14%**	**62.70**	**12.57%**
	50-400	Hydroponics.	428.70	85.96%	285.80	57.31%	142.90	28.65%
	500-1100		84.59	16.96%	56.39	11.31%	17.75	3.56%
	1200-7500		26.04	5.22%	17.36	3.48%	8.68	1.74%
	Total		**539.32**	**108.15%**	**359.55**	**72.10%**	**169.33**	**33.95%**
Al-Yadoodeh Neighbourhood	**Vacant area type**	**Production Method**	**Scenario 1 (75% of total area)**	**Scenario 2 (50% of total area)**	**Scenario 3 (25% of total area)**	**Scenario 1 (75% of total area)**	**Scenario 2 (50% of total area)**	**Scenario 3 (25% of total area)**
			kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)
	Vacant	Open	358.62	71.91%	239.08	47.94%	119.54	23.97%

	lot							
	Private garden		35.62	7.14%	23.75	4.76%	11.87	2.38%
	Total		**394.24**	**79.05%**	**262.82**	**52.70%**	**131.41**	**26.35%**
	Vacant lot	protected	1229.32	246.50%	819.55	164.34%	409.77	82.17%
	Private garden		122.11	24.48%	81.40	16.32%	40.70	8.16%
	Total		**1351.42**	**270.99%**	**900.95**	**180.66%**	**450.47**	**90.33%**
	Rooftop class	**Production Method**	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)	kg/HH/yr	percent of demand (%)
	50-400	Soil based.	194.53	39.01%	129.68	26.00%	64.84	13.00%
	500-1100		64.35	12.90%	42.90	8.60%	21.45	4.30%
	1200-7500		13.61	2.73%	9.08	1.82%	4.54	0.91%
	Total		**272.49**	**54.64%**	**181.66**	**36.43%**	**90.83**	**18.21%**
	50-400	Hydroponics.	557.76	111.84%	371.84	74.56%	185.92	37.28%
	500-1100		184.52	37.00%	123.01	24.67%	61.51	12.33%
	1200-7500		39.03	7.83%	26.02	5.22%	13.01	2.61%
	Total		**781.32**	**156.67%**	**520.88**	**104.45%**	**260.44**	**52.22%**

Resource: Researcher, 2024

CONCLUSIONS

This research provides a comprehensive analysis of urban agriculture potentonal production in the Greater Amman Municipality. It focused on the distribution of vacant spaces and overall productive areas across various neighborhoods. The findings reveal a significant opportunity for urban agriculture to substantially meet the city's vegetable population consumption demands, particularly through a combination of open and protected land cultivation, as well as rooftop farming. Rooftop gardening emerges as a valuable alternative to conventional urban agriculture, overcoming challenges like limited space and soil contamination while offering a foundation for further exploration of urban agriculture in GAM.The finding shows that there is a considerable potential with the optimal use of 50% of available land in GAM area, GAM can achieve 30-40% of their vegetable needs, demonstrating that large-scale urban agriculture could greatly enhance food self-reliance and stability in Jordanian cities.

These findings raise concerns about the urban development control, rezoning policies, and the spatial inequalities in food access that may arise from large-scale urban agriculture initiatives. To promote successful local food production, there is a need to build human capacity, including awareness, skills, and management processes, alongside financial and organizational support. This is particularly important since most of the residential buildings in Amman are four-storeyed structures with a number of apartments not less than eight, or more; necessitating the presence of a viable form of collective and collaborative action.

On the other hand, further research would be needed to figure out the suitable technologies to be implement for farming technique(s), particularly on the rooftops, which are often cluttered with water tanks, satellite dishes, and the like. Even more so, some rooftops are also used by some residents as an outdoor terrace or gathering area. This technical challenge

might include irrigation mechanism, or some protective shading in hot summer months, or freezing winds in winter, and, in some cases, precautionary measures for roof insulation. It is also recommended that further research be undertaken to develop an indicator of food self-sufficiency that considers the social, economic, and ecological trade-offs associated with large-scale urban food production.

This study serves as a critical first step, offering insights into potential vegetable production in Amman and providing a multi-scale analysis of land use compositions suitable for urban agriculture. These findings could guide land use planning policies aimed at enhancing urban sustainability and addressing the looming food crisis, opening new avenues for research in urban food systems.

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