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Proceeding Paper

Urban Agriculture in Morocco: Which Model Is Adaptable to Socio-Economic and Environmental Challenges? (The Case of Marrakech) †

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† Presented at the 3rd International Electronic Conference on Agronomy, 15–30 October 2023; Available online: https://iecag2023.sciforum.net/.

Abstract: Urban agriculture is considered one of the cornerstones of sustainable development, acting as a "magic wand" to address challenges related to food security, energy, and environmental sustainability, especially in a city like Marrakech. The latter is facing growing issues associated with urbanization and population expansion, jeopardizing its residents' food, economic, and energy security. This study aims to shed light on the current situation of the agricultural sector in the city of Marrakech and to identify constraints (both human and natural) affecting its agricultural sustainability. The goal is to develop agricultural solutions capable of strengthening the agricultural sector and maintaining resilience and sustainability in this red metropolis.

Keywords: sustainable agriculture; challenges; Marrakech; resilience

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Citation: Anas, A.; Mohammed, G. Urban Agriculture in Morocco: Which Model Is Adaptable to Socio-Economic and Environmental Challenges? (The Case of Marrakech). *Biol. Life Sci. Forum* **2023**, *27*, 56. https://doi.org/10.3390/IECAG2023-15987

Academic Editor: Jitka Kumhalova

Published: 14 November 2023

1. Introduction

By 2050, it is anticipated that three quarters of the global population will be urban due to rapid urbanization, contributing to socio-economic and environmental concerns such as increased poverty, unemployment, and food price volatility [1,2]. This urban shift has sparked interest in "urban agriculture", commonly referred to as "edible gardening", an agricultural approach centered around the city and a sustainable development endeavor [3,4]. Historically, Marrakech, founded in 1062 by the Almoravid dynasty, was a "green city" equipped with a sophisticated irrigation system supporting its agricultural sector (khettaras, séguias, etc.). This sector propelled Marrakech to a globally renowned metropolis, competing with cities like Baghdad and Cordoba in military, political, and socio-economic aspects [5].

However, contemporary Marrakech faces urbanization-related issues, notably the degradation of greenery and population expansion [6]. This jeopardizes food security and emphasizes the city's historical agricultural connections, underscoring the need for a new agricultural strategy tailored to Marrakech's specific characteristics. Despite the existing gap in research on agricultural models adaptable to the city's environment (natural, socio-economic, and cultural), both in Marrakech and in cities characterized by a semi-arid and arid climate in general. The main contributions of this article are as follows:

- Assessment of the current situation of urban agriculture and its socio-economic impact.
- Identification of current obstacles and challenges.
- Recommendation of new, creative agricultural approaches adapted to the city's specificity.

2. Materials and Methods

2.1. Research Questions

- What challenges hinder sustainable agriculture in Marrakech?
- Which agricultural approach can tackle socio-economic and environmental issues unique to Marrakech?

2.2. Research Approach and Materials

- Descriptive/analytical approach: This approach involves diagnosing and detailing the current state of agriculture in Marrakech, highlighting its strengths and weaknesses. We use field-collected data to address our research questions;
- The survey: Through a questionnaire aimed at farmers, this survey seeks to understand the current situation of agriculture in the city and identify challenges and obstacles;
- Computer software: We used Geographic Information System (GIS 10.8) to create maps and employed statistical software to examine the field-collected data.

2.3. Study Area

Marrakech is a city located in central Morocco at the foot of the Atlas Mountains, part of the Marrakech-Safi region (see Figure 1). It comprises 5 districts (Medina, Gueliz, Menara, SYBA, Annakhil) and an urban commune (Méchouar-Kasbah).

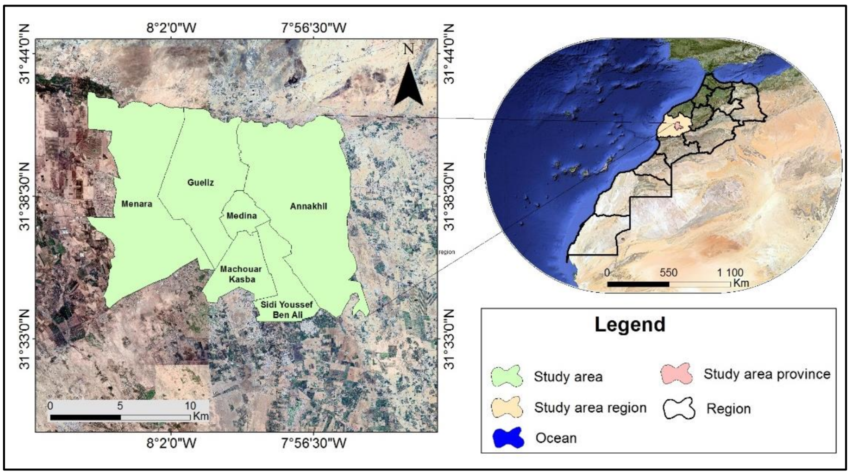

Figure 1. Study area location. Source: Authors (2023).

3. Results

3.1. Climate Change and Human Impact: Impediments to Agriculture

Urban agriculture in Marrakech confronts significant hazards from climate change. The city covers 10,945 hectares, 29% of its territory, and has an annual water demand of 92 million cubic meters [7]. In an arid region, Marrakech has witnessed its average annual temperature rise from 20.8 °C in 1990 to 22.6 °C in 2022. Concurrently, yearly rainfall rates have declined 79 mm, from 166.1 mm in 1990 to 87.1 mm in 2022 (see Figure 2), resulting in persistent drought and water shortages.

Moreover, the city grapples with pollution across various sectors, including air and water, and increased soil salinity from agricultural chemicals. Overuse of water resources, notably groundwater, is evident, given the numerous hotels and tourist locations outfitted with pools and extensive gardens. Such water resources accommodate recreational requirements and the socio-economic demands of many rural communities, farms, and agricultural territories, with 47% being irrigated and 53% relying on rainfall.

This situation has led to significant groundwater table reductions. Annual replenishing amounts to only 351 million cubic meters, whereas withdrawals total 535 million cubic meters. This results in an alarming annual deficit of 184 million cubic meters.

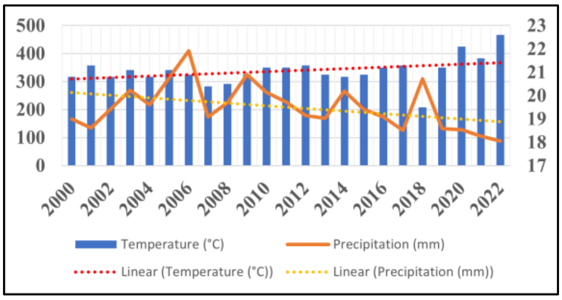

Figure 2. Variations in temperature and precipitation between the year 2000 and 2022. Source: Tensift water basin agency (2023).

3.2. Urban Growth and Socio-Economic Demands

Marrakech's fast urban development has decreased the acreage accessible for agricultural interests. As urbanization increases, lands once intended for agriculture are increasingly repurposed for housing, business, and infrastructure. Data reveal that between 1960 and 2023, land loss to informal projects and official structures was around 320.4 hectares and 4,455.30 hectares (see Figure 3), respectively. The Menara and Annakhil districts witnessed the most significant land conversions, with 37.8% and 41.5%.

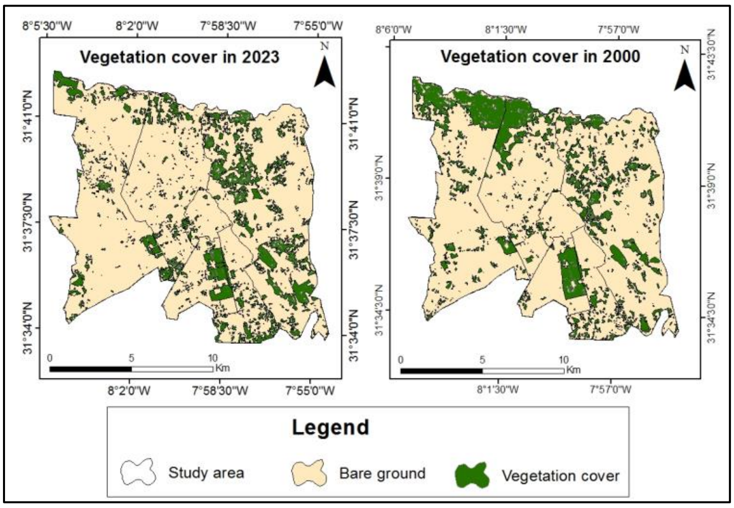

Figure 3. Map of the evolution of vegetation cover between the year 2000 and 2023. Source: Authors (2023).

Simultaneously, food security remains a significant concern for Marrakech and Morocco. Despite its great agricultural potential, Marrakech fails to meet its local food demands. An over-dependence on imports and a tilt toward income crops like citrus and olives has diminished the focus on primary crops, forcing the city into food dependency. The local economic model, driven by tourism, adds to this predicament, resulting in income inequalities and neglect of the agricultural sector. This has consequences, such as a diminishing agricultural workforce and lower production capacities, demonstrated by a jump in seed/plant prices and a corresponding decline in revenue.

Additionally, old farming methodology, traditional agricultural practices, and little exposure to current agricultural innovation have inhibited production increase. The continuous use of basic agricultural practices inhibits land efficiency and output potential, aggravated by weak marketing tactics and value addition. The main problems faced by farmers are shown in Figure 4.

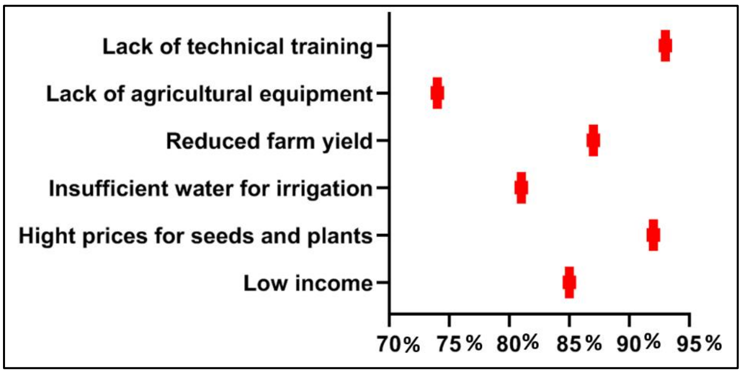

Figure 4. Main problems that farmers face. Source: Results of field research (2023).

3.3. Which Agricultural Model Is Adaptable to Local Specificity?

This concept delivers favorable effects because it offers food supplies that boost economic and social development via employment opportunities and social integration. Additionally, it achieves environmental goals, provides educational or recreational benefits, and plays a crucial role in landscape and urban planning.

3.3.1. Hydroponic Farming: When Science Marries Nature

Among the tailored solutions, floating hydroponics emerges as a notable alternative [7] and has garnered increasing popularity in recent years for cultivating high-quality crops. This system, straightforward in design, consists of a reservoir of circulating nutrient solution distributed across a horizontal expanse, analogous to a pond, where plants flourish on polystyrene rafts and receive nourishment. This arrangement not only conserves water but also minimizes nutrient losses, subsequently reducing the environmental footprint of these crops [8].

Plant leaves, the central focus for photosynthesis, function as energy transformers for primary producers. They are acutely responsive to environmental shifts and soil dynamics. The application of fertilizing compounds, particularly nitrogen, is pivotal. It enhances plant vitality, amplifies agricultural output, and enriches their nutritional essence [9].

3.3.2. Drone Technology: Toward a Fourth Agricultural Revolution

Traditional pesticide and fertilizer application techniques are time-consuming and often less efficient, underlining the need for technological developments in this field. Drones have emerged as a perfect option for intelligent farming or precision agriculture, solving these difficulties. Agricultural techniques may be modified to enhance yields utilizing drone data, which examines vegetation indices to detect fluctuating crop conditions and input from local stakeholders like agronomists and farmers. Drone monitoring systems give knowledge concerning irrigation, soil types, pests, and fungal infections. Moreover, photos captured by drones, particularly in the infrared spectrum, show plant health in ways undetectable to the human eye. Their capacity to constantly monitor crop yields, often on a weekly or even hourly basis [10], gives farmers up-to-date information, enabling them to apply corrective actions swiftly for optimum crop management.

Robots now employ algorithms for the automated harvesting of crops, an increasingly critical demand. Precise crop location and maturity evaluation are crucial for these harvesting robots [11]. They also deploy spray systems classed as "Green on Brown" (GoB) to identify green vegetation from soils and agricultural residues using spectral data and "Green on Green" (GoG) to discern green crops from weeds using sophisticated image algorithms. "Green on Brown" mainly detects the presence or absence of green plants, whereas "Green on Green" identifies many plant types, including crops, grassy weeds, broadleaf weeds, and perennial weeds. Precision sprayers target regions with high weed density (selective spraying) and individual plants (targeted spraying) [12] (See Figure 5).

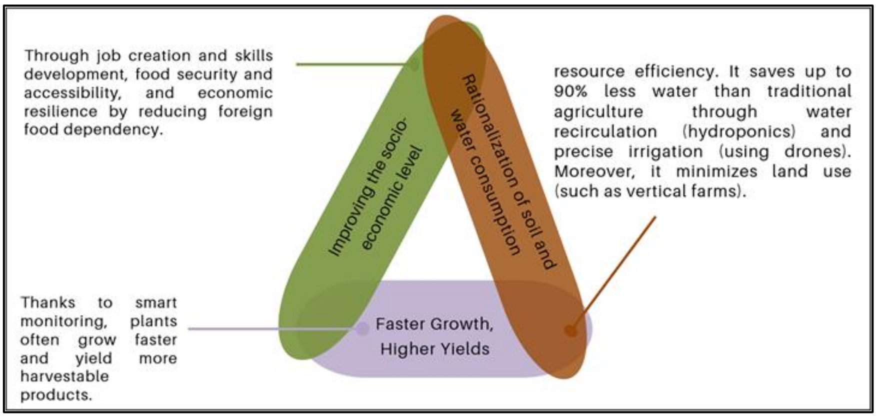

Figure 5. Socio-economic and environmental impacts of these agricultural models. Source: Authors (2023).

3.3.3. Rooftop Gardens and Community Gardens: Planting the Seeds for a Green Future

In today's cities, the ballet of steel and concrete often overshadows the scarce pockets of vegetation. However, rooftop and community gardens herald a new era in urban design, converting overlooked spaces into green revolutions. By transforming rooftops, vacant plots, and shared spaces, these gardens do more than just contribute vegetation; they become pillars of sustainable urban living. They catalyze sustainable cultivation, meet dietary requirements, and bolster environmental, economic, and community resilience. Drawing together various sectors, from the public to the private and civic organizations, these gardens bridge the divide between food production and consumption, highlighting the transformative impact of integrating farming into urban landscapes.

4. Discussion

This study stresses the relevance of earlier research in agricultural innovation, which can transform the socio-economic and environmental landscape. However, issues continue. Regarding hydroponics, as indicated by various studies [8,9], there are hurdles, including high expenses. Additionally, this hydroponics technology demands continual expertise, monitoring, and energy use. As for drones, as highlighted by several studies [10,11], there are obstacles, notably in regulatory and legislative frameworks (concerns connected to safety, privacy, and noise pollution). Moreover, the initial investment cost in drone technology might offer accessibility problems for small-scale farmers.

5. Conclusions and Prospects

This article proposes innovative agricultural techniques: hydroponics, drones, rooftop gardens, and community gardens. These techniques are suggested to satisfy the requirements and address the socio-economic and environmental challenges confronted by the city. In terms of prospects, these agricultural models correlate with Morocco's increasing concentration on sustainable agricultural development. The country is resolutely shaping its policies through international environmental agreements. By initiating programs aimed at enhancing the sustainable use of water resources and promoting sustainable agriculture, Morocco is paving the way for a promising future in urban agriculture.

Author Contributions: Conceptualization, A.A.; methodology, A.A.; software, A.A.; validation, G.M.; formal analysis, A.A.; investigation, A.A.; resources, A.A.; data curation, A.A.; writing—original draft preparation, A.A.; writing—review and editing, A.A. and G.M.; visualization, A.A.; supervision, G.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Girardet, H. *Cities People Planet: Livable Cities for a Sustainable World*; Wiley Academy: Chichester, UK, 2004.
2. FAO (Food and Agriculture Organization). *FAOSTAT Database Collections*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2012; Available online: http://faostat.fao.org (accessed on 8 October 2023).
3. Duchemin, É. (Ed.) *Agriculture Urbaine: Aménager et Nourrir la Ville*; VertigO. Presses de Marquis Imprimeur Inc.: Montmagny, QC, Canada, 2013.
4. Campbell, L.K. Getting farming on the agenda: Planning, policymaking, and governance practices of urban agriculture in New York City. *Urban For. Urban Green.* **2016**, *19*, 295–305. [CrossRef]
5. Pégurier, J. *Espaces Urbains en Formation dans le Tensift: Essai de Sociologie Régionale*; Société marocaine des éditeurs réunis: Rabat, Morocco, 1981.
6. Aboulaiche, A.; Gallad, M. Harnessing the potential of vegetable waste: A path towards sustainable development in Marrakech (Morocco). *Rev. Int. De La Rech. Sci. (Rev. -IRS)* **2023**, *1*, 546–557.
7. Van Os, E.A.; Stanghellini, C. Diffusion and environmental aspects of soilless growing systems. *Italus Hortus* **2001**, *8*, 9–15.
8. Pardossi, A.; Malorgio, F.; Incrocci, L.; Campiotti, C.A.; Tognoni, F. Comparison between two methods to control nutrient delivery to greenhouse melons grown in recirculating nutrient solution culture. *Sci. Hortic.* **2002**, *92*, 89–95. [CrossRef]
9. Sun, Y.; Wang, X.; Ma, C.; Zhang, Q. Effects of nitrogen and phosphorus addition on agronomic characters, photosynthetic performance and anatomical structure of alfalfa in northern Xinjiang, China. *Agronomy* **2022**, *12*, 1613. [CrossRef]
10. Hafeez, A.; Husain, M.A.; Singh, S.P.; Chauhan, A.; Khan, M.T.; Kumar, N.; Chauhan, A.; Soni, S.K. Implementation of drone technology for farm monitoring & pesticide spraying: A review. *Inf. Process. Agric.* **2023**, *10*, 192–203.
11. Su, F.; Zhao, Y.; Wang, G.; Liu, P.; Yan, Y.; Zu, L. Tomato Maturity Classification Based on SE-YOLOv3-MobileNetV1 Network under Nature Greenhouse Environment. *Agronomy* **2022**, *12*, 1638. [CrossRef]
12. Allmendinger, A.; Spaeth, M.; Saile, M.; Peteinatos, G.G.; Gerhards, R. Precision chemical weed management strategies: A review and a design of a new CNN-based modular spot sprayer. *Agronomy* **2022**, *12*, 1620. [CrossRef]