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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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Abstract: Urban agriculture has evolved as a cornerstone of sustainable development, acting as a "magic wand" to address challenges related to food, energy, and environmental sustainability. With a growing need for innovative agricultural solutions, Morocco firmly aligns its policies with international environmental agreements and implements programs to improve the sustainable use of water resources and promote sustainable agriculture. This is particularly essential as agriculture accounts for approximately 84% of water demand. Similarly, since its establishment as a garden city in 1062, Marrakech has benefited from a sophisticated irrigation system (Khettaras, etc.) supporting agriculture. However, the city has recently faced significant challenges, both environmentally (climate change, water scarcity, etc.) and socio-economically (population growth, food insecurity, socio-economic inequalities, etc.). This research aims to shed light on the current situation of urban agriculture in Marrakech and identify the constraints threatening its agricultural viability. Additionally, it aims to study several urban agriculture models to determine the best flexible and sustainable strategy to address socio-economic and environmental issues in the specific context of Marrakech. Through an in-depth investigation of these models' potential benefits and limitations, the research aims to promote sustainable agricultural practices in the city, thereby ensuring rational, intelligent, and sustainable use of urban agriculture's potential. Ultimately, this research aims to increase agricultural resilience in Marrakech and contribute to its long-term sustainability.

Keywords: sustainable agriculture; challenges; Marrakech; resilience

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Introduction:

By 2050, it is estimated that three-quarters of the world's population will be urban due to rapid urbanization, leading to socio-economic and environmental challenges such as rising poverty, unemployment, and volatile food prices (Girardet, H. (2004); FAO, (2012)). This urban shift has sparked interest in "urban agriculture," often referred to as "edible landscaping," a city-centric agricultural approach and sustainable development initiative (Duchemin, E. (2013); Campbell, L. K. (2016)).

Historically, Marrakech, founded in 1062 by the Almoravid dynasty, has been a "green city," boasting a sophisticated irrigation system supporting its agriculture sector (Khettaras, Séguias, etc.). This sector catapulted Marrakech into global prominence, rivaling cities like Baghdad and Cordoba in military, political, and socio-economic spheres (Pégurier, J. (1981)).

Nevertheless, modern Marrakech confronts urbanization challenges, including dwindling vegetation and rising population (Aboulaiche, A., & Gallad, M. (2023)). This

jeopardizes food security and strains the city's historic agricultural bond, underscoring the need for a unique agricultural model tailored to Marrakech's distinct attributes.

Materials and Methods:

Research questions:

What challenges hinder sustainable agriculture in Marrakech?

Which agricultural approach can tackle both socio-economic and environmental issues unique to Marrakech?

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) to create maps and employed statistical software to examine the field-collected data.

Study Area:

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

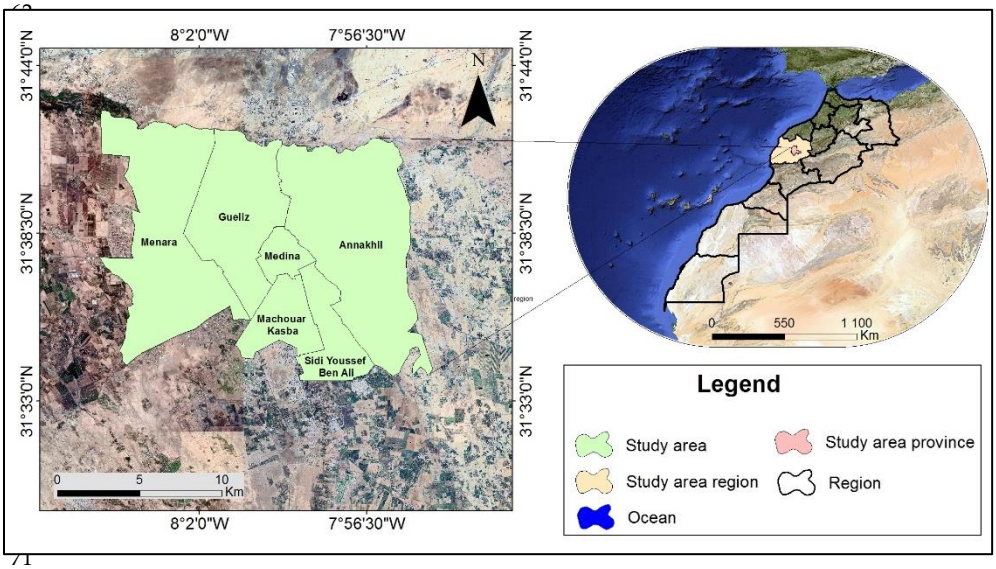

Figure 1. Study area location Source: Authors (2023).

Results:

1. Climate Change and Human Impact: Impediments to Agriculture

Urban agriculture in Marrakech faces significant threats from climate change. The city spans 10,945 hectares, 29% of its total land, and has an annual water demand of 92 million cubic meters (Regional Department of Agriculture, 2023). In a dry 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 dropped 79 mm, from 166.1 mm in 1990 to 87.1 mm in 2022, resulting in persistent drought conditions 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 spots equipped with pools and vast gardens. Such water resources cater to recreational needs and the

socio-economic demands of many rural communities, farms, and agricultural lands, with 47% being irrigated and 53% relying on rainfall (Regional Department of Agriculture, 2023).

This situation has led to significant groundwater table reductions. Annual refilling 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.

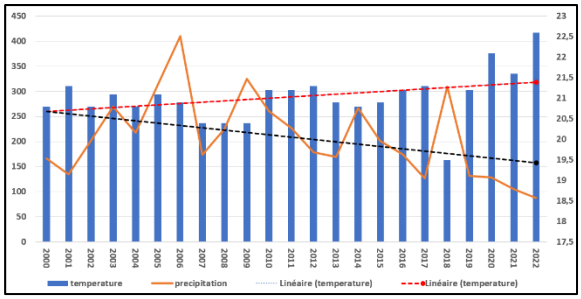

Figure 2. variations in temperature and precipitation between 2000 Source: Tensift water basin agency (2005 & 2022).

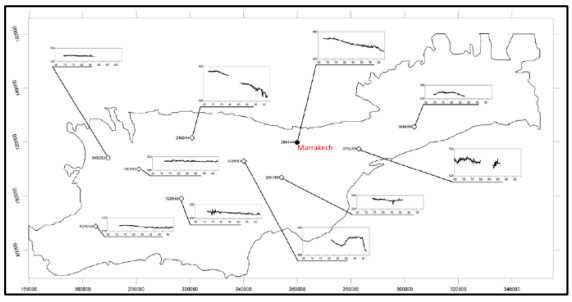

Figure 3. Piezometric level in the Haouz plain aquifer Source: Tensift water basin agency (2005 & 2022).

1. Urban Growth and Socio-Economic Demands:

Marrakech's rapid urban sprawl has diminished the land available for agricultural pursuits. As urbanization accelerates, areas formerly designated for farming are now being repurposed for housing, business, and infrastructure. Data indicates that between 1960 and 2014, land lost to informal developments and official constructions was roughly 320.4 hectares and 4,455.30 hectares, respectively. The Menara and Annakhil districts saw the highest land conversions, at 37.8% and 41.5%.

Simultaneously, food security remains a pressing issue for Marrakech and Morocco. Despite its rich agricultural potential, Marrakech struggles to satisfy its local food demands. An over-dependence on imports and a pivot towards cash crops such as citrus and olives has lessened the emphasis on staple crops, pushing the city into a state of food reliance. The local economic model, dominated by tourism, contributes to this scenario, leading to income disparities and neglect of the agricultural sector. This has consequences, such as a dwindling agricultural workforce and diminished production capabilities, evidenced by a surge in seed/plant prices and a subsequent drop in income.

Additionally, outdated farming methodologies, archaic agricultural practices, and limited exposure to advanced agricultural tech have impeded yield growth. The continued use of basic farming approaches restricts land efficiency and yield potential, compounded by inadequate marketing strategies and value addition.

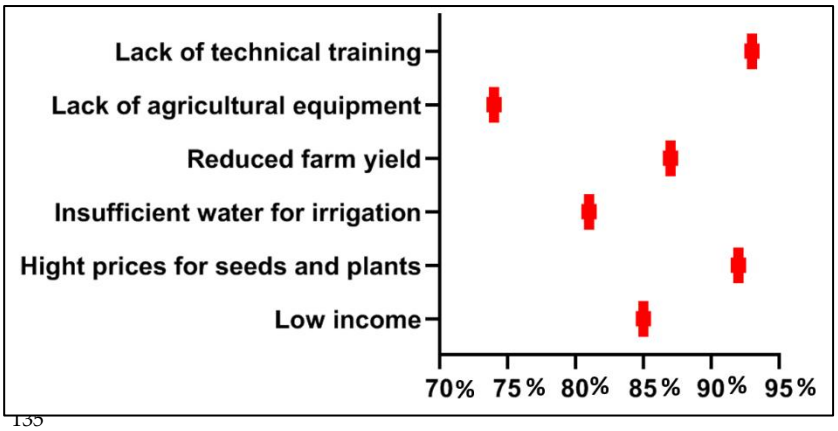

Figure 4. Main problems that farmers face Source: Results of field research (2023).

1. Which agricultural model is adaptable to the local specificity?

This model presents beneficial outcomes related to its role in food provision, stimulating economic and social growth through employment opportunities and social integration. Additionally, it addresses environmental goals, offers educational or recreational benefits, and plays a central role in landscape and urban design.

1.1. Hydroponic Farming: When Science Marries Nature

Among various suitable solutions, floating hydroponics stands out as a valid alternative (van Os & Stanghellini, 2001) and has become increasingly popular in recent years for producing high-quality crops. This system is relatively simple, consisting of a circulating nutrient solution tank on a flat surface, similar to a pond, where plants grow on polystyrene rafts and are nourished. In this way, water volumes are conserved, and nutrient leaching is avoided, thereby reducing the environmental impact of these crops (Pardossi & al, 2002).

1.1. Drone Technology: Toward a Fourth Agricultural Revolution

Traditional pesticide and fertilizer application methods are time-consuming and often less efficient, highlighting the need for technological advancements in this area. Drones have emerged as a fitting solution for intelligent farming or precision agriculture (PA), addressing these challenges. By leveraging data gathered by drones—which measure vegetation indices to identify various crop conditions—and insights from local stakeholders like agronomists and farmers, agricultural practices can be refined to boost yields.

Drone monitoring systems offer insights into irrigation, soil types, pests, and fungal infestations. Additionally, drone-captured images, particularly in the infrared range, reveal plant health in ways invisible to the naked eye. Their ability to consistently monitor crop yields—sometimes weekly or even hourly (Hafeez & al. (2022))—provides farmers with up-to-date information, enabling timely corrective actions for optimal crop management.

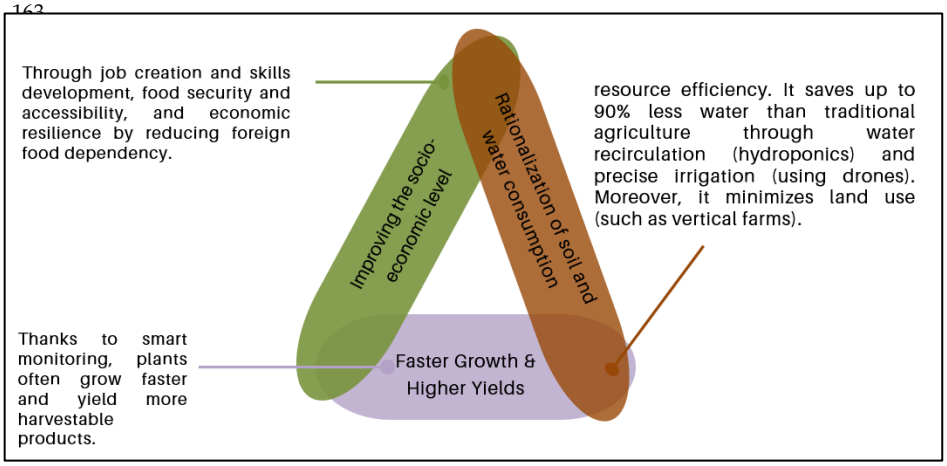

Figure 5. Socio-economic and environmental impacts of these agricultural models Source: Authors (2023).

1.1. Rooftop and Community Gardens: Planting the Seeds of a Green Future

In today's cities, the ballet of steel and concrete often conceals the meager green islands. Nevertheless, rooftop and community gardens herald a new era in urban planning, transforming neglected spaces into green revolutions. By metamorphosing rooftops, vacant lots, and shared areas, these gardens go beyond the addition of greenery; they become pillars of sustainable urban life. They act as catalysts for sustainable agriculture, address food needs, and enhance environmental, economic, and community resilience.

By bringing together diverse sectors, from the public to the private sector and civic groups, these gardens bridge the gap between food production and consumption, highlighting the transformative impact of integrating agriculture into urban landscapes.

Discussion:

While the proposed agricultural models carry numerous benefits and hold the potential to reshape the socio-economic and environmental landscape, challenges persist. For hydroponics, hurdles include high costs, as setting up the system requires significant investment in infrastructure and technology. Additionally, there is the knowledge barrier: hydroponics demands expertise and constant monitoring to avert issues like nutritional imbalances. Energy consumption is another concern, especially in systems reliant on artificial lighting, which can be power-intensive.

Regarding drones, there is a need for regulatory frameworks to govern their use in urban areas, addressing safety, privacy, and noise pollution concerns. Furthermore, the initial investment cost in drone technology can pose accessibility challenges for small-scale farmers. Also, the required expertise calls for support mechanisms to ensure inclusivity for all stakeholders.

Rooftop gardens may face constraints due to space limitations and structural concerns. Both rooftop and community gardens can find maintenance and access tricky to handle. Meanwhile, community gardens can grapple with concerns like land rights, water supply, and soil health.

Conclusion and prospects:

Traditional farming techniques in Marrakech, such as pesticide and fertilizer application, are becoming outdated due to their time-consuming nature and reduced efficiency. A shift in perspective is essential.

Sustainable farming is gaining traction as a standard for high-quality agricultural production. There is a growing need to reevaluate the management of fertilizers, pest control, and water while ensuring product quantity and quality remain at their peak. Shortening cultivation time, extending the shelf life of fresh produce, and enhancing nutritional

value for animals and humans have become paramount goals for intelligent, sustainable, and economically viable agriculture.

In alignment with Morocco's growing focus on sustainable agricultural development, the country is steadfastly shaping its policies in line with international environmental agreements. By initiating programs to enhance the sustainable use of water resources and promote sustainable farming, Morocco is paving the way for a bright future in urban agriculture.

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