



# A Comprehensive Review on Evolution, Challenges of Models, Opportunities in Urban Farming Practices in the World

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## ABSTRACT

This review delves into the historical evolution of urban farming, tracing its roots from ancient civilizations to modern-day urban landscapes. It explores diverse urban farming models, ranging from rooftop gardens and vertical farms to community gardens and hydroponic systems, highlighting their unique characteristics and contributions to food security, environmental sustainability, and community resilience. Additionally, the abstract addresses the myriad challenges faced by urban farmers, including limited space, soil contamination, regulatory hurdles, and access to resources. Despite these challenges, urban farming presents abundant opportunities for innovation, social entrepreneurship, and urban revitalization. By leveraging technological advancements, community engagement, and policy support, urban farming has the potential to transform cities into vibrant hubs of agricultural production and sustainability. This abstract sets the stage for a comprehensive review that not only illuminates the past and present of urban farming but also identifies pathways for its future growth and impact in shaping resilient, equitable, and sustainable cities.

*Keywords: Urban landscapes; soil contamination; regulatory hurdles; challenges.*

## 1. INTRODUCTION

With the goal of satisfying the day-to-day requirements of urban people via the use and recycling of urban waste and natural resources, urban agriculture is a sector that comprises all activities that take place in and around urban areas. These activities range from the production to the selling of food and associated non-food goods. It is an alternative food system and industry that is concerned with the production, processing, and marketing of all different kinds of food as well as associated commodities that are not linked to food. In and around settlements (village, town, province, district, metropolitan, megacity), urban agriculture may be performed utilizing a variety of technologies in a variety of locations, ranging from micro to macro scales [1].

The integration of urban agriculture with the ecological and economic systems of the city is the most fundamental distinction between urban agriculture and rural agriculture. Rural agriculture is not as integrated as urban agriculture. Various types of economic activity, associated categories of non-food products, location, and peri-urban agriculture are the fundamental components that comprise urban agriculture. Agriculture in urban areas has been the primary source of food for humankind for a very long time. It has the ability to put an end to poverty all over the globe and to strengthen the economy of emerging countries [2]. The agricultural system that is now being used, on the other hand, is unlikely to be considered sustainable because of the rising pressure that it puts on the few resources that our planet has. As a result of the expanding population, which is expected to reach a high of

roughly 11 billion by the year 2100, agriculture will have a difficult time satisfying the requirements of the global population [96]. It is vital to expand agriculture in order to meet the growing demand; yet, this is a difficult undertaking to undertake in the context of climate change, which necessitates the transition to a model that is consistent with sustainable development [3].

Within the realm of prospective solutions, urban agriculture (UA) has garnered a lot of interest. The term "urban agriculture" (UA) can be defined as "an industry that produces, processes, and markets food and fuel, largely in response to the daily demand of consumers within a town, city, or metropolis, on land and water dispersed throughout the urban and peri-urban area, applying intensive production methods, using and reusing natural resources and urban wastes, to yield a diversity of crops and livestock." This definition was provided by Smit et al. (1996). Traditional processes, which use enormous quantities of finite natural resources like water, are being replaced by UA, which is being marketed as a more environmentally friendly option [4].

Agriculture has a long history in urban settings, with instances such as the extensive adoption of "war gardens" in the United States during the World Wars and the usage of garden areas in Japan during the Edo century. Both of these examples are evidence of the long-standing history of agriculture in urban environments. Residents were not only provided with fresh products from the local area, but they also received enhanced sanitary standards as a result

of these systems' simultaneous exploitation of night soil as fertilizer [5].

In conclusion, urban agriculture is a vital component of sustainable development and makes a contribution to the ecological, economic, social, and healthy systems that are present in cities. It is possible to help alleviate the growing pressure on the limited resources of our planet by incorporating urban agriculture with other sustainable practices. This may also give a sustainable alternative to the approaches that have been using conventional farming techniques [6].

The concept of urban agriculture (UA) has become more important in contemporary discourses, notably in relation to the Sustainable Development Goals (SDGs) that have been established by the United Nations for the year 2030. The rising number of urban farm projects may be ascribed to the relevance of urban farming in food security efforts. This is because many cities in the Northern Hemisphere have been disconnected from the food supply chain, which has resulted in a reduction in the availability of commercially produced fresh produce and a restricted selection of foods that are high in nutrients for everyone. Because it is anticipated that by the year 2050, over 68 percent of the world's population will have relocated to urban areas, urban agriculture has the potential to assist these vulnerable and densely populated cities in overcoming the problem of combating food insecurity [7].

UA involves not just the provision of food security but also a larger range of other useful services that need to be implemented in an effective

manner [8]. In a number of cities, community farms have provided inhabitants with alternative social advantages. These benefits include educational programs and seminars on topics such as health and nutrition, environmental restoration, and political activity within the sphere of urban agriculture (UA). However, when combined with the current resurrection of the UA, the repercussions of such various methods and experiences have been the incompatibility of the UA with a legislative system that is rigidly defined [9]. This incompatibility has either slowed down or entirely hindered the absorption of initiatives into cities. At the most extreme end of the spectrum, agricultural and gardening activities have the potential to get consumed by systems that do not change, therefore becoming a component of socially equitable processes like as gentrification. Even in situations in which UA is not actively participating to the processes of gentrification, farmers have discovered that they are experiencing other issues. Due to a lack of access to required equipment or a limited understanding of alternatives that are more efficient, small towns or family farms often use techniques that require a significant amount of manual effort [96]. Large-scale commercial farms, on the other hand, may use recently developed agricultural techniques or technologically sophisticated systems in order to operate large-scale urban farms [10]. However, a significant number of these businesses are still in the process of emerging and may not be subject to policy control. Because these systems are still in the process of being explored and developed, it is possible that they may have ramifications or implications that were not anticipated, which would need further modifications in order to make them sustainable [11].



Fig. 1. Urban Farming Practices



Fig. 2. Recycling of urban waste



**Fig. 3. Urban agriculture**

The purpose of this research is to highlight the several elements of UA and the ways in which these characteristics have either directly or indirectly contributed to the feasibility of its use. This was accomplished by conducting an integrative assessment of the existing literature. Through the use of a multi-perspective approach and the provision of an integrated look at UA as a whole, it intends to bring the subject of UA up to date and make additions to it [12]. The body of research is broken down into five primary subcategories, which are as follows: economic, social, catastrophe risk reduction, health and wellness, and environmental views. This last part gives prospective suggestions by identifying acceptable technology and government regulations that might assist farmers in making UA more commercially feasible and socially important in the future. These recommendations are based on the findings that were made earlier [13].

## **2. CONCEPT OF URBAN FARMING**

Urban agriculture is a vital activity that has been present since ancient civilizations. It provides critical resources such as food, housing, security, and commerce. Urban agriculture has been around throughout history. Over the course of two distinct eras—the Industrial Revolution and the Second Industrial Revolution—the idea of urban agriculture has undergone significant development [14]. During the first stage, which was known as the City Farming period, enormous earth and waterworks were unearthed inside and around the highly developed urban centres of ancient civilizations. The separation of

agriculture from cities and the production of food from urban economies occurred during the second era, which followed the Industrial Revolution by a significant amount of time [15]. Metropolitan governments in both the North and the South are rediscovering urban agriculture in order to make the most of their resources, which include space and energy. Cities are able to progressively reduce the amount of resources they import from their hinterland, while simultaneously expanding the lifetime of the resources they continue to need [16]. The most significant advancements in manufacturing and marketing systems were developed in and around the major Asian cities in the latter part of the 20th century. Major Asian metropolises have been living in this paradise for a considerable amount of time.

Throughout the history of civilizations in many geographical locations, from Ancient Egypt to Greece, the Persian Empire to the Roman Empire, Medieval settlements to North American valley settlements, urban agricultural methods have been as ancient and important as the history of these civilizations [17]. The techniques of urban agriculture are regarded as an important resource because they make it possible for people to easily get nutritious food, which is a fundamental need for human beings. Urban agriculture encompasses a wide range of topics, including but not limited to: sustainable urban development, urban land management, urban livelihood and survival methods, rural agriculture, urban food supply systems, and urban food security [18].

The concept of urban agriculture is linked to a vast food chain and involves interactions with a variety of resources, including those that are economic, social, and environmental. All members of a community are able to get a diet that is safe, culturally acceptable, and nutritionally appropriate via the implementation of a sustainable food system that optimizes the community's capacity for self-sufficiency and social justice. This is the condition known as food security [19]. In conjunction with other strategies that aim to improve access to affordable food (such as healthy-corner store programs and supermarket financing efforts), urban agriculture has the potential to become a useful tool for enhancing community food security, particularly in urban districts that are characterized by low incomes.

Urban agriculture is responsible for fulfilling fifteen percent of the world's food requirements, according to estimates provided by the United Nations Development Programme (2010). As an example, forty percent of people living in Toronto and forty-four percent of homeowners in Vancouver, Canada engaged in urban agriculture. As a result of 10 years of effort, urban agriculture in Cuba is able to give employment opportunities for thousands of people and fulfil fifty percent of the city of Havana's food requirements [20].

The urban agriculture movement known as "victory gardens" provided assistance to agricultural endeavours in both urban and rural regions in order to combat the food crisis that was encountered during the World Wars. The year 1943 saw the establishment of more than twenty million urban gardens throughout the United States. These gardens included "victory gardens," personal gardens, rooftop gardens, urban parks, and empty lots. It is estimated that 41% of the nation's yearly supply of vegetables and fruits was generated by a set number of "victory garden" initiatives that are still maintained today [21].

### **3. RECENT STATUS OF URBAN FARMING**

Urban agriculture (UA) is becoming more popular in urban areas, especially in the Northern regions of the world, as a result of the socioeconomic advantages it offers, including food security, social justice, environmental quality, and health. Traditional agricultural techniques, which include the eradication of wildlife and the intensification

of land usage, have resulted in the rebirth of UA as an option that is more environmentally friendly. It has come to light that the COVID-19 outbreak and production difficulties have brought attention to the role that UA plays as a source of food in urban areas [22].

Nevertheless, there are several restrictions associated with UA, such as the restricted availability of land in urban areas and the need of specialized skills for operations on a big scale. When implemented within a framework that is sustainable, innovative techniques and technology have the potential to reduce pressure from rural agriculture and provide a stable food supply. In spite of taking up just ten percent of the available urban area, UA is able to produce a wide range of crops and vegetables [23]. In the past, it was believed that cities were not suitable for agriculture since there was a scarcity of land available. However, individuals have found methods to creatively use restricted space, such as creating rooftop gardens and farms. Vertical agriculture has been greatly expanded as a result of technological improvements, which have led to the development of a variety of systems for vertical farming, which are designed to improve space management. Moreover, developments in biotechnology have been a contributing factor in the creation of a greater number of crop types that are ideal for urban environments. The adoption of urban agriculture (UA) in urban areas is being driven in large part by developments in vertical farming and plant biotechnology [24].

### **4. EFFECT OF URBAN FARMING ON DIFFERENT ASPECTS**

The incorporation of urban agriculture (UA) into sustainable city planning has garnered a lot of attention in recent times. This is primarily due to the rapid urbanization that has occurred, as well as the significance of striking a balance between economic development, environmental protection, and equity in terms of income, employment, shelter, basic services, essential infrastructure, and transportation [25]. As a result of decreased land prices in the global south, the United Arab Emirates (UA) has been pushed to the margins of discourse, despite the fact that it is partially involved in the process of policy making. The situation, on the other hand, is progressively shifting thanks to the fact that urban agriculture has significant consequences for the long-term viability of cities in terms of the contribution it makes to the economy, the environment, and society [26].

The expansion of green spaces in urban areas leads to an improvement in air quality, and a partial dependence on urban agriculture leads to a reduction in emissions of greenhouse gases. Additionally, UA makes a contribution to the growth of local commerce, which results in the creation of full-time jobs or alternative sources of income. The proportion of low-income families who participate in UA is much higher than the percentage of households with average incomes in emerging areas. Nevertheless, in order to ensure the food supply of cities via the implementation of sustainable methods, it is necessary to strike a balance between urban and rural agriculture [27].

Because of the COVID-19 pandemic, the importance of the problem of food security was brought to light. Countries with low and intermediate incomes were the ones who suffered the most of the harm. A greater proportion of the population in developing nations spends a greater proportion of their income on food in comparison to the population in high-income countries, which places an extra burden on vulnerable populations [28]. As a result of restrictions placed on the movement of both people and products, access to food on urban markets is further restricted, which in turn leads to food shortages and inflation. During the pandemic, industrial activities have been halted in order to prevent the spread of the

illness, which has led to an increase in the number of people who are becoming unemployed [29].

Because of their decreased income and the increased cost of food, many families were compelled to cut the amount of money they spent on food and to lower their quality requirements in order to maintain their level of living. There will be around 130 million individuals who are experiencing severe food insecurity by the end of the year 2020. The seriousness of the situation is clearly shown by the present global food crisis and the consequences that it has brought about [30].

## 5. ECONOMICS AND SOCIAL OF URBAN FARMING

The term "urban agriculture" (UA) refers to a wide variety of livelihood systems that are capable of being adapted to urban settings. These systems vary from those geared toward households to those that are more large-scale and commercial in nature. There is the possibility that UA may make a contribution to the development of urban communities' resilience, particularly in terms of their ability to deal with economic crises. There are three different levels at which the economic feasibility of UA may be evaluated: the home level, the municipal level, and the macro level [31].

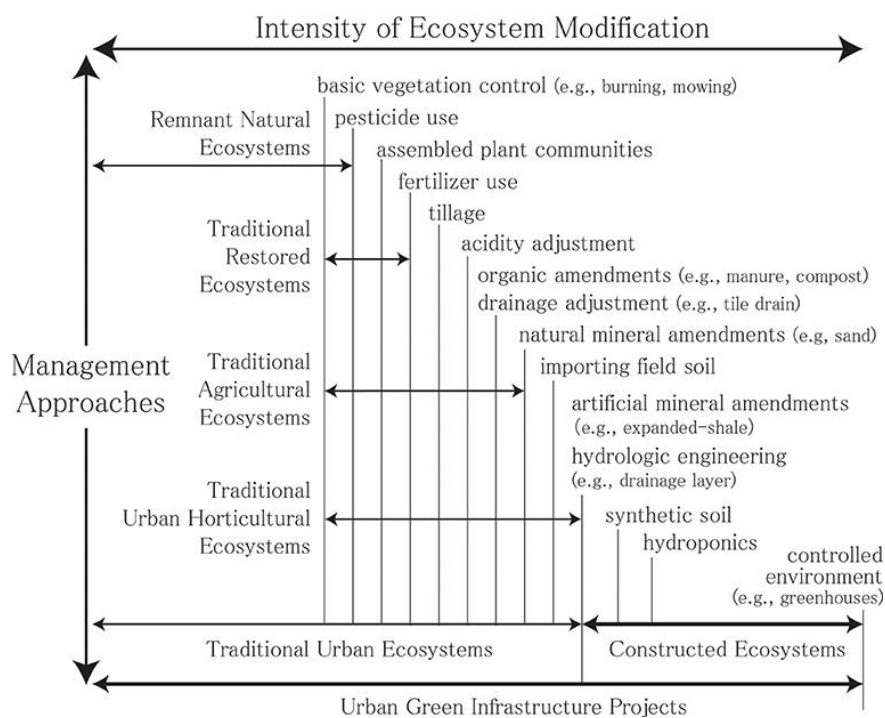


Fig. 4. management approaches

The economic advantages and costs associated with agricultural production are directly experienced by urban families. These include self-employment, the interchange of goods, revenue from sales, and savings on food and health expenses. Furthermore, urban households are directly responsible for the costs of agricultural production. Rainfed crops, such as maize and cassava, are mostly grown for consumption in households [32]. On the other hand, short-cycle and long-cycle crops, such as lettuce, cabbage, carrots, and onions, have the potential to create monthly revenue from sales. In Ghana, it was shown that the average revenue obtained from farming in rural areas was two to three times lower than the income gained from irrigated urban vegetable cultivation [33].

There are direct advantages and costs that are not borne by the farmers at the city level, as well as indirect benefits and costs that are in the form of positive and negative externalities. Both of these types of benefits and costs are available to the city. Within the context of urban environments, these externalities include the social, health, and environmental implications of urban agriculture. Comparisons across various city scenarios continue to be difficult due to the fact that these consequences are dependent on the policies and regulations that are already in place in the city [34]. Utilizing the cost-benefit framework is a typical method that economists use in order to investigate or quantify the effects of these variables [35].

At the macro level, the impacts of UA are felt via its contribution to the gross domestic product (GDP) of the country as well as to the effectiveness of the food system of the nation. UA goods have the potential to augment the restricted supply of agricultural products in rural areas, provide as an alternative for food imports, and increase the production of agricultural commodities for export [36]. Additionally, UA has been responsible for the greatest levels of self-employment among small-scale businesses in Kenya, as well as the third highest earnings rates overall. Due to the fact that the majority of research is concentrated on the home level, there are not many studies that have been conducted on the economic effects of UA at the macro level. 'economic viability of UA' is another word that might be misleading due to the fact that the economic viability of various forms of UA can vary significantly from one another. On the other hand, it typically takes into account the full and generalizes the economic feasibility of

UA based on the findings that they have outlined [37].

A number of the obstacles that urban farming seeks to address are brought to light by food insecurity and gentrification in urban areas. However, these concerns also point to wider socioeconomic issues that need addressed if urban agriculture is to become really economically viable [38]. The existence of food insecurity is a consequence of more widespread and deeply ingrained inequalities, and the expansion of agricultural systems into urban areas does not always ensure an improvement in food security for the population that is living there. At the same time as there is a preconceived concept that exploits "greening" as a technique in gentrification to make districts more appealing to the upper class, there is a conflict between the utilization of UA to alleviate food poverty [39].

In terms of the external social circumstances, the most ideal remedies require fighting structural inequities at their core. However, there are policy tools and methods that may assist in preventing UA integration from succumbing to destructive capitalist tendencies. In spite of the fact that there are variations between top-down and bottom-up approaches, initiatives that show a degree of municipal liberalism in practice demonstrate the ability to fulfil residential requirements as a result of an ongoing engagement with civic action [40].

When it comes to resolving social inequities and assuring a service-based system that is self-sustaining and less prone to gentrification, the incorporation of Urban Agriculture (UA) within local governments is very necessary. In order to address unique requirements, local governments have the ability to include the opinions of local inhabitants into the decision-making process, therefore addressing gaps in official policy and creating departments or focus groups [41]. Food policy councils in Portland and Vancouver are made up of local activists who provide guidance to municipal governments on how to navigate connected challenges and write suggestions for the development of projects. By holding policymakers responsible in the state of New York, councils provide communities an additional layer of protection against the possibility of massive growth or the establishment of an exclusive environment [42].

The use of UA in isolation is not a workable option; nonetheless, producers may be

positioned to act against social inequalities rather than being absorbed to sustain a system that is already corrupt. In order to allow room for grassroots activities and adequate contact with relevant social justice movements that are taking place in the community, it is helpful to bring the control and accountability of government officials into alignment. It would be beneficial for policy approaches to acknowledge the intersections and consequent variables that exist within the agricultural sector [43]. These are the factors that enable Urban Agriculture to embrace more than just food production and security. The future economic feasibility of these initiatives will be enabled by the use of policies in such a way as to extract advantages of UA that are often or seldom hypothesized [44].

When it comes to emergency situations and the rehabilitation of areas after a catastrophe, UA serves a variety of particular responsibilities. In particular, the consequences of global warming have made the effects of natural catastrophes on urban areas even more severe. This is especially true in nations that are still developing, countries that are experiencing water scarcity, coastal regions, and low-lying regions [45]. It is also common for many cities to be predisposed to the danger of interruptions in the food supply chain, which often have a disproportionate impact on the urban poor, the elderly, and the crippled. In developing nations, rapid urbanization and large migration into city centres may often result in conflicting demands, limited resources, and overextended infrastructure systems. This kind of situation can be particularly problematic [46].

The use of UA has the potential to provide a number of advantages, including the reduction of adverse effects brought about by natural disasters, the acceleration of post-disaster rehabilitation procedures, and the enhancement of overall urban and livelihood resilience. The disruption of supply chains is one of the most significant effects that natural catastrophes have on urban areas. This is because cities that are highly developed are more dependent on imported food, which makes them susceptible to rapid food depletion. During times of crisis, the presence of local agricultural food production helps to lessen the susceptibility of the supply chain to interruptions [47].

In addition, urban agriculture offers a multitude of social advantages that must not be disregarded when considering the reduction of risks and the enhancement of urban resilience. A constructive

depiction of the social components of UA may be seen in the experiences of refugee camps for refugees. In a study that was carried out by Tomkins et al. (2019), the function of UA was investigated in Iraqi refugee camps. The researchers found that gardens were often related with advantages like as fostering communal cohesiveness and giving a place for healing from traumatic experiences [48]. When it comes to disaster risk reduction methods, the incorporation of Urban Areas (UA) should be linked with larger development goals in order to make the most of the advantages it offers. One example is the use of UA in refugee camps for the purpose of promoting the construction of sustainable infrastructure. This includes the implementation of Sustainable Drainage Systems, which have resulted in enhancements to water mobility, water quality, greywater management, and the reduction of pollution and erosion. In cities such as Beijing and Toronto, urban agriculture (UA) has been included into municipal climate change action plans [49]. Additionally, the economic advantages of UA have funded "slum-upgrading" schemes in a number of South American nations. As a component of the attempts to decrease surface temperatures and lessen the effects of the urban heat island effect, UA has been adopted in dry areas such as Burkina Faso [50].

On the other hand, the absence of official recognition and technical help has often been a barrier to the full fulfilment of UA's potential. Furthermore, this is particularly true in post-disaster environments, which are characterized by the tendency to disregard agricultural productivity during times of crisis. During the first phases of the post-disaster cycle, initiatives that are relevant to agriculture should be undertaken. Studies have shown that a lack of municipal support aggravated pre-existing deficiencies, such as a lack of technical help, an inability to diversify commercialization channels, and trouble acquiring inputs. This has brought to light the fragility of UA systems, which has been brought to light by the repercussions of COVID-19 [51].

The United Arab Emirates has the potential to reduce poverty and food insecurity, enhance the health of city people, and protect the environment simultaneously. When it comes to providing healthy, sustainable, and liveable cities for all population groups, urban green space is an essential component. This is especially true for lower socioeconomic groups than other population groups. Research on the ways in



which urban environment might be employed as a strategy to lower health hazards has been expanding, but the outcomes of these studies have been inconsistent. Because there is a scarcity of empty land for green space on roofs in metropolitan locations such as New York City, rooftops have become an essential site for greening operations [52].

There have been studies that have been reported on the connection between green spaces and general health. Some of these studies have shown that the amount of green space within a three-kilometre radius has a significant impact on the relationships between stressful life events and the number of health complaints and perceived general health. Another research found that the influence of residential surrounding greenness on mental health status, perceived social support, and, to a lesser degree, physical activity was greater than the impact of subjective closeness to green areas [53].

## 6. ENVIRONMENTAL EFFECTS IN URBAN FARMING

The movement of agricultural operations into urban areas often results in the emergence of environmental hazards, which in turn have an impact on the production of products and services by farms and the community that surrounds them. Consumers are exposed to potential health concerns as a result of increased pollution in urban areas, which may lower the quality of goods cultivated in urban areas. Farming practices that include the use of certain pesticides, herbicides, and fertilizers might pose extra dangers to local populations and cause harm to the biodiversity of the area [54]. As a

result of these conditions, agricultural techniques may become harmful to the environment or undesirable in densely inhabited areas, especially in the case of commercial urban farms.

The link between the agricultural sector and the environment may be described in two different ways: the environmental effect that is caused by the modifications that are made by farming techniques, and the sort of environment that is formed by including food production in a particular place [55]. It is important to note that this is true for both urban and rural systems, as it sheds light on the ongoing effort to combine contemporary agricultural methodology with environmentally concerned rules. Exemptions have often been granted in the agricultural sector, which has resulted in severe regulatory gaps. This is despite the fact that many of the related negative externalities have been well investigated. Consequently, it is of utmost importance that agricultural techniques that are being introduced into urban areas function in accordance with broader environmental rules and norms, rather than being allowed to operate uncontrolled. In order to assist in the correction of negative externalities and hazards that are inflicted on the environment, such policies have the potential to be considered an effective solution [56].

When it comes to environmental contamination, urban agriculture operations in modern societies confront a number of environmental dangers, one of the most significant of which is the navigation and risk management connected with environmental contamination. Specifically, the contamination of soil and air caused by human activity, which includes activities such



Fig. 5. and 6. Environmental effects in urban farming

as mining, transportation, transportation, and transportation of waste, as well as the burning of fossil fuels [57]. It is dependent on a number of elements, including the amount and kind of pollutant that is present, the length of time that the product is left in the soil, and the type of crop that is being exposed, that the eventual effect of environmental contamination of produce is determined. On account of the increased surface area of their leaves, vegetables such as lettuce and cabbage are more susceptible to being exposed to particles in the atmosphere. Root vegetables, on the other hand, are more susceptible to being contaminated by soil matter. Additionally, the length of time that the plant is allowed to develop will either increase or decrease the amount of exposure to any pollution that is there. Additionally, herbs such as thyme, which are produced throughout the year, become more vulnerable to absorption [58]. Lead is a problem that is often brought up by urban farmers that cultivate crops using soil-based techniques. This issue is expressed in relation to contamination. There was a widespread use of paints and gasoline containing lead some decades ago; nonetheless, numerous metropolitan locations continue to test positive for varied amounts of contamination even now. On the other hand, with the exception of root vegetables and low-growing plants, the absorption of lead by plants is typically modest, and the dangers of bioaccumulation continue to be relatively low [59].

In particular places, there are other types of urban air and soil pollution that might provide a more significant obstacle to the implementation of urban agricultural systems when they are implemented. Indoor farming, hydroponics, and aquaponics are some examples of crop production methods that might help reduce the negative effects of soil and/or air pollution that are caused by human activities. However, these shifts in production have the potential to have an impact on the overall economic viability and sustainability of agricultural practices among urban populations [60].

On the other hand, agricultural techniques that are centred on the production of high-quality goods, particularly those that use a terroir approach, will have a greater propensity to enhance the environment and the status of the local ecology in the areas where the UA are situated. UAs that use a terroir approach will have a greater motivation to seek urban rules that support improved environmental

conditions surrounding their site since the high-quality items they produce attract a higher profit [61].

## 7. DIGITAL FARMING IN URBAN FARMING

Digital farming is a new kind of urban agriculture that has intersected with other sectors, such as the technology sector, which has enabled the development of new aspects such as automation, software integration, and silicon-based hardware. Digital farming is another name for urban agriculture. The result of this is that farmers in both rural and urban areas have begun to use digital alternatives in order to boost their output and improve their production, respectively [62]. Vertical farming makes use of heating, ventilation, and air conditioning (HVAC) systems to keep the surroundings in which crops are grown in an appropriate state. These systems also use automated monitoring procedures to keep track of environmental factors such as temperature and humidity. There is no longer a need for human management since sensors and actuators contribute to the accumulation of a database of information about the world around them [63].

As a result of the fuzzy defining boundaries and the lack of legislation that expressly target the burgeoning sector, digital urban agriculture (DUA) farms, according to the findings of a research conducted by Carolan (2020), enjoy increased ease of integration on the regulatory front. Consequently, this has resulted in difficulties in the planning process with regard to zoning rules, since digital farms are often subjected to less zoning limitations than traditional farms. As "digitized" operations proliferate and scale up output without sufficient controls, lax zoning techniques often favour land allocation to digital farms over conventional UA [64]. This results in a sinking of local market prices and poses a danger to other local vendors. One example of the quick extension of UA into other sectors is the development of DUAs. In order to counteract potentially negative regulatory grey zones, policymakers need to exercise caution and thoughtfulness towards these developments. The decision-making process is essential to the achievement of economic viability because it is responsible for the creation of an environment that is not only favourable to these kinds of changes but also sensitive to them [65].

## 8. CASE STUDY OF TAIWAN

Through the transition from an agricultural economy before to 1960 to a commercial economy between 1960 and 1980, Taiwan's urban agriculture growth has progressed from an agricultural economy. In the contemporary fields, this resulted in an increase in profitability while simultaneously reducing the amount of agricultural production output. In recent years, urban congestion, environmental concerns, and food difficulties have garnered attention on a worldwide scale. Additionally, agricultural production services such as leisure, tourism, and education have become increasingly essential. The production of space is currently the primary emphasis of urban agriculture space, with the goal of reducing excessive industrialization and fostering the creation of a beautiful environment. Tourist farms, citizen farms, and leisure farms are some of the several forms of urban agriculture that may be found in Taiwan [66].

Local governments in each county and city in Taiwan have the ability to exercise their own autonomy, which has an impact on the growth of urban agriculture in Taiwan. While the majority of Taiwan's counties and towns are still in the beginning phases of growth, Taipei City has reached a comparatively advanced degree of

development. The city of Taipei is seeing a growing elderly population, which brings potential as well as obstacles for the growth of residential agriculture. The development of urban agriculture in Taiwan has as its overarching goal the creation of a beautiful environment and the promotion of sustainable cultivation techniques [67].

## 9. CASE STUDY OF TAIPEI

The growth of urban agriculture in Taipei may be broken down into three distinct paths: informal operation, spatial initiative, and flexible use of public space. On the other hand, informal operations entail the production of food in public areas such as riverbanks, empty lots, apartment balconies, and roofs. These areas are often only visible to those who live or work in the immediate vicinity. The water department and the parks department of the government both ban unlawful planting on public property along rivers and in civic parks. Additionally, municipal agencies such as hydraulic engineering and parks also restrict unauthorized planting in civic parks and communal land along the riverside [68]. The second option is the government's spatial initiative of urban agriculture, which is being encouraged and implemented. During the year 1980, Taipei became the location of Taiwan's

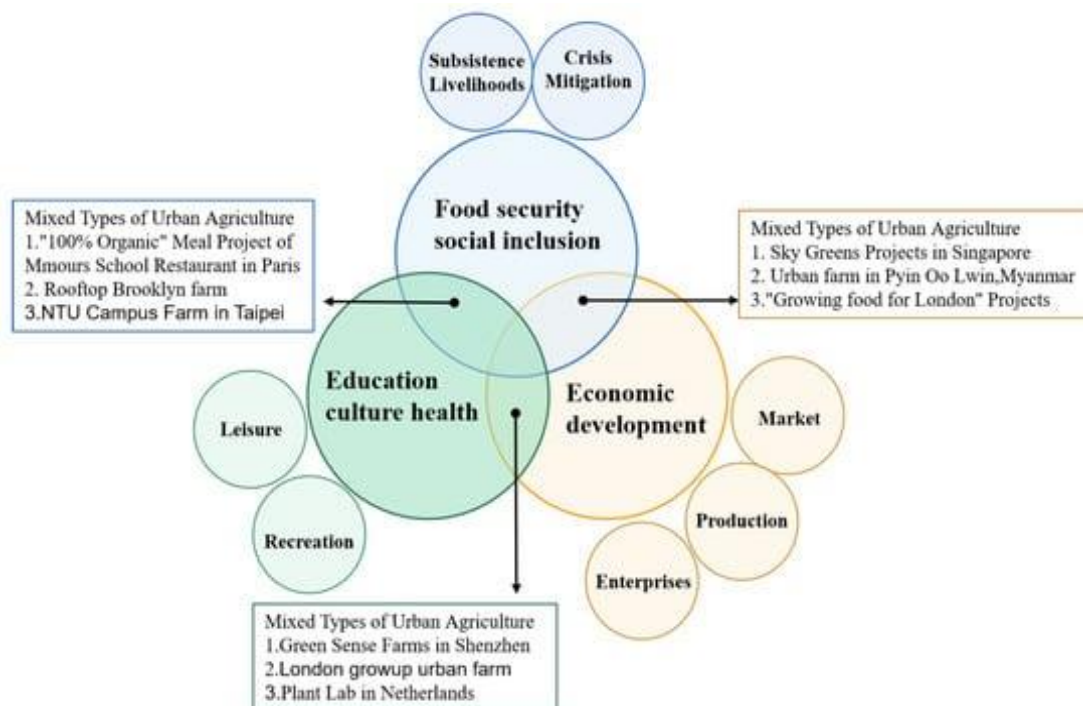


Fig. 7. Food security

first tourism farm, which was a tea garden. Between the years 1989 and the present day, the city of Taipei has been home to seventeen citizen farms that combine the activities of agriculture, recreation, and education. At the moment, almost all of the seventeen municipal farms are at capacity, and the individuals who take part in the farms have established a strong social connection with the land, the crops, and the urban farmer via the process of farming [69].

The adaptation of public space is the third possible course of action. In accordance with the guidelines for the administration of the Field Base Adoption by the Taipei City Government and the "Taipei City Park Management Ordinance," it is forbidden to cultivate or harvest any crops on parks unless specifically authorized. As a result of public concern over food safety in Taiwan and the political opportunity presented by the Taipei mayoral election, the Garden City Program was formed by the Farming Urbanism Network (FUN) in 2014 [70]. This program became the campaign platform of the contender for the position of Taipei Mayor. The garden city strategy was created for a period of half a year after Ko Wen-je was elected mayor of Taipei City in 2015. The policy primarily included the integration of the garden base area and the establishment of a garden bank, as well as the establishment of an agricultural technology guidance mechanism and the elite administration of the garden base [71]. There have been more than 600 gardens with a total area of over 100,000 square meters in 2018, and there will be more than 213,000 square meters and 740 vegetable gardens in 2020. This is all thanks to the promotion of the "Garden City" program in 2015. Roughly 520,000 individuals are now engaged in agricultural activities. This represents a significant increase. Indicative of the fact that the lessees have formed strong sentiments about the property is the fact that almost all of the seventeen citizen farms are operating at their maximum capacity and have limited mobility [72].

## 10. OTHERS

The availability and quality of resources, such as land, water, labour, money, the local climate, and access to technology, all have a role in determining the kind of gardens and farms that get UPA funding. There are a number of subjective and objective elements that influence the selection of crops for UPA. These considerations include the local environmental

circumstances, the availability of varieties, and the aims of the producers.

Generally speaking, UPA producers choose horticulture products because of the better value they provide and the faster turnaround time they need [73]. For instance, in China, the majority of the vegetables and fruits that are grown are vegetables and fruits such as cucumbers, eggplants, and Chinese long beans. This is the case in both personal gardens and large-scale commercial farms. Within twenty kilometres of the city centre of Hanoi, Vietnam, it is estimated that seventy percent of the urban production and supply of green vegetables may be obtained for consumption [74].

During the dry seasons, commercial farms in many parts of Africa are the primary producers of vegetables including lettuce, cabbage, and tomatoes. These products are widely available in many parts of Africa. Gardens on Antiqua and Barbuda are home to both indigenous vegetable varieties and those that are brought in from other countries [75].

Cereal crops are not as prevalent in the UPA, although they could be found on fields around metropolitan areas. As far as UPA producers are concerned, maize and other basic crops are the most popular options in Africa. The rice-based farming system is an example of a common style of peri-urban agriculture that is practiced throughout Asia. Paddy and maize are the most widely farmed crops in the Kathmandu Valley in Nepal. Other grains such as millet, wheat, and barley are also grown throughout the landscape of this valley [76].

In less affluent metropolitan and peri-urban regions, it is widespread practice to keep small livestock, which includes growing chickens and other small animals for the purpose of domestic consumption and commercial sale. Countries in Southeast Asia have a significant need for aquaculture systems, and these systems may also be found in cities in other areas.

In some cities, farmers with low and medium incomes are more likely to engage in crop cultivation, while farmers with high incomes are more likely to be interested in maintaining livestock and rearing fish owing to the greater investment and infrastructure needs involved in these activities. On the other hand, the cultivation of flowers and vegetables demands a greater amount of effort and a greater investment than the production of rice does since these crops are more susceptible to danger [77].

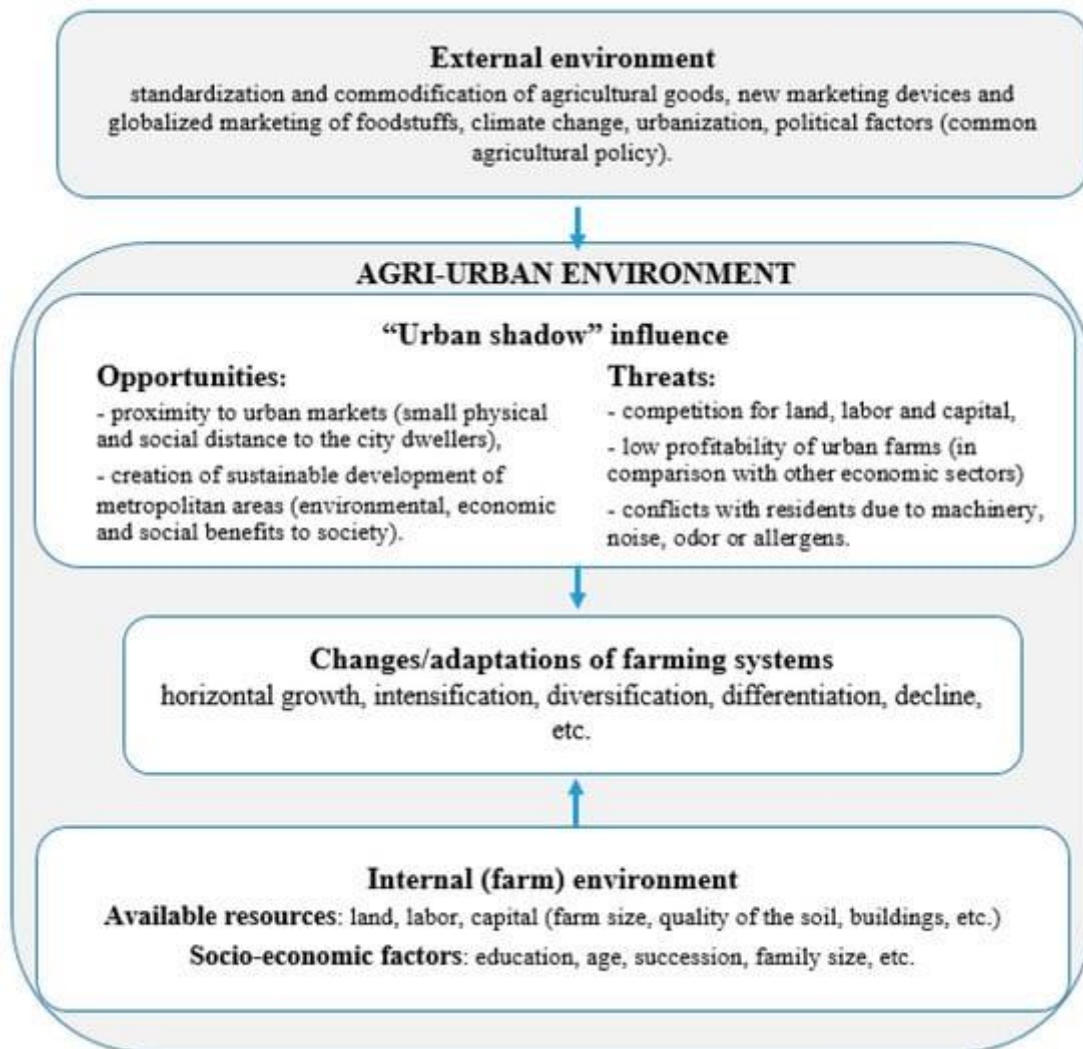


Fig. 8. Agri urban environment

## 11. MAJOR CHALLENGES IN URBAN FARMING

The limited area in cities and constraints of housing, industry, infrastructure development, and leisure on urban and peri-urban land make Urban Agriculture (UA) difficult to scale. Urban soils may be polluted and concrete overlay can render open spaces unsuitable for food production. Rooftops and vertical spaces might extend UA, but their worldwide availability is modest compared to unused urban land [96].

Space availability for prospective growers is the major challenge. In principle, a typical UK city has adequate growing land to supply residents' fruit and vegetable needs. However, ownership concerns, restrictive legal frameworks, and a lack of supporting policies limit UA's expansion.

Urban agricultural land is seldom protected, causing farms to divide and perish [78].

The size of UA depends on public engagement and rising space. In some parts of the developed world, urban food production is dying out, and expensive land leases, lack of growing space security, high costs of setting up and operating farms in urban areas, and low demand for urban-grown produce can discourage or prevent UA businesses and social enterprises [79].

Another important UA scale restriction is efficiency. Many cities in the global North are losing food-growing expertise, resulting in inefficient practices. Aquaponics and hydroponics may provide high yields in small settings, but they are still developing and not well understood. Own-growers, small firms, and

community efforts that cannot afford specialists may find technologically sophisticated techniques costly and demand specialized expertise.

Another major UA difficulty is integration [80]. Due to high land costs in core locations, commercial farms and market gardens are generally located on the periphery of cities, making customer delivery difficult. Food safety and organic certification restrictions might complicate matters. Due to minimal government backing, urban food distribution and retail outlets are few [81].

Consumer desire for UA goods may be limited by culture. Poor planning for resilient urban food systems and food in general is a serious concern. Some nations have no food department and few urban food production programs.

Urban horticulture (UA) may improve the environment and promote sustainable urban development. Uneven distribution of green space, growing space, and financial and physical access to urban-grown food are its obstacles. Urban growth trends in many regions of the global North have imbalanced green space, favouring wealthier places. UA initiatives frequently need networking, social work, business, and horticulture abilities [82].

Equal financial and physical access to urban-grown food is another important aspect that

might restrict UA's benefits. Many locations lack walkability to urban farms and alternative food retailers, and local product costs more than commercial farm produce. This has led to higher-income groups buying locally produced fruit and vegetables, while lower-income farmers struggle to sell their goods and may hike costs, worsening uneven access to local food [83].

Industrial activity, car emissions, and the use of amendment soil from polluted areas cause high amounts of heavy metals and other harmful compounds in urban soils and groundwater, raising safety issues. Some nations lack comprehensive urban-grown food safety laws, raising worries about the health risks of eating tainted produce. Gardeners near key highways and metropolitan centers may be at danger from air pollution [84].

An problem may be improper household agrochemical usage. Urban producers may overuse fertilizers and pesticides, harming the environment or polluting the city's water and food.

Cultural predisposition toward groomed landscapes, environmental generational amnesia, and public acceptance of UA might hinder its effectiveness. In many areas, single-family residential gardens dominate open space and have enormous potential for UA growth. Modern lives' hectic schedules may hinder the acceptance of UA.



**Fig. 9. Major challenges in urban farming**

The absence of volunteer contributions, restricted growing area, garden fees, difficult site access, and possibly unsafe conditions contributed to Urban Urban Farming (UA)'s success. Supermarket zed food buying and consumption behaviours make individuals less likely to choose sustainable products or comprehend healthy diets [85].

Institutional backing might also hinder UA's progress. Urban food production is seldom addressed in local council law and municipal planning. Zoning rules limit UA expansion, and municipally owned growing lands are frequently reserved for urban growth. Urbanization may endanger many periurban farms, and liberalized laws may enable anybody to buy agricultural property and utilize it for other purposes, threatening how limited productive land is exploited. Urban food production regulations are sometimes missing, and "organised irresponsibility" surrounding complicated concerns like pesticide pollution may be seen.

Instead of creating resilience via local self-sufficiency, governments may subsidize export-oriented food production to achieve national prosperity [86]. The EU's Common Agriculture Policy (CAP) promotes market globalization and favours bigger rural farmers. Many cities have issued strategic announcements about establishing more resilient urban food systems, noting UA's importance, but precise objectives and action plans are uncommon.

Small UA firms may struggle to compete with bigger producers owing to ineffective resource access policies. Multifunctional UA projects may provide extra revenue, but they need more investment and might be hindered by banks' unwillingness to support "risky" urban horticulture initiatives or legislative discrepancies. City authorities have also been criticized for leaving most of the work to community organizations and NGOs to guarantee fair access to nutritious meals for underprivileged neighbourhoods [87].

Limited government funding and green space development plans might also hurt UA, which is prioritized less. Larger municipal-led greening efforts neglect the poorest communities and may worsen spatial and social inequalities. In much of the global North, urban policy and planning seldom include ecosystem services and nature-based solutions.

Urban agriculture (UA) may help cities become more resilient, but it faces several obstacles.

Land cover and usage characterisation at high resolution is challenging and time-consuming, and calculating rooftop and building façade areas for alternative production techniques is tough. Integrating data from diverse sources may be challenging, and some critical information may be secret. Due to this, urban food production land is seldom understood, although current study shows it might be significant [88].

Many cities' food is grown in private gardens, allotments, and small farms, where yields are seldom documented. Statistics from traditional agriculture or mathematical models may not match ground-level reality. Quality, production, and supply-demand dynamics alter urban-grown foods economic worth, making it difficult to characterize.

Since hazardous residues in private growing places are seldom regulated, urban food is typically unsafe. Insufficient toxicity data, contested historical narratives, and mathematical ecosystem models make city agrochemical contamination danger uncertain. Its regulation is complicated by disagreements on tests and thresholds [89].

UA cultural services are subjective and hard to quantify, making it challenging to prove their advantages. Urban food garden ecosystem service supply is mostly assessed by practitioners.

What resilience implies for urban planning and policy, let alone UA's role, is unclear. These uncertainty, along with the fact that UA sites seldom give clear economic advantages to local authorities, might make them hesitant to expand growing area and restrict the efficacy of UA promotion activities [90].

Lack of communication and cooperation between academics, policymakers, and communities may also hinder UA. Multiple writers claim that weakening social relationships and a lower feeling of involvement have hindered informal learning and information interchange, rendering UA's social memory fragile. Limited connectivity and coordination between small projects and larger-scale agencies might hinder information and resource sharing and debate critical mass [91].

Finally, a lack of communication between towns and communities and a belief that scientific

knowledge is superior to local knowledge may lead to the neglect of local knowledge in UA practice and increasing space planning. Climate change adaptation, environmental protection, agriculture, food systems, and public health research and policy frequently lack linkage among institutions and government agencies. This puts urban agriculture (UA) in a tricky situation since its multifunctionality impacts sectors that may get little attention. Different understandings of complex topics like city resilience and urban agriculture's involvement in it might lead to conflicting policies due to poor information sharing and coordination across government ministries. Many resilience plans have many targets, few have city-wide strategies, and few use synergies [92].

Although multi- and transdisciplinary methods to evaluate environmental services are becoming more prominent, research information sharing is still limited. Urban green space evaluations seldom address multifunctionality, and most studies focus on one service from one stakeholder viewpoint. Urban resilience and ecosystem service research seldom incorporates stakeholders and may not concentrate on the poorest regions where green space, particularly UA sites, is required most [93]. Another issue is contextual variability, since urban agriculture's resilience advantages and essential elements vary within and within cities. Geographic constraints on food production, landscape features and land cover characteristics, land ownership, costs of key items, land use pressures, institutional designs and policies, cultural factors that affect practice, public perceptions of different forms of UA, and urban produce demand are examples. Wide contextual variability might hinder the transferability of research and policy methods across scales and locales, making it challenging to create space-appropriate UA promotion strategies [94].

UA's success in increasing city resilience depends on institutional and public support, a sufficient knowledge base to guide policy and practice, communication and collaboration among actors, and resourcefulness in finding locally appropriate solutions and efficient ways to use space and other resources. UA's success depends on people's motivation and capacity to participate. Effective communication between communities and local governments is key to this synergy [95].

## 12. CONCLUSION

In conclusion, this comprehensive review illuminates the multifaceted landscape of urban farming, showcasing its evolution, diverse models, challenges, and abundant opportunities. Urban agriculture has emerged as a vital component of sustainable urban development, offering solutions to pressing issues such as food insecurity, environmental degradation, and community disconnection. Through innovative practices like rooftop gardens, vertical farms, and community-supported agriculture, urban farming demonstrates its potential to transform urban spaces into productive and resilient ecosystems. However, the journey is not without obstacles, as urban farmers grapple with issues such as land scarcity, pollution, and regulatory complexities. Nevertheless, the review underscores the remarkable adaptability and creativity of urban farmers, who continue to pioneer solutions and forge partnerships to overcome these challenges. Looking ahead, the future of urban farming is promising, with opportunities for technological innovation, policy support, and community engagement driving its expansion and impact. By harnessing these opportunities and addressing the barriers, urban farming can realize its full potential as a catalyst for healthier, more sustainable, and more equitable cities.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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