Czech University of Life Sciences Prague
Faculty of Agrobiology, Food and Natural Resources
Department of Agroecology and Biometeorology

Urban agriculture as a promising way of food production in the cities

Bachelor Thesis

Author: Irena Knetlová

Supervisor: Ing. Josef Holec, Ph.D.

2018

Declaration

I declare that the Bachelor Thesis Urban agriculture as a promising way of food production in the cities is my own work and all the sources I cited in it are listed in Bibliography.

Prague, 20. 4. 2017 Signature

Acknowledgement

I wish to express my sincere gratitude to my supervisor, Mr. Ing. Josef Holec, Ph.D., for his continuing guidance, support and advice. I would also like to thank my family for their love and support.

Summary

In the past three decades world population has been growing steeply - according to estimates it is projected to reach 9.8 billion by 2050. Currently more than half of world's population lives in cities, a proportion projected to increase by almost 70% by 2050. The distribution of population is quickly beginning to be concentrated around megacities. Since the 1990s the number of megacities has multiplied three times and it is expected to keep growing. The environmental impact of urban expansion reaches far beyond the urban areas themselves. Citizens of urban areas are mostly entirely dependent on food trade and food supply coming from outside their cities. In turn, the food supply system is highly dependent on oil consumption and transportation to the destination market and consumer. Transportation of food is connected with the term "food miles" which is used to describe the fact that food is often transported over long distances to markets where it is consumed. In order to satisfy consumer demand supermarkets offer a wide variety of food products which are often not grown seasonally nor locally. There has been a call for implementing urban agriculture in the urban planning of cities, counting on integrating urban agriculture, help make cities more resilient. Urban agriculture is a term which is defined as "the growing of plants and the raising of animals within and around cities." It helps to diversify urban food sources and income opportunities, e.g. by maintaining open green spaces, enhancing vegetation cover and water infiltration and contributing to sustainable water and natural resource management. Urban agriculture has proven its importance especially in harsh times. One such example of urban agriculture are the Victory Gardens which served as an important source of food security during WWI and WWII and helped people to overcome challenging times. But history of urban agriculture practice goes much further into the past, with community gardens existing in Ancient Egypt or in Machu Picchu. Nowadays urban agriculture is practiced especially in the form of community gardens, home and backyard gardens. All UA forms contribute to food security and have the ability to improve social, health and financial well-being. The emerging form of urban agriculture which focuses more on large-scale production and has a greater ambition to contribute significantly to sustainable food production is vertical farming. It increasingly uses high-tech agricultural methods, such as hydroponics, aeroponics and aquaponics which can help obtain high yields whilst the technologically controlled environment helps maintain safe and ecological food production.

Key words: Urban farming, urban gardening, community garden, subsistence

Contents

1. Introduction

Agriculture is the basis of civilization. It has emerged around 9500 B.C. in the area of the eastern Mediterranean (New World Encyclopedia, 2018). Ever since then agriculture has shaped societies and has shown to be a powerful tool for enhancing dynamic social changes. It has enabled people to differentiate their skills and contribute to the society by developing different craft. In the areas where agriculture was fruitful, rapid blossoming of culture appeared. Major changes happened between the 16th century and the mid-19th century in Britain. Development in agriculture enabled to reach higher yield, with this yield increase accompanied by population growth. It contributed to freeing up a significant percentage of the workforce, therefore helping drive the Industrial Revolution which is considered as one of most important milestones in modern history (Nath et al., 2013).

Despite all the progress, it seems that nowadays agriculture is facing a significant challenge. The world population has been growing steeply - according to estimates it is projected to reach 9.8 billion by 2050 (UN DESA, 2017). Especially the developing parts of the world have been experiencing population as well as economic growth Wealthier societies display increase in consumer demand for a Western-like diet, which is high in calories, protein, and animal products, which in turn results in challenges for food security and sustainability (Despommier, 2011). Another global trend is urbanization. Currently more than half of world population lives in cities, which is projected to increase to almost 70% by 2050 (Wilson, 2012). Urban areas are highly dependent on food supply. This paper aims to discuss how to efficiently contribute to urban areas' food security and which solutions are the most suitable to be implemented in densely urbanized areas.

This paper will not only provide an overview of high-tech and high-yield practices of agriculture but also of small-scale urban agriculture practices such as urban community gardening. Urban agriculture is a tool contributing to local food security and reducing the need for transportation as well as improving social and economic aspect of cities, thus increasing their livability. In the developed wold urban agriculture provides leisure and strengthens community relationships. Conversely, in the developing world urban agriculture mainly serves direct nutritive purposes.

2. Aims

- To describe the current situation and future trends in the area of urban agriculture.
- To analyze every type of urban agriculture from the viewpoint of its productive and non-productive functions.

3. Objectives

- To review and compare the literature on urban agriculture and describe current and future trends in the area of urban agriculture.
- To use relevant literature sources, especially scientific papers.

4. Literature review

There has been a growing interest in urban agriculture, also referred to as urban farming or urban gardening. Plenty of researchers in this field have produced a wide range of literature focused on urban agriculture, urbanization, vertical farming, benefits of local food production, the social aspects of urban agriculture and many other related topics. For each chapter and subchapter, it will be used different sources because my Bachelor's thesis comprises themes that are similar but give general overview of this broad topic. The main source for the part of vertical farming are books and articles by Dr. Dicson Despommier who is one of the greatest supporters of the concept of vertical farming. I also consider the book "Cities That Think like Planets" an important source which generally introduced me to the issues of urbanization and the rapid growth of cities. Other literature sources I consider to be important: (Al-Kodmany 2013, 2016, 2018; Szabo, S., 2016; Miccoli, S.).

4.1. Urban agriculture and urbanization

4.1.1. Definition of urban agriculture

Urban agriculture, urban farming, or urban gardening is a term which according to (FAO, 2018) is defined as "the growing of plants and the raising of animals within and around cities." Various practices include cultivation, processing, and food distribution. Activities like animal breeding, beekeeping, horticulture and aquaculture are also included (Lyson, 2012).

Urban agriculture practice differs in scale. Small-scale personal or communal gardens help their users improve self-sufficiency and increase their food sustainability. Large-scale farming involves indoor agricultural production incorporating various technologies, such as precise LED lighting (which emits only certain light wavelengths) and other technologies to obtain a fully controlled climate in order to produce nutritionally balanced plants (Despommier, 2009).

Another concept which is mostly practiced indoors is referred to as "vertical farming." It is often practiced in or near by densely populated areas, using a soil-free cultivation method, incorporating high-tech components to control inner environment, and aiming to recycle its resource imput (Despommier, 2011).

Urban agriculture also differs according to levels of social and economic development. In the Global North it often takes the form of a social movement for sustainable communities where organic producers and people involved in agriculture form social networks founded on shared enthusiasm, a sense of nature and community holism. These networks can be supported by formal institutions and their activity is often incorporated into local city planning in order to be seen as a part of sustainable urban development. Nowadays creating more ecological and sustainable cities and modern planning have become a trend rising in popularity, and designer initiatives often take urban agriculture activities seriously (Pettenati, 2015).

In the Third World, the reason for urban agriculture is primarily to maintain livelihoods. Money obtained from agricultural practice constitutes an important part of income and food security and nutrition are not negligible.

In either case, more direct access to fresh vegetables, fruits, and meat products through urban agriculture represents one of the benefits for urban dwellers. However, urban agriculture is also an important part of the whole food production system. It has been estimated that almost one fifth

of agricultural production is produced in urban areas and it is being practiced by 800 million people worldwide (Ward, 2014).

4.1.2. History of urban agriculture

Urban agriculture (UA) is not a recent matter which would be driven by the currently growing interest in urban farming. UA is a part of a historical tradition, evidenced by e.g. the existence of community gardens in Ancient Egypt and many others. There were several other examples of UA practice in history – e.g. in Machu Picchu the stepped architecture of the city served for agricultural practice where vegetables, herbs and variety of crops were grown. Dwellers also paid attention to water management. They efficiently stored and reused water on each level the of growing beds which were constructed to attract sunlight in order to prolong the growing season In modern history, urban agriculture was incorporated into cities especially in times of disturbance. In 1893 citizens of Detroit were called upon to start agricultural practice, using all unoccupied plots to grow their own food. The vacant plots used for cultivation were nicknamed "Pingree's Potato Patches" after the Major Hazen S. Pingree who pitched the idea of farming inside Detroit in order to generate income, improve food supply and become more self-sufficient during the time of economic depression (Nath et al., 2013; Despommier, 2011).

Generally, the idea of urban food production without the need to be dependent on rural agriculture production arose with regularity during challenging times. During WWI, US President Woodrow Wilson appealed to all American citizens to utilize any space for food production. He promoted this idea as way to avoid a potentially damaging situation as the one in Europe where people starved because of the war, and with the Europeans unable to produce adequate food supplies to be sent to America. The new plan was to produce enough food to feed the Americans and even tried to generate a surplus to support countries in need. By the year 1919 food was grown on over 5 million plots and over 500 million pounds of produce was harvested (Nath et al., 2013).

During the Great Depression very similar practice was used. For the unemployed people urban agriculture practice meant a purpose, a job and food supply. These people would otherwise be left in misery. At that time, gardening really helped to improve the social and the economical situation. Over 2.8 million Dollars worth of food was produced from the subsistence gardens during the Depression.

By the time of the Second World War, the War Food Administration set up a National Victory Garden Program that set out to systematically establish functioning agriculture within cities. With this new plan in action, as many as 5.5 million Americans took part in the Victory Garden movement and over 9 million pounds of fruit and vegetables were grown a year, accounting for 44% of US-grown produce throughout that time. During the 1960s a number of community gardens were established in the United Kingdom, influenced by the community garden movement in the United States. The first city farm was set up in 1972 in Kentish Town, London. It combined farm animals with gardening space, an addition inspired by children's farms in the Netherlands. Other city farms followed across London and the United Kingdom. In Australia, several city farms exist in various capital cities. In Melbourne, the Collingwood Children's Farm was established in 1979 on the Abbotsford Precinct Heritage Farmlands (the APHF), the oldest continually farmed land in Victoria, has been cultivated since 1838. In 2010, New York City saw the opening of the world's largest privately owned and operated rooftop farm, followed by the building of an even larger location in 2012. Both were a result of municipal programs such as The Green Roof Tax Abatement Program and Green Infrastructure Grant Program (Nath et al., 2013; Henkel, 2015).

4.1.3. Urbanization

Urbanization is defined as an increase in the proportion of a population living in urban areas and the process by which a large number of people becomes permanently concentrated in relatively small areas, thus forming cities (OECD, 2018). The world has urbanized rapidly in the past six decades. Although in the 1950s less than one third of the world’s urban population lived in urban settlements, by 2014 the portion of people living in cities has increased to half of the world’s population. In 30 years it is expected that urban areas will host more than 60 percent of global population. Population growth and urbanization are predicted to add 2.5 billion people to the world’s urban population, with 90% of the increase concentrated in Asia and Africa. Although nearly half the urban dwellers reside in settlements of fewer than five hundred people, about one in eight live in one of the 28 megacities, with populations exceeding 10 million. The number of megacities has nearly tripled since 1990, and by 2030 the planet will host 41 of these urban agglomerations (Alberti, 2016).

Rapid urbanization might be problematic because it presents considerable obstacles and challenges for humans as well as the nature and its resources. Vast majority of urbanization is

taking place in developing economies, where rapid migration from rural to urban areas often occurs due to changes in economic and social arrangements.

This type of migration can contribute to the creation of slums which are defined as densely populated urban areas characterized by crowded and poor-quality housing and by inadequate public services and access to infrastructure (Marx et al., 2013). The conditions in slums - where the population density is very high without access to suitable sanitation and basic services - has a negative impact on human well-being and the surrounding environment. Poor infrastructure is typical for such rapid migration into cities because urban areas are not able to keep up with the rapid population surge. Marina Alberti claims that more than a billion people live in informal settlements and about 40% of the world's urban expansion is taking place in slums which aggravates the socioeconomic disparities and the environmental damage. Urbanization is changing societal organization. Cities accelerate the time-space compression which is associated with urbanization and this leads to expansion of interaction, such as the movements of people, production, access to and damage of natural resources, and thus to biodiversity (Warf, 2017). This influence of globalization poses significant challenge for the sustainability of cities, claims Alberti.

4.1.4. Urbanization and ecological footprints

Urbanization's impact on the ecosystem is complicated and varied. In order to include energy and other natural resources as well as environmental services, the ecological footprint is used as an indicator that can integrate various resource consumption and environmental impacts. William Rees and Mathis Wackernagel proposed the measurement of human demands on ecosystems (Wackernagel, Rees 1996) this is defined as the quantity of biologically productive land and marine area necessary to supply the resources a human population consumes and to assimilate the associated waste. Ecological footprint is composed of six types of land: cropland, grazing land, fishing ground, forest land, carbon uptake land and built-up land. Carbon uptake land, which is receiving more and more attention in the context of global warming, is regarded as the land necessary to absorb the anthropic carbon emissions. Therefore, the ecological footprint provides us with a tool to measure human impact on the ecosystem. In addition, the ecological effect of urbanization was not identical across low-, middle- and high-income countries (Long et al., 2017).

Generally, urbanization has led to the degradation of environment, especially the quality of water, air and the creation of noise pollution. Domestic waste, industrial effluents and other waste that were dumped directly to the river have affected water quality. Besides, air pollution has also increased due to emissions from motor vehicles, industrial development and the use of non-environmental friendly fuel sources. Meanwhile, noise pollution is generated by various human activities which are on the rise. The increase in population has generated a very high volume of solid waste in urban areas. The environmental impact of urban expansion reaches far beyond the urban areas themselves. In rapidly urbanizing areas, agriculture intensifies on the remaining undeveloped land and is likely to expand to new areas, putting pressure on land resources. Furthermore, urban areas change precipitation patterns in areas of hundreds of square kilometers. Urban expansion will thus affect the global climate as well. Direct loss in vegetation biomass from areas with high probability of urban expansion is predicted to contribute by about 5% to the total emissions due to tropical deforestation and landuse change. Although many studies have described how urbanization affects CO2 emissions and heat budgets, the cities have a disproportionally larger ecological footprint than rural areas. For example, London's ecological footprint is about 125 times its surface area of 159,000 ha, equivalent to about 2.8 ha per person. The average ecological footprint of Europeans is 3 ha per person, and that of North Americans is 4-5 ha per person. Vancouver has a land area of 11,400 ha and has an ecological footprint of 3,304,000 ha which is 290 times its land area. The 29 largest cities of Baltic Europe have ecological footprints which range from 565 times to 1130 times the area of their cities themselves (Zhang 2016; Long et al., 2017).

4.1.5. Food security risks

Food security is significantly being challenged by urbanization due to changes in the spatial organization of cities and the need for transportation. Another challenge is the change in consumer demand and preference. Food production, supply and food security as a whole are being affected by the aforementioned challenges (Despommier, 2011).

The definition of food security according to The Community Food Security Coalition is expressed as “all persons in a community having access to culturally acceptable, nutritionally adequate food through local, non-emergency sources at all times.”

The rising number of megacities represent a particular challenge to food security. Population distribution is quickly beginning to be concentrated around megacities. So far more than 12% of the urban population lives in 28 mega cities. Since the 1990s the number of megacities has multiplied three times and it is expected to keep growing to more than 40 by 2030. (UN, 2014). Arable land needed for food supplies is in high demand in most of the large cities. Cities like London, home to more than one tenth of the UK population, currently needs an area equivalent to 40% of the whole agricultural production land of the UK to meet its food demand. (Miccoli, 2016). This creates demand for production in areas which are located in other geographical contexts. As the cities and wealth of its residents grow, demand for food grows accordingly, thus further pressure on the global food supply system is generated. The world's agricultural production will need to respond to this demand and according to estimation it needs to increase by 70% to 100% of the current volume, while it is expected that by 2050 the area of arable land will not be able to grow by more than 12% compared to today (Miccoli, 2016).

The common problem of the increasing number of urbanized areas generates asignificantly higher demand for food. Urban areas have traditionally been perceived as not suitable for agriculture. Urban dwellers are dependent on food trade and food supply to their cities. Almost all of city dwellers are buyers of food. Another issue is the physical access to food - the generally better infrastructure of urban areas means a positive impact on food security. In highly developed countries physical food access is not an issue. For individuals who are not able to access grocery shops there is a variety of services, e.g. the possibilities of home delivery. This services are especially used by the elderly, sick and disabled people. However, in developing countries the access to food because of the inappropriate infrastructure can be a considerable problem. For example, in many African countries, farming plays a key role in subsistence, further complicated by the absence of tenure rights, inappropriate infrastructure and lack of finance for commercial agriculture. These problems also apply tor urban and suburban areas where poorer dwellers are habitually concentrated (Drescher, 2000).

The positive impact of urbanization leads to a better economic development in comparison to rural areas. Improved access to financial resources plays an important role in assuring food security, and due to various food imports urban and peri-urban dwellers also have a wider offer of food. Although residents of urban and peri-urban areas usually earn higher income they still tend to be more disadvantaged in comparison to their rural counterparts because they mostly have

to purchase their food, which makes them dependent on food markets and thus more vulnerable to potential price changes and spikes. One of the answers to how to ensure dwellers' independence on food supply may be urban food production. Although urban agriculture can supplement the diet of urban residents, in many cases such an option is not to the poorest urban communities (Szabo, 2015).

Another issue of urban food security is the fact that urbanization is highly correlated with access to processed foodstuffs which have higher sugar levels. In addition to sugar and artificial sweeteners, processed food tends to contain artificial coloring agents, hydrogenated fats, preservatives and chemical pesticides. In the contemporary world, processed food is often the most accessible type of food, both in terms of physical proximity as well as price. The urban poor also tend to consume high-energy processed food due to its affordability and accessibility. Although the obesity epidemic was traditionally considered to be a health concern in the developed countries, today the overall burden of obesity and chronic diseases is greater in developing countries (Drescher, 2000; Szabo, 2015).

4.1.6 Food miles and rising energy costs

Most food destined for consumption in the developed world has to travel long distances daily to reach markets and consumers. "Food miles" is a term that is used to describe the fact that food is often transported over long distances to markets where the food being consumed is often not due to seasonal variations. Supermarkets in developed countries offer a wide variety of food products which are often not grown seasonally nor locally (Peters, 1997).

The need for consumer satisfaction generates increased requirements for transportation. Viljoen (2005) describes two kinds of food miles; the transportation of food within a country due to an organized distribution system by large-scale retailers and agribusiness, and the transportation of food internationally. The freedom of international trade often leads to the import and export of the same product. For example, in 1997 the UK imported more than 126 million litres of milk whilst at the same time exporting 270 million litres of it (Viljoen et al., 2005). This practice allows for a broad offer for consumers, but it is also accompanied by hidden and overt costs.

Food miles influence the environment, the economy and the society. International and large-scale national trade in food products depends on a sophisticated network of roads, rail and increasingly air-freight transport. This dependence on transport causes air pollution and generates CO2

emissions. It is also connected with the decline in biodiversity due to farm specialization and it results in money loss for local economies due to alternative distant production locations (Peters 1997; Viljoen et al., 2005).

The worldwide increase in the transport of food is connected with the growth of urbanization worldwide. Expanding cities in the developed world are commonly pushing agriculture to the periphery. The increasing need for food transportation from distant areas as well as the wealth accumulation in expanding cities of the developed world causes an increased demand for a wider variety of produce. The industrialization of agriculture, the use of advanced technology and mechanization and the usage of inorganic fertilizers and pesticides derived from oil have created a more specialized and concentrated agriculture, especially in developed countries. The need for fewer farm workers and decreased specialization means that fewer people are living close to places of production. In combination with the advancement in food technology such as refrigeration and cheap and reliable transport including containerization, costs have thus been significantly reduced, creating a system of agriculture in developed countries that is highly specialized and dependent on distant, often international, markets (Halweil, 2004).

The high energy use in conventional agriculture has resulted in high yields, but this dependence on fossil fuel energy inputs has also increased the vulnerability of current food production to the price and supply of fossil fuel. If the practice of conventional agriculture remains the same then in the case of fuel cost growth possible price and supply variations may result inevitable (Gliessman, 2007).

The ratio of the energy and fossil fuel input to the food product, as compared to the returned energy in the form of food, is estimated to be ten times lower in the US (Halweil, 2004).

As urban areas continue to grow, agricultural land close to the city is often used for non-agriculture purposes. Johann Heinrich von Thünen created an economic land-use model that described the relationship between transportation costs and agricultural activity in the 18th century. This land-use model explained that with increasing distance from the market or a town center, agricultural land-use tends to switch from high-value perishable crops to other produce and animal products that are cheaper to transport and have lower value. In general, high-value and easily perishable food production, such as fruit, vegetables and milk, would be placed in short proximity to destination markets, otherwise the cost of transport from remote areas would be too expensive or the food may not reach the market in an appropriate condition. The Thünen model

adequately describes the spatial pattern of agricultural production surrounding urban areas (Block, 2001). The dependence on transport and fossil fuel poses the question of whether e agriculture should be more decentralized and located closer to cities, as many researches as e.g. Despommier claim.

4.1.7. The emergence of urban food planning

There was a lack of attention to the connection between food and urban planning until the beginning of the 20th century, until (Pothukuchi and Kaufman, 1999) as probably the first ones focused their attention on the low consideration given to food systems in urban planning. According to their opinion the urban food system is as important as transportation, infrastructure, housing and employment. They admit that urban food planning is connected to all the mentioned structures, but it is not attracting the attention. They describe four factors that could account for the lack of attention.

The first factor relates to the fact that the average urban resident undoubtedly takes food for granted. The second reason has to do with the historical process of urbanization in the US and elsewhere, a process that led to the definition of certain issues as quintessentially urban. The earliest cities grew against the firm backdrop of a rural, agricultural hinterland that provided them with food. Urban land uses and occupations were the exceptions to the rule of rural and agricultural practice (Pothukuchi and Kaufman, 1999).

The third reason accounting for the low prominence of the urban food system can be attributed to the technological changes in transportation, food preservation and processing. By the 1930s, population in the US and the industrialized world was more urban than rural. As highways cut through the countryside, development began to burgeon, spreading rapidly away from the boundaries of older cities, eating up farms in its path. Maps may have registered this rapid disappearance of farmland, but grocery stores did not. The average city resident, who had little use for the spatial arrangement of farmland, would have sprung to attention if food was missing from the shelf. As local farms disappeared, food simply came from more distant places and from farms that were more intensively cultivated by increasingly corporate players.

A fourth reason why the urban food system garners little attention from urban policy officials has to do with the dichotomization of public policy into urban and rural. To the average person and

even to most planners – as is becoming evident in – Pothukuchi and Kaufman's study, food issues are generally seen as falling within the purview of rural policy, applying mainly to farmers.

However, the situation has changed as many authorities and policy makers begin to realize the need for proper urban planning, bearing in mind the food transportation or incorporation of urban agriculture in local policies. Local authorities are looking for new policies in order to improve the environmental impact of urban food economy, especially in terms of energy use, transport and waste. There is an emerging need to improve supply chain efficiency in order to reduce problems and costs caused by food distribution, which contributes to climate change, claims Eleonora Morganti (2011).

FAO (2018) see building more resilient cities as a key issue for future urban development because city adaptation to climate change has become a growing concern as a significant number of poor populations are exposed to floods and landslides. Multifunctional landscape management, integrating agriculture, trees and forests help to make cities more resilient. It does so not only by diversifying urban food sources and income opportunities, but also by maintaining open green spaces, enhancing vegetation cover and water infiltration and contributing to sustainable water and natural resource management. Urban forestry, including agro-forestry, especially helps to improve air quality, reduces urban warming, curbs erosion and enhances urban biodiversity. As water becomes increasingly scarce, incentives for urban and peri-urban agriculture provide an ideal opportunity to productively use urban organic waste and wastewater as well as collected rainwater; and official guidelines are currently acknowledging the use of untreated wastewater as long as sufficient risk reduction strategies are applied. Appropriate techniques and practices as well as health risk reduction measures should be promoted to ensure safe production and healthy environment. FAO (2009) also stresses the importance of politicians in urban policy making. City and national authorities, as well as international agencies, have a key role to play. City-to-city cooperation is on the rise, with municipal authorities acting within multilevel partnerships to include (sub)national governments, the civil society and non-governmental organizations, and the private sector in a coordinated action to improve urban infrastructure, living conditions and public health. This should result in integrated interventions in urban and peri-urban food production, food processing and marketing systems, more modern urban-rural linkages, water and waste management, land administration and promotion of healthy food cultures at the municipal level.

4.1.8. Advantages of urban agriculture

The benefits and the potential of urban agriculture are often mentioned in most of the literature on the topic. Urban agriculture has usually been perceived as a tool to address social, economic and environmental problems. The most important benefits in the social area include improved food security, poverty mitigation, social integration of disadvantaged groups, improved livelihoods, the prevention of crime and other social problems, better nutritional constitution of diet, improvement of health through healthier food and exercise, community coherence, psychological well-being and improved leisure and educational opportunities (Garnett, 1996). The improvement of food security is seen as one of the primary reasons for promoting urban agriculture. Production of food in cities complements rural agriculture and provides more food, often with higher nutritional value (e.g. vegetables and fruits) and helps mitigate seasonal fluctuations in food supply, especially because many types of urban food production can be practiced all year round (Mougeot, 2000). In relation to food security, urban agriculture could especially contribute to providing more healthy food. This healthier diet could significantly reduce the occurrence of certain diseases, especially among the poorest and people in deprived areas who usually tend to save money on their food consumption and prefer to buy cheaper and less nutritious food. UA is generally linked with social equality, because it is considered to empower urban residents to take higher control of their own food supply. UA provides opportunity to educate urban residence in the areas of health, nutrition, food culture and growing food skills that many urbanites have either forgotten or never learnt. Growing own food or buying from a small-scale farmer contribute to the reduction of the concentration of food production in the ownership of a few already powerful corporations. Liveability of cities is one of the measuring parameters which show how citizens perceive their surroundings and what these surroundings can offer them. UA can contribute to higher liveability through the improvement of the local climate (e.g. air quality and temperature) by making the urban environment ‘greener’ and by providing opportunities for leisure activities and interaction with fellow citizens. A ‘greener’ city might not necessarily be perceived as an automatically better living environment, but research indicates that more green and natural environments help urban dwellers deal with stress. Urban agriculture can have a positive impact on community structures by bringing people together under a common purpose, and research also points at the social function of allotment gardens (Nelson, 1996). Urban agriculture could create positive activity within community gardens and contribute to

reduced maintenance expenses as well as influence the reduction of crime and increase personal safety. Economic benefits are another frequently mentioned group of advantages. Urban agriculture can provide income (Chaplowe, 1998), especially for many citizens in developing countries who are either dependent on the income generated from UA activity or the income represents a significant part of their family budget. UA can generate employment and make use of otherwise unused resources, especially waste and waste water (Van den Berg et al., 2007).

Some of the environmental benefits of UA include shorter transportation distances due to proximity of food production to consumption locations, a lower need for food packaging, decreased air pollution due to lower demand for transportation and improved air quality due to plants absorbing pollutants from the air, conservation of biodiversity (especially when organic methods of UA are used), preservation of agricultural land in the urban suburbs, soil erosion prevention, reforestation in urban environments, improved urban microclimate, the recycling of solid and liquid waste sustainably and their reuse as a fertilizer for agricultural purposes, reduced ecological footprint, and improved city esthetics due to the presene greenery. Waste recycling connected with UA activity contributes to the sustainability of cities. In most developed cities the majority of their food comes from the surrounding countryside and more often from far away international sources. Due to transportation the soil nutrients continuously get exported from rural regions to cities where they are converted to waste, thus leaving the system altogether. Urban agriculture could contribute to reduction of this lost organic matter by collecting urban organic waste to use as an input to the farming system, especially in the form of compost and fertilizer additions. Vast majority of organic material in cities is lost by being mixed with other waste in the sewage system or ending up in landfills as household rubbish. The utilization of unused organic waste holds great potential. It has been proven that the sorting of organic waste and its subsequent utilization saves citizens' money and contributes to a more sustainable usage of natural resources. To conclude, in the long-term UA constitutes a tool with the potential to make cities ecologically, socially and economically resilient (Nelson, 1996).

4.1.9. Disadvantages of urban agriculture

There are many challenges urban agriculture faces worldwide. Some of the more common ones occur especially in less developed countries, such as the refusal and even open animosity from officials and local authorities in African cities vandalism, and often also theft of equipment and

crops close to harvest time (Chaplowe, 1998). The more pressing challenges for urban agriculture in developed cities are e.g. conflicting demands for water. Urban agriculture is straining the need for water further and could compete with the demand from households and industrial users. This need for water availability is a significant issue in many cities which are experiencing unexpected droughts and possible lack of rainfall, and thus could cause many difficulties for urban agriculture. The possibilities of improving water management in cities lie in the potential use of wastewater or grey water to irrigate urban agriculture. According to estimates 3.5 to 4.5 million hectares are irrigated with wastewater worldwide, but there still is a significant public health risk due to the possible presence of pathogens in untreated wastewater (Halweil and Nierenberg, 2007). Nevertheless, new original and safe solutions which would contribute to the elimination of health risk in the future may need to be found.

Collecting rain water in water tanks and using drip irrigation are seen as a suitable solution to these issues. But the risk of pollution and soil, water and air contamination by urban agriculture practice still remains. The improper handling of soil used for agriculture practice may cause contamination and require expensive remediation.

Urban agriculture also poses the risk of atmospheric pollution because of the potential of being placed near busy roads or within industrial surroundings. The use of composted organic waste also runs the risk of bacterial pollution and it could also attract rodents (Nelson, 1996).

Taking into account the characteristics and functions of urban agriculture, it is important to examine the what can be done to encourage greater use of UA in more developed cities, as despite the obstacles to UA development throughout the world, there is a large potential for its promotion and acceptance in urban spaces (Despommier, 2011).

4.2. Small-scale urban agriculture

4.2.1. Urban gardeners and their practices

Urban gardeners can be divided into two categories: community gardeners and backyard gardeners (home gardeners). It has to be taken into account that this division is not precise with gardeners involved in different forms of urban agriculture simultaneously, but the division establishes the main categories. One of the reasons for growing food can be farming as a form of therapy, e.g. in senior centers, drug treatment clinic, hospitals etc. Urban gardening can also be a part of education with many schools trying to engage children in growing food and gain basic knowledge about this activity. The people practicing urban gardening in any form are generally diverse, with this community including men, women, retirees, ethnic groups and many others. The common feature of gardeners is the fact that twice as many urban gardeners are over 65 than those under the age of 35. Nevertheless, in the Western world the number of younger people who are involved in gardening practice is growing. According to Ann Carter it might be because they want to establish a new business connected to food production or they come from farming family backgrounds. The current trends show that many growers and citizens are looking to grow and buy fresh, nutritious produce and meat and dairy products free of chemical additives close to their homes, which is recognized as one reason for the growing popularity of community and backyard gardening (Carter, 2003).

4.2.2. Home and backyard gardens

Home gardens are found in many humid and sub-humid parts of the world. They are sometimes called backyard or kitchen gardens. Backyard gardens are plots around homes. They include gardening on balconies, patios, roofs. Plants grown in containers are also indentified as backyard gardens. According to Anne Carter, cultivators are likely growing some of their own food to supplement their diets with seasonal produce. In addition, any surplus produce likely becomes food to preserve and keep or to give to friends, neighbors and family, and thus urban gardening contributes to overall household food security. Home gardens have an established tradition and offer great potential for alleviating micronutrient deficiencies. (FAO, 2010) Even very poor, landless or near-landless people practice gardening on small patches of homestead land, vacant lots, roadsides or edges of a field, or in containers. Gardening may be done with virtually no economic resources, using locally planting materials, green manures, “live” fencing and natural

methods of pest control. Thus, home gardening is a production system that the poor can easily enter (Marsh, 1998). Although many forms of home and backyard gardening exist today, most of the scientific papers on this topic focus on backyard gardening in the developing world, and local authorities are often trying to promote backyard gardens to ensure food security. For example the seaport of Fortaleza in Brazil experienced hard times. Unemployment was widespread - an estimated 70% of families earned a monthly income of less than 150 USD and people were suffering from hunger. In these unfavorable conditions, the organization The Cities Feeding People (CFP) undertook a project. It was a study of the past and current efforts to promote UA, including a cooperative program funded by the state government and the European Union (EU) to promote backyard and community gardening, small animal husbandry, and fruit-tree planting to generate economic, health, microclimatic benefits and especially to ensure food security and subsistence (Mougeot, 2006).

Even though in the Western world, e.g. in North America, subsistence is not the immediate goal of gardeners, in many cases the harvest from the backyard garden can contribute to stretching the food budgets of low income families and their family and friends. Ann Carter's survey in Omnaha in 2003 has shown that many more would like to garden to stretch their food budget and two thirds of the participants of this survey in an inner-city extension nutrition education program reported that they ran out of groceries by the end of each month. Eighty percent of these respondents reported that they would like to have a garden where they could grow fresh produce (Carter, 2003).

4.2.3. Community gardens

According to Nettle (2014) community gardens are places created by groups of people to grow food. But more importatly, they are places where people come together to make things happen, thus also strengthening their community. In these gardens, people learn about the erosion of the countryside, conserve and improve urban environments, develop technologies of sustainable food production and urban living, foster community engagement and mutual support, engage in cultural maintenance and production, and create neighbourhood commons.

Globally these are thus significant sources of food security for many people. They differ in size, ranging from small plots to farms that occupy a large area. The volunteer labor is quite typical for community gardens, some of which are solely sustained on a voluntary basis, although some city

farms pay a salary to their employees. Some of the community gardens can also operate in partnership with local authorities. The community garden practice is welcomed by many urban planners and agriculture experts who are aware of the importance of internal food production to satisfying the demand posed by the growing population as well as of the potential to moderate harmful pollution and unaffordable food prices which are connected with conventional agriculture. The most common practice of community gardens in Europe is that of urban agriculture within allotments or privately rented plots. People who are involved in community gardening also consider their purchased food origin and content more than non-involved people, and are generally more aware of its environmental impact and footprint. Growing one's own food in urban conditions has become popular not only due to the increasing awarness about health, economic and environmental issues but especially because of the opportunity for social interaction and the creation of relationships. Although industrialized agriculture partly interupted the natural bond between people and their food production, in the last 20 years steady rise of food-based social movements and grass-roots initiatives around the world can be observed. (Turner et al., 2011).

Community gardens are similar but they are not synonymous with urban agriculture, and they also differ from backyard gardens that are privately managed by a family. Increasing amount of literature on these types of gardens reflects the growing interest in community gardens, including books, guides, evaluations, reports, manuals, conference papers, theses and academic literature. (Nettle, 2010).

4.2.4. Community gardens in context

The history of community gardens is very long as they have appeared in many forms around the world. Their origin is dated back to mid-18th century when allotment gardens were utilized for gardening. In the US this form of gardens played a crucial role in the time of industrialization which attracted many rural people to move to cities to work in dire condition in factories. (Lawson, 2005). In 1864 the idea of organized allotment gardening was promoted by the Schreber Movement in Leipzig, Germany. This movement decided to rent areas within the city to utilize them for leisure and environmental purposes to provide children with place to play and adults with an opportunity for healthy exercise.

Community gardens in any form have played an important role in times of crises when citizens have been encouraged to play an active role in food production. As it was mentioned in the History of urban agriculture chapter, they blossomed during World War I and World War II in the so-called Victory Gardens (Nath et al., 2013), in the times of the Great Depression when a large portion of the population was involved in food production as well as in times of the oil crisis in 1970 when the transport costs of food were rising steeply (George, 2018). One of the most active and productive sites of communal gardening activities can be seen in Cuba, specifically its capital, Havana. Due to economic problems after the collapse of the Soviet Union and in the time of an American embargo, economic necessity saw the citizens turn to food production as a good way to improve food security of the nation.

In a period of a food crisis in which residents lost access to an average of one third of their daily calorie intake, the government responded with an overhaul of agriculture on the island, prioritizing organic farming methods, the production of useful edible crops and the use of peasant labor. In urban areas, guerrilla gardening initiatives blossomed into new state-supported urban farming programmes, with widespread voluntary participation. These farming efforts have produced what may be the world's largest working model of a semi-sustainable agriculture, and in the process resurrected the country's local, affordable and accessible foodshed. Havana provides an example of a systematic approach to the reimagining of urban landscapes for more productive means. Food production infrastructure has been interwoven into the city fabric, with agricultural areas that range in size from backyard gardens to large peri-urban farms (Halweil, 2004).

In times of fear and crisis, people turn to food production via gardening. The reasons do not only need to involve obtaining produce but also to establish the feeling of reconnection, find a sense of purpose and belonging to the community, the land and nature as a personal and sometimes a rather intimate response to bigger issues over which people as individuals might feel they have little control (Cílek, 2016).

4.2.5. Current community gardens

All around the world many community gardens can be found. The popularity of urban farming is increasing because of the growing interest in environmental issues and the feeling of being a part of an urban community.

Several examples can be found in Europe. The German capital Berlin has undergone a transformation in urban agriculture over the past ten years and is very active when it comes to developing a wide variety of gardening and agriculture projects within the reunited city which was divided for almost 30 years. One of the examples is *Prinzessinnengärten* (the Princess Garden). It was created as a pilot project in the summer of 2009 at Moritzplatz in Berlin-Kreuzberg, a site which had been a wasteland for over half a century. The founder along with his friends, activists and neighbours cleared away rubbish, built transportable organic vegetable plots and soon reaped the first fruits of their labor. Green spaces that local residents create themselves and use to produce fresh and healthy food in turn increase biological diversity, decrease CO2 emissions and contribute to a better microclimate. The spaces promote a sense of community, the exchange of a wide variety of competencies and forms of knowledge, and furthermore help people lead more sustainable lives. This community garden is seen as a kind of miniature utopia, a place where a new style of urban living can emerge, where people can work together, relax, communicate and enjoy locally produced vegetables by its founder. They are also aware of the increasing urbanization and see the community garden as a key place for the development of more sustainable ways of eating, living and moving (Hortas, 2014).

In Prague, the capital city of the Czech Republic, a garden called *Prazelenina* can be found. It was established by the architect Matěj Petránek. His inspiration to start *Prazelenina* was a photograph of a small garden in Helsinki which was founded by group of people. He then decided to open his own community garden and use it to foster community relationships. In 2012 the community garden was established on an unused lot which was left after a building demolition following the 2002 floods. The site was in private ownership and in the 2013 the contract was not extended due to the owners' different intentions for the site. Because of this, the garden remains fully mobile and has also been moved several times to a more suitable place. The vegetables and herbs are grown in raised-bed bags which are each cultivated by an individual or a group of people based on the garden's membership. Although the cultivation and gardening is important, the main goal of the organizer is the cultivation of relationships among the community. Several activities and events also take place there. The garden's café is an important place where people can meet, and the money generated from its operation helps the community to buy items that are needed. Membership is open to anybody who is interested. The garden is now located in the Prague district of Holešovice (Prazelenina, 2018).

4.2.6. Sustainability and community gardens

Community gardens are an important source of food security. They contribute to the sustainability of the food system in times when food system is dependent on on fossil fuels (Wackernagel, Rees, 1996). The monocultures and low-diversity system of conventional agriculture is generally more vulnerable and displays lower resilience to shocks, although it is also highly efficient. Agriculture is one of the highest polluting activities in everyday life, yet it is a significant component in achieving a more sustainable future for humanity (Carlsson-Kanyama, Ekstrom, Shanahan, 2003). The achievement of more redundant, diverse system which would provide food security in the long term should be strived for. The contribution to local sustainability is ensured by local production in community gardens and direct access to produce. Community gardens are often located in the middle of the city in an area which has been perceived as food-deserted areas which are located far from supermarkets and grocery stores which offer affordable and high-quality products (Barthel et Isendahl, 2013).

It has been estimated that growing food locally might have a positive impact on the ecological footprint of imported food. This belief is based on the concept of food-miles which describe the relationship between food transport and the amount of fossil fuels needed for it - the further distance the higher use of fossil fuels, and thus the higher ecological footprint. Based on this logic it might be deduced that local-grown food reduces its ecological footprint due to local consumption. Nevertheless, it has also been argued that for locally grown food the output of transportation energy and fossil fuel is greater in comparison to industrially-produced food (e.g. Edwards-Jones, et al., 2008). It is difficult to conduct life-cycle analyses of food products due to the wide variety of relevant foods, the different production methods, spatio-temporal variations in climate and the multiple potential levels of processing. A life-cycle analysis which studied the greenhouse gas emissions of the food system suggests that only 4% of total greenhouse gas emissions in the US come from food miles (Weber et Matthews, 2008).

Therefore, growing food locally may in some cases increase the greenhouse gas emissions of a food product due to the higher inputs required for smaller-scale or out-of-season production.

However, the disagreement with the contribution of locally grown food to overall sustainability is narrowly based on the food-miles approach, yet excludes other aspects of sustainability and ignores that locally-produced food is also often produced and processed, applying different methods than imported food - which is typically industrially produced.

Although it is difficult to determine the ecological impact of food consumed by the producer in an urban community garden, community gardens and other forms of urban agriculture still have the ability to contribute to urban biodiversity (Van den Berg et al., 2007).

4.2.7. Social wellbeing and community gardens

Community gardens contribute to social sustainability. According to some authors community gardens may contribute to the resilience of social-ecological systems, especially when supported by civic environmentalism through environmental education (Krasny & Tidball, 2009). Quite often community gardens are geographically placed in the socio-economically disadvantages areas of cities, typically inhabited by the poor, minorities, the disabled, the elderly or the immigrant or homeless populations. In the areas where the citizens do not suffer from social exclusion and where there is easy access to fresh good-quality produce in food markets, the establishment of community gardens especially serves the purpose of the beautification of the community (Flachs, 2010). Community gardens can also be established with the aim of improvement in community socialization and also for building social capital (Glover, 2004). Glover defines social capital as "the trustworthy and reciprocal connections that exist between individuals in social networks" (2004). It contains two main generally recognized subtypes: bridging connections between groups and the bonding of connections within groups. Social capital is seen as an important concept by many community activists and policy makers because of the belief that successful cooperation for a long-term mutual benefit depends on the cultivation of social capital (Bridger et Luloff, 2001). Even though the development of social capital is seen as positive, it also has a dark side. If the bonds are too strong and they become too tight, the social network can behave in an exclusionary manner and refuse to allow for the development of bridging capital. A balance between bonding and bridging social capital is crucial because only then the group can behave beneficially for the maximum amount of people. The desired goal would thus be the creation of strong bonds without the need for exclusion.

Community gardens have the ability to build good relationships, especially when they are located where people with diverse background live. Even if community members differ demographically, e.g. have different race, age, sex, religion, and customs they can meet and interact. For example, immigrants can be integrated into the community through mutual involvement in these activities

as community members become supportive of each other. However, the most important thing for community gardens is the creation of social networks through volunteering (Flachs, 2010).

4.3. Vertical farming and high-tech agriculture method

4.3.1. Vertical farming

Vertical farming is a simple concept of farming which uses space in the upward direction. When Despommier (2011) describes the need for implementing vertical farms he often highlights the need to increase food production in order to be able to feed an increasing number of people on this planet. According to his book Vertical Farms the concept of indoor farming is not entirely new, since greenhouse production of tomatoes, a wide variety of herbs and other produce has been in its prime for some time. What however is new is the urgent need to scale up this technology to accommodate another 3 billion people. An entirely new approach to indoor farming must be invented, employing cutting-edge technologies. Vertical farming must be efficient (cheap to construct and safe to operate). Vertical farms, many stories high, can be situated in the heart of world's urban centers. If successfully implemented, they offer the promise of urban renewal, sustainable production of safe and varied food supply (all-year-round crop production), and the eventual restoration of ecosystems that have been sacrificed for horizontal farming (Kheir Al-Kodmany, 2013).

Vertical farms are usually divided into three types. The first type includes the construction of tall structures with numerous levels of growing beds, often lined with specialized artificial lights. This often smaller-sized urban farming type has been spreading around the world. Many cities have incorporated this model in new and old buildings, including warehouses and unused buildings that owners intend for new purposes (Kheir Al-Kodmany, 2016). The second type of vertical farming takes place on the rooftops of old and new buildings, atop commercial and residential structures, restaurants or grocery stores. The third type of vertical farming is that of the visionary, multi-story building. In the past decade, an increasing number of serious visionary proposals of this type could be seen. Nevertheless, none of those visionary projects have been built. A mix of the aforementioned three types also exists. The success of modestly sized vertical farming projects and the development of their technologies will likely pave the way for skyscraper farming (Despommier, 2011).

4.3.2. History of vertical farming

The idea of vertical farming has a long and a still evolving history. Some examples of vertical farming in ancient history can be found, dating back to the era in the Hanging Gardens of Babylon,

one of Philon's Seven Wonders of the Ancient World, built around 600 BC. In recent history, specifically in 1915, American author Gilbert Ellis Bailey used the term "vertical farming" for the first time and then wrote a book named "Vertical Farming". Gilbert Ellis Bailey described vertical farming in a controlled environment and implementing hydroponical method as environmentally and economicaly promising. One of the first trials of the hydroponical concept was made by the American plant nutritionist William Frederick Gericke in the early 1930s at the University of California at Berkley.

Recently in the 1980s Åke Olsson, a Swedish ecological farmer, suggested vertical farming as a means of producing vegetables in urban areas. Since the turn of the century, Dickson Despommier, an American ecologist and professor of public health, has been considered the greatest contemporary promoter of the vertical farmig idea. He described vertical farming as the mass cultivation of plant and animal life for commercial purposes in skyscrapers. Using high-tech greenhouse technologies such as hydroponics and aeroponics, he emphasises that the vertical farm could also produce fish, poultry, fruit, and vegetables (Despommier, 2011)

4.3.3. Current support for vertical farms

Vertical farming is considered to promote sustainable agricultural practices as opposed to conventional farming which refers to large-scale outdoor agriculture that includes systems that entail heavy irrigation, intensive tillage and excessive use of fertilizers, pesticides, and herbicides (Despommier, 2014). He recommends the idea of vertical farming because of several aspects with a negative enviromental impact. One of the threats is posed by the decrease in the quantity of arable land. According to FAO there was 0.42 ha of arable land per person on earth in 1961. But in 2002, due to steep population growth and urbanization, the number has dropped by nearly a half, to 0.23 ha. In 2011, FAO published a global assessment of the planet's land resources, emphasising that a quarter of all arable land is in a highly degraded state. Moreover, since the 1960s more than one million farmers in the US have given up farming. The Western world today suffers from a lack of farmers. Dicson Despommier also highlights another prediction where he claims that current agricultural supply will soon become inadequate because all people need on average 1500 calories daily, yet in order to meet such a demand an agricultural land the size of Brazil would be needed by 2050. According to Despommier (2009), the solution could lie in the vertical farming concept. He claims the idea of vertical farming has been supported by many

environmentalists, urban farmers, architects, agronomists, and public health experts due to emerging issue of a impending food scarcity in an ultra-urbanized future. A score of technology experts have converged on supporting the concept of vertical farming whilst advancing in the fields of robotics, aeroponics, aquaponics, and hydroponics. Nonprofit organizations, aiming to promote environmentalism and local economic prosperity, have also long been supporting the vertical farm concept. Similarly, for-profit ventures that seek to meet the demand for local production have supported this concept. Furthermore, governments looking for ways to boost domestic food security have been funding these aims. Numerous countries including Korea, Japan, China, Germany, the United Arab Emirates, China, France, India, Sweden, Singapore and the US have convened to discuss vertical farming (Despommier, 2009). They have supported the concept of vertical farming as integral to the long-term sustainability of their cities.

4.3.4. Climate change and vertical farming

Climate change has caused several environmental issues. It contributed to the decrease in arable land. The reason for this decrease is because soil is washed away by flooding, swept away by hurricanes and storms and degraded by drought. The decrease in valuable arable land causes disruption to world economy. For example, due to an extended drought in 2011, the US lost a grain crop worth an estimated 110 billion USD. It has been prediced that climate change and the unfavorable weather conditions it causes will continue to occur at a growing rate. It could lead to the loss of large areas of arable land, making them useless for farming. Traditional farming is supported by abundant amounts of fossil fuels to maintain agricultural activities (e.g. plowing, seeding, applying fertilizers, weeding and harvesting) which accounts for over one third of world's gasoline and diesel consumption. On average, food travels 2400 kilometers from the farm to the final consumer in the developed world (Despomier, 2013). "Food miles" can significantly rise in special circumstances like cold weather or long-term storage in freezing conditions. An FAO study concluded that food delivery is responsible for 0.4 tons of CO2 emissions per household per year in the US (FAO, 2013). This is especially important given the increasing distance of farms and cities from global urbanization. Greenhouse gas emissions from food transport and agricultural activities have contributed to climate change. However, according to Despommier it is crucial to come up with an adaptation policy for dealing with the unavoidable impacts of climate change, but this has been under-emphasised in the public debate in many

countries. An effective response to climate change will depend on creating the conditions for an international collective action. There is still time to avoid the worst impacts of climate change if strong collective action starts now. He sees in the widespread application of the vertical farm system as the solution which can slow down the processes of climate change and impact food security, which would free up the currently utilized agricultural land, providing time to regenerate this land and and restore natural ecosystems (Despommier 2013).

4.3.5. Proliferation of vertical farming

There are many examples of how vertical farming proliferates. Some of them use high technology and are set up mainly for economic reasons, whilst others are serving a community. Various methods of growth are used, some of which combine plant and animal production. One example of vertical farming established with simple resources and basic education can be found in Gaza, where private entrepreneurs and the FAO have established intensive and irrigation-based fish farms to help with food scarcity issues. Gaza is a self-governing Palestinian territory with severe area restriction which limits the space where fishing and agriculture can be practiced. Fish farms have been installed on the roofs and upper levels of existing urban structures. The entrepreneurs and the FAO provided participants with the supplies and training to create the system but then the locals were left with the responsibilities of maintaining it. This is an example of how aquaponic systems can be implemented into existing structures and are very easy to care for. Another example was FarmedHere, a vertical indoor farm that also incorporated aquaponics, placed in an old warehouse in Chicago, Illinois. Production of local food and the creation of local job opportunities in a sustainable environment were the goals of the company. The company produced wide varieties of greens, but the desired aim was to expand to soybean crops all inside. However, due to unfavorable economic conditions this company eventually closed. The co-founder Paul Hardej described the reason in open letter. “Since vertical farming is a rather unique blend between highly efficient manufacturing and technological farming, its success depends on the following: strong and smart capital, innovative sales and marketing, and a solid management team, working creatively with stakeholders from the local government, growers, technology providers, and customers. While the vertical hydroponic technology was proven to work at scale, FarmedHere missed on the business side, with some of the other necessary ingredients to expand on its initial success. In 2017 there are many examples of profitable vertical farms across the

country and abroad. As demand for local and organic food grows, so will the industry. There are numerous reasons vertical farming is in demand – food safety and transparency, consistency, availability, high quality, nutritional value, not to mention a push towards sustainability. But it's going to take all of us working together and exchanging ideas and sharing experiences." (Hardej, 2017). Even though there are some examples of unsuccessful vertical farms, the number has been increasing and they are expected to remain operational. A part of Los Angeles called Skid Row is considered to be in decay and an improper area for living, but its residents joined together to create urban community gardens. Residents of the Rainbow Apartments created a vertical garden that is attached to a block wall of a parking lot in the center of Skid Row. The vertical plot evolved from vegetables planted in wooden bins on the rooftop but failed due to improper maintenance. The second attempt resulted in an excess of produce that ranged from watermelon to corn. Through help from a nonprofit group called Urban Farming, they were able to install the green wall as part of the Food Chain Project. The Food Chain project allows residents in the poor area to grow food in underused spaces at low costs. The Skid Row vertical farm, a greenwall on the facade of the apartment, is maintained by the Rainbow Apartment residents and they receive the food produced, which they also share with other community members (Branas et. al. 2011). This vertical farm not only shows how vertical farming helps improve a community's appearance and well-being, but also how they can be integrated into certain areas easily. An analysis of 'greening' abandoned areas in Philadelphia was conducted by a group of researchers to see if this activity reduced violence and vandalism. The findings showed that the 'greening' of vacant areas reduced gun assaults, vandalism, criminal mischief and residents reported less emotional stress and increased physical exercise (Kondo, 2016). The 'greening' of urban spaces has proved to have a positive impact and the inclusion of community members only improves the chances of an area being successful. Other vertical farming examples are described in the book Carrot City. Carrot City explores various-scale farms with different production goals. It describes the case of the Eagle Street Farm in Brooklyn, NY, a vegetable farm located on a warehouse. Volunteers help with the farm during growing season and the harvest is sold at a seasonal on-site farmers market and to neighborhood restaurants. Carrot City also introduces how Brooklyn Grange, a rooftop farm, functions. Brooklyn Grange produces a variety of products and it also hosts events such as growing and cooking lessons, company meetings, dinners, and yoga. These two types of rooftop farms show how spaces and functionality vary due to production goals. Brooklyn Grange, and a

similar type of a farm, shows how vertical farming evolves and how it is also able to improve the social aspect of a comunity. While these examples are pushing vertical farming forward, the farms are still not connected to the net of the community. A variety of vertical farms that are currently starting to integrate into the surrounding neighborhood can be found but there are still a variety of problems which must be solved. Through analyzing the typologies for what social, economic, and ecological benefits could be achieved the problems can be identified and addressed. Not one system is currently meeting the requirements of what it means to be sustainable. According to William McDonough, an author, it is important that a design can renew its own source of energy and materials, which in turn creates a sustainable building. That is where landscape architects can help. By including a landscape architect in the process, vertical farming will expand from just urban agriculture. The inclusion of community members in the design is desirable especially if vertical farms are to be widely approved and incorporated into the urban structure. If people do not feel the sense of belonging in a place or community the projects often fail or remain dormant. There are several strategies for driving vertical farming forward. Some of them solely focus on food production for the local area but do not include the community. The vast majority of early vertical farms, in urban settings, were established in city areas that were economically struggling. This was conditioned by the lower cost of real estate, the lack of an active community and proximity to city centers. In the next development phase of vertical farming, the community started to be taken more into consideration. Some of the vertical farms started to expand from focusing on production to also focusing on tge education of the neighborhood community. Many of the first-generation vertical farms offered educational classes that enabled inner city children and adults to teach them about the positives of growing healthy food, while the more elaborate vertical farms tended to serve the wealthier clients by providing a variety of expensive services. The next step of vertical farming should expand to serve an entire community. Programs should be designed to include a variety of demographics and social groups. Landscape architects can help with program development of vertical farms for different purposes in order to include a wide range of community members (Gorgolewsiki, 2011).

4.3.6. Economics of vertical farms

Proponents of vertical farming also argue that it will supply food at competitive prices (Al-Kodmany, 2016). The rising costs of traditional farming are quickly narrowing the cost gap

between the two. For example, when vertical farms are located strategically in urban areas, it would be possible to sell produce directly to the consumer and reduce transportation costs by removing the intermediary, which can constitute up to 60% of the costs (Al-Kodmany, 2016) Vertical farming also utilizes advanced technologies and intensive farming methods that can exponentially increase production. Researchers have been optimizing indoor farming by calibrating, tuning and adjusting a wide-range of variables including light intensity, light color, space temperature, CO2 contents, soil, water, and air humidity (Notarnicola, 2017). In addition, vertical farming provides an opportunity to support the local economy. Abandoned urban buildings can be converted into vertical farms to provide healthy food in neighborhoods where fresh produce is scarce. Additionally, the high-tech environment of indoor farming can make it entertaining to farm. Hence, the technologically killed younger generation has recently been attracted by the practice, thus creating a new sort of farmers. Further, according to Despommier (2011) vertical farming provides an impetus for the development of innovative agricultural technologies. Finally, it could reconnect city dwellers with nature through the farming activities.

4.3.7. Methods of high-tech agriculture

Vertical farming is accompanied by technological development and the usage of high tech systems to enable agricultural production without using soil as a medium. High-tech agricultural methods mainly aim to bring more sustainablity to food production. High-tech cultivation methods could generate higher yields and less water could be needed in this practice in comparison to conventional farming. Ideally, the design, layout, and configuration of high-tech farms would provide the most suitable environment for cultivation. The aim is to attain balanced light exposure with suitable wave lengths accompanied by adding precisely measured nutrients for each plant. Designed to grow in a controlled, closed-loop environment, these farms would eliminate the need for harmful herbicides and pesticides, maximizing nutrition, and food value in the process. There is a posibility for indoor growers to improve the taste of produce to cater to people’s preferences. Researchers intend to develop, refine, and adapt these systems so that they can ultimately be deployed anywhere in the world and provide maximum production with minimum environmental impacts (Al-Kodmany, 2013). They represent a paradigm shift in farming and food production and could be seen as suitable for city farming where land availability is limited. These systems

(mainly hydroponics, aeroponics, and aquaponics) and associated technologies are rapidly evolving, diversifying and improving in order to be applied to vertical farming (Kalantari, 2017).

4.3.8. Hydroponics

Hydroponics is a technology for growing plants in nutrient solutions (water and fertilizers) with or without the use of an artificial medium (e.g., sand, gravel, vermiculite, rockwool, peat moss, coir, sawdust) to provide mechanical support. Liquid hydroponic systems use no other supporting medium for the plant roots. Hydroponic systems are further categorized as open (i.e. once the nutrient solution is delivered to the plant roots, it is not reused) or closed (i.e. surplus solution is recovered, replenished, and recycled). Food grown hydroponically is taking nutrients directly from the mineral nutrient solution. (Harris, 1992) The world hydroponics has a Greek origin and is composed from two words - *hydro* and *ponos* - which could be translated as "water doing labor" or "water works." The use of water as a medium for growing crops is not totally new, but the commercial introduction of hydroponics has advanced a great deal in the last 20 years. (Al-Kodmany, 2016) One of the first experiments with hydroponic took place at The National Aeronautics and Space Administration where they viewed hydroponics as an aproppriate method for growing food in outer space. They have experienced success with the production of various vegetables, such as onions, lettuce, and radishes.

The next stage of hydroponics development was a trial to make it more productive, reliable and improve its water management. Currently, the hydroponics system has entered more widespread agriculture production. It provides plenty of advantages over conventional soil-based cultivation. The main advantage of this method is that it could eliminate or at least reduce soil-related cultivation problems, for example insects, fungi and bacteria that grow in soil. The hydroponic method is also relatively low-maintenance, insofar as weeding, tilling, kneeling and dirt removal are not an issue. Another important advantage of hydroponics, as compared with plants grown in soil, is the isolation of the crop from the underlying soil which often has problems with disease, salinity, poor structure and draining. The costly and time-consuming tasks of soil sterilization and cultivation are unnecessary in hydroponic systems and a rapid turnaround of crops is easily achieved (Al-Kodmany, 2018). Hydroponics offers a means of control over soil-born diseases and pests, which is especially desirable in the tropics where infestations are a major concern. The hydroponic method also provides a less labor-intensive way to manage larger areas of production.

Furthermore, it may offer a cleaner process given that no animal excreta are used. Moreover, the hydroponic method provides an easier way to control nutrient levels and pH balance. In soil, many factors, such as temperature, oxygen level, moisture, and microorganisms, affect how soil-fixed nutrients are made accessible to plants since the nutrients are being dissolved in water through erosion and mineralization. Therefore, the hydroponic method may result in more uniform produce and better yields, as the optimum combination of nutrients can be provided to all plants (Cho et al., 2017).

4.3.9. Aeroponics

Aeroponics is a method which is derived from traditional hydroponics. An aeroponic system is defined as an enclosed air, water and nutrient ecosystem that fosters rapid plant growth with little water and direct sun and without soil or media. The main difference between hydroponic and aeroponic systems is that the former uses water as the growing medium while the latter utilizes no growing medium. Aeroponics uses mist or nutrient solutions instead of water, so it does not require containers or trays to hold water. It is an effective and efficient way of growing plants because it requires little water, concretely about 95 percent less than traditional farming methods, and it also needs minimal space (Al-Kodmany, 2018). Plant boxes can be stacked up in almost any setting, even a basement or a warehouse. The stacking arrangement of plant boxes is structured so that the top and the bottom of the plants are suspended in the air, allowing the crown to grow upwards and the roots downwards freely. Plants are fed through a fine mist of nutrient-rich, water-mix solution. The system is fully enclosed and the nutrient mix is fully recycled, leading to significant saving of water. The application of this method could be beneficial especially in water-scarce regions. Aditionally, the advantage of the aeroponic method is that it does not require adding fertilizers or pesticides. The high-density planting method provides better manipulation, and higher yields could be obtained, which has been proven by one of the aeroponic experiments with tomato in Brooklyn, NY, which resulted in quadrupling of the crop over the course of a year instead of the more common one or two crops (Cooper, 2013).

4.3.10. Grow cube

Recent research and technological development take the aeroponics method to a higher level of productivity and efficiency (Al-Kodmany, 2018). For example, the grow cube is a new aeroponic

prototype utilizing a high-tech cube which contains five light plastic plates that spin by a rotisserie-esque wheel and are lit by tripoflight-emitting diodes (LEDs) that provide the necessary light for the photosynthesis to take place. At the top of the cube, a device sprays a nutrient-rich mist. The cube and its devices are controlled and managed via a computer and software, and sensors inside the cube communicate with the computer to optimize the microclimate. The cube is also pressurized and equipped with an ultraviolet germicidal lamp and a high-efficiency particulate absorption filter as well as bug-killing filters in the pipes where the nutrient mixes are pumped. Consequently, the microclimate inside the cube is bug-free, making its produce free of pathogens. Several IT companies are developing special apps and guidelines, increasingly online. Consequently, the aeroponics system and the entire growing process can be optimized remotely. When it comes to planting, the owner of the grow cube puts the seeds intp a growing medium and by a downloaded app a growing recipe can be chosen. There are several posibilities to choose from, e.g. if the owner wants crispier lettuce he can select that as an option. Furthermore, by conducting the work autonomously, the computer-controlled environment reduces human errors and minimizes the effort of growing food. With such a computerized system, almost anyone can become a sophisticated farmer. The computerized system will help attain optimal taste and develop other characteristics, e.g. producing crispy or spicy produce. Grow cubes usually manage to produce herbs, flowers and foodstuffs like wheat grass, microgreens or pea shoots. As the use of grow cube in households becomes more common, a part of the needs for transporting produce can be satisfied this way. The prototype is suitable for small-scale farming in cities and benefits the owners are involved in grow proces (Cooper, 2013).

4.3.11. Aquaponics

Aquaponics is known as the integration of hydroponics with aquaculture and it has been gaining increased traction as a bio-integrated food production system. The integration of re-circulated aquaculture with hydroponic vegetable, flower, and herb production to create symbiotic relationships between the plants and the fish. It achieves this symbiosis through using nutrient-rich waste from fish tanks to hydroponic production beds. In turn, the hydroponic beds also function as bio-filters that remove gases, acids, and chemicals, such as ammonia, nitrates, and phosphates, from the water. Simultaneously, the gravel beds provide a habitat for nitrifying

bacteria which augment the nutrient cycling and filter water. Consequently, the freshly cleansed water can be recirculated into the fish tanks.

Several warm-water and cold-water fish species are adapted to recirculating aquaculture systems, including tilapia, trout, perch, Arctic char, and bass. However, most commercial aquaponic systems in North America use tilapia. Tilapia is a warm-water fish species that grows well in a recirculating tank culture. Furthermore, tilapia are tolerant of fluctuating water conditions such as pH, temperature, oxygen, and dissolved solids. Tilapia have white-fleshed meat suitable for local and wholesale markets. The literature on tilapia contains extensive technical specification and cultivating procedures. In Australia Barramundi and Murray cod fish species are raised in recirculating aquaponic systems (Diver, 2006)

Researchers are trying to find the best-balanced agaponics system to achieve sustainability in production. A great emphasis is placed on the recycling of each form of input into the system.

Aquaculture offers bountiful benefits, such as cleaning water for the fish habitat, providing organic liquid fertilizers that enable the healthy growth of plants, providing efficiency (since the waste products of one biological system serve as nutrients for a second biological system) or saving water (since water is re-used through biological filtration and recirculation). This feature is attractive particularly in regions that lack water as it reduces and even eliminates the need for chemicals and artificial fertilizers, which results in a polyculture that increases biodiversity (Al-Kodmany, 2013). It also supplies locally-grown healthy food, since the only fertility input is fish feed and all of the nutrients come from a biological proces. Another advantage is the facilitating of the creation of local jobs as well as of an appealing business model that supplies two unique products - fresh vegetables and fish - from one working unit. Consequently, aquaponics is preferable to hydroponics. However, aquaponic systems are currently still at the experimental stage, having had limited commercial success. This is because the technologies necessary to build aquaponic systems are relatively complex, requiring mutual dependence of two different agricultural products. For this reason, aquaponics also requires intensive management (Kheir Al-Kodmany, 2018).

5. Conclusion

As discussed in this paper, urban agriculture has proven to be an imporant tool in improving the social and economic well-being of cities. Although the rise of urbanization has led to various obstacles, urban agriculture remains a desirable and an efficient option to be implemented into cities.

- The number of people living in cities is increasing. This urbanization creates a time-space compression which leads to an expansion of interaction, increased population, and production as well as access to and damage to natural resources, and thus also to biodiversity.

- Urbanization is highly correlated with access to processed foodstuffs which have higher sugar levels and artificial sweeteners. In the contemporary world, processed food is often the most accessible type of food, both in terms of physical proximity as well as price. The urban lower class also tend to consume high-calorie processed foods due to its affordability and accessibility. UA can contribute to the moderation of this issue by providing a high-value nutritious diet and more financially affordable options.

- UA has proven to be an important source of food security and it has also provided meaning for people in harsh times of history (e.g. establishment of Victory Garden during both world wars).

- The current conventional food supply system is highly dependent on oil consumption and transportation to the destination market and consumer. The price of food is sensitive to fluctuating oil prices. The decentralization of current food production, including UA practice, can help mitigate this dependence.
- Community gardens contribute to the social and economic well being of its users and have the potential to bring people from different backgrounds together, balancing the budget of those households involved in the sustainability of UA.

- High-tech agricultural methods, such as hydroponics, could serve as an efficient method to cultivate safe and nutritionally balanced foods. Additionally, these technologies allow water and nutrients to be recycled in urban areas.

6. Bibliography

Agriculture 2005, a response to crisis?', Urban Agriculture Magazine, Vol. 1, No. 1, [online]. www.ruaf.org/node/106 agriculture, The Environmentalist, 18,

Alberti, M. 2016. Cities that think like planets: complexity, resilience, and innovation in hybrid ecosystems. University of Washington Press. Seattle. ISBN: 978-029-5996-660.

Al-Kodmany, K. 2018. The vertical city: a sustainable development model. WIT Press. Boston, MA. ISBN: 978-1784662578.

Al-Kodmany, K., Ali, M. M. c2013. The future of the city: tall buildings and urban design. WIT Press. Boston. ISBN: 978-1-84564-410-9.

Al-Kodmany. 2016. SUSTAINABLE TALL BUILDINGS: CASES FROM THE GLOBAL SOUTH. Archnet-IJAR , Vol 10, Iss 2, Pp 52-66 (2016) [online]. 10 (2). 52-66. [cit. 2018-04-14]. DOI: 10.26687/archnet-ijar.v10i2.1054. ISSN: 19387806. : https://doaj.org/article/d7cdf21132d34245a162c6804eed1cbc

Armstrong, D. 2000. A survey of community gardens in upstate New York: Implications for health promotion and community development. Health and Place [online]. 6 (4). 319-327. [cit. 2018-04-14]. DOI: 10.1016/S1353-8292(00)00013-7. ISSN: 13538292.

Barthel, S., Isendahl, C. 2013. Urban gardens, agriculture, and water management: Sources of resilience for long-term food security in cities. Ecological Economics [online]. 86 (C). 224. [cit. 2018-04-10]. ISSN: edsrep.

Block, D., Dupuis, E. M. 2001. Making the Country Work for the City: Von Thunen's Ideas in Geography, Agricultural Economics and the Sociology of Agriculture. American Journal of Economics [online]. 60 (1). 79-98. [cit. 2018-04-19]. ISSN: 00029246.

Bridger, J. C., Luloff, A. E. 2001. Building the Sustainable Community: Is Social Capital the Answer?. Sociological Inquiry [online]. 71 (4). 458-472. [cit. 2018-04-13]. ISSN: 00380245.

Carey, C. 2014. Cuba's Urban Farming Revolution: How to Create Self-Sufficient Cities. The Architectural Review [online]. [cit. 2018-04-14]. : https://www.architectural-review.com/rethink/cubas-urban-farming-revolution-how-to-create-self-sufficient-cities/8660204.article

Carlsson-Kanyama, A., Ekstrom, M. P., Shanahan, H. 2003. Food and life cycle energy inputs: consequences of diet and ways to increase efficiency. Ecological Economics [online]. 44 (2-3). 293. [cit. 2018-04-03]. ISSN: edsrep.

Carter, A. 2003. Urban Agriculture and Community Food Security in the United States: Farming from the City Center To the Urban Fringe. A Primer Prepared by the Community Food Security Coalition's North American Urban Agriculture Committee [online]. 2003. 32. Available : https://www.issuelab.org/resource/urban-agriculture-and-community-food-security-in-the-united-states-farming-from-the-city-center-to-the-urban-fringe.html#?

Chaplowe 1998, Havana's popular gardens: sustainable prospects for urban agriculture

Cho, R. 2011. Vertical Farms: From Vision to Reality. State of the Planet [online]. Earth Institute, Columbia University. USA. [cit. 2018-04-14]. : http://blogs.ei.columbia.edu/2011/10/13/vertical-farms-from-vision-to-reality/

Cho, W. J., Kim, H. J., Jung, D. H., Kang, C. I., Choi, G. L., Son, J. E. 2017. AN EMBEDDED SYSTEM FOR AUTOMATED HYDROPONIC NUTRIENT SOLUTION MANAGEMENT. Transactions of the ASABE [online]. 60 (4). 1083-1096. [cit. 2018-04-10]. DOI: 10.13031/trans.12163. ISSN: 21510032.

Cílek, V. 2016. Co se děje se světem?: kniha malých dobrodiní v časech velké proměny Země. Dokořán. Praha. ISBN: 978-80-7363-761-3.

Cooper. 2003. GrowCube promises to grow food with ease indoors (hands-on) [online]. [cit. 2018-04-10]. Available z: https://www.engadget.com/2013/11/08/insert-coin-growcubes-hands-on/

Despommier Dickson, author. 2009. The RISE of VERTICAL FARMS. Scientific American [online]. 301 (5). 80. [cit. 2018-04-14]. ISSN: 00368733.

Despommier, D. D. 2010. The vertical farm: feeding the world in the 21st century. Thomas Dunne Books/St. Martin's Press. New York. ISBN: 03-126-1139-0., DOI: 10.1016

Despommier, D. 2011. The vertical farm: controlled environment agriculture carried out in tall buildings would create greater food safety and security for large urban populations. Journal fuer Verbraucherschutz und Lebensmittelsicherheit [online]. 6 (2). 233-236. [cit. 2018-04-15]. DOI: 10.1007/s00003-010-0654-3. ISSN: 16615751. : https://link.springer.com/article/10.1007%2Fs00003-010-0654-3

Diver, S. 2006 Aquaponics—Integration of Hydroponics with Aquaculture [online]. [cit. 2018-04-11]. Available z: http://wptest.backyardmagazines.com/wp-content/uploads/2009/08/aquaponic.pdf

Drescher AW, Jacobi P and Amend J 2000, 'Urban Food Security – Urban

FAO 2009. Food for the cities [online]. [cit. 2018-04-14]. : http://www.fao.org/tempref/docrep/fao/012/ak824e/ak824e00.pdf

FAO. 2010. Improving Nutrition through Home Gardening. FAO [online]. [cit. 2018-04-15]. : http://www.fao.org/ag/agn/nutrition/household_gardens_en.stm

FAO. 2018[online]. [cit. 2018-04-14]. : http://www.fao.org/urban-agriculture/en/

Firth, C., Maye, D., Pearson, D. 2011. Developing 'community' in community gardens. Local Environment [online]. 16 (6). 555-568. [cit. 2018-04-15]. DOI: 10.1080/13549839.2011.586025. ISSN:13549839. : http://eds.a.ebscohost.com.infozdroje.czu.cz/eds/pdfviewer/pdfviewer?vid=4&sid=203de78a-8b37-49a2-bc14-2637d1e019bf@pdc-v-sessmgr01

Flachs, A. 2010. Food for Thought: The Social Impact of Community Gardens in the Greater Cleveland Area. Electronic Green Journal [online]. 1 (30). 1-9. [cit. 2018-04-20]. ISSN: 10767975.

Garnett 1996. Farming the city: The potential of urban agriculture. 26. 299-307.
Gaza leads the way with rooftop aquaponics for family nutrition [online]. Inter-American Institute for Cooperation on Agriculture (IICA). [cit. 2018-04-14].
Gaza leads the way with rooftop aquaponics for family nutrition. 2014. FAO [online]. [cit. 2018-04-15]. : http://www.fao.org/ag/agp/greenercities/pdf/GGCLAC/FAO-Gaza-aquaponics.pdf)

George. 2018. 14 THE WORK/ENERGY CRISIS AND THE APOCALYPSE.

Gliessman, S. R. 2007. Agroecology: the ecology of sustainable food systems / Stephen R. Gliessman. ISBN: 9780849328459.

Glover, T. D. 2004. Social Capital in the Lived Experiences of Community Gardeners. Leisure Sciences [online]. 26 (2). 143-162. [cit. 2018-04-10]. DOI: 10.1080/01490400490432064. ISSN: 01490400.

Gorgolewski, M., Komisar, J., Nasr, J. c2011. Carrot city: creating places for urban agriculture. Monacelli Press. New York. ISBN: 15-809-3311-4.

Guilherme Crispim Hundley, Rodrigo Diana Navarro. 2013. AQUAPONICS: INTEGRATION BETWEEN AQUACULTURE AND HYDROPONICS. Revista Brasileira de Agropecuária Sustentável, Vol 3, Iss 2 (2013) [online]. 3 (2). [cit. 2018-04-20]. DOI: 10.21206/rbas.v3i2.218. ISSN: 23175818.

Halweil B and Nierenberg D 2007, 'Farming the Cities', in State of the World 2007:

Halweil, B. c2004. Eat here: reclaiming homegrown pleasures in a global supermarket. W.W. Norton. New York. ISBN: 978-039-3326-642.

Hardej, P. 2017. Open Letter from Paul Hardej. IGrow [online]. [cit. 2018-04-12]. Available z: https://www.igrow.news/news/open-letter-from-paul-hardej

Harris,D. 1992,.Hydroponics: A Practical Guide for the Soilless Grower,2nded.;New Holland Publishing: London,UK,

Henkel, M. 2015. 21st Century Homestead: Urban Agriculture. Lulu.com. U.S.A. ISBN: 1312936517.

History of Agriculture. New World Encyclopedia [online]. [cit. 2018-04-14]. : http://www.newworldencyclopedia.org/entry/History_of_agriculture

Hortas. 2014, Hortas Comunitárias Se Popularizam Em Berlim, Laparola (17.02.2014)." Prinzessinnengarten, prinzessinnengarten.net/about/.

Hydropnics: Home-Based Vegetable Production System. ISSN: 0310-0367. Journal of the American Dietetic Association, Doi: 10.1016/S0002-8223(97)00230-7

Kalantari. 2017., F.; Tahir, O.M.; Joni, R.A.; Fatemi, E. Opportunities and Challenges in Sustainability of Vertical Farming: A Review. J. Landsc. Ecol. 2017

Kheir Al-Kodmany. 2018. The Vertical Farm: A Review of Developments and Implications for the Vertical City. Buildings, Vol 8, Iss 2, p 24 (2018) [online]. 8 (2). 24-24. [cit. 2018-04-15]. DOI: 10.3390/buildings8020024. ISSN: 20755309. : https://doaj.org/article/1597ebe14e8c4700889cb9e03799ac05

Kheir Al-Kodmany. 2018. The Vertical Farm: A Review of Developments and Implications for the Vertical City. Buildings, Vol 8, Iss 2, p 24 (2018) [online]. 8 (2). 24-24. [cit. 2018-04-18]. DOI: 10.3390/buildings8020024. ISSN: 20755309.

Kondo Michelle, Bernadette Hohl, SeungHoon Han, Charles Branas. 2016. Effects of greening and community reuse of vacant lots on crime. Urban Studies [online]. 53 (15). 3279. [cit. 2018-04-10]. ISSN: edsrep.

Krasny Marianne E. Tidball G. Keith, . 2009. Community Gardens as Contexts for Science, Stewardship,and Civic Action Learning. Cities and the Environment, Vol 2, Iss 1, Pp Article 8-18 pp (2009) [online]. 2 (1). [cit. 2018-04-10]. ISSN: 19327048.

Lawson, L. J. c2005. City bountiful: a century of community gardening in America. University of California Press. Berkeley. ISBN: 978-0-520-24343-9.
Long, X., Ji, X., Ulgiati, S. 2017. Is urbanization eco-friendly? An energy and land use cross-country analysis. Energy Policy [online]. 100. 387-396. [cit. 2018-02-19]. DOI: 10.1016/j.enpol.2016.06.024. ISSN: 03014215.

Lyson, T. A., 2012. Civic Agriculture: Reconnecting Farm, Food, and Community. Medford: Tufts University Press. Retrieved April 19, 2018, from Project MUSE database.

Marsh, R. 1998. Building on traditional gardening to improve household food security. FAO [online]. [cit. 2018-04-15]. : http://www.fao.org/tempref/docrep/fao/X0051t/X0051t02.pdf

Marx Benjamin, Stoker Thomas, Suri Tavneet. 2013. The Economics of Slums in the Developing World. The Journal of Economic Perspectives [online]. 27 (4). 187. [cit. 2018-04-14]. ISSN: 08953309.

Miccoli, S., Finucci, F., Murro, R. 2016. Feeding the Cities Through Urban Agriculture The Community Esteem Value. Agriculture and Agricultural Science Procedia [online]. 8. 128-134. [cit. 2018-04-14]. DOI: 10.1016/j.aaspro.2016.02.017. ISSN: 22107843.

Morganti Eleonora. 2011. Urban food planning and transport sustainability: A case study in Parma, Italy. Post-Print [online]. [cit. 2018-04-14]. ISSN: edsrep.

Mougeot, L. J. A. 2000. Urban Agriculture: Definition, Presence, Potentials and Risks, and Policy Challenges [online]. [cit. 2018-03-17]. : https://pdfs.semanticscholar.org/ab22/91e52833b8e6a2a89d86224c3d86a36b508b.pdf

Mougeot, L. J. A. c2006. Growing better cities: urban agriculture for sustainable development [online]. International Development Research Centre. Ottawa. [cit. 2018-04-15]. ISBN: 15-525-0226-0. :https://www.idrc.ca/en/book/infocus-growing-better-cities-urban-agriculture-sustainable-development

Nath, P. 2013. The Basics of Human Civilization: Food, Agriculture and Humanity [online]. Scientific Publisher. New Delhi. [cit. 2018-04-14]. ISBN: 978-93-86237-55-2. : https://books.google.cz/books?id=8aE4DwAAQBAJ&printsec=frontcover&hl=cs#v=onepage&q&f=false

Nelson T 1996, 'Closing the loop', World Watch, Vol.

Nettle, C. 2014. Community gardening as social action [online]. Ashgate. Burlington, VT. [cit. 2018-03-18]. Available z: https://books.google.cz/books/about/Community_Gardening_as_Social_Action.html?id=ZmV9BAAAQBAJ&redir_esc=y

New World Encyclopedia [online]. [cit. 2018-04-14]. : http://www.newworldencyclopedia.org/entry/History_of_agriculture

Notarnicola, B., Tassielli, G., Renzulli, P. A., Castellani, V., Sala, S. 2017. Environmental impacts of food consumption in Europe. Journal of Cleaner Production [online]. 140 (Part 2). 753-765. [cit. 2018-04-10]. DOI: 10.1016/j.jclepro.2016.06.080. ISSN: 09596526.

Our Urban Future, Worldwatch Institute, New York, NY.

Peters J. 1997, Community food systems: Working toward a sustainable future,

Pettenati Giacomo. 2015. Sustainable food planning: evolving theory and practice , edited by Viljoen and Johannes S.C. Wiskerke, Wageningen, Wageningen Academic Publishers, 2012, 600 pp., € 98 ex VAT (hardback), ISBN 978-90-8686-187-3. Urban Research [online]. 8 (3). 375. [cit. 2018-03-16]. DOI: 10.1080/17535069.2015.1090804. ISSN: edsrep.

Pothukuchi, K., Kaufman, J. L. 1999. Placing the food system on the urban agenda: the role of municipal institutions in food systems planning. Agriculture and human values [online]. 16 (2). [cit. 2018-04-14]. ISSN: 0889048X.

Pothukuchi, K., Kaufman, J. L. 1999. Placing the food system on the urban agenda: the role of municipal institutions in food systems planning. Agriculture and human values [online]. 16 (2). [cit. 2018-03-29]. ISSN: 0889048X.

Prazelenina. 2018. Prazelenina [online]. [cit. 2018-04-15]. Available z: http://www.prazelenina.cz/¨

ResearchGate [online]. 2000. International Food Policy Research Institute and World Resources Institute Washington, DC. [cit. 2018-04-14].

Sebastian, K., Scherr, S. J., Wood, S. 2000. Pilot analysis of global ecosystems: Agroecosystems. ResearchGate [online]. International Food Policy Research Institute and World Resources Institute Washington, DC.. 108. [cit. 2018-04-14]. : https://www.researchgate.net/profile/Niels_Batjes/publication/2934748_Pilot_Analysis_of_Global_Ecosystems_Agroecosystems/links/5617bda708ae353151bb141e/Pilot-Analysis-of-Global-Ecosystems-Agroecosystems.pdf

Senauer, B., Asp, E., Kinsey, J. c1991. Food trends and the changing consumer. Eagan Press. St. Paul, Minn., U.S.A. ISBN: 09-624-4072-8.

Specht, K., Siebert, R., Hartmann, I., Freisinger, U. B., Sawicka, M., Werner, A., Thomaier, S., Henckel, D., Walk, H., Dierich, A. 2014. Urban agriculture of the future: an overview of sustainability aspects of food production in and on buildings. Agriculture and human values [online]. 31 (1). 20. [cit. 2018-04-15]. DOI: 10.1007/s10460-013-9448-4. ISSN: 0889048X. : https://link.springer.com/article/10.1007%2Fs10460-013-9448-4

Szabo, S. 2016. Urbanisation and Food Insecurity Risks: Assessing the Role of Human Development. Oxford Development Studies [online]. 44 (1). 28-48. [cit. 2018-04-14]. DOI: 10.1080/13600818.2015.1067292. ISSN: 13600818.

Turner, B., Henryks, J., Pearson, D. 2011. Community gardens: sustainability, health and inclusion in the city. Local Environment [online]. 16 (6). 489-492. [cit. 2018-04-20]. DOI: 10.1080/13549839.2011.595901. ISSN: 13549839.

UN DESA, 2017, World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100. [online]. New York.[cit.2018-04-15]. Available z: https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html

UN. 2014. World Urbanization Prospects [online]. United Nations. New York. [cit. 2018-02-02]. ISBN: 978-92-1-151517-6. : https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.pdf

URBANIZATION. 2003. OECD [online]. Glossary of Environment Statistics. United Nations, New York. [cit. 2018-04-14]. : http://stats.oecd.org/glossary/detail.asp?ID=2819

Van den Berg, A. E., Hartig, T., Staats, H. 2007. Preference for Nature in Urbanized Societies: Stress, Restoration, and the Pursuit of Sustainability. Journal of Social Issues [online]. 63 (1). 79-96. [cit. 2018-03-05]. DOI: 10.1111/j.1540-4560.2007.00497.x. ISSN: 00224537. Available z: https://spssi.onlinelibrary.wiley.com/doi/abs/10.1111/j.1540-4560.2007.00497.x

Viljoen, A., Bohn, K., Howe, J.,. 2005. Continuous productive urban landscapes / designing urban agriculture for sustainable cities / Designing urban agriculture for sustainable cities / CPULS [online]. [cit. 2018-03-15]. ISBN: 0750655437. ISSN: edsagr.

Wackernagel, M., Rees, W. E. 1996. Our ecological footprint: reducing human impact of the Earth. New society publishers. Gabriola Island. New catalyst bioregional series, 9. ISBN: 15-509-2251-3.

Ward, J., Ward, P., Saint, C., Mantzioris, E. 2014. The urban agriculture revolution. Water: Journal of the Australian Water Association. 2014. ISSN: 0310-0367.

Warf, B. 2017. Time-Space Compression. Oxford bobliographies [online]. Oxford. [cit. 2018-04-15]. : http://www.oxfordbibliographies.com/view/document/obo-9780199874002/obo-9780199874002-0025.xml

Weber, C. L., Matthews, H. S. 2008. Food-Miles and the Relative Climate Impacts of Food Choices in the United States. Environmental Science [online]. 42 (10). 3508-3513. [cit. 2018-04-20]. ISSN: 0013936X.

What is community food security?. 2012. Community food security coalition [online]. [cit. 2018-04-14]. : https://web.archive.org/web/20120508044739/http://www.foodsecurity.org/views_cfs_faq.h

Wilson, M. 2012. By 2050, 70% Of The World's Population Will Be Urban. Is That A Good Thing?. FAST CO.DESIGN [online]. [cit. 2018-04-15]. : https://www.fastcodesign.com/1669244/by-2050-70-of-the-worlds-population-will-be-urban-is-that-a-good-thing

Zhang, X. Q. 2016. The trends, promises and challenges of urbanisation in the world. Habitat International [online]. 54 (Part 3). 241-252. [cit. 2018-04-19]. DOI: 10.1016/j.habitatint.2015.11.018. ISSN: 01973975.