



university of
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Sustainable Entrepreneurship *Project*

“How can we scale sustainable urban agriculture ?”

Abstract : Sustainable urban agriculture has the potential to generate positive outcomes for urban dwellers and our food system, however, in order to succeed, sustainable urban agriculture needs to be scaled. The scaling process takes into account the notion of scaling up, scaling deep and scaling out. To succeed, sustainable urban farmers need to understand the opportunities and challenges linked to the development of urban agriculture, such as the access to land, to education, to financial support. By understanding what implies to each notion of the scaling process, sustainable urban agriculture can be scaled by educating urban dwellers, by creating urban agriculture networks, by using production data or by training workers. By scaling each or all notions of the scaling process, urban agriculture will support the sustainable food transition towards a sustainable food system.

Keywords : sustainable urban agriculture, scaling process, sustainable food systems, scaling up, scaling down, scaling out, barriers and challenges

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Introduction

The food system which has been producing our food for decades has reached its limits, the quality of the soil is poor, the biodiversity has tremendously reduced, the nutritious qualities of the food are weak and those problems are only the top of the iceberg (Lorenz, K. 2015). However, many actors such as entrepreneurs, researchers, policy makers, farmers and so on, are working towards our food transition. This research is developed in order to support the creation of my company in the sustainable agricultural sector. The goal of the company will be to produce fresh organic food within urban areas and to retail them in our local sustainable shops. On top of that, this research should interest actors and stakeholders of the agriculture sectors to enhance the general knowledge on the scaling process of urban agriculture.

This project sits in a wider context, indeed in all countries, there is a need to modify and transform the food system in order to counter the negative impacts of conventional agriculture, stated in the first paragraph, and support the increasing worldwide population's demand for food (Westermann, O. Thornton, P. Förch, W. 2015), assure dwellers food security, allow the development of sustainable food production and the increase of social benefit (Kennard, N. J., & Bamford, R. H. 2020). Therefore, sustainable entrepreneurs find opportunities to modify our current system through the development of food production within an urban area, so called urban agriculture. Indeed, Urban agriculture can be a pillar to solve the sustainable problem generated by our current system by reducing transports (Kennard, N. J., & Bamford, R. H. 2020), optimizing urban spaces, reducing water consumption (Despommier, D. 2019), reducing chemical input dependence and regenerating our soil and our agricultural system. Consequently, modifying the urban relationship with nature and food production.

To bring urban agriculture onto the front scene of sustainability, it need to be scaled, therefore this research aims to identify and understand the need for actions to be triggered in order to scale sustainable urban agriculture. The scaling process is divided into scaling up, out and deep, these divisions' aims have a broad vision of the possibilities and the challenges linked to them. First of all, the secondary data will put light on urban agriculture, the notion of scaling and finally the barriers and challenges that sustainable urban farms are facing. Secondly, the primary data will aim to identify the need for action to succeed the scaling of sustainable urban agriculture. It's a primordial notion for the development of sustainable urban agriculture

because it includes, the quantity of food produced, the number of farms present and the education of society regarding the benefits of it.

The research question which has been developed for this research is the following :

How can we scale Sustainable Urban Agriculture ?

The overall objective of this research is to confirm and identify new challenges to scale urban agriculture in order to outline possible strategies and highlight the appropriate way to develop and scale urban projects. On top of that, this research will allow me to know the obstacles I'll need to overcome to scale my enterprise.

Literature review

Our planet and our societies are facing the global warming which is a direct result from human activities. The rise of the global temperature is caused by our activities, such as, the transportation, the deforestation, the production of goods or of livestock, the use of chemical products and many more activities. All of them are negatively affecting the Earth's conditions (Evseeva, O., Evseeva, S., & Dudarenko, 2021). Now days we already have reached some of the planetary boundaries, some researchers have identified 9 of them. They represent the limit of change the planet can support and we are already reaching the limits in some of the boundaries such as the quantity of nitrogen (Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., et al. 2015). Those limits ring like an alarm, we need to modify our way of living in order to protect future generations and because all of this results from human activities, we need to re-take the control.

Our agricultural system has a big part of responsibility in the depletion of biodiversity and the environmental arm already generated. Our current system began around forty years ago, supported by economic and political forces in order to generate some economy of scales and the creation of new markets and actors (Altieri, M. 2011). Industrial agriculture is based on the use of chemical inputs such as fertilizers or pesticides and requires a large quantity of water and of fossil energy in order to produce food and use big machinery (Horrigan, L., Lawrence, R. S., & Walker, P. 2002.). Some environmental and health concerns are linked to our production methods, monoculture is eroding all actors composing our biodiversity such as plants, animal or insects. The chemical inputs, which are used to compensate the biodiversity losses, are polluting the soil, the water and the air. On top of that, this system has reduced not only the fertility of our lands but also the nutritional value of our food (Horrigan, L. & al. 2002).

As noted above, the industrial food system has negatively impacted the environment and we are reaching the limits of our system (Steffen, W. & al, 2017).Therefore, sustainable urban agriculture offers possibilities to support the transition due to the opportunities it offer in term of environmental, social and economic returns. Based on a multitude of characteristics, urban agriculture has risen as a viable solution. In the following section, the research focuses on urban agriculture and the variety that composes it.

Urban agriculture

In order to modify our agricultural system, some actors are developing new agricultural projects which aim to transform our way of producing, processing and distributing food. This research will focus on one of the aspects of agriculture, which is urban agriculture. To understand what urban agriculture implies, it has defined it as “any form of formal or informal agricultural production in the city region. This comprises primary or secondary agriculture. Primary agriculture refers to land uses that are primarily focused on the activity of agriculture, whereas secondary agriculture comprises all land uses that integrate agricultural activities as an add-on to their primary land use, including vertical farming, rooftop gardens on residential or commercial buildings, or window sill and house gardens” (Kasper, C., Brandt, J., Lindschulte, K., & Giseke, U. 2017). This way of producing could take even more sense when we know that 60% of a country’s population is expected to live in an urban area by 2030 (Clark, K. H., & Nicholas, K. A. 2013).

As noted above, urban agriculture is divided into two groups, the primary and the secondary agriculture and have to be located within an urban area, which can also be divided into two zones, which are, nearby towns (urban) and peri-urban (suburbs) areas (Kennard, N. J., & Bamford, R. H. 2020). Urban agriculture is based on different typologies, size, location, type of agriculture, neighborhood, purpose and type of products (Kasper, C & al. 2017). On top of that it sits in a multidimensional context with many interactions between actors (inhabitants, policy makers, community representatives, waste and water companies, other enterprises or NGO’s and more) influencing its development (Kasper, C & al. 2017). Entrepreneurs need to take into account all these dimensions in order to decide which type of production they want to develop and what are the outcomes they’re aiming to deliver. There are is mostly three types of commercial production possible within urban areas. Firstly a small/medium or big urban farm, in the most common way, on a plot of land. Secondly, an indoor production inside buildings, also called controlled environment agriculture, like in a shipping container or in a warehouse and finally the last possibility is a vertical production which can occur either inside or outside (Kennard, N. & al. 2020). However, within these 3 types of production, we can find many techniques such as regenerative agriculture, permaculture, hydroponics, aquaponics, aeroponics, intensive green roof, green corridors, bioponics and so on (Canet-Martí, A., Pineda-Martos, R., Junge, R., Bohn, K., Paço, T. A., et al. 2021.). Even if horticulture represents the biggest production rate within urban agriculture, we can find other practices such as

aquaculture, arboriculture and even animal breeding (Lorenz, K. 2015.). In Table 1, you can find the different typologies of urban agriculture with their different techniques and you will find a general explication of the typologies and their benefits.

Urban agriculture offers many production possibilities which can have a positive impact on each aspect of the triple bottom line (economic, environmental and social). Despite the benefit of producing within a city boundary, urban agriculture needs to develop organic productions in order to have the desired sustainable impacts. Sustainable agriculture has been defined by Klaus Lorenz. 2015 as “ a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity, and cycles adapted to local conditions rather than the use of inputs with adverse effects. It combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.” This notion is primordial, it needs to be taken into account in order to have a sustainable food system. As we saw, urban agriculture includes different ways of producing with each way having its own benefits. The following part will present the general benefit of urban production, then the benefits of : in soil production, vertical production and finally indoor farming.

Urban agriculture offers in general many benefits with substantial positive impacts. First of all it has an economic impact by generating economic value through the enhancement of business flows, by creating job opportunities (Lorenz, K. 2015.) and by the economic revitalization of neighborhoods through the use of vacant land (Othman, N., Mohamad, M., Latip, R. A., & Ariffin, M. H. 2018). Secondly, it has a social impact by creating new spaces where urban dwellers can reconnect to nature and the food system. It can improve their personal health and their well-being and it can also provide places for communities and education (Kennard, N. & al. 2020). We can also list the reduction of food deserts and the enhancement of the urban food security (Kennard, N. & al. 2020) as social benefits. Regarding the environment, numerous benefits have been identified, such as the reduction of food transport and therefore a reduction of greenhouse emissions, it can improve water and air quality, reduce local air temperature or the heat island effect. We can also add as a benefit of urban agriculture the reuse of organic waste and the conservation of various crops and seeds (Wortman, S. E., & Lovell, S. T. 2013). In addition to all those cited benefits, each typology of urban production brings their own benefit to the triple bottom line.

	Techniques	Explication	Benefit
In Soil production	<ul style="list-style-type: none"> - Regenerative - Permaculture - Bioponics - Forestry - Agroecology - Arboriculture - Animal husbandry - Biointensive 	Producing food in soil present numerous advantage, the term regenerative include mostly all sustainable farming practice. It aims to protect are regenerate our soil, our insects, our birds by protecting them in a healthy eco-system.	<ul style="list-style-type: none"> - Restoring and maintaining the water cycle (R.N1) - Water and waste treatment, recovery, and reuse (R.N 1) - Nutrient recovery and reuse (R.N 1) - Material recovery and reuse (R.N1) - Energy efficiency and recovery (R.N1) - Long term soil recovery and fertility (R.N2) - Recycling natural waste (R.N2) - Sequestering carbon (R.N3) - Creating wild life habitat (R.N3) - Increase of food nutriment
Vertical production	<ul style="list-style-type: none"> - Wall based green façade - Green roof - Hydroponic - Aquaponic - Aeroponics 	It aim to create floors of production, reducing the space needed for the production, vertical agriculture is soilless.	<ul style="list-style-type: none"> - Reduction of land use(R.N 4) - Water and energy reduction(R.N 5) - Increase of yield (R.N 4)
Indoor production	<ul style="list-style-type: none"> - Controlled environment agriculture - Hydroponic - Aquaponic - Aeroponics 	Mostly all indoors productions are vertical but it's not a requirement. Indoor farming cut the production from any external risk and recreate the benefit.	<ul style="list-style-type: none"> - Reduction of land use (R.N 4) - Water reduction(R.N 4) - Avoid diseases - Avoid food contamination

Table 1 : Techniques, explication and benefit of urban agriculture typologies

Reference number (R.N)	Authors
R.N 1	Canet-Martí, A., Pineda-Martos, R., Junge, R., Bohn, K., Paço, T. A., et al. 2021
R.N 2	Lorenz, K. 2015
R.N 3	Kennard, N. J., & Bamford, R. H. 2020
R.N 4	Despommier, D. 2019
R.N 5	Al-Chalabi, M. 2015

Reference table 1

Barriers and challenges of sustainable urban agriculture

Despite the benefits of urban agriculture, some barriers and challenges have been identified which reduce its impact and its development. First of all, urban agriculture suffers from a lack of general knowledge and education. Research on the subject and what urban production implies is needed (Kennard, N. & al. 2020). On top of that, indoor, vertical (Despommier, D. 2019) and sustainable agriculture (Lorenz, K. 2015.) require skilled workers in order to overpass the technical problems and the sustainable challenges linked to an urban area. The technical problems regarding urban agriculture are due to the energy challenges, it concerns indoor farming, which requires recreating natural light conditions to grow food (Al-Chalabi, M. 2015.) and depending from which resource the electricity is produced, it could be environmentally harmful and very costly (Despommier, D. 2019). On top of that urban agriculture will need to either find a plot of land, a building or a roof and, within a city, this could represent the biggest expense and could impact business profitability (Kennard, N. & al. 2020). If the typologies are either vertical or indoor production, some additional costs are present like the installation, the maintenance and the continuity of the system (Despommier, D. 2019) and also all the equipment for organic small scale production (Kennard, N. & al. 2020). There are also water management instabilities which represent a risk, urban agriculture will have to fight against all users of the water system and if the production is generalized this could result in disparities and an increase in prices (Lorenz, K. 2015.). Urban is multidisciplinary and multisectoral, which makes the negotiation with the stakeholders to find some solutions for its development harder (Lorenz, K. 2015.) even more so, if the government does not support it (Kennard, N. & al. 2020).

Finally, the two major challenges that urban agriculture needs to overcome are the contamination of food/soil and the land management. First the contamination represents a big threat, cities have a high population density (Despommier, D. 2019), a lot of transport and factories which enhance the probability of having soil, air and water contamination with many chemicals or heavy metals such as arsenic, mercury or cadmium. The contamination of the production environment could be transferred to the food and thus be ingested by consumers (Wortman, S. & al. 2013). The air pollution is also a risk, the presence of aerosols can be found in outside production products which will also face altered atmospheric and microclimatic conditions (Wortman, S. & al. 2013). As stated before, land management represents barriers for urban agriculture, first of all, farmers have to compete with all development projects such as

residential, industrial or community gardens (Kennard, N. & al. 2020) in order to find a place. It makes it even harder to establish if local institutions don't have urban food strategies favoring them (Kahiluoto, H. 2020). To further complicate access to land, an urban farmer implementing an in soil strategy needs to take into account the quality and the contamination of the plot (Lorenz, K. 2015.).

As we saw urban agriculture has various barriers and challenges to overcome in order to implement a successful sustainable production, all this will require investments and research & development which will logically impact the retail price. Consequently it will have a negative impact by creating social problems, people with low revenues will struggle to have access to local sustainable food (Lorenz, K. 2015.). When establishing their scaling process urban food producers need to take into account these challenges in order to successfully implement scaling strategies.

The scaling process

Despite the challenges facing urban agriculture, its social, environmental and economic benefits are numerous. In order to have the desired impact generated by urban agriculture it is primordial to scale it. The process of scaling can be divided into 3 strategies: scaling up, scaling out and scaling deep. The notion to scale up is the most known and has been defined by Westermann, Thornton and Förch as “bringing more quality benefits to more people over a wider geographical area, more quickly, more equitably, and more lastingly” (Westermann, O. Thornton, P. Förch, W. 2015). A second definition of scaling up, which has a more political sense is “a vertical form of scaling, based on understanding that many social-ecological problems are embedded in law, policy and institutions and that transformations require institutional change at the levels of policy, rules and laws” (Nicol, P. 2020). Based on these definitions, we will consider scaling up in this research as the increase of food produced within urban areas. Moving to the second notion, scale out is defined as “a horizontal form of scaling, both increasing the number of people or communities impacted or involved and expanding geographical reach through replication or diffusion” (Nicol, P. 2020). In this research, we will consider scaling out as the process of increasing the number of farms and the diffusion of producing techniques to apply in urban agriculture. Finally, scaling deep is defined as “centered upon acknowledgement that culture plays a powerful role in shifting problem-domains, and change must be deeply rooted in people, relationships, communities and cultures” (Nicol, P.

2020). It can be understood as a learning process or the development of awareness regarding a subject. In this study it will be based on the knowledge and awareness of all actors present in the urban agriculture context. Entrepreneurs in the scaling process of their enterprises or of the solutions needed to take into account all three aspects of the process in order to have a durable and weighty change (Nicol, P. 2020). Furthermore, even if this process is needed, if the entrepreneur has the desire to bring his company to a new stage, it present risks and barriers which need to be overcome. The first barrier which impacts all three types of scaling strategies is the cost of it. Indeed, to either scale up the production, to scale out farms or to scale deep urbanist relation to food will be costly (Nicol, P. 2020) (Westermann, O & al. 2015). Logically increasing production or the number of farms is very expensive because it requires more space, more equipment and more human forces thus big investments. This is also applied to scaling deep, bringing knowledge is also costly, entrepreneurs need to invest in campaigns and develop a network with an educational institution. The second major barrier to the scaling process is the lack of political support (Nicol, P. 2020). Indeed, if cities or regions haven't got a strategy regarding urban farming development, projects will struggle to find plots of land, economic support like tax reductions, to organized education for the public or access to subsidies (Westermann, O & al. 2015).

As noted above, the scaling process is complicated but necessary in order to reach a sustainable food system. The empirical study of this research will emphasis on the scaling process, it aims to identify possible new barriers or challenges and how urban farmers can overcome them in order to ensure the development of their farms.

The literature review has provided the secondary data, defining the boundaries of the research. Indeed based on it, the aim of the empirical study will be to confirm the challenges linked to urban agriculture and highlight strategies to scale urban agriculture.

Research method

In order to understand how we can scale up urban agriculture and to identify the actions which have to trigger to succeed, I will develop a qualitative research. To acquire viable qualitative data on the various topics of this research - urban farming, scaling up strategies, urban agricultural needs for action - in order to answer my research question, I will conduct 6 interviews. This qualitative research will be developed following a descriptive design, it aims to discover associations and relationships between or among selected variables, on top of that this research design should provide accurate characteristics of a particular situation (Dulock HL. 1993). A multiple case study will also be applied during this empirical study, this format, of case study will allow me to study multiple cases in order to understand the difference and the similarities and to analyze the data from each situation (Gustafsson, J. 2017).

Applying a qualitative research fits my research question because “it is research that helps us to understand the nature, the strengths and the interaction between variables” (Black, N. 1994,). In the case of this study, the variables are the process of scaling, the urban agriculture and the obstacles to overcome. Qualitative research will allow me to ask precise questions which should provide my primary data in order to answer my question. Due to the multiple dimension of the subject and that the relation between them can be blurry, therefore, interviews will provide the needed data. Indeed this qualitative approach is composed of three steps : interviews, observation of activities, interpretation of written material. Such approach is more revealing when the variables of greatest concern are unclear (Black, N. 1994)

As noted above, I will conduct 6 semi-structured interviews. This structure of interview is the best regarding my research because it provides details, depth and an insider’s perspective of research question and topics, in the same time semi-structured interviews allow a qualitative analysis of the interviewee’s responses (Leech, B. L. 2002). Three interviews will be conducted with urban farmers, the objective will be to have a variety of farmers, using different farming techniques but also with different business models. One interview will be with an institutional actor within an urban area. One interview will be with a food tech company. Finally the last interview will be with a researcher specialized in Urban Agriculture. All interviews will be conducted in a short time frame, during the month of April 2022. The selection of interviewees is the following in order to cover the entire subject and to reduce bias by having a large panel

of competencies. Finally interviewees will be selected depending on their localization (western Europe), their production techniques and their positions and their market.

In order to do the interviews in the best conditions, I will develop an interview guide. It will be divided into various sections with different topics to ensure that the entire context is covered. To ensure the reliability of this research, all interviewees will have the same questions, the first part will concern their position and their relation to urban agriculture. The second part and main part of the interview, will be about urban agriculture, how to scale it up and the obstacles which can occur in the process. The interviews will be conducted either online (with google meet or another software) or in face to face depending on their localization. In order to ensure the ethics of this research, all interviewees will have to sign a consent form, it will guaranty that the information and the data provided during the interviews will be used only for this research and it will guarantee that what they say stays anonymous. Once the interviews done, they will be transcribed with the tools “Amber script”.

To finalize my empirical study, once all interviews are conducted and transcribed, I will apply a grounded theory for my coding and my data analysis. First of all, it will allow me to maintain a neutral stance regarding the data and the interviews, to stay objective. Secondly, “the grounded theory coding allow the comparison of occurrence in order to reveal broad pattern and trends that will emerge as categories” (Howard-Payne, L.2015). The coding will be processed through the software Atlas. This software supports the coding of all interviews in order to highlight the major themes. Themes represent some categories which express and define urban agriculture, they will regroup some crucial information which will have an impact on the need for action to trigger successfully scale it.

Furthermore, three phases of coding will be implemented :

1. Open coding, individual → concepts are derived from interviews, observation and reflection.
2. Axial coding, individual → emerging/first order concepts, inductive → Data organized into categories that represent themes or subplots.
3. Selective coding → combining theory and first order concept → second order concepts → as categories develop, they are compared together in order to identify competing theory.
4. Construction of the concept and results

However, some bias can be present in this empirical study, the fact that half of the interviewees are urban farmers, their objectivity regarding the importance of urban agriculture could be biased. A way to tackle this bias in this research is to interview some agricultural experts who are not involved in any urban project and who will have an objective view of the situation. All this primary data has provided the knowledge, the frame and the gap for the empirical research. The following section presents and discusses secondary data in order to answer the research question.

Result

After pursuing the empirical study in the field, this section of the research highlights six major topics related to urban agriculture. In the results, we can distinguish the implications of stakeholders, the challenges which need to be overcome and the decisions actors need to take in order to successfully scale agriculture within our urban and peri-urban settings. These six topics are : Environmental, Social, Needs, Education, Political implication and Financial. The six topics are the result of 6 interviews done with experts on urban agriculture. Once the data collected, it was processed through a coding scheme. The results put light on the need for action which has to be triggered by the urban agriculture stakeholders in order to scale up, deep and out sustainable urban agriculture.

The following topics are composed of challenges, opportunities, need for improvement, thoughts and needs expressed by the interviewees which could have a positive or negative impact on the scaling process of urban agriculture. Therefore, this section highlights the relation between the six themes and the scaling process. The following section, discussion, will present action which needs to be done to successfully scale sustainable urban agriculture.

Needs :

In order to rise up the challenges of urban agriculture some needs have to be fulfilled. They will have an influence on the creation and the scaling process of the urban farm. Such as the human force needs which are vital in a project, they bring the knowledge, the techniques, the motivation and the strength in its development and without those forces projects' viabilities are reduced. It was expressed by interviewee 1 : "The big challenge is to find people who are motivated to carry out this kind of project, which can be heavy, which again involves a lot of different know-how and at the same time, pressure from all sides, and who are really knowledgeable and competent." In the urban agricultural field, which is still a niche market, there is a real need of networking among stakeholders, it can be between farmers but also from the educational system to the farm. Which was expressed by 2 interviewees.

- Interviewee 3 : " I think it would also be good that we, as small urban farms, that we exchange knowledge".
- Interviewee 2 : "I do about three interviews a week, but this knowledge all goes into the air. There is nowhere to put the knowledge, a center or a place where all these studies are registered."

Political :

The political situation and the implication of local and national institutions was often expressed by the interviewees. They have explained how the food strategies of a city can support or diminish urban agriculture development. They have a position of break-even points due to their central role regarding land management, subsidies, food system strategies but also regulation. On top of that, political situations are very unstable, every few years there can be changes which can affect the institutional support.

- Interviewee 2 : “Again, there are hardly any maps of soil quality in the city. This is one thing that the government should do. I think we need to treat the soil in the city on the same level as we treat soil in rural areas.”
- Interviewee 1 : “ We change the mandate, it is no longer supported. And today, it's that, because there are other priorities, again. »

Education :

Education has been highlighted by the interviewees as a major topic in urban agriculture. Education concerns everyone and every level, from consumers and civilians to entrepreneurs and politicians. It refers to the education of consumers towards a more sustainable and healthy diet or to show them the real cost of food. It also refers to the education of entrepreneurs in order to develop viable projects, it concerns the education of city designers to include green spaces and so on. The interviewees have highlighted the benefits which would result from an educated society towards urban agriculture.

- Interviewee 5 : informing people about the possibilities of mycelium, what are the possibilities for food and nutrition. Because for us, if our product should definitely symbolize something its healthy, tasty and definitely good for the environment.
- Interviewee 6 : “Yes, of course. In any case, when we educate, that is to say, we manage to show people that it is possible to do it in the city, that it works, that the production is not as small as that.”

Financial :

The financial dimension appears in the results as a major influence in the development of urban agriculture. It impacts all actors in a positive or negative way. It can refer to the amount of money investors are ready to inject in the farm, it can be linked to the final price the consumer will have to pay, for the amount of subsidies, the farms' fixed costs, the price to support innovation, but it also refers to the institution's values. They can be monetary value based which will have an impact on the scaling process of urban agriculture. This break-even point could result in major changes in our urban agricultural system.

- Interviewee 5 : “For me, I think you always have to strike a balance because even within sustainability, we have to become economically viable.”
- Interviewee 3 “Yeah, I think these subsidies to help small or small scale urban agriculture start up, I think it's really great.”

Social :

The social dimension in urban agriculture appears to be a major topic. It has a real power to bring people together, to work for a common project but also support the human social needs. Many community gardens are flourishing, it can also have an effect on other urban farms seeking a productive business model. The social aspect has be taken into account by all the stakeholders in the development process of an urban agricultural project because it has the faculty to support the project by bringing more human forces, knowledge and also communication towards a bigger public.

- Interviewee 1 : “I think that communities, in any case, which may also have projects themselves, farms in management for example, could also really have the vocation to try to create a training center by trying to welcome people who want to be trained in order to disseminate a city which has a farm.”
- Interviewee 2 : “the garden has become a kind of a church. So it's important for sense making in my life. My identity is also dependent upon my work as a gardener in the garden.”

Environmental :

The environmental impact of urban agriculture cannot be diminished, but it has to be considered with all the others topics. Projects can have an impact and support a sustainable food system, however, it seems that urban agriculture will not replace rural agriculture. So in order to increase the sustainable positive net impact, urban agriculture needs to be paired with new technologies, a social dimension, new projects and new objectives which will increase the benefits.

- Interviewee 2 : “But it also seems that many plants can cope with this kind of air pollution in the city and also the soil.”
- Interviewee 6 : “For the same ratio per square meter, I think we use much less water than conventional agriculture. That's for sure, because there's no water loss, the plant will feed on what it needs.”

Discussion

Urban agriculture started its development during the second world war as a solution to feed Americans during this time of crisis. Nowadays, urban agriculture has started its professionalization (interviewee 2), it is presented as a possible solution to our food system in this time of ecological crisis. On top of that, the covid 19 and the war in Ukraine, has highlighted the weakness of our global system and the need for a sustainable food transition. Drawing lessons from the primary and the secondary data, this section will consider all three dimensions of scaling. It will allow actors to develop and scale urban agriculture in order to make it a pillar of our future sustainable food system. These three dimensions of scaling are scaling up, scaling deep and scaling out. By taking into account those three dimensions, the research aims to bridge the gap between the challenges and the need for action in order to scale sustainable urban agriculture.

As mentioned above, urban agriculture needs to be scaled up, out and deep in order to have a sustainable impact, but this requires some changes at every level. Indeed, urban agriculture is a multi-dimensional topic, implicating actors from various fields, organizations and institutions (Kasper, C., Brandt, J., Lindschulte, K., & Giseke, U. 2017). In addition to this, a scaling process implies some challenges and barriers to overcome, those challenges are the results of political and economic choices, of technological and educational constraints. The main challenges for urban agriculture are a lack of human forces, access to affordable lands, financing of projects, educating the public and the political implication. To over pass these challenges and scale sustainable urban agriculture, all actors in this context will have to work together to change our current food systems and the relation of urban dwellers towards food.

In the following paragraphs, you will see how we can scale up, scale out and scale deep sustainable urban agriculture. Scale up refers to the quantity of food produced within the urban boundaries, scale out refers to the number of farms developed in the urban area and scale deep refers to the education regarding urban agriculture. Finally, at the end of this section, you'll find a pathway to scale urban agriculture. It represents the need for action to implement in each dimension of the scaling process. All the actors involved in sustainable urban agriculture can rely on it in order scale one or all the dimensions of the process.

Scaling deep sustainable urban agriculture

Scaling deep is the first part of this section because education can have a tremendous impact on the development of urban agriculture and without this dimension, scaling up and out would be harder to implement. Indeed scaling deep refers to the education of everyone - politicians, consumers, farmers, city planners, chefs, universities - regarding sustainable urban agriculture. This process is primordial for its development and can be divided into three sub-categories. First of all, the education of public institutions regarding the benefits and the possible added value of urban agriculture is needed. Political institutions influence the development of an urban farm project through laws and regulations, through their city development plans and through the projects they support or not. The aim of educating public institution is to influence them towards a sustainable urban development and a sustainable urban food system. Such changes will support the scaling process of urban agriculture by financing new projects with public subsidies, by giving access to affordable lands, by offering technical support such as a city soil map as mentioned by interviewee 2. On top of that, an educated public institution will take into account other benefits generated by farms for the development of new buildings or the design of public spaces. Farms present in or on buildings can reduce its energy consumption due to better isolation, can reduce the waste of water by connecting the grey water system to the irrigation of the farm and also, it can reduce bio food waste with compost-which will be used in the farm later (interviewee 4). As we saw public institutions have a real influence on the development of urban agriculture, therefore, it is of paramount importance to educate our political leaders to support sustainable urban agriculture which would result in green sustainable cities with better living conditions.

However the education doesn't stop at public institutions, indeed, consumers also need to be educated that the food system works on behalf of the biodiversity and for low wage workers (interviewee 2). The education of consumers would create opportunities for urban agriculture, indeed, after those six interviews, it seems that more and more people are interested by food quality and its origin, however a majority stay unaware of the social and environmental damage generated by global conventional agriculture. By educating consumers, they will be able to make better choices in their daily consumption, they will be aware of the real price of food and the impact of an industrial system. As mentioned by interviewee 4, education has to occur at

all levels of the food system, to enable it to move towards a sustainable food system where people will eat healthy and sustainable food which will also benefit urban agriculture.

Finally, professional actors such as farmers, entrepreneurs, universities, architects have to be educated. By doing so, urban agriculture would assure its development in the long term by attracting new investors, by developing green buildings with dedicated spaces on the roof or in the back yard, by allowing farmers to apply environmental farming techniques and finding some support if needed.

As we saw, scaling deep is a pillar to ensuring the development of sustainable urban agriculture, however, to avoid any loss of knowledge, an urban agriculture knowledge center is needed. As mentioned by interviewee 2, it will allow any actors working in urban agriculture to access or increase the global knowledge on the subject.

Scaling out sustainable urban agriculture

Scaling out refers to the number of farms developed in the urban area. In order to enhance their development, some actions need to be triggered by all the actors. The first challenge urban farms have to overpass is the access to land. Indeed, as stated by interviewees 1, 2, 3 and 4, the access to land represents a major struggle for the development of urban farms due to strong competition, high prices, long term insecurity and soil/ air pollution. Different possibilities would allow urban agriculture to tackle these challenges. First of all, an implicated public institution in urban agriculture would reduce the challenges, by giving access to fertile and affordable land (interviewee 3), by implementing indoor and roof farms in their construction plans (interviewee 4), by supporting their development with subsidies (interviewee 5), by giving access to knowledge or technical support (interviewee 2). However, such ideal conditions are not yet present so much and as interviewee 4 stated, “it will be hard to convince everyone of the urban agriculture potential”. In order to scale out urban agriculture in a harder context some solutions exist. Access to land is possible but might not be the ideal one, maybe polluted, maybe expensive, so urban farms need to be adaptable and find some solutions. For polluted soil, farms need to run tests on the soil and the production or need to move to an out soil production either based on low-tech (interviewee 1) or high tech. High tech solution projects also have the possibility to attract more investors (interviewee 2).

Regarding the founding and the commercialization of projects which can't benefit from any support, projects have to develop themselves as any business, find a viable business model (interviewee 1), find some customers, communicate on their commercial activities in order to reach growth as would any business.

Urban agriculture can also have a social oriented purpose and thus answer social concerns, such as food deserts, elderly communities, food for all. Answering such concerns could favor their expansion.

Despite the context in which the projects are launched, to sustain the scaling out of urban agriculture some networking is needed. Indeed, as mentioned by interviewee 2, networking among actors is really weak, we need to enhance it which will bring the knowledge, the support and a sense of community that urban agriculture needs to scale out.

Scaling up sustainable urban agriculture

Scaling up, refers in this research to the quantity of food produced and it's a critical phase of the scaling process because, as stated by four interviewees, "urban agriculture will never displace rural agriculture". Therefore, as mentioned by interviewee 1, entrepreneurs and public institutions need to define their urban agriculture strategies between a productive business model or a social business model. This choice will help to define which type of farming techniques would be the best to apply, indeed it seems that a vertical farming better suits a productive business model and an in-soil production better fits a social business model. The implication of public institutions in this choice depends on their development strategies, depending if they prefer the creation of social activities and access to healthy food for everyone or if they prefer reducing their dependence on rural areas regarding food. This choice is also influenced by the national context, but will not constrain urban agriculture in one unique business model. As mentioned by interviewee 1, this choice will support urban farmers in their strategy definition, depending on the support they want.

As mentioned, vertical agriculture offers more productive possibilities with a reduction of water consumption, an increase of yield per square meter (interviewee 6). On top of that, vertical farming paired with indoor agriculture increases the productivity of the plant by offering the perfect growing conditions. However, we need to balance these advantages because sustainable indoor production also depends on the source of energy used to recreate the conditions. Farms

need to use renewable energy because, as stated by interviewee 5, using a mix energy composed of fossil energy reduces any positive outcomes. On top of that, vertical and indoor agriculture needs to adapt its communication and educate the consumers because “such production is still facing suspicion by the consumer even if it is in the front line of sustainability” (interviewee 2). On the contrary, a small scale in-soil farm can be very efficient without any light or add on, just by applying regenerative techniques and maximizing space (interviewee 3). Therefore, it seems that even if vertical farming favors high production, conventional in-soil urban farms can answer a growing demand and even more if the amount of farms increase.

To ensure the scaling up of urban production despite the business model used, urban agriculture needs more human forces. As mentioned by interviewee 1, there is a need for knowledgeable and motivated people to carry out heavy urban agriculture projects. On top of that, urban agriculture needs to move to more data based production, indeed, such data would allow urban farms to be more productive, reducing their cost and increasing their positive impact by reducing the quantity of water used, adapting light setting depending on the needs of plants (indoor agriculture).

As we saw, to scale sustainable urban agriculture, all actors have to work together in order to create more knowledge, more spaces, more forces, more investments and new technologies which should result in greener cities with better living conditions based on a sustainable urban food system.

Implication

As mentioned above, to successfully scale urban agriculture, all actors need to take into account the triple dimension of the scaling process. These suggestions support the development of sustainable urban agriculture in the three dimensions. Hopefully, by taking this into account, farmers, entrepreneurs, investors, political institutions and consumers will recognize the utility to scale urban agriculture in order to support a sustainable food system.

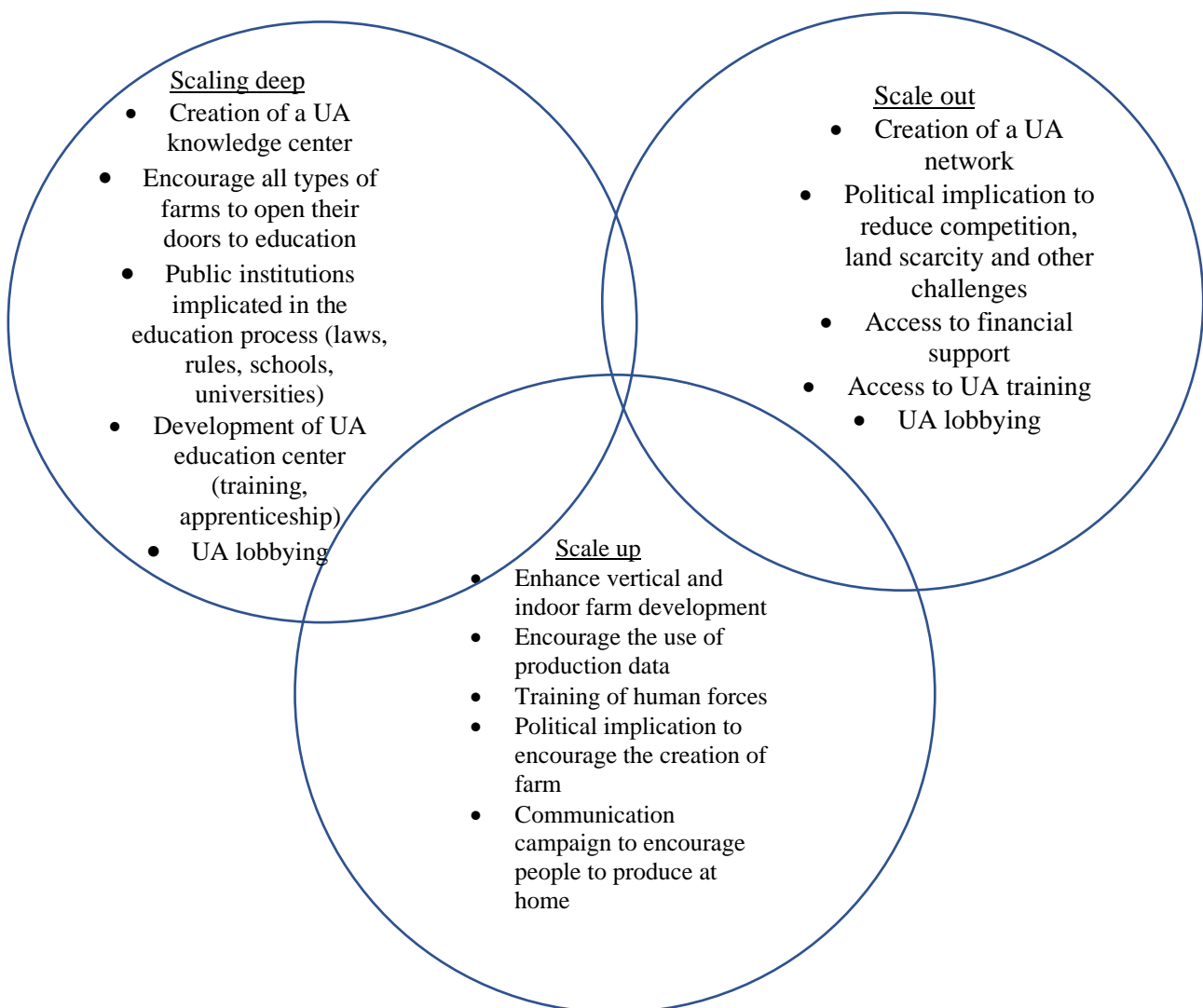


Figure 1 : Pathway to scale sustainable urban agriculture

Limitation and conclusion

Limitation

Some limitations in the research need to be taken into account. The first limitation refers to the localization of the interviewees. Indeed, they come from different cities and countries, therefore it could bias the research because they are from a different context, facing different problems, so their point of view regarding urban agriculture is influenced. The second limitation in this research concerns the actual strategies of cities, regions and nations. The strategies that are currently being developed or implemented across Europe regarding urban agriculture and food systems. Those strategies and plans haven't been taken into account in this research, but their current choices could have an impact on the development of urban agriculture and thus on the result of this research. The third limitation in this research can be my point of view as a researcher. I'm passionate about such topics and I believe in urban agriculture and the changes which can result from it, therefore it may have impacted my empirical study. The final limitation within this study concerns the time frame. Indeed, this study was written in a short time frame which may have influenced the quality of the research in order to stay in the time boundaries.

Conclusion

This research makes contributions to the sustainable urban agriculture scholarship by answering the question, "how can we scale sustainable urban agriculture". It enhances the general knowledge of the scaling process in urban agriculture through the three dimensions from which it's composed. Namely, scaling up, scaling deep, scaling out. The research is based on primary and secondary data. First of all the secondary data brings general knowledge on urban agriculture, its benefits, the barriers it faces and on the scaling process. The empirical study is based on 6 interviews pursued with experts of urban agriculture (2 urban farmers, 1 urban farm project manager, 1 sustainable manager, 1 city planner and one academician). It has put in to light 6 main topics impacting positively and negatively the scaling process of urban agriculture. Those topics are: needs, finance, political, environment, social and education. They are all directly linked to the development of urban agriculture, such as the education of consumers and institutions, the need for human forces, the investments or subsidies received by a project, the creation of communities, the reduction of water consumption or the support of local institutions.

Urban agriculture is a multi-dimensional field, it requires various know-how in order to scale it.

This research has drawn a pathway based on the insight of the empirical study and the secondary data. So in order scale urban agriculture, all actors have to take into account each dimension of the process. To scale deep, it is necessary to educate as much as possible by opening farms, creating a knowledge center, creating educational programs. This awareness will show the economic, social and environmental benefits of developing urban farms. As a result, it will support scaling out. The number of farms can increase if it's supported by public institutions and if urban farms manage to access land, avoid useless competition and find a viable business model based on production and tackling social concerns. To scale up urban food production, the projects need to be well designed from scratch with its aim in head, either based on low or high tech production. To support this dimension, knowledge and data is of paramount importance, they allow a better efficiency in the production.

The scaling process of sustainable urban agriculture presents many challenges to be overcome, however, this research presents possible solutions to succeed and support the sustainable transition of our society.

Literature list :

Evseeva, O., Evseeva, S., & Dudarenko, T. 2021. The impact of human activity on the global warming. *E3S Web of Conferences*, 284: 11017.

Horrigan, L., Lawrence, R. S., & Walker, P. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental Health Perspectives*, 110(5): 445–456.

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., et al. 2015. Article: Planetary boundaries: Guiding human development on a changing planet. *Journal of Education for Sustainable Development*, 9(2): 235–235.

Altieri, M. 2011. Modern Agriculture: Ecological impacts and the possibilities for truly sustainable farming. *Division of Insect Biology University of California, Berkeley*.

Kasper, C., Brandt, J., Lindschulte, K., & Giseke, U. 2017. The Urban Food System Approach: Thinking in spatialized systems. *Agroecology and Sustainable Food Systems*, 41(8): 1009–1025.

Clark, K. H., & Nicholas, K. A. 2013. Introducing Urban Food Forestry: A multifunctional approach to increase food security and provide ecosystem services. *Landscape Ecology*, 28(9): 1649–1669.

Kennard, N. J., & Bamford, R. H. 2020. Urban agriculture: Opportunities and challenges for sustainable development. *Encyclopedia of the UN Sustainable Development Goals*, 929–942.

Lorenz, K. 2015. Organic Urban Agriculture. *Soil Science*, 180(4/5): 146–153.

Despommier, D. 2019. *Urban Agriculture: Another Way to Feed Citi*: 68–74. Rep., Paris, France: Veolia institute .

Canet-Martí, A., Pineda-Martos, R., Junge, R., Bohn, K., Paço, T. A., et al. 2021. Nature-based solutions for agriculture in circular cities: Challenges, gaps, and opportunities. *Water*, 13(18): 2565.

Othman, N., Mohamad, M., Latip, R. A., & Ariffin, M. H. 2018. Urban farming activity towards sustainable wellbeing of urban dwellers. *IOP Conference Series: Earth and Environmental Science*, 117: 012007.

Al-Chalabi, M. 2015. Vertical farming: Skyscraper sustainability? *Sustainable Cities and Society*, 18: 74–77.

Kahiluoto, H. 2020. Food Systems for Resilient Futures. *Food Security*, 12(4): 853–857.

Wortman, S. E., & Lovell, S. T. 2013. Environmental challenges threatening the growth of urban agriculture in the United States. *Journal of Environmental Quality*, 42(5): 1283–1294.

Nicol, P. 2020. Pathways to scaling agroecology in the city region: Scaling out, scaling up and scaling deep through community-led Trade. *Sustainability*, 12(19): 7842.

Westermann, O. Thornton, P. Förch, W. 2015 Reaching more farmers, innovative approaches to scaling up climate-smart agriculture. *CGIAR research program on climate change, agriculture and food security (CAAFS)*, 135 : 14-17.

Black, N. 1994. Why We Need Qualitative Research. *Journal of Epidemiology and Community Health*, 48: 245–246.

Leech, B. L. 2002. Asking Questions: Techniques for Semistructured Interviews. *Political Science and Politics*, 35: 665–668.

Hayes, B. K., Heit, E., & Swendsen, H. 2010. Inductive reasoning. *WIREs Cognitive Science*, 1: 278.

Dulock HL. Research Design: Descriptive Research. *Journal of Pediatric Oncology Nursing*. 1993;10(4):154-157. doi:[10.1177/104345429301000406](https://doi.org/10.1177/104345429301000406)

Gustafsson, J. 2017. Single case studies vs. multiple case studies: A comparative study. *Academy of Business, Engineering and Science*, 2–3.

Kennard, N. J., & Bamford, R. H. (2020). Urban agriculture: Opportunities and challenges for sustainable development. *Encyclopedia of the UN Sustainable Development Goals*, 929–942. https://doi.org/10.1007/978-3-319-95675-6_102

Howard-Payne, L. (2015). Glaser or Strauss? considerations for selecting a grounded theory study. *South African Journal of Psychology*, 46(1), 50–62. <https://doi.org/10.1177/0081246315593071>

Benke, K., & Tomkins, B. (2017). Future food-production systems: Vertical Farming and controlled-environment agriculture. *Sustainability: Science, Practice and Policy*, 13(1), 13–26. <https://doi.org/10.1080/15487733.2017.1394054>