CIRCULAR URBAN AGRICULTURE IN THE HAGUE

WHERE WE ARE AND WHERE WE COULD GO

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Summary

Cities account for approximately 75% of Greenhouse Gas (GHG) emissions. This, along with the fact that cities also account for 75% of natural resource consumption and 50% of global waste production, makes urbanization a world-wide issue (Sukhdev, Vol, Brandt, & Yeoman, 2017). Additionally, the widely-practiced urban linear economic structure only amplifies the problems of city life, taking goods from far-off places, using them for a limited time and discarding them in such a way that cuts value chains. A shift toward a circular economy (CE) with the aim to reduce, reuse or recycle materials could be a winning sustainable development strategy for cities aiming to lower their negative environmental impacts.

Problems of urbanization are only expected to increase. In Europe, cities house 70% of the population, making it one of the most urbanized regions in the world. In the Netherlands particularly, the percentage residents living in cities has grown from 87% in 2010 to over 91% in the last 8 years (United Nations Population Division, 2018).A major challenge facing the Netherlands is the sustainability of the food system that accompanies this urbanization. Cities depend heavily on imported food to fulfil the needs and preferences of their residents. Besides the negative environmental consequences of excessive and often fossil-fuel driven importation, cities also produce a large amount of food waste which is often simply incinerated or landfilled. A more circular and localized food system, in this case addressed through Circular Urban Agriculture (CUA), would address both the issues of the linear economy and the growing food needs of cities. The Hague presents an interesting opportunity for CUA with its increasing popularity, carbon neutrality goals, location in a highly-productive agricultural area and expanding innovativeness.

This research assesses the current state of CUA in The Hague, its potential for growth and possible future scenarios in which it is a larger part of The Hague's food system. A conceptual framework comprised of quantitative and qualitative criteria from various frameworks leads the way into The Hague's sustainable future. The contributing frameworks are the Urban Harvest Approach, Strategic Niche Management and Backcasting and draws from three domains: urban metabolism, sustainable transitions and future studies. A literature review gives insight into the current state of both urban agriculture (UA) and circularity in The Hague. Using the three examples of macro-level CUA initiatives available in The Hague (the Edible Park, Urban Farmers and Haagse Zwam), network development, learning opportunities and expectations regarding CUA create a strong story for the future potential of the sector. Those involved externally with the CUA sector, such as municipality representatives, circularity experts and researchers, also contribute to the analysis by providing insight into the landscape of The Hague. Finally, taking expectations, interviews and knowledge of Industrial Ecology into account, a future vision for The Hague in 2050 exemplifies what "could be" for the future food system. The use of multi-level investigations for individual CUA initiatives, the CUA sector, the larger food system and the sociotechnical landscape of The Hague allows for an in-depth analysis that ultimately leads to recommendations for next steps related to CUA's development.

Conclusions arise regarding all levels of analysis. The CUA sector of The Hague is underdeveloped despite the various organizations and municipal departments working towards carbon neutrality and a more sustainable city. Lack of collaboration and transparency both within the CUA sector and between it and the municipality contribute to

this. Quantitative assessments, though somewhat unsubstantiated because of limited data, also suggest that circularity in the CUA sector and The Hague's food system as a whole leave much room for improvement. Lack of knowledge regarding composting policies, plus a lack of locally-driven nutrient recycling, results in a what seems a completely linear system. However, improvement is possible through increased communication, cooperation and support between the CUA initiatives, the municipality and potential customers. Additionally, more rural agricultural areas like Midden-Delfland could be considered for inclusion in The Hague's definition of "urban" farming, which could jumpstart the local food market and the growth of CUA technologies like permaculture. Related to learning, the CUA stakeholders recognize the importance of the sector to those with distance to the labor market and the need for a business-to-business structure to be successful. However, very little learning about waste management policies or potentials occurred, signaling a need to investigate this core element of nutrient recycling the city's ability to implement it. On a positive note, expectations illustrate the belief that sustainability and circularity will continue to grow in popularity throughout the years as they have in the last decade. Many believe that food cooperatives will be the key to a developing market around local produce by increasing accessibility. However, all agreed the locally-grown food will never be the main supplier for The Hague. In this sense, the vision for 2050 addressed a "best case scenario" for CUA in The Hague. Although not complete nor discussed by stakeholders, the future vision provides some recommended next steps for the immediate future and further research to incorporate more of the backcasting methodology. The hope is that these suggestions will kick off the discussion around both urban food growth and circularity in a way that increases communication, cooperation and support between the case studies themselves, the municipality and potential customers.

Acknowledgements

This process was not easy. After indecisiveness, some bad luck and delays with my proposal, I finally completed my thesis. While it is not at the place I wish it could be, my hope is that my work will inspire future investigations of circularity and urban agriculture in The Hague.

I would like to thank everyone who helped me along the way, especially in the beginning phases of researching and proposal. First, my main supervisor Jaco, who was patient with me as I learned and grew as a writer and researcher. He has an amazing way of being encouraging yet honest when things need to come together. His expertise in the frameworks I used was especially helpful. I owe a lot of getting to this point to him. My second supervisor, Benjamin – thank you for sticking with me even though my topic was not in your specific field of interest. Thank you for helping me through the quantitative setbacks I faced and developing a way to work through them. To my parents – thank you for supporting me through the entire IE program. The nights you spent listening to my doubts and fears helped me realize that I could do this. Three years ago, we could have never dreamed of this international future. I'm so glad we went on this journey together. To my IE family – I had the time of my life getting to know you. You are the most interesting, intelligent and inspirational people I've ever met. Thank you for your support through the engineering courses, thesis preparation and finishing this report. The long nights were worth it with you all by my side.

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List of Abbreviations

CE	-	circular economy
UA	-	urban agriculture
CUA	-	circular urban agriculture
UHA	-	Urban Harvest Approach
SNM	-	Strategic Niche Management
UN	-	United Nations
DMI	-	Demand Minimization Index
SSI	-	Self-Sustaining Index
WOI	-	Waste Output Index

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1. Introduction

1.1 Problem Definition

The UN's "Agenda of Sustainable Development of 2030" aims to "… make cities and human settlements inclusive, safe, resilient, and sustainable" (UN-Habitat, 2016). Cities exist between the largescale country agenda and the small scale of individuals (Vergragt et al., 2016). All walks of life, however, can feel the growing stress of rapid urbanization on the environment. As global urban populations passed the halfway mark in 2008, Europe was already boasting a 70% urbanization rate (United Nations, 2010). Madlener and Sunak (2011) report that cities represent 75 percent of global resource consumption, a majority of which comes from distant places with transportation contributing to the environmental footprint (Ramaswami et al., 2016) A major contributor to urban consumption is the food system. Cities depend on imported goods and produce organic food waste, much of which is simply incinerated or landfilled. Without proper material separation and composting, cities are destroying the economic potential held in food waste and other organic materials. Abuse of the urban food system also has environmental and social consequences. There is a mismatch in how much urban areas consume versus what they produce within their own borders. For example, cities consume 60 to 80 percent of global energy resources while producing less than 10% of their own food (UN-Habitat, 2016). A more efficient urban food system in the form of circular urban agriculture could be an example of moving away from linear resource consumption as well as a solution for issues associated with the urban food system.

1.1.1 Linear Metabolism and the Circular Economy

The core of many urban environmental issues lies in linear metabolism's "take-use-toss" mindset. The system reduces high quality inputs to low quality waste that leaves the system unseparated and without a hope for future reuse. Alternatives to linear activities can include filling toilets with storm water runoff, usable excess energy for another system, reusing plastic water bottles and efficiently composting food waste into fertilizer for the next season.

While cities face major problems, they are also powerhouses for innovation and sustainability movements. Cities are the perfect places to adopt more sustainable metabolism systems like those found in closed-loop supply chain management practices because of the constant in-and-out flow of materials (UN-Habitat, 2016; Rosanne C Wielemaker, Weijma, & Zeeman, 2018). The circular economy (CE) is a trending topic in the fields of sustainability and efficient business practices. The idea of a transition from the linear "take, use, toss" rhetoric to circularity's "make, use, return" approach is appealing due to its role in increasing efficiency and, subsequently, decreasing long-term costs. Closed-loop systems preserve resources, optimize yields and minimize risks by protecting against the overuse of finite stocks, which is likely to occur if urban growth and linear consumerism continues in tandem (Sukhdev et al., 2017). Urbanization is unlikely to cease, making it our responsibility to mitigate its effects as much as possible. The Ellen MacArthur Foundation was one of the first to bring attention to urban circularity. The organization's main focusses are "designing out" waste and pollution, keeping products and materials in use at their highest value and regenerating natural systems, all of which fall under circularity's domain (Ellen MacArthur Foundation, 2017a). Current CE research tends to focus on meso-level eco-parks or micro-level manufactured

products (Pomponi & Moncaster, 2016). There is far less research on circularity in the geographical context of the city. Within the city, an even more highly uninvestigated means to achieve circularity's goals lies in the urban agriculture sector. Experimenting with urban closed-loop food and organic material systems is promising because they are rarely managed solely within city boundaries. Current inefficient urban planning strategies and policies inevitably cause urban food systems to be linear. Implementing changes to the very structure of the city and how it functions could trigger a food-based circularity breakthrough with far-reaching impacts on other urban sectors. While a completely circular urban food system is nearly impossible, investigating how far away from linearity it could go drives this research.

1.1.2 The Potential for Circular Urban Agriculture to Change the Narrative

Before directly addressing circular urban agriculture, the sector's mother-niche, urban agriculture, must be defined and contextualized. Urban agriculture, or UA, is the growing, processing, and distribution of food crops, other useful crops, or livestock within an urban area. (Mougeot & Centre, 2006). The aims of UA initiatives often involve improving human and ecosystem health, education, quality of life, social justice and local economies (Wiskerke, 2009). In the last five years, research on UA practices has increased. Golden (2013) argues that UA not only expands production opportunities, but also creates unique job prospects and improves social cohesion and development in the surrounding neighborhoods. While socially beneficial, many UA initiatives fall flat on environmental and economic aspects because they still rely on outside inputs and produce waste that could be reused within their own initiative or used somewhere else in the sector as input. In addition, traditional definitions of UA initiatives often address the micro- scale, encompassing community gardens or personal plots that do not generate revenue or have a city-wide impact. Because of this, municipalities may not be interested in investing the time or money in these smaller organizations. Restructuring UA practices to be circular and on a larger scale could ensure adequate and sustainable food production and further develop the sustainability of cities as a whole, acquiring the attention of the municipality. Circular urban agriculture, or CUA, is promising development path to consider due to the increasing popularity of local food and sustainability, especially in the densely- populated cities of Northern Europe. CUA should appeal to municipalities and farmers alike because of its ability to reduce costs through reused inputs or to add value by providing further services (e.g. wastewater treatment or soil regeneration). Even as far back as the year 2000, Mougeot stated that circular urban food systems best exemplify the benefits of city-based agriculture over traditional agriculture by creating integrated networks and efficient waste flows. Literature mainly addresses the technological requirements of CUA practices such as aquaponics and permaculture from an individual, initiative-based perspective. However, there is a gap in research about the circularity and possible connections within the larger CUA sector, leaving space for new conversation and cooperation.

1.1.3 A Case for The Hague, Netherlands

The Netherlands has been known for its forward-thinking sustainability measures like wind energy and greenhouse-centered agriculture in recent decades. The country is currently the world production leader, in tons produced per square mile, for tomatoes, cucumbers, carrots and potatoes (Viviano, 2017). However, 75% of their agricultural land is classified as" high input," meaning that a large amount of resources goes into each hectare. This

statistic is in comparison to the average of 26% in EU (European Commission, 2015). The global market motivates Dutch production with exportation rates of over 80% for these commonly-consumed vegetables. With such a large stake in the global market and the large investments put into accomplishing this ranking, it becomes economically unfeasible to only sell domestically and exclude the profitable global market using the current growing methods (Wascher & Jeurissen, 2017). Either the Dutch must export less, increase production on more land, or use currently-occupied space more efficiently. Since the Netherlands holds this high position in agricultural trade, ruling out exportation cuts, and land is limited, ruling out agricultural area expansion, increasing efficiency appears to be the only option (Wascher & Jeurissen, 2017). The Hague, being the center of peace and justice and the political capital of The Netherlands, is a wise place to test out an efficient urban food system.

The area surrounding The Hague is one of the most agriculturally-productive in the country. The municipality recently committed to a sustainability agenda that involved carbon neutrality by 2040; ten years before the national and European Union's target. The Hague goes even beyond the statement from the national Department of Agriculture, Food and Nature Quality' Energy Agenda, which aims to reduce the country's emissions by 80-95% by 2050. While still ambitious, this seems slightly more feasible (Ministry of Economic Affairs and Climate Policy, 2018). Wascher and Jeurissen (2017) argue that, by using the current greenhouse technology, the hinterlands of the city could technically feed the population of The Hague, but at the cost of five times the energy necessary to import the same amount of food from Spain. The costs of using current growing methods, even if considered "local," are concerning. The "trendy" solution would be a transition from peri-urban farms to growing in a truly urban environment in a way that reuses as many resources as possible (Van der Schans & Vos, 2010). However, the feasibility of such an assertion remains elusive. The European Commission (2015) confirms that if the Netherlands is to reach its environmental goals, it must improve the environmental sustainability of its agricultural sector. This thesis investigates the possibilities of doing so.

1.2 Research Statement

The Hague has the potential for a shorter food supply chain compared to many areas of the world due to its location. While it may be naïve to think that the city could be completely fed using urban agriculture, starting the conversation and taking the first steps toward a more local, sustainable food system are key. Closed-loop supply chains can be options to accomplish The Hague's sustainability goals. However, innovative UA enterprises are emerging around The Hague at about the same rate that others are closing down. The objectives of this thesis are to investigate the current state of CUA in The Hague, evaluate what is necessary to expand its influence and create a vision for the future that incorporates CUA practices. The Hague could potentially be an example for cities looking to close their food and resource supply chains. Before this technology can expand to other areas, it must first be evaluated on its ability to integrate with current landscape of The Hague. Both traditional UA and CUA are "niches," meaning they exist in small, semi-protected spheres away from the threats of more common-place practices. However, CUA could be considered a "niche within a niche" because it exists as a subcategory of UA. As a result of this relationship, both sectors must be overviewed to get a sense of how CUA can develop further. This study offers the chance to look closely at one innovative sector (CUA) in the context of one city (The Hague, Netherlands) and develop possible sustainable future ambitions for cities with similar profiles.

1.3 Research Questions

From online searches and networking events, the initiatives already practicing forms of CUA have been identified as UrbanFarmers, Haagse Zwam, and the Edible Parks of The Hague. This thesis will take these CUA case studies of and ask the question:

How can urban agriculture in The Hague become more circular?

This requires research into niche and sociotechnical transition literature in order to develop a framework and a methodology applicable to CUA's current state and its future potential in The Hague. To answer the main research question, several sub-questions I pose four sub-questions with their own necessary steps:

1. ***What is current state of circular urban agriculture in The Hague, Netherlands?***

   Using both interviews and a literature review method, I map and evaluate case study initiatives involved in CUA and create a conclusion about the sector's current state. In addition, using municipality data and very limited information from the CUA sector initiatives, I calculate a baseline circularity level of the CUA sector along with the other sustainability indicators from the Urban Harvest Assessment framework. Since data was widely unavailable, I also provide a model that could be used if proper data was available.

2. ***How is the idea of circular urban agriculture put in practice by the case study initiatives of The Hague and what is its potential for expansion?***

   Evaluating actor interviews, I use the Strategic Niche Management framework to assess the network formation, learning processes and expectations of the actors on the relevant levels of interest: individual initiatives, the CUA sector of The Hague, the current food regime of The Hague, and the landscape in which all the previous levels function.

3. ***What could circular urban agriculture look like in The Hague in 2050?***

   Integrating inspiration gathered during interviews with circularity experts, municipality representatives and the case studies themselves with my Industrial Ecology education, I develop a future vision for CUA in The Hague. I also include comparative calculations of the sustainability indicators presented earlier.

4. ***What are the possibilities for bringing the CUA sector further toward this future vision?***

Finally, I present a brief outline of what needs to change in order to reach this end goal. I identify drivers and barriers to CUA growth and extrapolate the takeaways as general action points. In addition, I outline short-term steps and methods that are useful in growing the CUA sector.

Chapter 2 is a literature review that answers sub-question 1 to set the scene for the analysis and development overview of CUA in The Hague. The chapter also gives an insight into CUA technologies and the current urban food system. Chapter 3 discusses the frameworks and the selection of methods used to create a unique evaluative structure. This chapter also gives an overview of the methodology and the way it will answer the remaining sub-questions. Chapter 4 begins interview analysis and answers sub-question 1. Chapter 5 evaluates the potential of the CUA niche to expand and become more mainstream, thus completing the answer of sub-question 2. Chapter 6 brings together actors' aspirations and knowledge from Industrial Ecology to create a future vision for CUA in The Hague and answer sub-question 3. Finally, Chapter 7 answers sub-question 4 and forges a basic pathway into a more sustainable future. Together, the sub-questions bring clarity to the overarching question, "how can urban agriculture in The Hague become more circular?"

2. Literature Review

2.1 Introduction

I divide the overview of the existing literature on the topic of circular urban agriculture into several parts. First, there is a summary of current UA strategies and their components. Then, there is an introduction to the concept of circularity and the circular economy. Finally, a definition and argument for circular urban agriculture is presented along with its ability to combine trends within sustainability studies.

2.2 Urban Agriculture

UA is the growing, processing and distribution of food crops, other useful crops and/or livestock within an urban area. (Mougeot, 2006). Mougeot (2000) also states that what makes UA different from traditional rural agriculture is its integration into urban economic and ecological systems. Recent literature focusses on the last two decades of urban development research and practice, including many pieces related to urban agriculture, such as "Cities Feeding People" (Mougeot, 2006), "Smart Cities and Urban Areas: Aquaponics as Innovative Urban Agriculture" (dos Santos, 2016) and "Feeding the City: The Challenge of Urban Food Planning" (Morgan, 2009), playing into the idea that UA can be a huge player in sustainable urbanization. Wascher and Jeurissen (2017) use Life Cycle Thinking to evaluate the potential of urban food supplies and their role in addressing climate change, biodiversity loss and food chain efficiencies. Several authors consider UA to be comprised of economic, ecological and social component (Cretella & Buenger, 2016; Davids & De Olde, 2014; Morgan & Sonnino, 2010; Vernay, Salcedo Rahola, & Ravesteijn, 2010) This is backed by Wielemaker and colleagues (2018), who state that UA involves methods that result in a diverse selection of plant life and integrate themselves with urban economic, social and ecological systems. The social benefits of UA also lie in providing fresh produce to urban residents to increase food security (Rhodes, 2013). Diaz-Ambrona and Maletta (2014) focus on using innovation and creative management techniques to ensure food security for a growing world population, some of which can be achieved with urban agriculture. In more recent literature, authors like Cretella and Buenger (2016) use urban agriculture in Rotterdam as an example of 'creative' politics to show its multifaceted benefits because UA targets low-income citizens as well as the upper-class. This concept is not new, but dates back to World War I when food shortages demanded supplemental production and provided a sort of community amidst war-torn times (Rhodes, 2013). In the years following, UA diminished in popularity in tandem with the rise of materialism and linear economies, only to be seriously realized again within the last ten years. The author-formulated keywords found in recent literature related to UA often include 'urban land use,' 'food security,' 'urban metabolism,' 'urbanization,' and 'resilience.'

Socioeconomic and environmental problems associated with food procurement are most evident at the municipality level, making UA an important factor in a sustainable future (Morgan & Sonnino, 2010). The UA concept is frequently divided into three levels: the micro, meso and macro level. All three scales require public and private co-ownership to be successful (Cretella & Buenger, 2016). UA is a collaborative tool because it brings together several activities, locations, scales and interests into one practice (Rosanne C Wielemaker et al., 2018). Using

urban growing, solutions and implementation strategies are born within the city limits. Literature addresses several forms of UA within these levels, from rooftop gardens to community-run garden plots (micro), to more sophisticated technologies like vertical farming and aquaponics (meso or macro). Community gardens especially have a long history of contributing to the economic, social, and environmental wellbeing of local communities, following along the path of sustainable development (Zimbler, 2001). The Netherlands is no exception, with community gardens providing food security, green space, and a calming environment for urban residents (Zimbler, 2001). These newly greened spaces also provide a place for residents to gather and feel a sense of community, either through helping with the labor, buying the locally-grown produce, or simply coming together around a common goal. UA may also serve as a form of solid waste management by using both household and vegetation waste as compost instead of landfill or incineration fodder (Drescher, Holmer, & Iaquinta, 2006). As with food systems, waste management, which is often described as the core of circularity, is most impactful at the municipal level.

Roemers (2014) writes that the barriers to implementing UA are competition for land in cities, a deficiency of legal and institutional frameworks to protect UA initiatives, a lack of spatial planning to incorporate UA and the absence of education, both in terms of awareness and skill. In addition, many believe that classifying conventional food production versus urban agriculture as an "either, or" situation will further the system's vulnerability, leading to hesitation in truly supporting UA (Feenstra, 2002). Feasible solutions will require integrating the two systems and addressing the political, economic, technological and social aspects related to them. However, there is still a long way to go until traditional agriculture and urban agriculture are on the same footing. Supporters of UA are making their mark by demanding local produce, involving themselves in local food culture, making use of available land and fighting for governmental support (Roemers, 2014). Without collaboration between grassroots supporters, UA associations, relevant government agencies, urban planners and community members, sustainable implementation of UA will be nearly impossible (Zimbler, 2001).

2.3 Urban Circularity and the Circular Economy

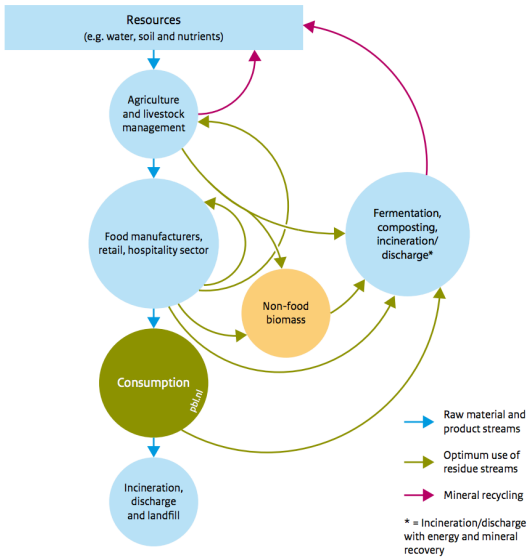
Circularity is attainable at multiple levels: the individual organization, the immediate network, the sector-wide level, the city level and even the regional or country level. Examples include using collected storm water to fill toilets (individual level), using the waste heat of one energy company to fuel the function of another energy company (sector level), and implementing an area-wide efficient composting plan to reduce the need for imported nutrients (regional level). The city is an interesting point of evaluation because of its density of prospective "traders" and the potential impact of strong city governments.

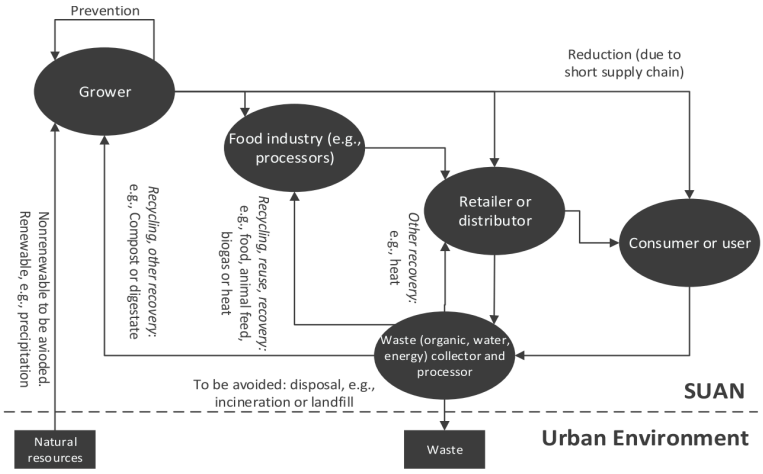
The idea of circular cities arose from the Ellen MacArthur Foundation's research on urban sustainability. The organization holds the optimistic view that changing the economy from a linear to a circular design can help mitigate the issues associated with mass urbanization. Three principles stand out as main contributors to this ideal: designing out waste and pollution, keeping products and materials in use at their highest values and regenerating natural systems (Ellen MacArthur Foundation, 2017a). The foundation also addresses elements to be included in a circular city, like a flexible and reusable built environment, a localized and renewable energy system, an accessible and affordable transit system, a value-driven and local food system and a collective and efficient production system. The societal dimension

of circularity is often seen as just as important as the design and economic dimensions. Partnerships and collaborations lead to wider engagement and openness in resource sharing and reuse (Pomponi & Moncaster, 2016). Each of these components contributes to a resilient city functioning within this new circular mindset.

2.4 Circular Urban Agriculture: Combining Sustainability Trends

Firstly, the infographics shown below show the overall flows of materials and steps necessary to achieve CUA:





Figures 1 and 2 Circular economy for the food system from Rood, Muilwijk et al., 2017; Visual created by Lange and colleagues (2017, p.3) depicting a simplified model of waste flows in a CUA network (which is referred to here as SUAN, or Symbiotic Urban Agriculture Network)

For calculations, this thesis constrains the scope of the above model to only address the reuse of nutrients grown in the system as fertilizer for the next harvest. Here, circular urban agriculture, or CUA, is the growing of food within the municipality-defined limits of a city, using initiatives that participate in a more closed-loop supply chain system. This can be accomplished by initiatives reusing their own waste as secondary inputs, donating or selling their waste to be reused as inputs for another urban agriculture initiative, or consuming the waste of another urban agriculture initiative as a primary input. Hence, there are two levels of CUA: circularity at an individual initiative level and circularity within the CUA sector manifested through material exchanges between initiatives. While circularity in the current food system regime level (such as widespread, though often inefficient, composting programs) and the regional level (using industrial waste heat for heating greenhouses) do exist, they are not

investigated directly in this thesis due to the focus on growing the city-based circular agriculture niche. In addition, this thesis focuses on the previously-described macro-level UA initiatives since they offer the greatest potential to demonstrate large-scale circularity in an economically-productive way, potentially gathering more attention from municipality, other city-based sectors, and national leaders.

CUA can provide benefits like better environmental health, reduced purchasing and waste management costs, and increased awareness regarding sustainability that cross sectoral boundaries. Using CUA, urbanites can grow some of their own food while reusing food waste to produce more vegetables, fruit, and fish, thus creating a closed loop (Ellen MacArthur Foundation, 2017a). The Ellen MacArthur Foundation adds that CUA offers financial benefits as well, reporting that every ton of food waste treated for composting reasons costs 70 euro per ton, while the average cost for disposing residual waste is 100 euro per ton. As a result of composting, nitrogen, phosphorus and potassium are returned to the cycle with a net return to the municipality. In addition, urban agriculture initiatives often convert abandoned open spaces into green areas, not only embodying the idea of circularity by reusing present resources, but by also creating a positive urban micro-climate that residents can enjoy (RUAF, n.d.). CUA initiatives can also cycle their "waste" products to keep the value embedded and alive. Hydroponics is a stellar example in which the plants grow without traditional soil matter. Conventional mainstream and urban agriculture often face challenges with water irrigation, drainage and treatment. Hydroponic growing, on the other hand, frequently involves vertical planting, with the roots directly submerged in the nutrients, gravel, sand, peat, mineral wool, or other substrates that provide them with a growing base (Lu & Grundy, 2017). This method is considered more sustainable because water and nutrients are closely monitored and applied precisely to the plants as to not produce any waste. They are also circular because these materials are also recycled to reduce excess input and waste. Hydroponics is cited to cut water use by 75%–95% (Lu & Grundy, 2017). The ability to grow local food, thus saving the hinterlands from intensive farming, alongside circular measures, is a more ecofriendly way to provide vegetables to urbanites. However, hydroponic systems are sophisticated and require technical skills and knowledge to operate and maintain. In addition, the amounts produced will likely be much lower than traditional agriculture, as the scale and experience levels are quite variable. Without the proper care, this sensitive growing method will face imbalances and severely reduced yields.

Aquaponics represents another promising example of a sustainable circular UA practice. It is a closed-loop cross of aquaculture, or growing fish, and hydroponics (dos Santos, 2016). By combining these technologies, aquaponics systems recycle the waste products of one part of the system to increase the overall sustainability of the entire system (Lu & Grundy, 2017). This technique can utilize materials and nutrients already in use, capitalizing on potential additional revenue streams (Ellen MacArthur Foundation, 2017a). The ammonia and organic matter from the aquaculture wastewater are sent into a closely-monitored hydroponic system. Nitrification of ammonia into nitrate by bacteria enables the plants to absorb the nitrogen and use it to fuel their growth. At the same time, the plants also purify the water for recirculation into the aquaculture system (Lu & Grundy, 2017). It is a beautiful example of circularity within the world of agriculture, especially related to UA, since the system can be built in a vertical fashion and takes up less space than more traditional community urban gardens. Dos Santos (2016) claims that aquaponics can be a key factor in local food production, especially when used on an urbanized scale or in partnership with short supply chain tactics. The technology can also be used in neglected industrial buildings to support urban sustainability without incurring the effects of urban sprawl (Goddek et al., 2015). While the technological aspects of aquaponics

have been researched thoroughly, the economic feasibility and large-scale commercial implementation strategies lack much supportive literature (Goddek et al., 2015). Continued experimentation is necessary to test CUA's scalability.

While some claim that these new innovative technologies are the future of CUA, others argue that we must return to natural cycles instead of high-tech methods to find answers. One of the best and oldest examples of CUA is the practice of "permaculture," which is based on the principles of ecology and working with natural processes to optimize agricultural efficiency and be completely entwined with the environment (Rhodes, 2013). Hence, it focusses on sustainability and resilience through minimized inputs that naturally occur in biology. Permaculture is more directly related to urbanization issues than aquaponics and hydroponics because it addresses interactions and unity between local ecosystems and the built environment (Vernay et al., 2010). In general, permaculturalists observe their surroundings and take note of what could work naturally within a specific situation. Structural adjustments like green roofs, edible landscaping and refurbishment of old infrastructures into gardens can all incorporate permaculture, but at its heart, it is truly about following nature's cycle of reuse.

As with other UA perspectives, CUA encompasses educational and societal components as well (Rhodes, 2013). The development of nature-inspired agriculture involves collaboration with provinces, farmers and water authorities because, at a regional level, this is the way that development translates into concrete measures (van Dam, 2017). CUA is a way to bring knowledge of the food system and the sustainability movement together. The previously-discussed practice of permaculture further supports sustainability by including regenerative agriculture, which takes sustainability a step further and revitalizes areas adversely affected by urban development in an attempt to reverse the consequences of urbanization (Vernay et al., 2010). Milder (2018) gives an in-depth report on the background of regenerative agriculture and its differences from both mainstream and organic agriculture. The latter, the difference between regenerative and organic agriculture, is less well-known. Milder describes organic agriculture as a stepping stone to regenerative agriculture because, while it does not use harmful chemicals or synthetic fertilizers, it does not mend the soil like regenerative agriculture does. Permaculture is the core of circular agriculture and is gaining traction as a city-based option for food procurement and environmental healing.

2.5 Conclusion

The different levels of UA each come with their own benefits and drawbacks. Smaller low-tech UA initiatives, like community gardens or individually-rentable farm plots, are represented more in both literature and in practice because they are more familiar and visible to residents. However, these micro or meso-levels UA projects, despite serving a worthy social purpose, sometimes lack the widespread impact that municipalities hope to see because they produce less and serve a mainly educative purpose. (Dutch Ministry of Infrastructure and the Environment & Ministry of Economic Affairs, 2016). Therefore, macro-level initiatives that practice circularity could be a solution if they are approachable and connected with surrounding neighborhoods. All levels of UA can incorporate some form of circularity, but those on a macro-level offer the greatest potential for profitability and expandability. In terms of development, CUA is an emerging "sub-niche" within the already-developing UA niche because it comprises many of the same geographical and social aspects but has its own technological and legislative requirements. In-line with these unique characteristics, CUA need an equally unique evaluative framework.

3. Framework and Methodology

Because of the urban food system's complexity and deeply-engrained structure, pieces of different frameworks in unique combinations are necessary to assess the feasibility of CUA becoming a household acronym. The analysis methods for this thesis stem from both urban metabolism studies and innovation/transition practices. Quantitative and qualitative measures are necessary to achieve a full picture of the current situation of The Hague and where it could go. These frameworks all require different sources of information, making for well-rounded and widespread knowledge development. This chapter reviews these methodologies and explains how they function within the thesis.

3.1 Urban Metabolism and the Urban Harvest Approach

First, it is imperative to remember that material metabolisms, both circular and linear, occur at several levels. Efficient supply chains function on company, sectoral, city, regional, national and even worldwide scales. In detail, this looks like:

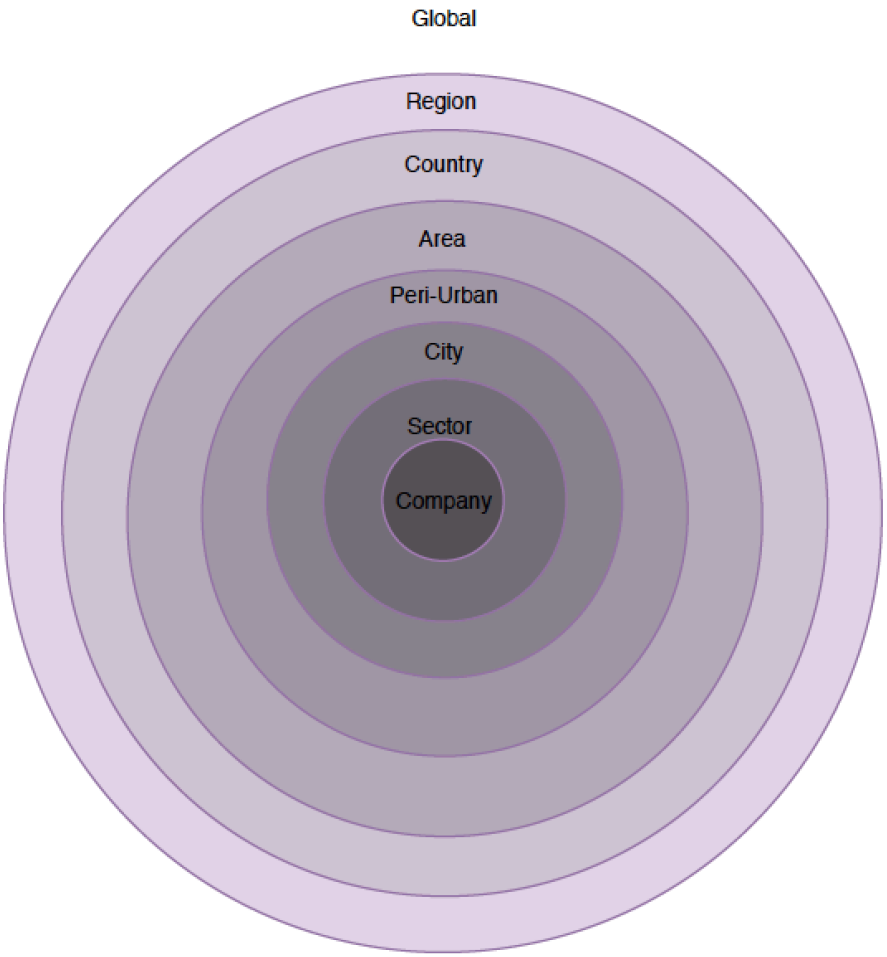


Figure 2 Possible levels for material circularity

Material metabolisms, much like biological metabolism, describe the inputs and outputs of materials to a system. In cities, seen above as the third innermost circle, metabolism flows often pertain to water, energy, and nutrients (Kennedy, Cuddihy, & Engel-Yan, 2007; Kennedy & Hoornweg, 2012; Webb et al., 2017). From this perspective, a city can be seen as an ecosystem or an organism in and of itself. An analysis of this phenomenon requires quantification of a city's inputs and outputs, along with possible stocks being held within its limits, just like nutrients and matter are stored within an organism (Kennedy & Hoornweg, 2012). Studying urban metabolism can also shed light on other sustainability issues like low groundwater tables and the urban heat island effect because they both involve some sort of city-based retention (Kennedy et al., 2007). In order to design sustainable and circular urban resource systems, it is important to understand these metabolic properties. The Urban Harvest Approach (UHA) fulfils this goal and elaborates on the social dimensions of urban resource consumption. UHA improves resource management by measuring the closing of cycles (aka practicing circularity) with innovative technology and resource reuse (Agudelo-Vera, Mels, Keesman, & Rijnaarts, 2012; Leusbrock et al., 2015; Rosanne C Wielemaker et al., 2018). UHA does this through reducing demand, minimizing output and multi-sourcing inputs. The first strategy aims to use resource inputs efficiently, while the second two strategies evaluate the possibility of harvesting resources within city limits from other material flows (Agudelo-Vera et al., 2012; Roemers, 2014). The use of these secondary resources, which are outputs from natural or human processes, become more tangible under the UHA framework. Urban systems are evaluated using several indices like Demand Minimization Index (DMI), Waste Output Index (WOI) and Self-Sufficiency Index (SSI). UHA not only calculates the efficiency of a system, but also offers insights into infrastructural connections necessary for circular cities (Agudelo-Vera et al., 2012).

Before analysis, UHA offers a baseline scenario of current demand and technology statistics (Rosanne C Wielemaker et al., 2018). This could include the input or output of energy, nutrients, or products themselves to understand the current state of urban metabolism (Agudelo-Vera et al., 2012). An important factor is ascertaining the quality of resources required for the different subsystems in order to choose the most efficient inputs (Agudelo-Vera et al., 2012). Evaluative measurements of sustainable possibilities and circularity follow. How these equations apply to the food system of The Hague is discussed in chapter 3.3.

Demand Minimization

UHA derives this first step from sustainable approaches to waste management (Agudelo-Vera et al., 2012). Current urban living demands massive quantities of resources that result in equally large outputs and stocks (Agudelo-Vera et al., 2012). Demand minimization requires either changing behavior or implementing more efficient technology to reduce baseline demands (Rosanne C Wielemaker et al., 2018). Agudelo-Vera and colleagues (2012) state that demand minimization often requires technological innovation, while Wielemaker and colleagues (2018) emphasize that both technological and behavioral changes are necessary to do so. The main targets of the Demand Minimization Index, or DMI, are activities that consume at least 10% of the current demand. The DMI equation is presented below with the note that a DMI of 0 indicates that there was no reduction of demand.

$$DMI = \frac{Baseline\ demand\ (Do) - Minimized\ demand\ (Dm)}{Baseline\ demand\ (Do)} * 100$$

Output Minimization

Output minimization is the next part of the UHA framework and is comprised of three possible strategies: cascading, recycling and recovery (Agudelo-Vera et al., 2012; Rosanne C Wielemaker et al., 2018). This is the most profound example of circularity found in the UHA framework because the system retains value. Cascading is the reuse of outputs immediately following their disposal. The quality of this "output turned input," however, is never as high as its original form. Wielemaker and colleagues (2018) state that this output should be used for a process requiring a lower quality input. Cascading is the more technical term for what most people call "recycling." Using the baseline assessment as a comparison provides researchers with information on the remaining quality that can be extracted for reuse (Agudelo-Vera et al., 2012). This phase of output minimization also requires an in-depth assessment of the quality requirements for different activities so that the remaining outputs can be matched with qualities demanded. Agudelo-Vera and colleagues (2012) cite examples like using lightly-polluted water for non-potable activities and using waste heat from industrial processes like household heating. Recycling is identified in the output minimization phase of the UHA framework as the reuse of flows after regaining some of the original quality. This often requires energy inputs and produces similar yields to the virgin product (Agudelo-Vera et al., 2012; Rosanne C Wielemaker et al., 2018). Recycling technologies should be chosen according to the local context to gain maximum results. Examples include grey water reclamation and using a heat pump to increase temperatures for an industry or household (Agudelo-Vera et al., 2012). Finally, recovery is the extraction of resources from waste flows (Agudelo-Vera et al., 2012). With regards to UHA, recovery alludes to the extraction of actual products from one flow that could be inserted into another. Examples include the recovery of nutrients or heat from wastewater that are reused in fertilizer or industrial processes, respectively (Agudelo-Vera et al., 2012).

The Waste Output Index (WOI) is a measure of waste sent out of a system. This can be helpful for individual companies and sectors alike to see where the most waste comes from in their systems. A WOI of -1 represents the traditional linear metabolism structure. The closer to zero the WOI, the less waste is leaving the system and the more circular it is. The WOI is calculated as:

$$WOI = -\frac{Waste\ exported\ (We)}{Demand\ (D)}$$

Multi-sourcing

Multi-sourcing is the last step of the UHA formula and is the harvesting of resources from primarily local producers in a well-distributed manner (Rosanne C Wielemaker et al., 2018). Ideally, these local products would also be produced sustainably (Agudelo-Vera et al., 2012). As Agudelo-Vera and colleagues (2012) argue, the feasibility of using completely circular systems relies on temporal availability, spatial needs, impacts on other flows and acceptance from residents and the municipality. City life is notoriously unpredictable, so claiming to achieve full circularity with any

certainty is doubtful and requires external procurement. To fulfil the rest of the demand, it is ideal to source from as many sustainable sources possible. These producers should be varied as to not "put all eggs in one basket" in case of system failure.

Self-Sustaining Index

Resources collected from cascading, recycling, recovering and multi-sourcing can either be sent to another system or reintroduced into the same system. The ultimate goal is, of course, to keep as many resources in the system because this reduces input demand. The SSI is used to measure the portion of input demand represented by recovered. The SSI equation is:

$$SSI = \frac{Resource\ reused\ (Rr)}{Demand\ (D)} * 100$$

A completely circular system would have an SSI of 100. While this is extremely rare, the higher the SSI, the more circular and sustainable the system (Rosanne C Wielemaker et al., 2018). Recovery within the output minimization phase improves the SSI most because materials are reused and help increase self-production (Agudelo-Vera et al., 2012). When taken together, the elements of the UHA framework create a picture of urban circularity. UHA can be applied on the individual initiative level, the sector level or the city level, making it a flexible and useful tool for municipalities. However, it is most relevant at the city level as demand is guaranteed to increase in future decades.

3.2 Innovation and Transition Frameworks

The frameworks of Strategic Niche Management and Backcasting address niche-to-regime expansion and future vision creation, which encompasses a scenario where the marginal niche technology becomes more a way of life. SNM and Backcasting are often used in tandem, connecting the expectations of the actors (SNM) with their ambitions (Backcasting) to shed light on where the gaps lie.

3.2.1 Strategic Niche Management

As mentioned, niches are protected spaces, or "incubation rooms," in which innovations can safely develop (Rip & Kemp, 1998 as cited by Smith, 2007). Niches lie on the outskirts of the regime, or the common way of doing things, and provide a space for new ideas and practices (Geels, 2002; Smith, 2007; van Eijck & Romijn, 2008). Due to their often radical and experimental nature, niches cannot compete with already developed markets or well-known technologies. Niches typically evolve from needs that are not being met by regime practices. Typically, those involved in the niche already have a vision of what the technology could bring to the market to fill this gap (Geels, 2002).

Niches also provide a haven for learning processes and social network formation because they are often made up of small businesses or innovation centers that are willing to experiment and work together toward their common passions (Geels, 2002). On the other hand, larger organizations typically do not support niches because they could alter already-existing markets and create competition. Governments and concerned citizens must take an interest in protecting niches from these larger organizations and the current market. Protection can come in the form of subsidies, funding for experimental projects using the innovation and preferential treatment for users (Raven, 2005). Innovations can then grow with fewer boundaries and, if developed correctly, can influence markets, user preferences, policies, institutions and behaviors (Geels, 2002). When external forces like behavior or opinions change in response, it is said that the landscape surrounding the regime is adjusting to the evolving regime.

Simply assessing the niche, regime and landscape of a system is not enough to make impactful changes to existing unsustainable practices. Landscape shifts like cultural changes, demographic trends and political upheavals have a trickle-down effect on the regime and ultimately on the niche technology as well (Geels, 2002). The niche migrates slowly upwards toward the regime level through these small openings caused by landscape instability using the supportive inertia provided by niche allies. The chaotic state of the regime gives the niche an opportunity to link its common elements together and stabilize its innovative structure. Through this, the niche gains even more strength and the momentum toward market presence increases. Eventually, the niche, which found its way in using landscape influences, creates a tension within the regime. If successful, the new configuration will shake the status quo and enter the market, changing the original sociotechnical regime from the inside-out (Geels, 2002). Although seemingly complicated, Strategic Niche Management, or SNM, can provide a clear roadmap through these transition levels and communicate the possibility of a technology to break through.

SNM is a common framework for assessing the feasibility of innovation integration into daily systems. Its success is determined by the expectations of the actors, the networks in which they are connected, and the learning processes that arise from implementation. SNM facilitates the diffusion of new technologies and gauges the success rates of such transitions. The official definition of SNM comes from Rip and Kemp (1998), which is mentioned in almost all SNM-related publications, state that the methodology is the 'creation, development, and phase-out' of protected spaces for the development of promising technologies to learn about their desirability and scalability. In other words, the framework investigates the movement of an innovation from the niche phase to the regime phase. SNM can be useful as both a policy tool model by steering and managing technological changes and a research model by explaining the process of SNM and understanding the necessary technological changes. The former mainly introduces the innovative technology to an audience not yet acquainted with it and for whom there is no market. The policy tool model is mainly about learning rather than defining a destination and articulating pathways (Raven, 2005). On the other hand, the research framework model investigates the *how* and *why* of innovation and can be used to formulate policy suggestions related to the technology. Taken together, SNM as a policy tool and a research framework evaluates all sides of innovation transitions: the *how,* the *why* and the *what now?* This thesis considers SNM as serving both purposes and is further supported by incorporating backcasting later on.

As mentioned before, friction or uncertainties within a regime, caused by landscape changes, can allow a gateway for the niche technologies to break through. These new alternatives can then attract a wider interest, which

was previously engaged with the mainstream regime, and expands their grasp on society (Smith, 2007). Innovative technologies will be successful when they capitalize on the state of broken regimes using three processes that interact and examine the possibility of successful dissemination (van der Laak, Raven, & Verbong, 2007; van Eijck & Romijn, 2008). They are:

1. Network formation: Interconnections between actors with a stake in the niche should take place. These actors include developers of the new technology, users, local governments and organizations concerned with its success. Information on the technology itself, user preferences, levels of acceptance, economics, alignment and governance are also established in this phase.
2. Learning: Learning among actors helps avoid uncertainties about niche development and allows for questioning of initial perspectives. Learning occurs at every stage of the development process, from initial market protection, to expansion and to embeddedness in society. Effectual learning supports expansion of the technology within society.
3. Voicing Expectations: Each actor has different expectations for the niche's development process and outcome. Shared expectations have the potential to attract further support and create a secure foundation for the innovative technology. Expectations also contribute to the development of future visions. By converging on a "view-of-best-fit," maximum satisfaction can be met to ensure a successful integration into society.

The goal of SNM is to not only develop new technologies, but to do so using real-life social experiments (Hoogma, 2002). This often leads to co-creation, using both the expertise of users and stakeholders to form a base for the niche and its potential. Each of the previously-mentioned processes can occur regarding the niche, the regime, or the landscape. In other words, to see the full potential of a niche technology, assessments of networks, learning lessons and expectations at each relevant structural level is necessary. Without assessing the entire context surrounding the niche, co-creation would fall flat. Van Eijck and Romijn (2008) explain the potential outcomes of co-creation as well as elaborate on the SNM steps components mentioned above. These are:

1. The elaboration of changes in technology and institutional frameworks in order to ensure *economic success* of the new innovative technologies;
2. Creation of technical, economic and environmental *learning processes* in order to determine social preferences related to the innovation;
3. Encouraging further development of the new innovation where cost efficiency, mass production, complementary technologies and social organization are necessary to further *diffuse the innovation, and;*
4. Building a *network of actors*, including firms, researchers, and public authorities that are integrated and necessary to expand the innovation.

The processes mentioned above are necessary in order to reach these goals. No matter the author, network formation, learning and voicing expectations are the core concepts of SNM and will now be expanded upon.

Network Formation

A balanced network is one that includes producers, users, policymakers and social organizations that have an interest in the innovation at hand (Raven, 2005). In the beginning, the network is smaller due to the just-emerging state of the technology. Developers and a small group of users may be the only ones participating. Larger organizations may not even be aware of the innovation or may be opposed to it on the basis of future competition (Raven, 2005). Actors on the edge of the network may show limited commitment to the niche because they do not see the benefits of becoming involved yet. At the niche stage, actors' specific roles in the network are also vague, adding an unstable network scenario to the list of discouragements (Raven, 2005). As the niche gains traction from its loyal followers, however, the network expands along with it in both size and in trust. Actors now have more experience with the niche technology, their specific roles are clearer, and the network slowly becomes more stable as a result.

Ingram (2018) describes networks as "niche knowledge systems" comprised of people with the responsibility of fostering innovations. She writes that these networks can include actors with similar sets of practices, ways of learning, support systems, or beliefs. Leising and colleagues (2018) agree by stating that network connections are both technological and social by nature. Their article also stresses the uniqueness of supply chain-specific networks, which are formed around actors, resources and the activities necessary to exchange or create these resources (Leising, Quist, & Bocken, 2018). Furthermore, Leising and colleagues (2018) take inspiration from Barratt (2004) and address the cultural, collaborative and strategic components necessary when developing the networks of supply chain-related niches like those involved in urban circularity. Cultural elements include aspects like trust between users as that is an integral part of an innovation network (Leising et al., 2018). Besides providing useful information on the innovation, users can also be helpful in the innovation process itself (Hoogma, 2000). Hoogma (2000) also adds to Barrat's argument and recognizes that even non-users are important to network formation and, ultimately, to niche transition because the innovation will inevitably affect society. Collaborative elements, like activities between and within organizations, are also key to forming a network because networks function best with efficient communication and cooperation. Circular initiatives require an entirely new model of collaboration to succeed because they depend on the exchange of materials (Leising et al., 2018). Finally, strategic elements require organizational and institutional support to work in a specific setting.

Networks cannot be made blindly. Composition of the network is important to the successful development of the niche (Hoogma, 2000). Again, Hoogma (2000) explains that the radicalness of a specific niche's development is related to the number of actors involved in the network that are disconnected from the current regime. He also discusses the perils of an unbalanced network. Too many large firms, while having the resources necessary to support the innovation, may have lasting ties with the current regime and limit niche development. To avoid foul play, it is important that the network include new firms that do not have any ties with the current regime. However, Hoogma also addresses the other end of the scale by stating that too many new firms might limit access to necessary resources and cut niche development short. The balanced involvement of users, both industrial and commercial, is crucial to a healthy network.

The alignment of actors' activities within the network also determines the outcome of niche development (Raven, 2005). This is tied to expectation convergence mentioned later in the SNM framework. Actor alignment is the sameness of actors' strategies, expectations, beliefs, practices and visions (Raven, 2005). Established firms, those mentioned earlier to have adequate resources but perhaps insincere concern for the problem at hand, will have different ideas about the innovation than the newer firms. Hoogma (2000) explains that established firms focus on *improving* technologies than *replacing* technologies, whereas new firms think oppositely. A balanced network with a stable and proactive alignment takes effort and does not arise naturally (Raven, 2005). Generally, higher alignment, meaning more parallel beliefs and practices, leads to further-reaching niche development. As the network grows, the goal is to grow in trust and effective communication as well to ensure a smooth transition into the regime levels

Learning

Learning is perhaps the most important part of an innovation transition because it secures a pathway toward niche diffusion and development (van der Laak et al., 2007). Experiments within a niche and the knowledge that arises should produce results that improve the feasibility of regime embeddedness (Raven, 2005). Learning also improves previously-mentioned network alignment because broader support of the innovation develops with increased knowledge. The structure of niches allows the time and knowledge development necessary to mature the alternative sociotechnical practice. These learning lessons are first generated and then dispersed, leading to niche development (Smith, 2007). Hoogma and colleagues (2002) discuss focus points for actors' learning. They are:

1. **Technical development and infrastructure**, including design aspects and complementary technological needs;
2. **User and market contexts**, including characteristics and meaning attached to the innovation. Actors should also learn about the barriers that users face when participating in the innovation;
3. **Societal and environmental impacts**, including safety, fairness, community development, energy use and/or emissions that arise from the innovation;
4. **Industrial development**, including learning about sector development, production and maintenance processes used now or that are necessary for innovation expansion;
5. **Government, policy and regulatory frameworks**, including legislation, policy, and/or incentives that are used or could stimulate expansion.

Smith (2007) supports these focus point by arguing that learning not only happens regarding the more technical aspects of the innovation, but also occurs within the user context or market. This can encompass learning about the meanings users give the niche, its economic performance, the barriers to success, institutional or policy changes necessary to foster growth and what actually qualifies as successful niche growth (Smith, 2007). Hoogma and colleagues (2005) include the aforementioned focus points in this later work, but also add organizational development. This category speaks to learning about organizational aspects like leadership requirements, technologies, or network dynamics that assist in niche development.

Several authors distinguish between what are called first-order and second-order learning processes that help move toward niche expansion. First-order learning is the innovation's effectiveness in achieving a certain goal within

a set of underlying norms. It is helpful when verifying pre-defined goals of actors and relies upon the immediately visible features of the practice (Smith, 2007). Raven (2005) describes this type of learning as the way in which the niche adjusts to user demands which are already in place and oriented toward a specific goal. In this way, first-order learning is a unidirectional process. Examples of first-order learning are realizing how to improve a design, discovering which features of a product are acceptable to users and finding a way of creating policy incentives that would further niche adoption (Hoogma, Kemp, Schot, & Truffer, 2002) Second-order learning, on the other hand, questions the underlying and often stagnant norms with the aim of cooperating toward an ever-developing goal. It takes a step back and requires deeper reflections about the core practice at hand (Smith, 2007). Again, Raven (2005) describes second-order learning as adjusting both the technology itself and the user demands. Consumers can openly communicate preferences to the niche, which, in turn, makes crucial adjustments to win over the market. The second-order learning process can also be called higher-order learning because of its multidirectional and complex nature. Higher order learning often leads to a better chance of the technological niche evolving into a regime (Raven, 2005). Examples of second-order learning are new ideas for problem-solving and how users would be integrated into the system (Hoogma et al., 2002). The concept of first and second-order learning is rather abstract, so Hoogma provides a concrete example using the car industry (Hoogma, 2000). In first-order learning, customers simply provide information about product's *functioning* to the manufacturers, who then learn how to improve the product. Second-order learning also involves users, but they communicate their *needs* from the product itself to the manufacturers, giving them information about how to better satisfy their customers. As a result, manufacturers learn about the in-depth functions related to their product. It is necessary to identify if learning, both first and second-order, has occurred within a niche.

The categorizations mentioned above are tools for describing learning processes rather than assessing the quality. Leising and colleagues (2018) venture into this realm. Citing Brown and colleagues (2003) and Brown and Vergragt (2008), they describe ways to identify if and how well actors are learning. Quality-driven indicators are especially helpful for assessing the level of second-order learning that occurs because evaluators can almost "see the wheels turning" in the minds of the actors. Effective learning takes place if:

1. There has been a shift in problem-framing
2. There has been a shift in the priorities of the problem or the way in which it is solved
3. There appears to be joint learning and experiences among the actors

Voicing Expectations

New technologies, like those in the niche phase, depend on actors' positive expectations to jumpstart their expansion. Promises of success provide incentives to invest time and effort into the innovation (Raven, 2005). Actors have a wide range of expectations at the beginning of the transition period because of limited communication and little to no goal convergence. Each deviating expectation may affect the innovation process, creating chaos in actors' efforts to expand the niche. However, after experiments or inter-actor conversations, expectations begin to converge toward a secure map for the future. When actors share their promises and goals, they become part of the innovation agenda. This agenda is the starting point for transformation as the expectations become set tasks for each actor to pursue. Hoogma

(2000) characterizes three ways in which expectations can change through studying the innovation more in-depth. They are:

1. Expectations can become more *robust* when a certain expectation gains traction among more actors. The expectation then becomes more stable due to the increased number and diversity of actors that agree upon it;
2. Expectations can gain *quality* when there is more support for them or proof of success. This can come from experiments, publications, or expert discussions;
3. Expectations can become more *specific* through the definition of succinct steps necessary to develop the technology in a way that meets these expectations.

Berkhout (2006) writes that actors align themselves to expectations with their own interests in mind. Stable regimes often boast common outlooks, while those under pressure or just developing will have a variety of expectations. No single actor can determine the direction of convergence, so voicing expectations helps actors come to a common vision that will lead the system into the future.

The premise of SNM is to highlight the interactions between network formation, learning and voicing of expectations. Knowing who is in the network and gathering their expectations is worthless without evaluating their development processes. Likewise, gaining access to learning experiences and goals for the niche technology is not effective if the full network is a mystery. Leaving one of these steps out undoubtedly hampers niche development because they all work together. In addition, the success of the new technology also relies on developments within the larger regime and sociotechnical landscape (Geels, 2002). This echoes back to the idea of niche embeddedness within a larger system. Changes at the landscape level could impact the regime and create an opening for the new technologies, while a strong landscape will prevent the niche from expanding (Geels, 2002; Smith, 2007). Without system-level interaction and cooperation, any kind of transition would simply fall flat.

3.2.2 Backcasting

Analysts and engaged stakeholders widely apply backcasting to generate future visions. Backcasting is the act of creating one or multiple goal(s) and looking back from the desired future to create steps and pathways to get there (Neuvonen et al., 2014). Visions are related to expectations in the fact that they both communicate future possibilities and expectations can inspire the future vision. However, they are different in a few ways. First, expectations describe what actors think will actually happen, while visions often incorporate components that actors might not necessarily believe will happen in full (Berkhout, 2006). Second, visions have objectives (qualitative or quantitative goals), orders (relationships to achieve these objectives) and technologies (means to achieve these objectives), making vision more "story-like" than statement-focused expectations (Berkhout, 2006). Finally, visions are said to be moralized while expectations are more factual (Berkhout, 2006). The story depends on the opinions and views of the researcher rather than the reality of the situation. However, researchers can use SNM and backcasting together because the steps of SNM, especially voicing expectations, offer support for future visions. Raven (2005) explains that expectations are often seen as promises that influence system design. Stakeholders can share these expectations or promises which become integrated into the agenda for the innovation and meld with visions as new projects and tasks take shape

within the agenda. In other words, visions justify the practices while expectations guide them (Raven, 2005). While Leising and colleagues (2018) emphasize that guiding future visions using SNM expectations can provide direction to niche expansion, backcasting visions also require the creativity of the researcher to evaluate current situations and imagine positive changes. Neuvonen and colleagues (2014) state that backcasting's normative approach to creating future scenarios, rather than just simple descriptions used in other visioning methods, is the method's defining factor. However, backcasting scenarios cannot be seen as definitive projections of the future. Instead, backcasting develops promising endpoints and potential pathways that give the vision structure. Backcasting encompasses five steps: strategic problem orientation toward a common goal, developing future visions that incorporate this common goal, the actual backcasting analysis, elaborating on these future visions and making a follow-up plan and encouraging the agenda of this plan (Bourque, 2000; Quist, 2016; Robinson et al., 2011). The move from step one to step two (problem orientation to vision development) is where expectations from SNM can connect with backcasting. Steps three through five involve in-depth investigation of the technology and teamwork amongst actors. These are the steps where backcasting can have its greatest impact because tangible plans and pathways are presented, pursued and monitored for maximum efficiency. While each step has its own individual value, all five steps used together can create a clear and concise pathway to reaching systemic changes. In order to perform the backcasting steps, Quist and Vergragt (2006) describe four tools. These are:

1. *Participatory tools* to involve stakeholders in the vision-creating process and steer them towards cooperation;
2. *Design tools* to create the actual vision itself and its feasibility;
3. *Analytical tools* to guide assessments of the vision and related aspects like drivers and barriers;
4. *Management, coordination and communication tools* to direct the organizational or network changes that occur through the backcasting process.

Visions can map the possibilities for innovations, act as a way to define problems in the current system and generate a framework for monitoring progress toward the set goals (Berkhout, 2006). Vergragt and Quist (2011) state that backcasting is useful when dealing with sustainability issues because the framework accounts for their complex and uncertain nature. In an earlier paper, Quist and Vergragt (2006) also outline compliance criteria for sustainability visions, which include that the vision should involve a wide range of stakeholder opinions from both sides of the supply chain and that they should also incorporate the economic and social factors associated with sustainability issues. In this way, vision creation is more of a systems approach because all of these components work together in real-life scenarios.

Leising and colleagues (2018) also create a ways to analyze future visions built on the work of of Quist (2007) and van der Helm (2009). They are:

1. **Vision image**: Using metaphors and explicit descriptions (words and images) when describing the vision;
2. **Vision guidance**: Identifying collective goals with new rules and leadership potential;
3. **Vision orientation**: Setting the vision's direction in-line with the motivations and inspirations of the group.

The backcasting methodology can be target-oriented, pathway-oriented, or action-oriented depending on the system in question. The common thread between them is the making of visions, which requires knowing 'where to go' and 'what to do.' Target-oriented backcasting focusses on more normative goals of *what* can change. Pathway-

oriented backcasting addresses *how* these changes can actually occur through non-technical activities such as policies and behavioral changes (Neuvonen et al., 2014). Finally, action-oriented backcasting considers the aspects of the previous two methodologies and adds the *who* component by identifying stakeholders necessary to complete the future vision. Overall, the most important aspect of backcasting is the creation of future visions that fulfill the goals of the system.

3.3 Unique Integrated Framework

The methods for this thesis consist of quantitative elements (material flows) and qualitative analytical elements (SNM, Backcasting). Together, they evaluate the current state of the CUA sector and its possibilities for the future. The Hague has varying types and scales of UA initiatives. However, only the largescale and business-driven ones meet the macro-level requirements of this thesis. The ultimate goal of this research is to determine how urban agriculture in The Hague can become more circular. In order to do this, the current state of CUA must be assessed as a baseline for comparison, the possibilities for expansion into a regime realm must be assessed and a future vision must be established along with drivers, barriers and suggested short-term actions. This section is divided into four parts: the conceptual framework, the selection of the case studies and data collection, the methodology and the planning strategy for the thesis itself.

The conceptual framework combines qualitative SNM and backcasting with quantitative material flows and the principles of UHA. SNM concentrates on the formation of networks, learning processes, and voicing expectations for the niche. Together, these elements lead to niches developing their own distinctive knowledge systems and moving one step closer to a regime (Smith, 2007). The SNM method is relevant for evaluating CUA's development in The Hague because the niche is close to an experimental phase but has the opportunity to influence the well-engrained food regime. Backcasting involves taking stakeholders' explicit aspirations into account and forming a vision to which all actors can ascribe. In addition, backcasting expands upon the findings of SNM to move the most visionary expectations from ponderings to possibilities. While these frameworks can sometimes involve quantitative measures, they often only address qualitative and social aspects of the niche. Measuring physical material flows, like is done in UHA, is the core of closing systems. Therefore, calculating flows of materials in a way that assesses circularity fills the quantitative measurement gap within SNM and Backcasting. While the preceding literature review describes these methodologies in full, their implementation and the relations between them will now be explained.

Without assessing the current supply chain network (UHA) and addressing its potential for expansion (SNM), it is impossible to create feasible future visions (Backcasting). Actor expectations would not be communicated clearly or translated into visions without a strong network, as actors could potentially miss opportunities for interconnection and leave out valuable information from these future visions. In addition, quantifying the current level of circularity using material flows gives a starting place from which to base these future visions. Finally, without the use of Backcasting specifically for vision formation, these future visions would have no clout and would simply die along with the network formed during SNM and data collected during UHA. There would be no tangible outcome from the analysis and no way of moving forward.

Besides the trio of integrated frameworks, the truly unique aspect of this integrated framework is the use of level-oriented evaluation. As discussed, CUA exists in a system composed of individual initiatives, the CUA sector, the current food system regime and the sociotechnical landscape in which they all exist and interact. With regard to the landscape, I define it as outside forces or socially-derived behaviors that can influence the food regime but are not directly related. The case studies are not alone in their knowledge of these system components and interactions. There are also groups of actors that sit on the edges of the supply chain with social, political, or economic stakes in CUA. All aspects of niche management and vision formation cannot be fully recognized by one "interview group" because of their different roles and experiences with the system. Therefore, "external" actors that still have a stake in the success of CUA also contribute to this thesis. These more external actors, like municipality representative and circularity experts, contribute mainly to answering sub-questions 1 and 3.

For the material flows, data is only available through literature sparse municipal data. There is no data available from the case studies themselves. Therefore, the measurement of UHA elements is presented only on the sector and city scales. The individual and sector scales are also used for the "network formation" element of SNM. Learning, especially the all-important second order learning, addresses these two levels as well because actors have to learn about their own initiatives and the entire sector to assist in the transition. Expectations, however, are applicable at all levels because in order for a system to change, actors must ponder on system-wide goals. In other words, actors have opinions on what they think "will" happen in their individual initiatives, the CUA sector, the overarching regime and the landscape of The Hague. By giving the framework this flexibility, each actor, no matter their level of direct impact, can contribute to the data. This process is depicted below. The black outlined boxes represent where that sub-questions will be answered.

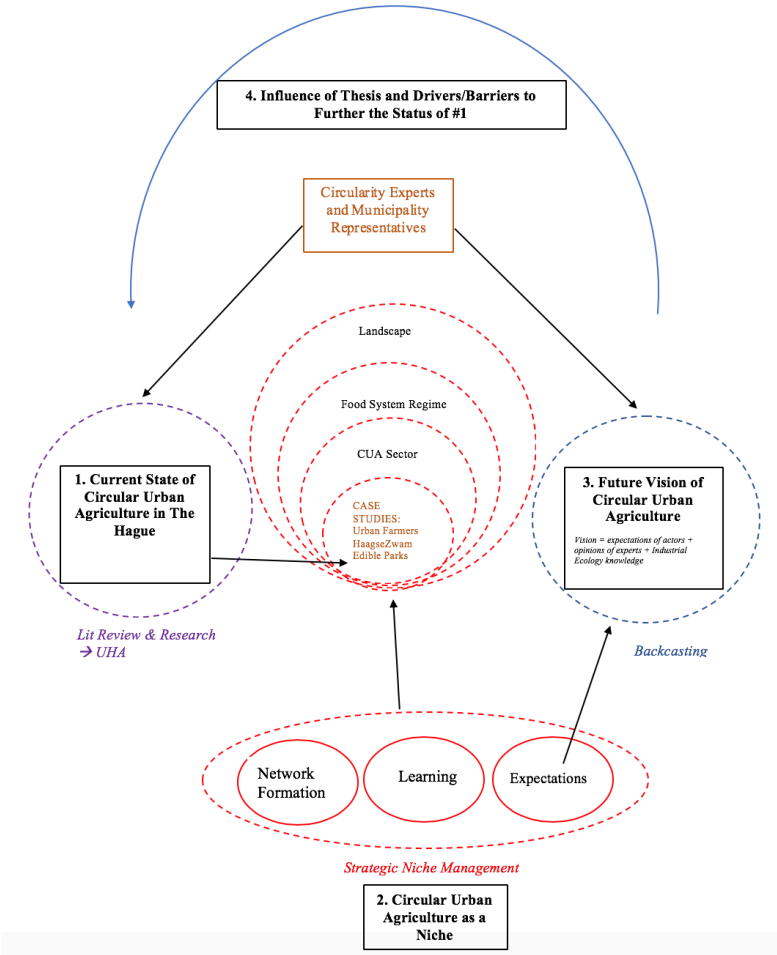


Figure 3 Conceptual framework of this thesis

By studying material flow, niche management and vision formation components in the context of CUA in The Hague, a new sustainable is visible for this burgeoning sector. The next subchapter explains the specific indicators used in this unique integrated framework.

3.3.1 Urban Harvest Approach for CUA

All aspects of the UHA framework apply to CUA except multi-sourcing. Multi-sourcing is an unavoidable part of an urban food system because all products cannot come from one farm. Therefore, multi-sourcing is not mentioned for the CUA sector and is more relevant for other sectors.

The original plan was to gather data on each case study and the sector at-large to calculate the UHA elements related to CUA in The Hague. However, due to several factors like a case study going bankrupt, thesis timing and lack of data from case studies, I was unable to map the exact stocks and flows of materials within both the individual initiatives and the sector itself. However, I do create a model for future research that describes what is possible with adequate data. As a rough example, I calculate the baseline demand for fruit and vegetables in The Hague using municipality data and other publication specific to the Netherlands or The Hague. This is the baseline demand from which I calculate the Waste Output Index (WOI) and the Self-Sustaining Index (SSI) for produce on a city-wide level for 2018. Residents of The Hague either consume or “waste” all of this produce demand. From the latter arises either a missed opportunity (food waste goes unseparated into municipality trash) or an embraced potential (food waste is

separated into GFT, or which stands for the Dutch translation of "vegetable, fruit and garden waste"), making UHA calculations that much more complex and interesting. Then, using literature, other case studies related to future visions of urban agriculture and assumptions of future trends, I calculate the potential changes in WOI and SSI for the food system of The Hague, along with the DMI (Demand Minimization Index) for imported produce against current levels. These calculations show the impact of population growth and consumption patterns in addition to the effect that CUA could have on imported food demand. Together, the indicators create a strong deliverable that should appeal to the municipality as a way forward into a circular future.

In the case of the SSI for the CUA sector, I focus on the amount of nutrient matter from food waste that could be kept in The Hague's system. SSI is the ultimate test of circularity because it represents the physical amount of material being reused in a system. A perfectly circular system would have an SSI of +1. However, for anything that is physical consumed, like food, this is impossible because not everything can be reused. In this case, getting as close as possible to +1 for all food and organic matter that is *not* consumed is the goal.

3.3.2 SNM of CUA

As mentioned, I assess the components of SNM in a multi-level, tiered manner. The ultimate goal is for networks, learning opportunities and expectations to form not just between supply chain actors and their immediate networks, but among different initiatives and all entities with a stake in the fight for a sustainable city. It is important to mention that different actors are not able to address every assessment level or category within the framework. For example, a municipality representative might not know about the network dynamics of the CUA organizations but might be aware of the dynamics *between* organizations and the local government because of policies or previous conversations. Likewise, an individual initiative might have several expectations regarding the social impacts of CUA but might have no expectations for policy because they are unaware of current municipal plans. The actors are sometimes referenced as belonging to "groups" for ease of organization, namely the "Relevant Actor Group" (circularity experts, municipality representatives, landscape designers, urban planners, etc.) and the "Supply Chain Group" (the case studies). Despite their apparent separation, they both contribute to each part of the framework, especially vision-making. The main function of the Relevant Actors Group is to provide insights when mapping the broader niche of UA in The Hague and offer advice when forming the future visions for CUA. On the other hand, the Supply Chain Group will go through the processes of SNM more intensely due to their first-hand experience and help prove the existence of the CUA niche itself and understand the adaptations necessary for a more localized, circular and urban-driven food system. Getting this wide range of perspectives regarding ambitions creates more interesting and well-rounded results.

Network Formation

Both actor groups have a stake in CUA's success and are integral in defining the networks associated with the sector. Network formation is assessed at both the individual CUA initiative level and the CUA sector level. In addition to

naming those involved, descriptive indicators assess the quality of interactions within the network. Each descriptive indicator applies to both of the two levels:

Table 1 Indicators for Network Formation as inspired by Leising et al., 2018

Indicator	Description
CASE STUDY LEVEL	
Network Composition	Completeness of inclusion; the success or lack of participation of desired actors in the network of the CUA case study
Network Interaction	How and to what degree supply chain actors are communicating with the CUA case study; collaboration
Network Dynamics	Whether or not the network of the CUA case study has grown in size or level of trust; the attitudes represented by the initiative or its actors; how the network is organized
CUA SECTOR LEVEL	
Network Composition	Completeness of inclusion; the success or lack of participation of desired actors in the larger CUA sector
Network Interaction	How and to what degree actors in the CUA sector are communicating; collaboration
Network Dynamics	Whether or not the CUA sector network has grown in size or in level of trust; the attitudes represented in the sector; how the network is organized

Each network element is equally imported and thus has its own section for clear and in-depth assessment. Describing and evaluating networks can influence the alignment of stakeholders' goals and regular interactions between the actors (van der Laak et al., 2007). Positive dynamics are built on collaboration and trust within the initiative-based and sector-wide networks.

Learning

Each CUA case study is in itself an experiment trying to test the limits of both urban agriculture and closed-loop supply chains. For this reason, there is a substantial amount of higher-order learning that occurs in each initiative through its constant need for innovation and change. Like network formation, learning applies to both the individual level and the CUA sector level. Hoogma and colleagues (2002) distinguish learning into six characteristics that evaluate learning in the individual CUA case studies and the broader CUA sector: **technological development and infrastructure; development of user and market contexts; economics and environmental aspects; social components; industrial development and governmental policies;** and **regulatory frameworks**. These elements serve as a "checklist" for what has already been learned on both levels. However, they are also more descriptive in nature and only signal first-order learning. In response, I incorporate the "problem shifts" element to distinguish low-order learning from high-order learning, which is the key driver of niche transitions. In other words, low-order learning is a "tool" used to correct a problem without adapting norms and values, while high-order learning is an overarching "theory" that corrects the problem from within by either changing its definition or searching for new approaches to solve the problem (Brown & Vergragt, 2008). Second-order learning can occur in both levels, but for individual initiatives, the problem shifting and solving occurs before they start; the CUA initiative is a result of second-order learning. On the sector level, second-order learning is a result of building, experimenting and failing

within the CUA sector (Brown et al., 2003). Incorporating both levels of learning gives a well-rounded view of the state of CUA.

Expectations

Expectations go beyond the realm of network formation and learning by contemplating all levels of The Hague's food system: individual organizations, the CUA niche sector, the current food regime and the landscape in which they all operate. Expectations give a backbone to the CUA niche's movement toward a more widespread, regime-reaching sector. As with the other SNM characteristics, expectations must also be categorized descriptively for organizational purposes. In this case, I use the PESTEL categorization method, which appears in several SNM-based studies, to create a checklist for expectation topics. Expectations can apply to **P**olitical, **E**conomic; **S**ocial; **T**echnological; **E**nvironmental; and **L**egislative elements of the future. Because CUA relies strongly on good organization, cooperation and leadership, I also include **O**rganizational/**S**tructural expectations. Again, expectations are first divided by application level and then assigned a field label. Overlaps, gaps and disagreements in what actors "think" will happen versus what they "want" to happen become clear when these expectations are taken into account alongside vision creation, which is the next step.

3.3.3 Future Visions for the CUA Sector

This thesis involves the second step of participatory backcasting which explicitly develops future visions (Quist et al., 2011). While the original goal of this thesis was to also define specific pathways necessary to get to this final vision, it is no longer possible due to time and resource limitations. However, to help answer sub-question 4, chapter 6 addresses some possible short-term steps along with drivers and barriers to incorporate more of a true backcasting analysis. While these steps do not a fully flesh out a plan for vision accomplishment, the future vision itself provides the groundwork for pathway development and future research. The other stages of participatory backcasting are not strictly addressed in this thesis. The first, 'strategic problem orientation' already results from the voicing of expectations in SNM. These expectations can guide the vision, especially when these expectations are somewhat in-line with the vision itself. However, they can also be in direct opposition, making the future of the niche more uncertain and intriguing. The fourth and fifth stages of backcasting, which involve creating and completing a follow-up agenda, are beyond the scope of this thesis but could be grounds for future research.

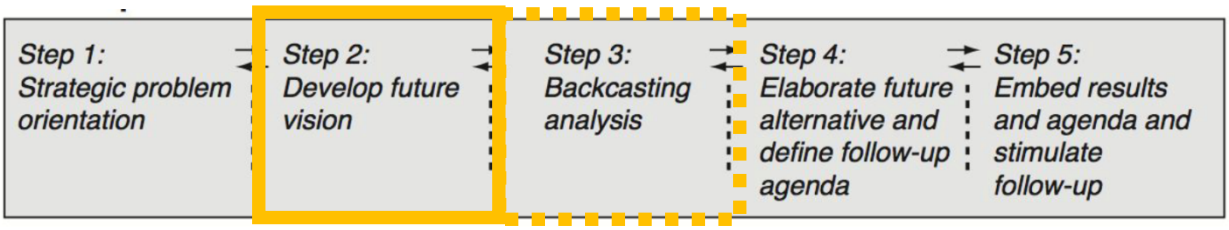


Figure 4 Backcasting from Bourque (2000). The steps used in this thesis is highlighted. The future vision fully incorporates "Step 2" (solid line), while the short-term steps partially cover "Step 3" (dashed line).

The future vision, defined here as the expanded state of CUA in 2050, takes inspiration from interviews as well as my own knowledge of the Industrial Ecology field. Overlapping expectations between actors, both supply-chain based and external, can influence the general direction of the vision because they communicate common interests and possibilities for the future between those with the most influence. Literature from similar cases and general knowledge of Industrial Ecology fill in the holes that inevitably occur because, despite best efforts, not every expectation is feasible. At the same time, expectations may also be cautiously optimistic because of personal experiences or setbacks caused by the current landscape. In this case, imagination and scientific knowledge can boost the positive outlook on the future of the CUA niche. Unlike the previous framework components, the future vision only relates to the CUA sector level. Vision aspects are also strictly categorized into dimensions related to technology, behavior and culture, organization, economy and structure, or legislation. These are described in depth below:

Table 2 Classification indicators for future visions included in the backcasting analysis

Indicator	Description
Technological Dimensions	technological aspects in vision for CUA sector
Social/Cultural Dimensions	cultural/behavioral aspects in vision for CUA sector
Organizational Dimensions	institutional or organizational aspects in vision for CUA sector; how the components of the sector are organized
Economic/Structural Dimensions	Economically-driven aspects in the vision for the CUA sector; how the sector is structured as an industry
Legislative Dimensions	legislative or political aspects in vision for CUA sector

By bringing quantitative, qualitative, descriptive and analytical classification criteria together into one framework, CUA as a part of the food system begins to take shape as a possibility rather than just an entrepreneurial conversation topic. The varying classification levels and indicators allow actors to see the issues, have a say in how to fix these problems and voice their ambitions for a better future while giving politicians a roadmap to achieve this future. Although the results are not an "end all" solution for The Hague's food supply chain, they maybe be able to provide guidance for this and other sectors hoping to make the transition to a circular economy.

3.4 Selection of Case Studies

Those on an individual or neighborhood level, such as community gardens or rentable garden plots, are not the focus of this thesis due to their sheer numbers and their likely inability to impact circularity at a city-wide scale. Those on a more commercial scale that already have their eyes set on circularity and have the potential to set an example for other sectors will be the focus during this limited timeframe. However, smaller initiatives are important and addressed in the future vision because they are inevitably integrated into the landscape to which the future CUA initiatives will belong.

Selection criteria included the presence of more than five employees or volunteers with a steady presence that allows for daily functioning of the initiative, board members or a defined leadership structure and a business-like mindset. The case studies also already focus on circularity (like reusing coffee grounds at HaagseZwam, practicing aquaponics at UrbanFarmers, or permaculture at the Edible Park). In addition, the initiatives are well-established with a working time of over two years so that networks are in place and expectations and learning are already developing. As with many niche practices, the CUA initiatives also have an "institutionalized" structure, meaning that they serve

purposes beyond providing a small amount of food to neighbors or being a community green area. All the case studies serve a social purpose by having some sort of educational component related to circularity, healthy food, sustainability and/or agriculture. Using these criteria, only three initiatives crossed the radar and, being such a small sample, they were all considered for the thesis. Taking all of these criteria into account, the CUA case studies are HaagseZwam, the Edible Park in the Zuiderpark, and Urban Farmers.

3.5 Data Gathering

Semi-structured interviews evaluated the current state of CUA and possibilities for the future. While there was a set list of questions, all questions could not be answered by every interviewee because of time or knowledge constraints. The Revelant Actors Group consisted of municipality representatives with jobs related to the environment, urban development or urban agriculture while circularity experts included consultants on circular economy projects, urban landscape architects with a specialization in closed-loop design and researchers at TUDelft or Leiden University. Case studies involved in the Supply Chain Group, mentioned above, were identified through online research as well as through conversations with CUA specialists.

3.6 Methodology

This study required two types of data collection: semi-structured interviews and literature research, of which more detail can be found in the Appendices. For a complete picture of the current state of CUA and its potential in the future, it is important to gather information from a variety of actors. Interviews were conducted with the CUA case studies, circularity experts, and municipality representatives involved in sustainability issues. Therefore, as mentioned, two different groups of actors can be distinguished: the CUA case studies themselves (Supply Chain Group) and municipality representatives and circularity experts (Relevant Actors Group).

The selection of CUA case studies included in the Supply Chain Group came about through internet searches and the "snowball" effect from other actors. All interviews were done in-person and all interviewees agreed to recording for later transcription along with the inclusion of their names and direct quotations. Once transcribed, each interviewee received a copy for review or possible addition. Upon response or no response within a week, interviews were coded using the atlasti online tool. An overview of supply chain-based interviewees is below.

Table 3 CUA case study interviews in the Supply Chain Group

CUA initiative	Name of interviewee	Position	Main output of initiative	Circular practices in place	Date of Interview
Edible Park	Menno Swaak	Director of the Edible Park and Permacultuurcentrum Den Haag	Education and workshops	Permaculture	July 18, 2018
Urban Farmers	Luuk Rijkx	(former) business director	Vegetables, fish, event space/tours	Aquaculture	June 19, 2018
HaagseZwam	Annelies Goedbloed	Founder and director	Oyster mushrooms	Local collection of coffee grounds → mushrooms → local restaurants	July 3, 2018

Internet and literature searches determined the relevant circularity experts and municipality representatives for the Relevant Actors Group. I contacted a large number of organizations to “cast a net” over the possible stakeholders. As expected due to the vacation season and the amount of work put upon these actors on a daily basis, only a few came back with interest. To be considered as a relevant external stakeholder, the organization or individual must be involved in urban circularity projects, research, or a governmental division addressing sustainability. Four of the interviews were in person, one via telephone and two via email, with one of those (Ger Kwakkel) being a single question response. Recording was only possible with one Relevant Actors Group member (Pieter Veen). The other were limited because of manner of interviewing or location. All interviews had some form of note-taking involved, which were sent back to all interviewees for review and possible additions. Like the case study interview, upon response or no response within a week, interviews were coded using the atlasti online tool. An overview of the externally-based interviewees is on the next page (Table 4).

Table 4 External actor interviews in the Relevant Actors Group

Organization	**Name of interviewee**	**Position**	**Role of organization**	**Main interest in CUA**	**Type of Communication;**	**Date**
Circular Landscapes	Pieter Veen	Founder and key landscape architect	Design and facilitate development of circular green landscapes	Designing a landscape in which urban agriculture can take place	In-person interview (recorded)	July 9, 2018
Municipality of The Hague	Tom Voorma	Project leader for "Urban Agriculture and Food Strategy," City Management Service of The Hague	Organizes and cooperates with "Duurzam Den Haag" and "Stadslandbouw Den Haag"	City planning, development, collaboration, education	Email	August 7, 2018
Municipality of The Hague	Ger Kwakkel	Circular Economy Advisor	Advises on circularity projects within the city	Circularity, reuse, waste streams	Email (via Tom Voorma)	September 10, 2018
Circulaire Zaken	Gerko Brouwer	Independent circularity consultant (mainly working with Binkhorst)	Circularity consulting	Promoting and advising on implementing circular urban systems (governmental and company levels)	In-person conversation (outline)	August 28, 2018
TUDelft	Kasper Lange	Researcher on sociotechnical interventions for the circular economy	Circular economy studies	Knowledge on transitions to a circular economy, especially circular designs and urban agriculture	Email	August 23, 3018
Haagse Makers; Haagsche Schil	Arn van der Pluijm	Organizer and project director	stimulate resourcefulness and collaboration in the city; development of organic waste collection alternative	Stimulate collaboration around circularity	In-person conversation (outline)	August 28, 2018
AMS Institute	Jan-Eelco Jansma	Researcher and organizer	Interdisciplinary metropolitan solutions using applied technologies on urban themes (energy, water, waste, food data)	Circular and urban food supply research	In-person conversation (outline)	September 6, 2018

Ideally, there would be two interviews with each stakeholder: one to conduct the interview and one to follow up with questions and assess the future vision. Due to time constraints and summer vacation, this was not possible. However, all interviewees received a transcript of their interview along with additional questions or petitions for any additional information. Additionally, all stakeholder received their direct quotes within the context of the thesis to ensure their approval. While there was a list of set questions, not all interviews addressed every question or were able to answer all of them. Gerko Brouwer, Kasper Lange, Arn van der Pluijm and Jan-Eelco Jansma answered more general questions because of their later involvement in the thesis process. As for the literature, sources include individual initiative reports, media releases, municipality reports and scientific literature about urban agriculture, circular urban agriculture, or circularity in general. Both forms of data collection (interviews and literature review) contributed to all parts of the thesis and helped inspire the future vision of The Hague.

Answering Sub-Question 1: What is current state of circular urban agriculture in The Hague, Netherlands?

Goal #1: Make a summary of food procurement in general in general, the UA niche and the CUA initiatives already in place in The Hague. This provides a backbone for the rest of the report.

Before the quantitative data assesses the sector's circularity, I present an overview of the food system and both the UA niche and the CUA "sub-niche" in The Hague. While UA hosts the "sub-niche" of CUA, CUA is addressed as its own niche throughout the text for simplification purposes. Both actor groups are useful to achieve this first goal. An online-based literature review and interviews help flesh out this section.

Goal #2: Create a model to calculate current state of circularity in the food system of The Hague

Due to lack of data, I present a model and rough calculations for the baseline demand, WOI and SSI for produce in The Hague using municipality data and well-educated assumptions. Necessary information includes fruit and vegetable consumption, demand, waste, and percent composted in the system. Fruit and vegetables are the food group focus because, realistically, CUA would rely on growing these food groups rather than cereals or animal products.

Answering Sub-Question 2: *How is the idea of circular urban agriculture put in practice by the case study initiatives of The Hague and what is its potential for expansion?*

Goal #2: Assess the networks, learning processes and expectations of Strategic Niche Management for the CUA initiatives and the CUA network at large to evaluate its potential for expansion.

- **Network Composition**: Pertains to those involved in the individual or sector-wide network. Relevant network members fill the role of technological support, financial support, supplier, distributor, or customer. Each interviewee was asked if there were any stakeholders not included in their network that they would like to see involved. They also voiced if those who are involved are doing so at a desirable intensity;
- **Network Interaction**: Beneficial alignment is supported by regular interaction between the actors (van der Laak et al., 2007). Questions addressed how and to what degree stakeholders are interacting. This could be either simple conversations at workshops and meetings or physical exchanges of materials;
- **Network Development**: The network should show signs of growth and expanded trust with positive signs for continued growth in the future. Interviewees were asked if they have seen a growth in size or trust in their personal networks or the network related to the CUA sector.

The next phase of SNM involves evaluating learning that occurs in the CUA sector, including what actors have already learned within their own networks and about the CUA sector at large. Interview questions addressed aspects of both lower and higher-level learning. Lower-level learning includes the more descriptive indicators, while

high-level learning encompasses the more abstract aspects like problem changes and shifts in problem-solving. Like the network, learning pertains to the individual level and the CUA sector level.

Lower/First-Order Learning

- **Technological development**: How much learning occurs regarding the design specifications and complementary technology or infrastrucutre necessay for every day functions;
- **User and market context:** Knowledge regarding end-users' involvement, characteristics and the meanings they attach to the individual initiative or the CUA sector;
- **Social impact**: Knowledge and learning opportunities regarding safety, communication, wellbeing and other socially-focussed components related to individual CUA organizations or the sector as a whole;
- **Environmental/economic aspects:** Knowledge and learning opportunities regarding environmental aspects, like energy use, emissions, or land and resource use, as well as knowledge about the cost of materials and matinenance. These apply at both at the individual scale and the sector scale;
- **Industrial development:** Learning about production requirements, organizational improvements, or sector development required to expand the concept of CUA;
- **Government policy and regulatory frameworks**: Learning about the institutitonal structure and policies relevant for expanding CUA, including incentives to encourage adoption and the government's role in doing so.

Higher/Second-Order Learning

- **Problem definition shifts:** Learning about problem definitions, priorities and the need to possibly alter them;
- **Problem solving shift**: Learning about new ways to solve old or newly-defined problems.

For the final phase of sub-question 2, actors expressed their expectations for their own initiatives, the CUA sector niche, the food regime of The Hague and the landscape into which CUA will hopefully grow. Questions used rhetoric like what actors think will happen or what they believe the future will encompass. Explicitly put, expectation classifications are:

- **Individual Expectations**: Expectations for the future of individual CUA organizations;
- **Niche Expectations:** Expectations for the niche of CUA in The Hague;
- **Regime Expectations:** Expectations for the future of the urban food system;
- **Landscape Expectations:** Expectations for the outside forces or social environment in which the urban food system operates.

After this, the expectations received a PESTEL categorization with the addition of the "organizational" component mentioned before. These expectations partially inspired the vision because more normative expectations, like those using terms like "should" or "could," represent a hope for the future without necessary certainty. However, the more positive and widly-supported the expectations, the more actors will believe in positive returns in the future even in the midst of uncertainty (Hoogma et al., 2002). Therefore, normative expectations are important for the creation of a future vision for niche development, which is inherently uncertain.

Answering Sub-Question 3: *What could circular urban agriculture look like in The Hague in 2050?*

Goal: Develop a future scenario using interviews as inspiration in which CUA is more of "the norm" in The Hague in 2050.

As mentioned, there is a difference between what CUA actors think *will* happen (descriptive expectation), what *should* happen (normative expectation) and what they would *like* to happen (aspiration/vision) within the sector. The latter two are addressed in this section using the second step of participatory backcasting as defined by Quist and colleagues (2011). Vision-making centered around the question, "What could the future of circular urban agriculture in The Hague look like?" Using interviewee inputs as inspiration along with industrial ecology knowledge, I create an innovative future vision for 2050. This phase of research is also where the members of the Relevant Actors Group lend their expertise and knowledge of the city. The vision addresses technological, social, organizational, economic/structural and legislative ambitions. Together, these categories tell the whole story of The Hague in 2050. In addition, I calculate a hypothetical Waste Output Index of food waste (WOI), the Self-Sustaining Index of The Hague's produce (SSI) and the Demand Minimization Index (DMI) for imported produce based on the vision and compare them to the current model presented in chapter 4. I also use these indicators to calculate relevant statistics that go along with the vision on a city-wide scale. These UHA calculations create a quantitative measurement of what CUA and the general food system could be like in the future.

Answering Sub-Question 4: *What are the possibilities for bringing the CUA sector further toward this future vision?*

The goal of this thesis is to provide guidelines on how to develop efficient, sustainable and circular urban agricultural practices in The Hague. From interviews, literature and industrial ecology knowledge, I present drivers and barriers to expanding this niche practice along with derived general lessons for urban circularity. Finally, I describe small short-term steps towards the future vision and methods to incorporate more of the backcasting framework and create a stepping stone for future research.

3.7 Conclusion on Framework and Methodology

In conclusion, this thesis aims to answer the question: *How can urban agriculture in The Hague become more circular?*

Interviews play a large role by contributing a majority of city-specific data and representing the current state of the landscape surrounding the food sector, the current agricultural regime, the UA niche, the CUA sub-niche and individual initiatives. Interviews also assess current actor interactions to help envision what needs to change in order for CUA to become a more widespread practice. Online research and municipal statistics present a rough baseline circularity level for the city against which the future scenario is compared. While not detailed, the calculation model for CUA in The Hague will be useful once data collection improves. The outcomes of this thesis are useful for innovators, municipal leaders and farmers interested in taking the leap into the niche of CUA. Parts of this thesis could

also be applicable to other cities by providing guidelines to circular development within the realm of urban agriculture and perhaps offering inspiration for other sectors. Drivers, barriers and short-term steps form the foundation for future research into creating pathways toward a circular food future.

4. Current Food Procurement of The Hague

4.1 Introduction

This chapter describes the consumption patterns of The Hague, its current UA system and how circularity is already incorporated into some initiatives. The Netherlands, being both an agricultural and urbanized country, is an interesting and hopeful target for urban agriculture (RUAF, 2010; Van der Schans, 2010). Urban development is frequently at odds with agriculture in the Netherlands because of the competition for its limited space. The current rate of soil loss from urbanization in the Netherlands amounts to a staggering 36 hectares per day, bringing attention to yet another ecological problem associated with urbanization besides the commonly cited greenhouse gas emissions (Wascher & Jeurissen, 2017). Recent articles published about the UA sector in The Netherlands cover topics like a comparisons to other countries (Wiersum, Witte, & Doulos, 2017), food as inspiration for city politics (Cretella & Buenger, 2016), urban livestock (Hackauf, 2015) and urban agriculture as a community practice (Jansma, Veen, Kop, & Eijk, 2014). Hence, Dutch-specific UA literature either focusses solely on a description or the social aspects of the practice. Very few articles address the potential of improving environmental impacts by incorporating circularity into UA, let alone the steps necessary to get there. This thesis hopes to fill that gap and show that CUA in the Netherlands, particularly in The Hague, could provide ways to combat the negative effects of population growth and urbanization as well as provide an example of a successful circular urban sector.

CUA can be seen as a "niche within a niche" because its umbrella practice, UA, is in itself a niche practice. Since produce (fruit and vegetables) is the main output of UA and CUA, I first lay out the current demands for these items in The Hague. Then I establish the greater context of urban food growth by outlining the UA sector. Finally, I evaluate through literature, interviews and calculations the current state of CUA in The Hague as it lies within the niche of UA. The goal is to develop a context surrounding the CUA niche and provide a foundation for more circularity-based UA initiatives to distinguish themselves.

4.2 Background: Consumption Patterns and General Circularity of Food in The Hague

Sources report that 68 percent of open space in the Netherlands is used for agriculture, leaving the other 32 percent available to house the country's extremely high population density (PBL, 2013 as cited by Jansma et al., 2014). A majority of people live in big cities like The Hague and bring their appetites with them. Calculated from Dutch national averages, the demand in The Hague for vegetables equates to 31,606 tons annually, while the demand for fruit comes to 25,970 tons (The Netherlands Nutrition Centre Foundation, 2016). These two food groups, referred to as "produce" throughout this report, are the focus of circularity, demand and waste measurements because they are the most commonly grown on urban farms. Taken together, the baseline demand for produce in The Hague is 57,796 tons per year.

However, purchasing produce does not necessarily equal consumption. According to data from RIVM (2017) and van Rossum and colleagues (2016), the Dutch waste 23% and 10% of the vegetables and fruit they purchase, respectively. If we assume that waste rates are fairly consistent throughout the country, 9,866 tons of produce goes

uneaten every year in The Hague. This uneaten produce has two main routes of disposal: going unseparated into municipal trash or being collected as organic waste, or "GFT." GFT can be turned into biofuel, liquid CO2 or, in the interest of this thesis, compost. The municipality requires companies and restaurants to handle their waste and separate their GFT through private contracts. Unfortunately, this prevents the municipality from having access to collection or production records. Therefore, it is difficult to quantify the total amount of food waste collected in The Hague, how it is processed, or its ultimate destination (Kwakkel, personal communication, September 10, 2018). In addition, GFT collection is not uniformly available across The Hague's neighborhoods, discouraging separation and neglecting the inherent value of this "waste." However, The Netherlands Nutrition Center (2016) reports that the Dutch separate 54% of uneaten produce into GFT. When applied to The Hague, this becomes 6,215 tons of produce that leaves the city every as GFT for processing in Alphen aan den Rijn. Sadly, from statistics given by Ger Kwakkel of the municipality in an email reply, only 7.9% of this GFT is composted, resulting in 491 tons of usable recycled nutrients (personal communication, September 10, 2018). While seemingly small in comparison to the total amount of wasted produce, these 491 tons could still be of great use to the municipality if they were returned to the city as fertilizer. However, Kwakkel also reports that none of this compost returns to the city. This concept returns in subchapter 4.4.

To get a sense of both the planning weaknesses and the food growth potential, the maps below depict the green space and agricultural areas in and around The Hague. Most of these cluster to the north-east of the city, with only small patches throughout the city. Midden-Delfland, one of the main agricultural area in the immediate region, is outlined in red in the Figure 5. Westland, the other agricultural area, is outlined in red in Figure 6.

Figure 5 Overview of green space and agricultural land in and around The Hague, especially focusing on Midden-Delfland, and Westland

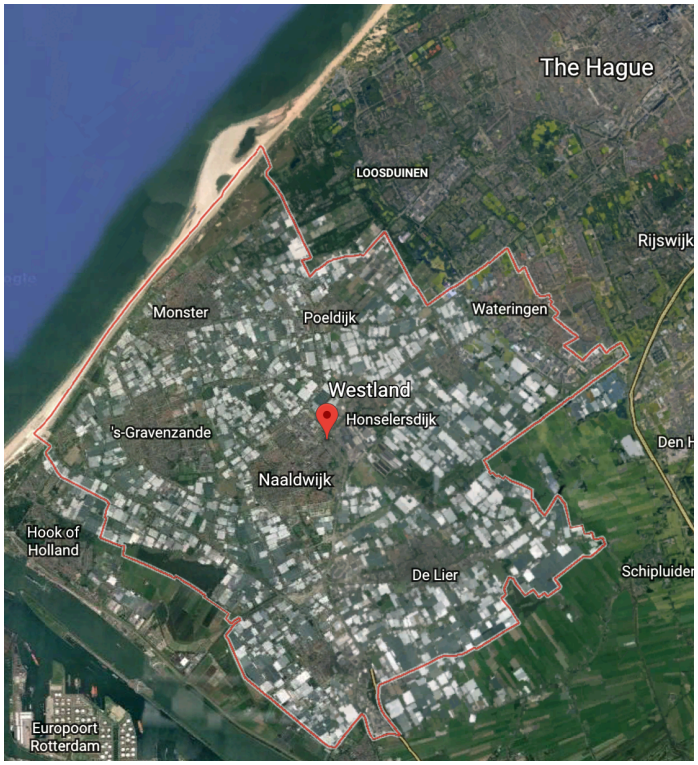


Figure 6 Westland in comparison to The Hague

It is obvious that little agriculturally-productive land exists within the city limits, further supporting the fact that an overwhelming majority food demand relies on imported goods. We can therefore assume that almost all of the 57,569 tons of produce bought in The Hague is imported (calculated using average Dutch consumption patterns given by The Netherlands Nutrition Center, 2016). There are no statistics on the amount of produce brought in from Westland or Midden-Delfland. These two areas are also not currently considered within the "urban" sphere. The CUA sector has the ability to change this number, along with improving environmental statistics, but is currently stuck in the niche phase. As will be discussed later, the incorporation of Midden-Delfland into the food system of The Hague, specifically via CUA practices, could be the major factor in the niche's transition. The reasons why Westland is not included as "CUA potential" will also be examined later. Before circularity can explicitly be incorporated, however, a general overview of UA in and around The Hague is necessary.

4.3 Larger Picture: The Niche Practice of UA in The Netherlands and The Hague

UA in The Hague covers all three scale-levels: micro, meso, and macro. The micro, individual level of UA is mainly visible in the form of community gardens or personal plots. The Hague, as with most European cities, is not known for its ample residential garden spaces. However, those lucky enough to have outdoor space in the city often take advantage. Small vegetable gardens on balconies, in courtyards, or even in neighborhood common areas may satisfy some need but are very unlikely to make a huge impact to food consumption or provide sufficient greenspace to city residents. In 2015, the municipality acknowledged this lack of green space and offered subsidies to residents and companies to build rooftop gardens and green roofs, an innovative step above backyard gardens that serves additional environmental benefits. The municipality's website stresses the ecological importance of these urban green spaces, referencing pollution reduction, water retention and cost efficiencies related to their insulating properties as reasons to expand this practice ("Subsidy for 'green roofs,'" 2015). *Groene Daken Den Haag* makes it easier for residents to

participate by relieving some of the construction burdens. For a small fee, the organization measures buildings' suitability for conversion, estimates costs after subsidization and makes an appointment with green roof builders to get the project started. They also ensure that applicants' subsidy solicitations meet all the requirements of the municipality in order to streamline the process ("Groene Daken Den Haag," 2017). Green roofs, while mostly decorative and serving ecological purposes like reducing runoff and curbing the heat island effect of cities, can provide a small source of edibles. Community members can also rent school garden plots from the municipality during the summer vacations. There are four schools involved in this program ("Inschrijven buurttuinen 2018," 2018). However, the scale of these gardens is not quite enough to provide ample produce to users or experiment with circularity, leading them to classification as meso-level initiatives. Other meso-level UA practices include, but are not limited to, the ten "city farms" (mainly targeting children through recreation and education), Mens en Tuin (a care garden with flower nurseries, fruits, vegetables and a kitchen) and Pluk (an event space with gardens, a lunchroom, animals and activities). These initiatives are larger and serve a broader audience than micro-level gardens, but they still do not show potential to feed the city, let alone a focus on circularity. A majority of the UA initiatives in The Hague are of micro or meso-level organization, leaving room for this thesis to investigate the few, yet meaningful, macro-level initiatives. A full list of initiatives involved with UA and fostering green space in The Hague can be found in Appendix 10.4.

Besides the actual initiatives themselves, there are several other groups involved in the UA niche. Local markets (Lekkernassûh and Urban Farmers), locally-made products (Passie voor Puur, Eiber Bier, Haagse Honing, Kompan), composters (Haagse Schil and Le Compostier) and drivers of UA (Lokaal Voedsel Den Haag, Den Haag in Transitie, Debat Mobiel and Initiatives of Change Nederland) bring awareness to UA and help create a market for the sector ("Haagse Initiatieven - Stadslandbouw," n.d.). The municipality also plays a role in the UA network. The *Stadslandbouw Den Haag* (Urban Agriculture The Hague) has a website that lists municipal entities like Duurzam Den Haag (Sustainable The Hague) and Impact City that are specifically interested in UA. In addition, the municipality provides access to assistance regarding renting land, following regulations, material procurement, subsidies, financing and volunteer/employment opportunities for UA. The national government also has a say in UA in The Hague through the Ministerie van Landbouw (Department of Agriculture), the Ministerie van Natuur en Voedselkwaliteir (Department of Nature and Food Quality) and RIVM (through the Department of Health, Wellness and Sport). UA is therefore a difficult sector to manage because of its inherent multidisciplinary and necessary involvement of producers, consumers and city leaders.

The previously mentioned *Stadslandbouw Den Haag*, which is the go-to organization for all things urban and local agriculture- related in the area, maps out the UA initiatives of The Hague on their website for easy referencing. The person tasked with this challenge, Tom Voorma, who also works with this organization, was also interviewed for this thesis as a member of the Relevant Actor Group. His map gives an overview to the wide distribution of UA initiatives. The areas circled in Figure 7 represent the specific case study initiatives used in this thesis which demonstrate larger-scale, well-established circular urban agricultural projects.

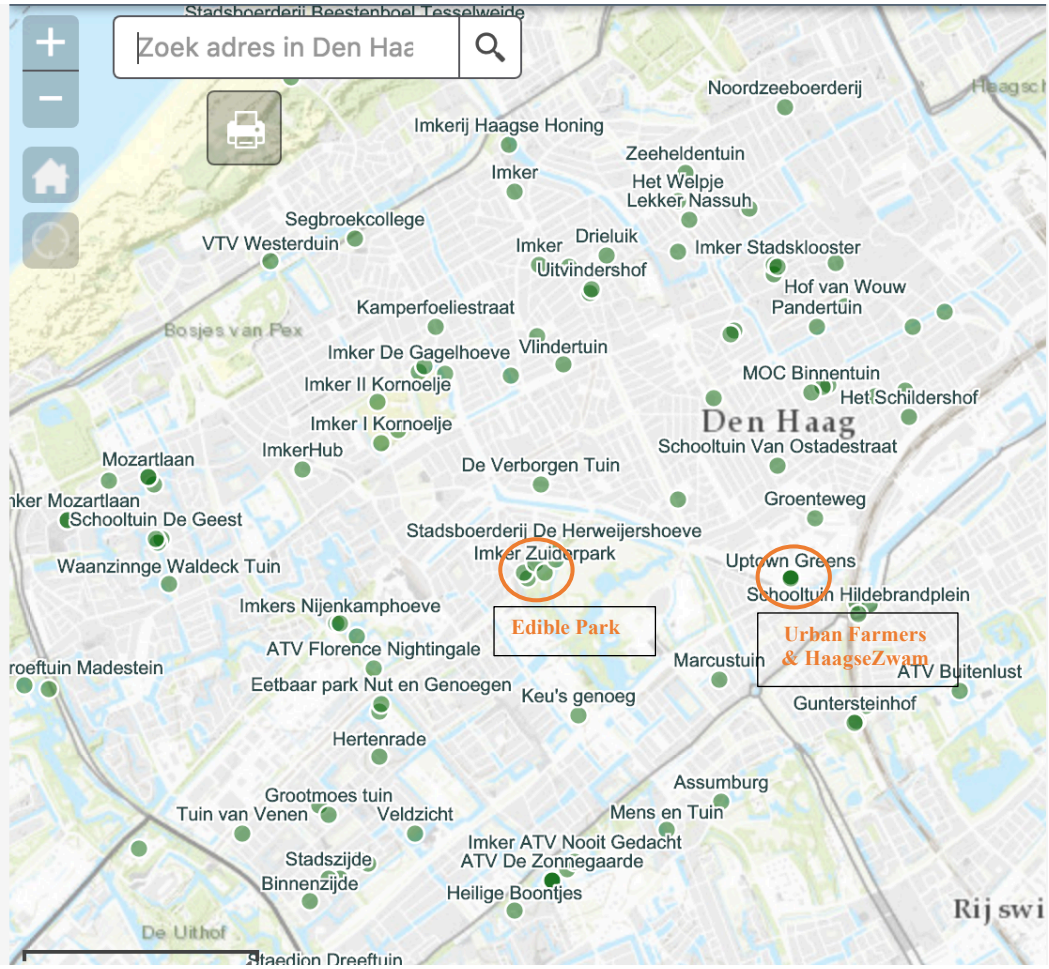


Figure 7 Map of urban agriculture initiatives with orange circles representing case studies ("Haagse Initiatieven - Stadslandbouw," n.d.)

4.4 CUA as a Sub-Niche in The Hague

As mentioned, this thesis not only addresses CUA as circularity within individual initiatives or on a municipally-driven scale (aka through return of city-made compost to the CUA sector) but hopes to establish possible connections *between* these initiatives to create a locally-driven circular supply chain. As evidenced by interviews, these inter-initiative connections appear to be nonexistent. Pieter Veen of Circular Landscapes confirmed this by stating that circularity is still too restricted to the scale of separate businesses, products or materials (personal communication, July 9, 2018). Urban agriculturalists risk focusing too much on reusing their own resources rather than expanding their impact to other entities and creating networks.

While neighborhood gardens are essential to the environmental and social health of cities, they perhaps do not offer the same potential to improve circularity from a supply-chain perspective or to feed the city. Many of the smaller community-based initiatives may reuse their own materials, but the potential for interconnectedness, which would contribute to a broader impact, is lacking. The initiatives considered for investigation are those on the macro-level, since they often collect more data, have a wider distribution of customers and include an aspect of economic or educative contribution to the city. Through literature, online searches and conversations with knowledgeable resources in The Hague, these were selected as UrbanFarmers, HaagseZwam and the Edible Park Zuiderpark. These were also the *only* initiatives that met these criteria in the city, so no CUA initiative was left out.

Two of the three case study initiatives reside or resided in the previously mentioned De Schilde building, now called the New Farm Building. The building was erected in the 1950s as what was then a high-rise office space. In 2013, the municipality decided to revive the old building into this revolutionary New Farm urban agriculture collective. Instead of tearing down the old infrastructure, the building found new value in experimenting with growing vegetables, fruit and fish without the use of pesticides, herbicides, or antibiotics. This in and of itself is an example of circularity. The renovation was completed in 2016. The most well-known of the initiatives housed here was Urban Farmers, whose products were sold on premise at Saturday markets. According to reports, Urban Farmers produced 20 tons of fish and 50 tons of vegetables in 2017 (Seijdel, 2018). The project was part of a larger company by the same name with farms in Basel, Berlin and Zurich. Their main focus, along with the other initiatives in the New Farm building, was to "produce high-quality food using natural resources in a sustainable and efficient way" ("Our Story | The New Farm," n.d.). Unfortunately, Urban Farmers officially went bankrupt in August of 2018 after months of financial struggles. There are talks of a Midden-Delfland agricultural entrepreneur taking over the space, but no official plans as of yet. The implications of Urban Farmers' failure are discussed throughout this thesis, especially in the "Discussion" section. Their input is, of course, still included in the thesis.

There are not many scientific articles about urban agriculture in The Hague, specifically. Prendeville et al. (2016) discuss The Hague briefly in a case study that investigates circular cities. The authors chose The Hague for closer study because of the city's recently-set sustainability goals and the little to no progress toward them. Circular initiatives only exist on a small scale here, like through individual companies or isolated sectors (Prendeville et al., 2016). While the article addresses a wide range of circular initiatives, it gives a good background to the environment, or landscape of circular urban agriculture. The Hague has the goal of being climate change neutral by 2040 (Gemeente Den Haag, 2015). According to Prendeville and others (2016), city politicians see sustainability as an important topic but have not yet formalized a vision on circularity or expanded efforts across different departments. With farming being such an important part of Dutch culture and urban agriculture growing in popularity, CUA could open the doors to tangible examples of circular urban initiatives and inspire their further implementation. The Netherlands is also known for its technologically-experimental nature and early adoption of greenhouse technology. In this sense, it is interesting that the experimental technique of vertical farming using LED lights is not used in The Hague apart from demonstrations or experimentation. This would be an interesting technology to incorporate because The Hague could then become an almost complete sample of CUA technologies. Nevertheless, the selected case studies demonstrate a wide range of technologies and phases of development.

It is important to address that there is currently little to no circularity in terms of nutrients for the CUA sector of The Hague. This is because of four reasons: the CUA sector is a small and undeveloped sub-niche of UA, which is already underdeveloped; there is no data on how much individual CUA initiatives compost their own organic waste and reuse it for more food production; legislation prevents many initiatives from using their own compost or exchanging materials with other growers; and there is no locally-driven compost, regardless of its origin, that returns to the city (Kwakkel, personal communication, September 10, 2018). In opposition to this last statement, Kruit (2014) writes that locally-produced compost is given out to citizens on one day per year. However, since this compost would

likely not be used to produce more food, it could not be considered a circular measure within the sector of UA anyway. In any case, there is a standard for the amount of nitrogen, phosphorus, heavy metal and other contaminations in the soil as basic insurance for food product safety. The government mainly regulates compost for the amount of nitrogen and phosphorus, but not for heavy metals and other contaminators (Kruit et al., 2014). As soon as an urban farmer sells his or her produce, it is susceptible to food safety regulations and municipal-level composting. GFT waste in the Netherlands is a Category 3 material (bio-waste or industrial/commercial organic waste) that is subject to the strict hygiene requirements of the ABPR (Animal By-Products Regulation) and requires highly-regulated, external treatment (Hogg, Lister, Barth, Favoino, & Amlinger, 2009). These regulations should perhaps be reinvestigated as the municipality tries to grow CUA.

If individual initiatives or CUA sector-specific statistics were available, calculations of the WOI would be possible. However, this is currently not the case. Researchers might be interested in calculating the nutrients wasted that could be recycled within the CUA system. This could technically be done by composting on-site, composting in partnership with other CUA initiatives, or sending the sector's GFT waste to an external processing plant and returning the compost to the CUA system specifically. However, to keep a true sense of sector circularity, I chose to keep the equation CUA sector-specific. As a model, the WOI for compost/fertilizer in the CUA sector would be:

$$WOI = -\frac{GFT\ or\ compost\ that\ leaves\ the\ CUA\ sector\ (\frac{tons}{year})}{Demand\ for\ compost\ or\ fertilizer\ in\ the\ CUA\ sector\ (\frac{tons}{year})}$$

For example, if there was a demand of 60 tons of fertilizer per year in The Hague's urban farming sector that could be met its own compost, but perhaps some farms wanted to sell half of their high-quality compost elsewhere, use artificial imported fertilizers and irresponsibly leave another 10% of their organic waste unseparated, the WOI could be:

$$WOI = -\frac{36\,\frac{tons}{year}(compost\ sold\ or\ leaving\ sector)}{60\frac{tons}{year}\,(demand\ for\ compost\ in\ the\ sector)} = -.6$$

This -.6 is closer to the linear marker of -1 than to the circular "zero." This means that 60% of the total demand for compost would be leaving the sector. The WOI could also be done for individual nutrients like phosphorus, nitrogen, or carbon if data was available. The principle would be the same as the equation above, with the amount of said nutrient exported from the sector in the numerator and the demand for said nutrient in the CUA sector in the denominator.

Technological and legislative restrictions have an influence on initiatives' ability to reuse and trade material or nutrients to create a high SSI. Using this fact, I conclude that the current SSI of the CUA sector of The Hague is 0. I assume that almost none of the compost currently produced by the CUA sector is reused within the sector without being treated elsewhere. Despite the lack of data, I present a model which could be used if more data was available:

$$SSI = \frac{Compost\ reused\ within\ the\ CUA\ sector\ (\frac{tons}{year})}{Demand\ for\ compost\ in\ the\ CUA\ sector\ (\frac{tons}{year})} * 100$$

If data was available or the CUA initiatives had the ability to reuse their compost, a situation could arise where the SSI was an indicator of circularity for the municipality. For instance, using the example scenario presented above, the SSI of The Hague's CUA sector would be:

$$SSI = \frac{24\frac{tons}{year}}{60\frac{tons}{year}} * 100 = 40\%$$

This means that around 40% of the demand for compost would be produced by the sector itself. On the other hand, the remaining 60% of compost or fertilizer would have to be imported. Ideally, the remaining demand would be met from sources as close as possible to The Hague.

CUA should ultimately encompass the reuse of water, heat, energy, materials and nutrients within and between initiatives. In the interest of typical products found in CUA and data limitations, I focus on nutrient reuse through compost on the sector scale. A WOI of -1 represents a linear system while a WOI of 0, in partnership with an SSI of +1, or 100%, would be a completely circular system. However, the SSI of any physically consumed material cannot be +1 because there will always be some element absorbed or lost to bodily processes. Therefore, the SSI calculation uses organic matter than is wasted versus actual nutrients stored in the food. The WOI of The Hague's food system could be improved by reducing the amount of potentially valuable organic waste that leaves the system. While the physical amount of compost produced from The Hague's GFT could be improved drastically, the more disappointing factor is that none of this compost returns to the city, let alone to urban farmers. The Hague's CUA-based SSI of 0 leaves room for exponential improvement in the future.

4.5 Conclusions on the State of CUA in the Food System of The Hague

This chapter provides the answers to sub-question 1: *What is current state of circular urban agriculture in The Hague, Netherlands?*

Overall, CUA in The Hague is underdeveloped both in size and quality of interactions perhaps due to the newness of the sector and inexperience with accompanying legislation. This is explicitly stated by Tom Voorma of the municipality, who observes that, "... almost all [urban agriculture initiatives] are just basic gardens, only a few of the pioneers include circularity" (personal communication, August 7, 2018). There is little to no data on initiative or sector supply chains along with no apparent interconnected resource pathways and almost negligible amounts city-grown produce being consumed in The Hague. While purchasing produce from the nearby areas of Westland or Midden-Delfland would at least decrease food mileage, there is also no definite data available on those numbers. Entrepreneurs seem to be interested in creating a strong sector, but with the variety of stakeholders necessary to do so and the current lack of collaboration, there arises a mismatch between interest and action. As a result, CUA in The

Hague is still in its early stages. More traditional UA remains in micro- and meso-spheres as community gardens or rentable individual garden plots ("Haagse Initiatieven - Stadslandbouw," n.d.; RUAF, 2010). There are three macro-level UA initiatives that appear to be more focused on circularity. However, as discovered through interviews, they all survive, intentionally or not, on workshops, on tours and volunteer opportunities instead of customer-driven business models.

In addition, publications about CUA often only address circularity *within* an initiative instead of cooperation and *exchange between* initiatives to create a circular supply chain network (dos Santos, 2016; Rood, Muilwijk, & Westhoek, 2017). The Hague's CUA sector mirrors this trend because there are no interconnections between initiatives. This could be due to a lack of awareness, strict policy regulations or the limited size of the sector. As a result, there is a research gap in building CUA networks and creating a safe space in which they can function as an integrated system. When put into practice on a larger scale, CUA could function as a new economic model and educational hub for the city in its goal to be carbon neutral and more sustainable.

5. Potential for CUA's Expansion in The Hague

5.1 Introduction

Strategic Niche Management focuses on how niches emerge and develop using cooperative involvement and practice. This section answers sub-question 2 by investigating how far CUA has already come and its potential to expand into a more regime practice. Each section is divided into descriptive categories addressing the level at which the indicator applies. Urban Farmers is referred to in the past tense because of its recent bankruptcy. HaagseZwam and the Edible Park are still functioning, along with the external actors who follow the sector closely. Again, chapter 8 addresses the failure of Urban Farmers. A detailed description of each of member of the Supply Chain Group is Table 5 below.

Table 5 CUA case studies in The Hague and their descriptions

Initiative	Opening Year	Products/Services	Mission Statement Points	Examples of Circularity
Urban Farmers	2016	Vegetables/herbs; tours and workshops; café and event space	• Local agriculture • Convenient, healthy and fresh produce • Empower growers, engage customers	Aquaponics (reported savings of 90% on water)
HaagseZwam	2016	Mushrooms; mushroom bitterballen; tours and workshops	• Provide mushrooms within 10 km radius • Reduce CO2 from unnecessary transportation • Collect coffee grounds to repurpose • Utilize employees with a distance from the labor market	Collecting local coffee grounds to produce local mushrooms; produce high-quality compost from waste (not yet sold/distributed because of health and safety policy)
Edible Park Zuiderpark	2010	Tours and workshops; education; volunteer opportunities; some seeds/seedlings	• Educate the public how recycling and systems thinking • Resiliency • Growth of permaculture awareness	Use of permaculture practices (based on circularity)

5.2 Network Formation

This sub-chapter outlines the unique features and overlaps found in actor networks. First, I outline networks for the level of the individual CUA case studies and evaluate them based on the indicators of **interaction**, **composition**, and **dynamics**. Beginning with the smaller-scale provides a picture of the similarities and differences that exist amongst individual CUA initiatives. The greater CUA sector's network formation considers the same descriptive criteria and brings attention to the current structure of the niche. It becomes apparent the differences in relationship emphases and how involved stakeholders are with the entire sector.

5.2.1 Individual Initiatives' Networks

Composition

It is important to mention that Urban Farmers was the only initiative to have a "parent company" leading the way in its development, abet unsuccessfully (see quotes 1 and 2, Table 6). The other two started from scratch without the help of a larger entity. This inevitably impacted the network composition of their networks and the decisions made by the initiatives.

Firstly, the three case studies of The Hague have very different **suppliers**. For example, Urban Farmers partnered with several large material providers like Koppert (a biological pest control provider), Priva (a privately-owned company that sells equipment and software for climate and procedural control for horticulture and buildings) and Rijk Zwaan (an independent vegetable breeding enterprise), to name a few. Urban Farmers either bought their materials from these companies, received a purchasing discount, or gained donations. Only a few of these providers were in the immediate vicinity of the farm. While some, like Rijk Zwaan, "opt for a local approach" and "work with distributors… at the heart of their particular market and take local climate conditions and market conditions into account," others may be less interested in shortening supply chains and more driven by the innovative nature and popularity of this urban farm ("About us | Rijk Zwaan," n.d.). HaagseZwam, on the other hand, relies solely on local providers like restaurants and hotels for its coffee grounds, which are used as substrate for growing mushrooms. HaagseZwam's supply network is much smaller and not nearly as diverse as Urban Farmers; because of both their limited resources requirements and the relatively small size. HaagseZwam's explicit desire to keep both supply and distribution local fuels these differences. In contrast to both, the Edible Park, which utilizes a permaculture-focused system, has very few suppliers outside of the initiative itself because of the very nature of permaculture. Besides the occasional purchase or donations of soil and seeds, there are very few external supply chain partnerships because, "we buy and exchange seeds, but we also grow our own seeds more and more" and they are more "educational and informational" (Menno Swaak, personal communication, July 18, 2018). The varying missions of these three case studies (profit v. locality v. education) ultimately drive their supply chain makeups, especially for suppliers.

However, all of the case studies do share ties with the **municipality** in that they receive funding or some form of support directly from the government or from government-affiliated groups. Relevant municipal departments include the Department of Finance, the Department of Social Affairs and the Department of City Management, all of which were mentioned in interviews explicitly or through the services they provide or were found to play a role in the sector via online searches (see quote 3, Table 6). While the case studies may have different interactions with the municipality, all of the initiatives received the rights to the land or facility from the local government, giving them a common beginning. The Edible Park and Urban Farmers even mentioned that city representatives volunteer at or visit their initiatives, perhaps bringing them into more personal interactions that could translate into growing support (see quotes 4 and 5, Table 6). The municipality website does state that they offer subsidies for sustainability projects, but it is unclear if or how much they contributed to these particular case studies. The CUA initiatives also seem unclear as to their place in the municipality's agenda or how the municipality can help them (see quotes 6 and 7, Table 6). There does not seem to be one direct point of contact between individual initiatives and the municipality.

The municipality is also often tied to **sustainability centers and environmental organizations** which I assume to work with the CUA initiatives on an individual basis. For example, Duurzaam Den Haag (or Sustainable the Hague) has the Permaculture the Hague festival, organized by the Permacultuur Centrum, on their event calendar for October of this year. In partnership with both the municipality and Duurzaam Den Haag, Stadlandsbouw Den Haag (or "Urban Agriculture the Hague") aims to direct residents toward nearby UA initiatives as well as inform housing corporations and policy makers on UA (see quote 8, Table 6). However, most of these organizations seem more useful for customers rather than the CUA case studies themselves. There does not appear to be an organization that works individually with the initiatives on sustainability, marketing and profitability issues, let alone one that brings them together into a true sector. However, they are included in the network because of their role in connecting the CUA initiatives with workers or visitors.

In addition, **waste management** of The Hague belongs in each case study's network. Although all of the case studies express the desire to reuse and process their own waste, financial and policy restraints still require the involvement of municipality's waste management system. Naturally, the main waste product of all three case studies is organic matter, which has national rules for treatment and removal. HaagseZwam and Urban Farmers mentioned trying to integrate their waste streams with another entity or circularity-based entrepreneur. However, HaagseZwam has not put this into practice yet because of regulations (see quote 3, Table 6) and Urban Farmers' organic waste results from wasted crops and a lack of regular customers (see quote 9, Table 6). The Edible Park mentioned on-site composting, but the scale of such a practice is currently limited by policy. Ultimately, the initiatives seem to be responsible for their own waste collection/disposal but must do so externally through a municipality-approved entity.

Utility providers for energy and water are present in each case study's network because of their inability to generate these resources independently. All of the initiatives interviewed rely on externally-controlled water and electricity, which are necessary for every day functions. The case studies also recognize that even if they were to produce or collect their own resources, they would still be partially reliant on the municipality because of demand and monetary limitations (see quote 10, Table 6). However, a few (like the Edible Park) have educative examples of such technologies for their visitors and customers (see quote 11, Table 6).

The **customers** of the three case studies vary significantly. The largest and most prominent initiative, Urban Farmers, sold directly to consumers, which, due to their high prices, were wealthier individuals or young curious students (see quote 12, Table 6). HaagseZwam, however, only sells its mushrooms to restaurants, cutting out direct contact with ultimate consumers. Despite their different business approaches, Urban Farmers and HaagseZwam both have paying customers, although not enough in the case of Urban Farmers leading up to their bankruptcy. The Edible Park, on the other hand, is just beginning its planning to have a true consumer base. When they do, their focuses will be on selling to the neighborhood through food cooperatives, which are mentioned later and distribute local food and create a centralized market around local food (see quote 13, Table 6). The Edible Park's goal is to echo The Hague's reputation as the city of peace and justice in making their produce available to all, counteractive to Urban Farmers' selective buyer group and HaagseZwam's business-to-business model, although the Edible Park does recognize the importance of profitability alongside social services (see quotes 13 and 14, Table 6). Another form of customer, which

was present in all three case studies, are visitors for tours, workshops, or events. Currently, these patrons provide the most profit to the CUA initiatives (see quotes 15 and 16, Table 6). While not ideal, visitors do raise awareness and can also serve as consumers if they buy products. However, consumer bases for all three CUA initiatives are underdeveloped.

The composition of **workers** associated with the case studies are also quite different. Urban Farmers ran on a paid employee, business-driven system while HaagseZwam makes use of those with a distance to the labor market. Some of those involved with HaagseZwam do receive pay, but the main purpose is to train and acclimate these individuals to a working environment (see quote 17, Table 6). On the other hand, the Edible Park works solely with unpaid volunteers who simply enjoy the job. While employees receive money as an incentive to work hard and be present, volunteers are not required or motivated by money to work, which could ultimately diminish productivity. However, the social benefits of volunteering outside in an active manner is highly rewarding to most (see quote 18, Table 6). On the other hand, working with those with a distance to the labor market also creates its own challenges like training, working with social services and occasional conflicts, as noted by Annelies of the HaagseZwaam. The differences in workforce composition is immediately noticeable and possibly contributes to the CUA initiatives' success and profitability disparities. To become resilient businesses, the initiatives might need to focus on building a strong employee base.

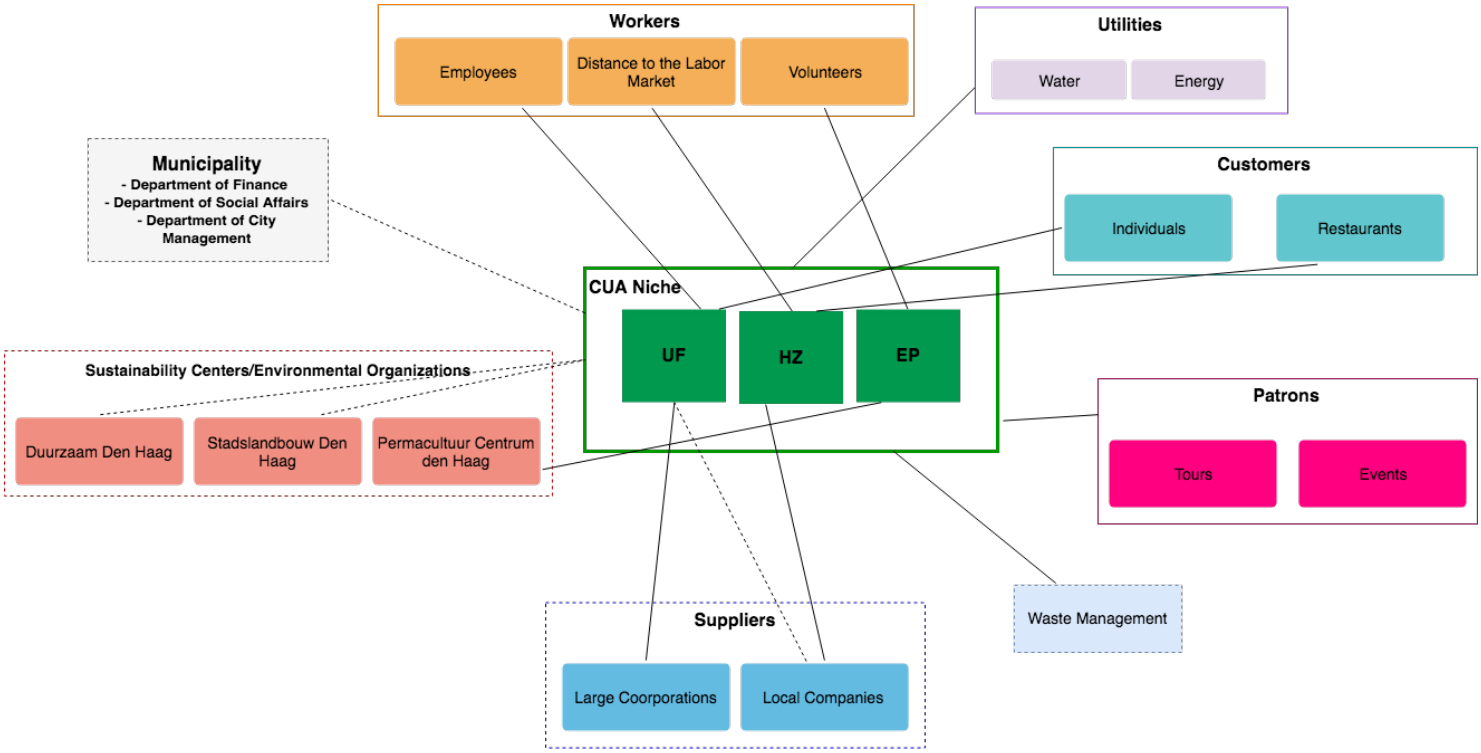


Figure 8 General composition of individual CUA initiative networks (solid lines = clearly-voiced network partnerships; dashed lines = unclear or inferred network partnerships)

Interaction

The common thread among all three case studies is that interactions between their initiatives and the municipality are lacking. No matter the size of the initiative, each expressed frustration in the lack of contact and transparency regarding municipality policies and finances. There appear to be conversations about how important supporting

circularity and urban agriculture is to the municipality, but when it comes down to action, there is a mismatch of support (see quote 19, Table 6). When asked about this, Tom Voorma of the municipality agreed, saying that there is definitely a lack of support and cooperation felt by the initiatives. (see quote 20, Table 6). Interestingly, he added that protection in the form of "support" is more important than financing or funding, but that the municipality sometimes gives urban farmers advice on gardening techniques, leftover materials and surplus products from municipality landscapers as a form of interaction (see quote 21, Table 6). However, these actions did not come up in any case study interview. This could be because the municipality mainly focusses on neighborhood gardens and "green space." While two of the three case studies (Urban Farmers and the Edible Park) mentioned that a few municipality representatives work directly with their organizations through volunteering or visitations, all three mentioned that municipality departments, especially those working on sustainability, could be more involved.

The case studies also recognize that interactions between the initiatives themselves should be increased in quality and frequency. The lack of communication is surprising because of limited distance between initiatives, especially those housed in the New Farm building. Both Urban Farmers and HaagseZwam, who were or are tenants of the building, voiced their disappointment in the lack of collaboration between initiatives in the New Farm building, which all have common goals of sustainability, circularity and creating a future-proof city (see quotes 21 and 22, Table 6). Urban Farmers also expresses its lack of interaction with surrounding neighborhood because of the previously-mentioned financial barriers caused by their high produce costs (see quote, Table 6).

Dynamics

In general, the networks of the CUA case studies seem to be fairly unsteady. The initiatives are trying to grow their networks, both in size and in trust, but attitudes within the individual networks reflect an instability. All three case studies mention tensions between their initiative and the municipality. Trust is waning because of a lack of transparency regarding relevant policies and insufficient support systems. Initiatives like HaagseZwam, which serves more than one purpose, claim that this is because the municipality is not used to integrating their departments in a way that caters to these unique organizations (see quote 3, Table 6). The Edible Park cites a lack of communication and time given to urban agriculturalists (see quotes 23, Table 6). No matter the motivation, however, support appears inconsistent.

In addition, there is a lack of cooperation between the case studies themselves. By seeing each other as competition for resources rather than possibilities for support, CUA initiatives are missing out on fruitful relationships that can ultimately grow their individual networks and the sector as a whole. For instance, smaller initiatives might be suspicious of ambitions of larger, more high-tech initiatives (see quote 24, Table 6). While all of the initiative representatives seem to recognize this substantial gap, proposals to cooperate are only in the planning stages (see quotes 25 and 26.

While some neighborhoods welcome green spaces and urban farmers, several actors, including the municipality, report that there is some resistance and trust issues between CUA initiatives and surrounding neighborhoods. However, depending on the type of initiative, the reasons for such tensions vary. For more tech-based

initiatives like those housed in the New Farm, community members seem afraid of gentrification and feel left out of their networks because of high prices. Urban Farmers acknowledges the economic disparity between their initiative's customer bases and the neighborhood (see quotes 9 and 12, Table 6). On the other hand, more visible initiatives like the Edible Park see tensions arise from these initiatives "taking" their neighborhood space and also the fear of vandalism or unknown people in the area. Neighborhoods are essential to the growth and positive outlook regarding CUA initiatives. Without their support, there is a visible divide that could be reflected in the initiative's success. These dynamics could be improved drastically.

Table 6 Interview quotes related to network formation of individual initiatives

Nr.	Quote	Interviewee
1	*"Urban Farmers AG, which is the holding company which owns 8 percent of us, has gone bankrupt."*	Luuk Rijkx of Urban Farmers
2	*"The business we have here is actually a copy from what they want to do in Switzerland, which might be one reasons why so far there are some hiccups in the process."*	Luuk Rijkx of Urban Farmers
3	*"I'm not being helped. Only the social department of the local government is very helpful…I have here several papers from the ministry of finance. It's harsh. What they are not used to is the fact that I'm not only making food, but I also collect waste. I also have people with distance to labor… I'm a social entrepreneur. I don't do one thing, I do ten things."*	Annelies Goedbloed of HaagseZwam
4	*"[Municipality representatives] have become aware that things are changing and that maybe we could produce food in these areas. They shared all this information a few weeks ago. They organized a tour through this place. They chose to visit this place, so they already had an open eye for it. I was able to surprise them with what we are doing. And people were enthusiastic and listening."*	Menno Swaak of Edible Park
5	*"The Alderman, the government official from the municipality, is actually involved here. But they also have some sustainability departments indeed for the municipality."*	Luuk Rijkx of Urban Farmers
6	*"I think the park here (Zuiderpark) should be an example (of UA). And if the municipality is not doing it, then we have to do it…the municipality doesn't have a strong view on this kind of thig. [It] doesn't really have a vision… plans to change this area to a food theme park. They have been working now on it for four years and it has not been very successful."*	Menno Swaak of Edible Park
7	*"The municipality [has] no targets set, just talk and competition"*	Arn van der Pluijm of Haagsche Schil and Haagse Makers
8	*"[Our] platform is a website to find examples of urban agriculture, connect volunteers and communicate municipality rules [and] inform people within the municipality itself"*	Tom Voorma of Municipality Den Haag
9	*"… [when you are] not having the neighborhood there to buy your produce, which actually makes it difficult to get your connection to the neighborhood… The neighborhood so far is not really involved in this because the produce is more expensive. I don't think it's the best one (neighborhood) in The Hague."*	Luuk Rijkx of Urban Farmers
10	*"One of the problems that we have in terms of circularity is not only not using the energy properly, but also, we're using too much. If you do everything indoors, that means you're going to use more energy the whole time instead of actually using the sun as part of your energy. Yeah that's one of the main costs that we have."*	Luuk Rijkx of Urban Farmers
11	*"We thought at first that we could do without electricity. But we also want to cook, so we need electricity. Or we need a beamer for educational workshops. We wanted to use solar panels, but they don't produce enough… So, we are on the grid. But we would like to have some solar collectors as an example or for the day-to-day functions."*	Menno Swaak of Edible Park
12	*"The people that come here are generally students that are generally more well-off or just being students. And people that have money. That's logical for these kinds of things."*	Luuk Rijkx of Urban Farmers
13	*We plan to cooperate with them (food cooperatives) much more than we do now… we work with our knowledge and their business skills… Right now, we are really only focusing on the educational part or on biodiversity, but not enough on real production. And to really get this working, we need to also focus on production."*	Menno Swaak of Edible Park
14	*"We have a certain responsibility in this city, as well. This city is called "the city of peace and justice." We should be an example. Which feeds into the urgency. It has to be quick, and it has to be soon."*	Menno Swaak of Edible Park
15	*"We make some money from the tours and education. There are some months where we break even, but sometimes it costs more than it makes."*	Menno Swaak of Edible Park
16	*"The sad thing is that the revenue from actually events, not from what we sell. Those are the things that bring in the most money. The produce we don't sell above cost price because we don't have technology to actually do that. You can do it, but then you won't have partners to buy it from you. Which is a difficult struggle to have."*	Luuk Rijkx of Urban Farmers
17	*"With the option that there are subsidies for these people [with a distance to the labor market], it's marvelous. And this was a way that I could do more. Besides that, I'm also*	Annelies Goedbloed of HaagseZwam

	helping the guys. It takes a long time for them to get up the stairs. But every step is at least a step. That's what is happening here."	
18	*"I'm more interested in these grassroots things. They offer work to a lot of people and volunteer opportunities. Which is sometimes seen as a negative thing, as it requires a lot of work. But I think a lot of people like the work and it's also a good experience. The value lies in labor opportunities."*	Pieter Veen of Circular Landscapes
19	*"The Hague is a "circularity desert," not just with food but in other sectors… [there is] lots of interest in circularity, but no one to take the lead."*	Arn van der Pluijm of Haagsche Schil and Haagse Makers
20	*"[With] food policy, [we] wanted to support initiatives like this [and raise] awareness of food and sustainability. We're not actually supporting them as well as we could."*	Tom Voorma of Municipality Den Haag
21	*"[There should be] more protection in the form of support, rather than financing or funding… [like] advice, research to find out who owns patches of desired land, coaching, supervising, introductions to potential partners… [They are] helped in terms of advice on how to plan the organization, how to write papers asking for funding… Sometimes municipality teachers visit initiatives to give advice on greenery and gardening techniques… [They are] Sometimes given leftover materials from municipality landscapers."*	Tom Voorma of Municipality Den Haag
21	*"There's a lot more we can do, at least in this building… you can actually make compost and use it in your building this way perhaps… So, I think in that sense urban agriculture can do a lot more.*	Luu Rijkx of Urban Farmers
22	*"With all the food in this building, we can make a farm for the neighborhood…. On the third floor, there's the KookFabriek where you come and cook yourself. I want to combine things together. Everybody is [here]. Different cultures, backgrounds, colors… together… combining things. Think of the possibilities… We have the space. We have an area for people to cook and sit and eat."*	Annelies Goedbloed of HaagseZwam
23	*"I had a two-hour session with someone from the municipality once, and we were able to share information. But it was too short to look into the future. And the one who followed up after that person left, I had a 45-minute talk with. Which is ridiculous."*	Menno Swaak of Edible Park
24	*I will continue to say I think it (high-tech urban agriculture) is stupid because it costs a lot of energy. Maybe it produces enough kilos and maybe it looks nice, but food that is produced in this kind of environment, food that has the sun and the wind and insects… plants need to be able to grow protection for themselves to grow strong.*	Menno Swaak of Edible Park
25	*"If we work together, we will find a place to expand and build this example and prove that it can be done. And also, we need to take care of each other. Community gardens and urban farms need to take care of each other and help each other with knowledge in order to help us survive."*	Menno Swaak of Edible Park

5.2.2 CUA Sector's Network

Composition

Of course, the main component of the CUA sector is of course the **initiatives** themselves. As previously cited, there are only a few circularity-focused macro-level farms. While those on a more industrialized scale are the main focus of this thesis, it is important to note that other smaller-scale urban gardens can also practice closing or shortening supply chains. Home and community gardeners often collect rain water for maintenance, compost household or garden waste for fertilizer and try to be as 'green' as possible by recycling materials they cannot process on their own. Even though circularity and UA are, "… indeed related, if you look at the very definition of Urban Agriculture," as given on page 10, most of the initiatives of the larger-scale UA sector are far from circular (Kasper Lange, personal communication, August 23, 2018). However, Lange also adds that a few larger-scale UA cases which had their beginnings in traditional organic farming, can be partly circular. He writes that the owners of these CUA companies already rely on knowledge about organic farming, regulations and quality demands, which prepares them for the transition to circularity (Kasper Lange, personal communication, October 8, 2018). Currently, these kinds of initiative are lacking in both number and level of circularity.

The CUA sector also needs **consumers or visitors** since their goal is profitability alongside sustainability. As mentioned, the current case studies vary in terms of whether they profit mostly from customers buying their produce or visitors taking tours and participating in workshops. As a general theme, visitors appear more financially important to the sector than customers since low production and distribution rates limit the development of a consumer base. While beneficial from a social and educational standpoint, the long-term business plans and success of the initiatives could suffer from a lack of regular customers, as seen from the bankruptcy of Urban Farmers (see quote 1, Table 7). The residents of The Hague naturally make up a key component of the CUA sector's network because they are the main customers. While each of the case studies interviewed have very different customer bases, they all agree that providing fresh food to The Hague is their main goal and that the residents of the city are their target audience.

Employees and/or volunteers make up a large part of the CUA network. As mentioned, Urban Farmers was the only initiative with a true employee-bankroll structure. Case studies, circularity experts and municipality representatives all agree that the social value of the CUA sector, such as neighborhood cohesion, volunteer opportunities and job creation for people with a distance to the labor market, is currently the main focus of the sector. This is supported by Kasper Lange of TUDelft, who writes that "… many UA initiatives focus on other things than circularity, such as the social benefits" (personal communication, August 23, 2018). If left unbalanced, a focus on social benefits, while important, could perhaps stand in the way of circularity's environmental benefits.

All of the case studies and two relevant actors mentioned the importance of **food cooperatives** as food buyers, educators and distributors of goods. Organizations like Lekkernassûh create connections to customers by purchasing produce from urban farmers and selling them at neighborhood-based locations. Food cooperatives allow for greater access for the community members to local produce. So far, Lekkernassûh appears to be the only food cooperative in The Hague with a substantial following. Lekkernassûh's website states that they source from, "… farmers and market gardeners as close as possible to The Hague… that we sell in the weekly vegetable package…. we take vegetables from certain suppliers, because their management and cultivation method does not use pesticides or artificial fertilizers and they support the vision to set up a local, resilient, honest food system" ("Waarom Lekkernassuh | Lekkernassûh," n.d.). However, none of their suppliers are within the city limits of The Hague, as can be seen below from their website's map:

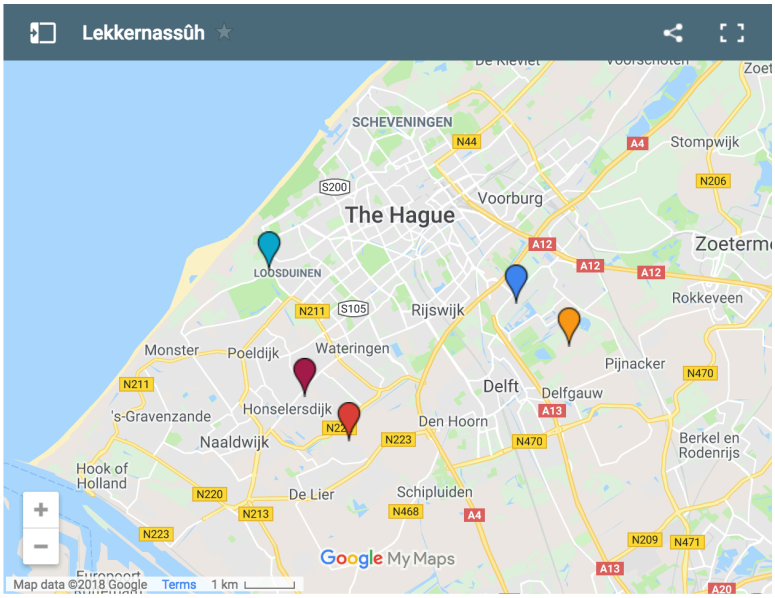


Figure 9 Map of Lekkernassûh's produce suppliers ("Leveranciers | Lekkernassûh," n.d.)

In addition, the website "Boeren & Buren," translated "Farmers and Neighbors," maps out local food distributors across Europe. While they are not specifically focused on urban farms or circular practices, they do stress the importance of shorter food supply chains and connecting people to their local farmers. Upon investigation, The Hague, and the Netherlands in general, has surprisingly few local food distributors like the aforementioned food cooperatives. The map below in Figure 10 shows the only distribution points for local food in and around The Hague. Two of the three are "under construction," while the lone current distributor is actually located in Leiden.

Figure 10 Map of local food distribution points in and around The Hague ("Boeren & Buren," n.d.)

Nevertheless, I include food cooperatives, specifically Lekkernassûh, in the CUA sector network for a few reasons. First, they collect food that would be wasted from farmers markets, which contributes to urban food circularity. Second, Lekkernassûh also allows for "separate sales" where smaller initiatives not on their supplier list can sell their goods under the conditions that the products are completely (or almost completely) biological and they

are locally grown or made. In addition, if you have an organic vegetable garden with overproduction, you can sell at Lekkernassûh ("Single sale Lekkernassûh," n.d.). This food cooperative and others act as gathering spaces for neighborhoods. One CUA case study believes that food cooperatives are the future of local food (see quote 4, Table 7). Because of the small production levels of the current CUA sector, connections with food cooperatives are currently not as strong as they could be, but definitely appear promising because of their similar missions and apparent enthusiasm for collaboration.

The **municipality**'s main function in the CUA network is providing subsidies or facilitating CUA initiatives with their network formation or expansion. All of those interviewed mentioned the indispensable value of a positive urban farmer-municipality relationship because of their financial dependence, at least initially, on government support (see quotes 2 and 3, Table 7). Tom Voorma of the municipality lists connecting, facilitating, acknowledging, supporting, lobbying, giving platform and promoting as roles of the municipality in CUA development and expansion. (personal communication, August 7, 2018). The municipality has a management and financial role in the development of CUA.

The **New Farm building** is also a key factor in the current CUA sector of The Hague. The repurposed building houses several circularity-based startups and offices, including two of the interviewed case studies. Urban Farmers mentioned that the building is not only important to the CUA sector because of its tenants, but because of its ties to the municipality. Rijks states that the New Farm leases the building directly from the municipality, making its success a prime interest of the city (see quote 4, Table 7). The failure of Urban Farmers was undoubtedly a blow to the reputation of the New Farm building and the municipality, who appeared to favor this initiative (see quote 5, Table 7).

Nonprofits and Environmental Organizations like Duurzaam den Haag, Stadslandbouw Den Haag, Stichting Lokaal Voedsel Den Haag, Natuurlijk in je Kracht, Milieudefensie and Permacultuurcentrum Den Haag are also connected to the CUA sector network. The first two appear to be directly connected to the municipality and a middle man for communication between the city of The Hague and urban farmers. The other organizations are separate entities but still influence the CUA sector with education, events and workshops. Though the Duurzaam Den Haag's website lists all of these organizations as partners in urban agriculture, no case studies mentioned them except the Edible Park, whose founder is also the founder of the Permacultuurcentruum. As mentioned, they appear to be sources for residents rather than for the CUA initiatives themselves.

Utilities like energy, water and municipal waste management are currently a part of the CUA sector network, although the hope is to diminish reliance on these in the future (see quote 6, Table 7). Some energy providers include, but are not limited to, Eneco, Nuon, energydirect and Engie. Dunea appears to be the sole provider of water for The Hague. A private company, Renewi Overheidsdiensten BV, manages and controls household waste, but HMS (Haagse Milieu Services) is responsible for physical collection and transport. However, large companies are obliged to take care of their waste themselves, meaning they often hire independent companies. While there are utility companies dedicated to sustainability, having multiple companies creates a lowest price-driven market instead of one focused on sustainability.

Lastly are the **neighborhoods** surrounding these CUA initiatives. These communities are the core of urban development and acceptance of niche technologies like CUA. However, the case studies and those involved with the municipality stated that neighborhood involvement is not nearly where it should be for a healthy UA system (see quotes 7 and 8, Table 7). Neighborhoods both house the initiatives and provide the customers necessary for success. Without reaching out to or matching the demands of surrounding households, CUA has little hope of becoming more integrated into The Hague's food system.

Interaction

As mentioned, interactions between CUA initiatives themselves are almost nonexistent, making the sector weak even as circularity and local agriculture grow in popularity. Initiatives could interact on several fronts, including knowledge-sharing, material flows and simply cooperating toward their obvious common goal, but resource competition or lack of awareness seems to override these possibilities (see quotes 9 and 10, Table 7). The only evidence of some sort of collaboration resides in existence of the Permacultuurcentrum, which is a catch-all for permaculture-based gardens. However, there could be a change in the future, as the Permacultuurcentrum is planning a festival to bring together all agriculturalists, especially those growing in cities, inspired by natural cycles. Hopefully, this will be a platform for different initiatives to come together and develop new relationships. The Edible Park expressed hopefulness when discussing teamwork between members of the CUA network, demonstrating that there is potential for a more integrated, cooperative network (see quote 11, Table 7)

Interviews with the municipality, circularity experts and CUA case studies brought to light the limited, yet potentially fruitful, interactions between the CUA sector and food cooperatives. Customers have the opportunity to conveniently purchase locally-grown produce through cooperatives like Lekkernassûh, rather than through the initiatives themselves. However, as seen earlier in Figure 9, "local" farms are still kilometers away and cooperation between urban farms, under the current definition of CUA, and organizations like Lekkernassûh is underdeveloped (see quote 12, Table 7). Interactions are on too small of a scale and must grow to truly impact the sector and become a key actor. While the Edible Park mentioned that their sister permaculture farm cooperates with Lekkernassûh, it appears that no other "urban" farm sells their produce there. This could be because urban farms cannot produce enough to provide a reliable supply to the cooperatives, which ultimately run on a profit platform. There is a definite room for improvement in this relationship, especially as CUA initiatives gain more support and are able to produce more steadily and on a larger scale.

On the surface, interactions between the municipality and the whole of the CUA sector might seem strong. There are designated pages on the city's website related to sustainability subsidies, maps of the initiatives, promotions for the New Farm building and education pages for residents on how they can compost ("Haagse Initiatieven - Stadslandbouw," n.d.; "Separating waste: Organic waste (GFT)," 2017; "Subsidie duurzaamheid aanvragen," n.d.) . However, there is no straightforward mention of how the municipality works *with* this unique sector or advertises its productive potential. The municipality agrees that communication between themselves and the CUA sector could be better, although there does not seem to be a platform to do so (see quotes 13 and 14, Table 7). In addition, communication within the municipality itself, especially between departments that should work together toward a

more circular city, is lacking (see quotes 15 and 16, Table 7). This lack of inter-departmental communication is not visible to the outsider eye and may lead to many of the problems facing the sector. However, this may be due, in part, to the newness of UA as a sector, the intricacies of changing existing policies and tough financial times accompanied by budget cuts (Voorma, personal communication, October 22, 2018). This valuable information gives perspective on the complexities of city-wide projects and the communication necessary to grow a niche.

Dynamics

On a positive note, actors acknowledge that the CUA sector grew in recent years, with tech-based initiatives gaining the most traction in The Hague in the New Farm building in particular. The municipality adds that those starting the new initiatives come from more diverse backgrounds and focus on making partnerships with city planning, housing corporations and other businesses (see quote 17, Table 7). This, hopefully, points to continued growth in the CUA sector and more opportunities to implement circularity because there is high-level learning on all levels of CUA. However, initiatives are also failing. While this is not surprising in such a young market, it is worth noting that the municipality's "favorite" initiative and the largest of this thesis, Urban Farmers, went bankrupt during research, proving that the sector is still extremely unstable.

Like the poor dynamics between individual initiatives and the municipality, relationships are strained between the entire CUA sector and the city government. Tensions appear high and trust seems low. While the municipality says that there is a growing interest in the environmental and economic benefits of CUA, sector members argue that all of this talk does not translate into action (see quotes 16 and 18, Table 7). According to Tom Voorma of the municipality, some city farms already serve as salespoints for regional farmers, which was not mentioned by the urban farmers themselves (Voorma, personal communication, October 22, 2018). Despite which perspective is the most accurate, this mismatch of opinions further limits network growth and cooperation.

Finally, case studies and municipality representatives alike claim that there are definite tensions between the CUA sector and the surrounding farmlands of Midden-Delfland and the Westland. The rhetoric conveys a lack of acknowledgement and appreciation from both sides because the two groups see themselves in direct competition for resources, customers and municipal support (see quotes 19, 20 and 21, Table 7). Rural farmers often seem to believe that they are not acknowledged for already working towards sustainability (Voorma, personal communication, October 22, 2018). These city-edge farms, especially those of Midden-Delfland that are more experimental and do not rely on greenhouses to support the global food market, could be a huge asset to the CUA sector network but is currently not being utilized to expand its reach.

Table 7 Interview quotes related to network formation of the CUA sector

Nr	Quote	Interviewee
1	*"There have been some management decisions that not everybody agreed upon. Some work out some don't. It's the risk of having a business. It can fail. When you join (the sector), you're also a new start up, which can mean that within a year you are without a job... what we're doing, as well as with Haagse Zwam, is trying to make a business model… I think in terms of the business models, it's proven just to be difficult. [Our] business model is very difficult to actually be profitable with just a greenhouse. Because you are next to the Westland, you have higher prices [here] (for produce). It costs you more to run [because] you have a lower scale of production. So, in that sense, the company purely selling produce is not going to be viable."*	Luuk Rijkx of Urban Farmers
2	*"… another partner is the Fred Fund which I think stands for funds economic development in The Hague… It used to be governmental… They're part of our financiers as well as part of our shareholders."*	Luuk Rijkx of Urban Farmers
3	*"When it (the Edible Park) started, they (the municipality) did [give us subsidies]. It was also a green political year. So, they had budget for green projects."*	Menno Swaak of Edible Park
4	*"… politics plays a huge role in this building. I think because it's partly funded by the municipalities."*	Luuk Rijkx of Urban Farmers
5	*"I think the municipality is learning more and more. Especially since a lot of their plans are failing. Like Urban Farmers."*	Menno Swaak of Edible Park
6	*Circularity in The Hague should be possible, especially for organic streams because of the high density All flows are represented, it's a matter of changing existing value chains. So much effort, energy, and waste go into municipal-level compost."*	Gerko Brouwer of Circulaire Zaken
7	*"… having them (the neighborhood) properly here can actually strengthen your whole case as well. The neighborhood so far is not really involved in this because the produce is more expensive."*	Luuk Rijkx of Urban Farmers
8	*"[There is] too much of a gap with the surrounding communities [and urban agriculture]."*	Tom Voorma of Municipality Den Haag
9	*"They (urban farms) almost all stand alone. They just start and maybe find each other somewhere down the line."*	Tom Voorma of Municipality Den Haag
10	*"There was another group of people who started working on healthy food from healthy soils and working with the farmers and the neighborhood. Bringing farmers and citizens together and helping farmers act in a more circular way. At that time, some people really didn't like us. I noticed a resistance to us. So, it's not easy to get open communication."*	Menno Swaak of Edible Park
11	*"If we (UA initiatives) work together, we will find a place to expand and build this example and prove that it can be done. And also, we need to take care of each other. Community gardens and urban farms need to take care of each other and help each other with knowledge in order to help us survive"*	Menno Swaak of Edible Park
12	*"[Lekkernassûh is a] project around food cooperation. They have food from farms around, people can make their own food. I heard it's a community project. And it's also connecting with farms around the area. I work with some farms who give their food there. It has a larger involvement of the consumers… There could be more connection between these."*	Pieter Veen of Circular Landscapes
13	*"Maybe together [urban farms] could work to get more attention and advertise their benefits, which could lead to more political support… The municipality could also help them out to get started by offering to advertise the knowledge and benefits for society."*	Tom Voorma of Municipality Den Haag
14	*"[They] don't know where circularity fits… The municipality [has] no targets set [toward circularity or urban agriculture], just talk."*	Arn van der Pluijm of Haagsche Schil and Haagse Makers
15	*"[The municipality] is a "broker" of knowledge and connections… Currently, subjects/teams within government are fairly separated and need to communicate better."*	Tom Vorma of Municipality Den Haag
16	*"[The municipality] built a 'façade' that they are doing stuff related to urban agriculture and circularity, but they actually don't know what they're doing. The term 'circular economy' wasn't even on municipality agenda…No policy arises from talks… [they] don't know where to start"*	Arn van der Pluijm of Haagsche Schil and Haagse Makers
17	*"… more diverse groups [are] starting these initiatives… [There is] more diversity in implementation and cultivation within partnerships [like] reintegration, city planning, housing corporations [and] businesses in harvest or material… Different types of UA are developing as well. [They are] not just a patch of land in the middle of the city, but more advanced techniques like the HaagseZwam and Urban Farmers… [They have] different backgrounds and learn more about business or sustainability [because of that]."*	Tom Vorma of Municipality Den Haag
18	*"I think there is a lot of talk about how important it is to support it (CUA) and to change local production methods. Some policies even say it's important. But when you go look and see what the chances actually are, they are very limited. The big chains and supermarkets still are the focus of policy. That's a big contradiction within the whole agricultural system."*	Pieter Veen of Circular Landscapes
19	*"I did a kind of project in the Westland area, and there they were like, 'Okay, well what they do in The Hague is peanuts. Here is the real thing'"*	Pieter Veen of Circular Landscapes
20	*"[Urban farmers] could cooperate with Westland… [they are] really productive and innovative but don't sell to city folk and complain they're not accepted (in how they*	Tom Voorma of Municipality Den Haag

	already try to produce in a sustainable way) … The municipality could facilitate distribution spots for local agriculture from the Westland and Midden Delfland."	
21	*"I think one of the main shareholders that we're missing are not shareholders, but stakeholders, is the Westland itself. So far, they're not really integrated in it. They're also looking at us from an angle of, "What are you doing? What do we have to do with it?" They see us as competitors. Well I think it is more complementarity actually, not really competitor."*	Luuk Rijkx of Urban Farmers

5.2.3 Network Conclusions

The networks of the CUA case studies and the CUA sector are quite similar because they require the same resources and connections to be successful. Compositionally, CUA case studies appear content with *who* is involved in their individual networks but displeased with the *level* of interaction. The main stakeholder missing from the CUA sector's network are more rural agricultural areas like Midden-Delfland or the Westland. Midden-Delfland could be a fitting addition to the network because of its already entrepreneurial and innovative nature ("Home - Midden in Delfland," n.d.). Currently, there is very little interaction between the CUA initiatives and rural farmers and very little emphasis on creating a locally-driven food system. With this in mind, another missing entity could market spaces for the agriculture produced in these areas.

Related to interactions, the overarching themes appear to be a lack of communication, cooperation and support between the case studies themselves, the municipality and potential customers. All parties convey that most interactions between the CUA sector and outside parties occur during tours or workshops. This applies to both customers and potential business partners. CUA case studies, members of the municipality and circularity experts alike addressed the lack of interaction between customers and the urban food producers due to high prices, lack of productivity or inaccessibility. There also appears to be a lack consistency when residents of The Hague try to interact with the CUA sector. Urban Farmers operated directly with customers, requiring them to visit the New Farm to purchase their food. HaagseZwam collaborates strictly with restaurants in The Hague, making them the middlemen between the farm and consumers. The Edible Park, while not currently selling produce, wants to sell mainly through food cooperatives. The lack of stable customer-to-sector relations damages the CUA sector's reputation as a feasible alternative to the urban food system regime. In this sense, interactions must become more streamlined and widely available.

As for interactions with the municipality, they are also lacking in efficiency and transparency. While both parties acknowledge the municipality's crucial role in strengthening the CUA sector's network, financially supporting the sector and communicating more often and effectively, there appears to be a lot of talk with no affirmative action. Sector-wide network interactions must be both robust (strong) and stable (often) in order to stand a chance at competing with the current food regime. Furthermore, the CUA initiatives mainly focus on circularity within themselves and not with other farms or like-minded organizations. This is partially because of laws preventing them from exchanging materials but may also be a result of undeveloped awareness. These missing interactions could be the key to CUA's success because initiatives would truly be able to embody the circular mentality and increase their resource efficiencies.

Finally, there appears to be a lack of trust between individual CUA practitioners and the municipality, which expands to the entire sector. To many of the CUA initiatives, the municipality seems uninterested and distant. While the municipality agrees that it could do better, representatives also insinuate that communication and harmony are increasing, signaling a difference of opinion. One thing the two parties can agree on, however, is the palpable tension between urban farmers and more peri-urban or rural farmers. With the aforementioned potential benefit of their incorporation into CUA network composition, this lack of understanding and communication must be put to rest in order to make CUA a part of everyday life in The Hague.

5.3 Learning

5.3.1 Learning on Individual Initiative Level

One of the common learning lessons from the CUA case studies was how to balance their desire for circularity and the **technological development and infrastructure** required for working farm. Many of the initiatives had the intention to either initially or eventually incorporate renewable energy solutions or water reuse systems, which incorporated **economic and environmental aspects** as well. The CUA initiatives soon learned that the economic feasibility of providing their own energy while trying to run a nonprofit or low-profit business was nearly impossible. This was especially the case for Urban Farmers, whose aquaponics system, greenhouse and event space used a large amount of electricity, which was simply taken from the city's energy grid. Despite their desire to provide some of their own energy via solar panels, Urban Farmers learned that the scale at which this was possible at the New Farm would not make a significant difference and that they would likely always rely somewhat on grid-based energy. In fact, energy, gas and water use were all problems for Urban Farmers (see quote 1, Table 8). These sentiments were carried through a majority of the CUA case studies, as they also recognized that they could not be completely self-sufficient, at least for now. This is especially true for the multi-functional nature of high-tech initiatives, which need consistent and reliable sources of energy and water for growing technologies, events, workshops and tours. The case studies also stressed that off-grid renewable energy technologies can be expensive and require daily monitoring, which proves challenging since most do not turn a profit or are not open every day of the week (see quote 2, Table 8).

Learning about the **development of user and market contexts** on an individual initiative level, of course, depends on the initiative. For Urban Farmers, users were typically wealthy and well-educated about sustainability. They were also interested in the high-tech applications used and, through tours, took away knowledge more so than produce. Urban Farmers had to learn about the disadvantages of their business-to-customer model brought about by disparities between their high-cost produce and their surroundings, which was not "the best neighborhood in The Hague" (personal communication Luuk Rijkx, June 19, 2018). Since customers had to visit the farm in order to buy produce, aligning prices with neighborhood financial abilities would have been more effective. Since this was not possible, Urban Farmers learned the hard way that a business-to-business model works best for a high price niche practice. HaagseZwam took this business-to-business approach with picking up raw materials (coffee grounds) and delivering products (mushrooms) to restaurants. Because of this, HaagseZwam had to learn about not only who would buy the mushrooms, but who could donate or sell coffee grounds to them from within the city. While not all those

involved in HaagseZwam's market might be as circularity- minded as the initiative itself, the model is a win-win because restaurants can sell or donate their waste and receive a high-quality product in return. The classification of a "totally local product" is also a selling point and could attract new customers or supplying/purchasing restaurants, which could influence the meaning they attach to HaagseZwam's services. Circularity could become part of their identity as well. HaagseZwam learned this and uses it to encourage partnerships, as is communicated on their website with, "… we are very proud of our customers. They put a nice sustainable product on their card" ("HaagseZwam," n.d.). The Edible Park, on the other hand, bases its market around education and a "connection with nature" rather through selling produce. While they are looking to expand the profitability of their market, they will always undoubtedly cater to users who prefer natural and relatable farming to high-tech CUA initiatives. The Edible Park has also learned that their market is expanding due to increased interest in learning about where food comes from and how it can be grown on a smaller and visible scale (see quote 3, Table 8). This is different than when the initiative first started, as leaders and volunteers in the Edible Park noticed a resistance to their integration. They soon learned that open communication, even when in very close proximity, is difficult to manage and create rifts in market context (see quote 10, Table 7). The user and market contexts of the individual CUA case studies vary widely, which contribute to a wide variety of learning experiences that are valuable to the whole sector. However, most of the initiatives also learned of the difficulties of growing and developing strong market and user networks due to supply and demand mismatches, legislative limitations, or high prices that segregate some potential customers.

The main **social components** learned by individual CUA initiatives relates to the importance of this hands-on, rewarding work to those with a distance to the labor market. While only HaagseZwam cooperates directly with the Social Services Department of The Hague to fulfil this role, the other two initiatives learned about the benefits and spoke highly of HaagseZwam's social services. Another component of social learning is the importance of communication. While this is not a completely new realization, as it was emphasized as one of the main roadblocks to growth, the CUA initiatives each voiced their own personal struggles related to transparency and open communication with the municipality. (see quote 4, Table 8). Without openness and interaction, a niche practice will be stuck and unable to find a place in the well-established regime.

The **regulatory frameworks** and policy instruments surrounding resource procurement further complicate matters for CUA case studies, including policies for water purification and material reuse. Although not completely clear what they are, a major learning lesson for individual initiatives stemmed from this unknowingness and lack of transparency from the municipality regarding organic waste treatment and material exchange. All of the case studies and even some circularity experts mentioned their interest in on-site composting or exchanging their materials to create a more "inter-circular" supply chain. However, after learning about governmental restrictions regarding compost for growing food, the case studies were forced to simply throw out their organic waste, separate it through the municipality, or externalize their waste treatment through an independent company. Because waste management is not controlled by one consistent entity and is so integrated into the landscape of The Hague, initiatives have no control over their waste's fate (see quotes 5, 6 and 7, Table 8). The CUA initiatives cannot fulfill their ultimate goal of circularity and seem to feel helpless in the matter.

Learning at an individual initiative level can be incredibly insightful for the whole sector because each initiative has different drivers, barriers, and experiences that create an environment of learning. Taking learning lessons of individual initiatives together can help map out what must be learned as a sector. While most of the aforementioned lessons would be considered first-order learning because of their more descriptive tone, they are extremely useful in understanding where the niche is and what knowledge has to be expanded upon to reach a regime status.

Table 8 Interview quotes related to learning on the initiative level

Nr	Quote	Interviewee
1	*"Gas is used for heating the fish primarily, but also in winter you have to heat the greenhouse. Which [uses] a lot of gas. For tilapia to taste properly, you have to purge it first. Which means you're cycling clean water through the system for five days in that one tank. It uses a lot of water but for the quality and what people want the in terms of taste, you have to [do it]."*	Luuk Rijkx of Urban Farmers
2	*"We started once to build our own water system. Collect the water off the roof. But then, we found out it's too risky because you have to filter it many times and store it correctly. And when it's getting warmer, there's the danger of bacteria. If you were in a place where the water was used daily, it's okay. But sometimes here, we won't use the building for four or five days. So, we would have to make sure someone was here to clean out the tanks."*	Menno Swaak of Edible Park
3	*"There's much more interest in learning about where food comes from and how it can be grown on a smaller, more intimate scale is really growing."*	Menno Swaak of Edible Park
4	*"I'm hoping that new members in the municipality have a different view than they do now. They have plans for the environment and they invited people from Wageningen to advise them, but never asked us about our thoughts. They had open nights for everyone to give their ideas, but they never just sat with us to talk about it. I'm the one person here who has been working for 8 years and is here most of the time. I'm here at different times of the day and the year. I know what is happening here. So, that's the kind of experience they could use."*	Menno Swaak of Edible Park
5	*"The next step is figuring out the compost. There are so many steps to make. There's so much opportunity. They seem small, but they can make a difference. We are adding value. Which is not value with money, but value with nature…The next step should be taken. Don't make it harder for me to do so with tax and regulations and law. Help me out."*	Annelies Goedbloed of HaagseZwam
6	*"The main reaction from government is that only the municipality is allowed to collect waste… Compost from waste to redistribute to neighborhood is not the focus because of regulations, they focus on energy production."*	Arn van der Pluijm of Haagsche Schil and Haagse Makers
7	*"The municipal waste system is not interested in this kind of local thing because they want to do it on their large scale and with contracts. And it's very hard to change that."*	Pieter Veen of Circular Landscapes

5.3.2 Learning on the CUA Sector Level

On the whole, the case studies and circularity experts seem to learn much of the same information regarding the CUA sector despite their apparent lack of communication. The bankruptcy of Urban Farmers brought to light the most commonly-shared learning lesson for the niche, which is that circularity, both technologically and incorporated into a manageable business model, has a long way to go and urban agriculturalists still have much to learn in terms of **industrial development and governmental policies**. All of the CUA case studies and two of the external actors voiced that they have learned about the difficulties of creating a sustainable business model around circularity because of its "niche within a niche" status and insufficient protection from market forces. (see quote 1, Table 9). Without financial or policy-centered protection, these initiatives are hampered by competition and lack of resources. The municipality recognizes this as well, making this lesson one that all parties can continue to learn from and address in the future to encourage sector growth.

As in previous years, sustainability is a growing trend in community conversation and supports initiatives related to circularity, nutrition and local production. Actors were glad to learn that the **social components** of CUA, like providing community spaces and access to nature, are gaining attention and becoming a part of many initiatives' business models. However, all of the CUA case studies voiced that social services cannot be the only resource offered by local farmers in The Hague. They recognize the importance of **economic and environmental aspects** like a customer base, drawing a profit from sales and not just from tours or workshops and environmental aspects like reduced CO2 and decreased chemical fertilizer use. Although two of the three case studies did sell their produce, they were not yet profitable and reaffirmed the argument that a business-to-business model works better than business-to-customer for a developing niche (see quote 2, Table 9). Interestingly, the external actors, especially the municipality, seem to focus on and learn more about the social benefits CUA rather than the economic possibilities. So, while initiatives are trying to move toward more business-focused approaches and create a true place in the food market, the municipality appears stuck on the social benefits. Actors must learn about all sides of CUA for it to expand its reach into the food regime.

Furthermore, network actors, especially those in the supply chain group, learned about the importance of the **development of user and market contexts** through accessibility and approachability with CUA. Larger initiatives need more space and often incorporate newer innovative technologies, which can limit relatability and prevent them from being fully incorporated into neighborhoods. Many CUA initiatives, like Urban Farmers, end up distancing themselves from their most immediately-available customers with their high prices high and lack of visibility. As a result, the customer base for Urban Farmers was mainly wealthier, more educated individuals who were willing to travel to the farm for produce or tours. This created an ever-increasing rift with the surrounding less well-off neighborhood. Urban Farmer's ultimate bankruptcy, perhaps partially contributable to this phenomenon, was a learning lesson for the entire CUA sector to balance prices with customer bases. The municipality certainly absorbed this experience with years of money and marketing invested in the hopes of a revolutionary CUA hub (see quote 3, Table 9).

User and market contexts also involve learning about the meanings that users attach to the niche. In this case, the municipality especially learned of the diversity of motivations for creating food, sustainability and circularity startups. The CUA sector is growing in variety of partnerships, which hints at a positive potential for interesting conversation and innovation (see quote 4, Table 9; quote 5, Table 7). Tom Voorma of the municipality claims that this is because people are combining their inner drives with professional approaches to circularity and sustainability. Also, in the interest of circularity, customers should be as close as possible to the initiative, meaning that the sector needs to adapt to its surroundings instead of the other way around. Circularity experts and municipality representatives did not heavily address affordability as a form of accessibility, but rather focused on physical convenience. Again, Urban Farmers was on the top floor of a building quite isolated from other companies or marketplaces. Their customer base, which developed from their high-tech approaches and high prices, had to go out of their way to purchase or collect their circular local produce. The actors learned the importance of visibility and ease of access in the CUA sector, especially while there is no central distribution point for local produce and connections with food cooperatives and grocery stores are limited.

The greatest learning lesson and the most addressed by the most CUA initiatives and external stakeholders alike is that making connections between rural farmlands like Midden-Delfland and the Westland would be beneficial to the growth of CUA (see quotes 5 and 6, Table 9). Looking at the CUA sector from a broader spatial perspective is necessary in order to maintain and develop a strong place in the city. Especially in an area as agriculturally-fruitful as North Holland, there is much to learn from cooperating with other farmers with years of experience. Rural farmers are trying to fit their products into urban demand, but without meeting them halfway and creating productive collaborations, the two potential partners will remain separate entities.

Table 9 Interview quotes related to learning on the CUA sector level

Nr	Quote	Interviewee
1	*"Circularity is in a very early stage. From a technical perspective, a lot of cycles can be closed, and many initiatives have been created [in] the past years. But it seems to be very hard to create a sustainable social business network. Circularity means interdependency, and when one or more stakeholders quit, the circular network must be resilient enough to survive this loss. UA is mainly small scale, and therefore it can't simply compete with large scale agriculture companies."*	Kasper Lange of TUDelft
2	*"So, then the question is "is this the perfect location?" I don't think so. But you can be creative. I think B2C for a niche doesn't work. Or you should really do it in Amsterdam, Rotterdam, or in the city center. With a lot of traffic. Which you don't have here."*	Luuk Rijkx of Urban Farmers
3	*I think the municipality is learning more and more. Especially since a lot of their plans are failing… like Urban Farmers."*	Menno Swaak of Edible Park
4	*"Since the birth of this movement… [I have seen people of] different backgrounds starting sustainable businesses and urban agriculture. They are learning to widen their view."*	Tom Voorma of Municipality Den Haag
5	*"But actually, having them (Westland and Midden-Delfland) properly here can actually strengthen your whole case as well, which hasn't been done so far."*	Luuk Rijkx of Urban Farmers
6	*"I also think that new entrepreneurs who are active in urban food could also expand to the agricultural land around cities. I think there's a growing group of these people, because in the rural areas you have more space and more opportunities. There are a lot of ideas coming up, so I would expect more urban farmers to start with this idea… Why shouldn't a new innovative person be able to take over with new ideas? It's impossible [now]. If that would change, then I think there would be much more innovation in the areas around the cities. Then you could really make the connection between cities and rural areas.*	Pieter Veen of Circular Landscapes

5.3.3 First and Second-Order Learning

A majority of the previously discussed learning, especially that which is done on an individual initiative level, would be considered "first-order learning" because of its focus on *how* things are done, instead of second-order learning, which addresses *why* they are done in the first place. First-order learning experiences are important for establishing short-term goals because they provide guidelines to what practices can be changed without necessarily addressing the underlying components of the landscape. For example, CUA case studies could increase their advertising to solve the short-term problem of a limited customer base, but without considering their fundamental beliefs or evaluating the core market, long-term progress will evade. Because of the individuality of these situations and how short-term learning occurs within them, sector-wide learning based solely on initiatives' personal experiences might not be the most effective method to support long term CUA development. This backs the already defended point that second-order learning, such as learning about the underlying rules associated with the sector itself, is necessary to expand a niche's hold and move into a regime practice.

Learning on the sector level is often considered second-order because of its cooperative nature and the need to test underlying structures that affect everyone involved with, and perhaps even beyond, the CUA sector. Individual initiatives can also experience second-order learning, but this usually occurs before the business has even begun and is thus difficult to assess retrospectively. Higher-level knowledge development can especially be seen in the redefinition of a problem or changes to problem-solving measures and are now presented in support of CUA's potential to grow.

Problem Definition Shifts

The CUA case studies and external actors all had to redefine themselves or their goals in the midst of the niche's development because of the intrinsic uncertainty that accompanies any transition. A major problem shift that came from the ultimate goal of urban agriculture itself. Optimistically, many actors entered this sector with the goal of feeding the city. Through experience, they learned that city-grown food, especially using CUA techniques, will probably never produce even half of what is needed due to deeply-engrained dietary habits, lack of space and urban climate challenges (see quotes 1 and 2, Table 10). The question is now, "to what extent *could* CUA feed The Hague?" Along with that idea comes the new questions of "does regional food have to cooperate with retail, which decides 90% of what we eat, or can it make its own rules?' and "do we have to break down the regime completely of just made minor adjustments to make it fit a local urban food system?" (personal communication, Jansma, September 6, 2018). The municipality and urban growers alike seem eager to answer these questions, despite their obvious complexities, over the coming decades.

The main problem shift, however, occurred in answering the question, "Why should we incorporate urban agriculture and circularity into The Hague's urban structure?" Many who were originally only interested in green infrastructure creation now see CUA and edible landscapes as protective devices against climate change and changes in the global market. Questions of using urban farming to supplement The Hague's food market are now seen by some as more of a necessity and a *requirement* for the city's food system (see quote 3, Table 10; quote 4, Table 6). CUA may become the core of the resilient city. Both actor groups also stressed the importance of social services that accompany CUA in addition to the environmental benefits. While many actors said they were previously aware of the social benefits, they did not experience the true impact until they entrenched themselves in CUA network. This was especially true for the social value provided to those with a distance to the labor market (see quote 4, Table 10). One initiative, HaagseZwam, even altered her initiative's mission to incorporate this social aspect, rather than just encouraging local, healthy, and sustainable food as originally defined. The municipality recognizes and supports the social benefits, as mentioned previously, with their focus on providing green spaces for citizens to recreate and relax (see quote 5, Table 10). However, it is unknown to what extend food production will be part of their plans. The challenge will be balancing the social and the economic aspects of CUA initiatives and keep the problem definitions stable.

Problem-Solving Shifts

The CUA case studies shared communal knowledge regarding changes in problem solving techniques for the sector's success. In the wake of Urban Farmers' bankruptcy, they and other members of the CUA sector learned that

business-to-business setups work better and are more profitable for niche technologies like CUA. The hope is that using a more forgiving and widely-accessible business model will help solve issues with profitability and prevent initiatives from having to only serve educational purposes to make ends meet (see quote 6, Table 10). While socially beneficial and part of the foundation of CUA, a profitable and sustainable business model is the ultimate goal for the sector. Many in the CUA sector embrace food cooperatives as middle-men to fulfil this goal of making profit while maintaining their socially-conscious platform. A few actors made the case that food cooperatives like Lekkernassûh are the future of local and urban agriculture because they solve the problems of accessibility for customers and profitability for producers (quotes 7 and 8 Table 10).

Circular business models, especially those using high-tech solutions, are still developing and are not stable. As a result, other sectors are also hesitant to adopt closed-loop models. Several actors mentioned that modeling human-created systems after natural processes, like is used in permaculture and natural water filtration, can inspire others within and outside the agricultural sector to adopt circular business models. This comes from experimentation and years of experience, with some even saying that they were astounded to see how well nature works (see quote 9, Table 10). While these methods will not be suitable for every urban-based sector experimenting with circularity, it could help solve the stagnation problem cities are facing in the transition to a circular economy.

Table 10 Interview quotes regarding second-order learning

Nr	Quote	Interviewee
1	*"… you could investigate how much food a city could produce for itself. It could maybe be 25%, which is still a lot, and how could you do that… or you could see urban agriculture as a type of experimentation… It's not so much about whether you could feed the city or not, but more about innovation, technological and social. So, then the first question is, 'why would you want to promote urban agriculture? What's the real perspective?" It won't feed the city. But it would be interesting to say, though, okay… but to what extent could it?'"*	Pieter Veen of Circular Landscapes
2	*"… it will not be the main food supplier for the city, since the city requires so much food, that there is simply not enough space to grow it. Even with technologies such as vertical farming. In my opinion, large scale (precision)farming in rural areas will remain the largest food supplier."*	Kasper Lange of TUDelft
3	*"… to study how to build a sustainable system that can then be scaled up. Climate is changing, especially with extreme weather. We need to make sure urban agriculture is resilient enough to keep producing despite that. We also want to get more experience with the resources you would need if there comes a situation when the city or the country cannot import the same amount or the same kinds of food."*	Menno Swaak of Edible Park
4	*"In the first permaculture garden I was working in, I did not understand much of the basic theory behind it. But I thought what it did for people working there was great. People with health problems or with distance from labor. For some, it really worked as a healing garden."*	Menno Swaak of Edible Park
5	*"The municipality had a whole day where they demonstrated the different positions in their departments. They have been working more and more on providing green spaces for people to recreate and spend their time. They have become aware that things are changing…"*	Menno Swaak of Edible Park
6	*"Over time you see that many companies change their business models towards education and recreation, to make ends meet."*	Kasper Lange of TUDelft
7	*"We also want to partner with Lekkernassuh, because I think that (food cooperatives) is going to be the future of local food. I see it as a turning point for local food."*	Menno Swaak of Edible Park
8	*"It (Lekkernassûh) has a larger involvement of the consumers. So, you have those initiatives from the production side, like the urban farmers. But, you also have initiatives from the consumer side like these food cooperatives. There could be more connection between these."*	Pieter Veen of Circular Landscapes
9	*"Now I'm working with a big permaculture farm, which I didn't have a lot of experience with. But I'm involved in this big project, and I think it's really astonishing how they can use all of these natural processes from the soil and water and trees and animals and the food production in a whole system. It takes more time to invest because you don't have your products the next year. It takes a longer time, so you need*	Pieter Veen of Circular Landscapes

	more time for starting up this farm. But then, if it works, then you don't need a lot of inputs like manure or pesticides. The system itself arranges that."	

5.3.4 Learning Conclusion

Many of the learning processes related to the individual CUA case studies were different because of the initiatives' various states of development, size and business structure. Supply chain actors have developed a distinct knowledge system from years of experimentation and experience with the unique aspects of The Hague. Initiative-based learning mainly addresses economic, market and technological aspects like the importance of productivity, the benefits of using a business-to-business model and the challenges of incorporating renewable energy technologies into niche-level practices. These lessons, especially those related to business models, are essential for the growth of CUA. Without economic success and a stable place in the market, the municipality might not be as willing to support the sector's development, despite any desire to make the city more sustainable. In the end, learning requires trying and often failing in the search for successful strategies, which can only be achieved through cooperation and wide support.

On the other hand, there appears to be a high degree of cohesion of learning themes regarding the CUA niche as a whole. This is promising for the further development and integration of CUA in The Hague because cohesion creates strength. In other words, the more actors that are on the same page, the easier it will be to have conversations about growing the niche and commit to future developments. Second-order learning around the social components of CUA, like jobs for those with a distance to the labor marker, hints at the growing support for CUA as both an economic and social services contributor. However, there was little learning with regard to waste management policies and how to change these to be more circularity-friendly. Supply chain actors seem to know some of the rules around waste management but do not completely understand the details or why they are so. This could change in the future because of the early stages of the CUA niche, but is worth noting as waste management and nutrient cycles are the core of CUA. Urban farmers seem frustrated by the lack of transparency around what could change to make their sector more successful or how to appease the municipality. This information could be held by the municipality but is not yet communicated effectively to the individual initiatives. Environmental learning lessons were also fleeting, which could be due to the lack of monitoring within the initiatives. Without keeping track of emissions, resource use or material reuse, very little can be learned about the impacts of the sector or how to improve. CUA integration will not be fully realized until CUA initiatives, more rural farmers and the municipality see each other as assets for fixing the same problem and share their learning experiences. Support from the top-down in terms of subsidies or even just transparency would kickstart CUA's upward transition.

5.4 Expectations

Expectations related to the previously mentioned indicator categories are in **bold**. Due to the unstable nature of the CUA niche, many expectations of what will happen came across as negative, especially with the bankruptcy of Urban Farmers and other economic pressures weighing heavily on initiatives' shoulders. As will be explained in detail in chapter 6, more optimistic expectations communicating what *should* or *could* happen are accounted for in the vision.

5.4.1 Expectations for Individual Initiatives

Expectations regarding the individual CUA case studied vary widely because of their different business models, sizes and development statuses. The expectations ranged from topics like business growth to greater urban development and market expansion. Interestingly, only one case study mentioned implementing **technological** advances in the future. Renewable technologies like solar panels and greywater systems offer initiatives the opportunity to be an example for their visitors. HaagseZwam and Urban Farmers only mentioned implementing green technologies as a skepticism, wish or a far-off possibility, not as a distinct expectation for the near future. This could be attributed to the fact that both initiatives were or are in the New Farm building under a higher jurisdiction (see quote 1, Table 11). The Edible Park, which expects to install both greywater and solar systems, has more free-reign on its management. However, it still does not expect to provide all of its resources in this way, but rather use the technologies as an educative experience for their visitors. However, they will have to balance their educational efforts with affordability to reach their goal of becoming a true business.

On the other hand, a shared **social** expectation between multiple case studies is their intent to create or be a part of educative events in the near future. For example, the Edible Park planned and succeeded in hosting a permaculture festival in October, while HaagseZwam intends to host a community conversation over a locally-grown dinner later this year. The case studies expect that **organizational** changes will result from such events. The festivals or events should also bring attention to urban farming in the municipality, advertise initiatives already in place, stimulate integration with the surrounding neighborhoods and help gain more customers (see quote 2, Table 11). Stemming from learning about the importance of food cooperatives by the sector, initiatives also expect partnerships with existing food cooperatives like Lekkernassûh to flourish and, perhaps, even the development of new distribution sites altogether (see quote 3, Table 11). Case studies also believe that they will focus more on **economic** aspects like profitability and productivity in the coming years, transitioning away from an education-only platform. While they see the value and necessity in educating community members and raising awareness for sustainability and local food systems, the case studies know that productivity and selling their produce are what will keep them in business and in the good graces of the municipality.

Table 11 Interview quotes related to expectations for individual initiatives

Nr	Quote	Interviewee
1	*"They (the de Schilde/New Farm building) are even installing solar panels on the side of a building. Which I'm very skeptical of. But at the same time, something is better than nothing. Perhaps. I have my doubts about that one. But they're trying a lot."*	Luuk Rijkx of Urban Farmers
2	*"I want to combine things together. Everybody is there. Different cultures, backgrounds, colors… together. And we invite some important people from the city. Put the invitation out to other people…. We combine the food here, the food from the surroundings… we have to tell a story."*	Annelies Goedbloed of HaagseZwam
3	*"… [Lekkernassûh is] the most important, innovative and growing partner in this kind of field. They really play a big role. We plan to cooperate with them much more than we do now. I think we're on the brink of a very fruitful relationship where we work with our knowledge and their business skills."*	Menno Swaak of Edible Park

5.4.2 Expectations for the CUA Sector

All actors have **organizational** expectations of growth regarding the CUA sector. The most commonly-voiced expectation amongst CUA initiatives and external actors alike was that circularity, within urban agriculture and as its own concept, will continue to grow and develop into a part of the city's structure (see quote 1, Table 12). One actor even voiced his belief that UA could perhaps supply up to 25% of the city's food needs (see quote 1, Table 10). To achieve this growth, actors expect that the CUA sector will become more integrated with organizations like food cooperatives, nonprofits and local businesses, which will only enhance the argument that CUA is not just a "hype." CUA initiatives expect the municipality to act in support by freeing up space for CUA experimentation, permaculture and agroforestry. This, along with circularity-based entrepreneurs expanding their reach into the agricultural areas surrounding The Hague, is likely to help grow the CUA sector (see quote 5, Table 12). From a **social** perspective, actors expect that acceptance and involvement will grow amongst residents of The Hague as the sustainability trend continues to be a part of regional and national conversation (see quote 2, Table 12). Combining **social** and **economic** aspects, stakeholders believe that more jobs will be made available in the CUA sector for those with a distance to the labor market. While this is incorporated into a few initiatives already, actors from all sides believe that the value of this practice will be disseminated widely across the entire sector, making it a main selling point for CUA. On the same note, actors believe that awareness of the beyond-harvest value of CUA will continue to grow and flourish (see quotes 3 and 4, Table 12). People see less of a need for material wealth and focus more on inner satisfaction (Voorma, personal communication, October 22, 2018).

There were some disagreements about the timeframe in which these expectations will happen, however. Many case studies and circularity experts seem positive that CUA growth and integration will happen quickly. Two case studies (Urban Farmers and HaagseZwam) seemed more skeptical that both the municipality and the community would soon accept the sector's growth, with HaagseZwam even stating that it will take two generations for circularity and urban food procurement to become normalized (personal communication, July 3, 2018). Other expectations followed this more pessimistic route. One of the major expectations that arose and was communicated by 4 out of the 7 interviewees is that CUA and local agriculture in general will not be the main supplier of food for the city, while the other 3 made no mention of it (see quote 6, Table 12). Despite the anticipated development of a Food Theme Park in the Zuiderpark and the possibility of municipal land being freed up as CUA experimentation sights, there is little hope for a completely independent food system. While many initiatives fight for an "urban-driven food system" on paper, in reality, many realize that this goal might be too lofty for a city as densely-populated or globally-reliant as The Hague. This sentiment supports the integration of the Westland and Midden-Delfland, especially, into the "urban" food chain and spread entrepreneurial practices (see quote 7, Table 12).

Table 12 Interview quotes related to expectations for the CUA sector

Nr	Quote	Interviewee
1	*"I would say that it (circularity) is not a hype, and that it will remain a part of the urban context."*	Kasper Lange of TUDelft
2	*"[CUA] might grow. Acknowledgment will grow within the municipality and more acceptance within the community. It all starts with acceptance and acknowledgements from decision-makers. Inhabitants [could] make themselves heard and let politicians know what they value."*	Tom Voorma of Municipality Den Haag
3	*"[There is] (a growing) insight within the municipality in what the benefits are…more than just harvest and a hobby."*	Tom Voorma of Municipality Den Haag
4	*Some people still focus on their business model and not on circularity, but a lot of people are motivated around sustainability and somewhere in their process think about circularity, especially inspired by other initiatives. [There is an] increasing popularity of 'doing something good'"*	Tom Voorma of Municipality Den Haag
5	*"I think that permaculture, local and regional food systems will grow. And perhaps there will stay a few large scales worldwide producing farms, but I think the shift will be quite different in the coming years."*	Pieter Veen of Circular Landscapes
6	*"However, it (CUA) will not be the main food supplier for the city, since the city requires so much food, that there is simply not enough space to grow it…. In my opinion, large scale precision farming in rural areas will remain the largest food supplier."*	Kasper Lange of TUDelft
7	*"Cities are places of innovation. So, food innovation is happening more in the cities than the rural areas. So, you see this food innovation in the cities, which I think will spread out on a larger area around the city."*	Pieter Veen of Circular Landscapes

5.4.3 Expectations for the Food System Regime

Surprisingly, few expectations arose explicitly addressing the future of The Hague's food system besides the previously mentioned belief that CUA will not form its majority. Again, actors believe that large-scale rural farms will continue to dominate, leaving urban farms only as a supplement to cities. Even with a growth in permaculture, local food appeal and entrepreneurial experimentation, CUA will not take a majority of The Hague's market, hinting at both **economic** and **organizational** expectations. However, some have hope that the continued growth of organic food sales will inspire a similar growth in CUA (see quote 1, Table 13). In this respect, CUA would hold a larger portion of the food system and begin its transition away from the niche stage. On a similar note, almost all of the actors interviewed expect **social** acceptance of circularity and the CUA sector to grow, strengthening the **organizational** legitimacy of the sector (see quote 2, Table 13).

Cooperation between rural and urban farmers is another possibility for the future of The Hague's food system. Circularity experts and municipality representatives believe that the two sectors will tap into this potential relationship and control a larger, more locally-driven part of the food regime. This would be a significant change from the current regime, which consists of mainly imported food items from widely-supported global manufacturers and little to no collaboration with the surrounding productive land (see quote 2, Table 13). Even an increase of a few percentage points, which is possible, would change the structure and reputation of The Hague. As a further change to the food regime, some also argue that the food system will become less about trading physical produce and more about exporting knowledge and technology around food growth (see quote 4, Table 13). In this way, CUA could become an even more important part of the food regime because of its innovative and knowledge-driven character.

Table 13 Interview quotes related to expectations for the food regime of The Hague

Nr	Quote	Interviewee
1	*"Biological food sales are increasing every year, which is inspiring the trend of circularity of food."*	Gerko Brouwer of Circulaire Zaaken
2	*"Acknowledgment will grow within the municipality and more acceptance within the community."*	Toom Voorma of Municipality Den Haag
3	*"I think there is a lot of talk about how important it is to support it and to change local production methods. Some policies even say it's important. But when you go look and see what the chances actually are, they are very limited. The big chains and supermarkets still are the focus of policy. That's a big contradiction within the whole agricultural system."*	Pieter Veen of Circular Landscapes
4	*"I think it's also changing that it's not only about exporting bulk produce, but about exporting knowledge, experience, and technology."*	Pieter Veen of Circular Landscapes

5.4.4 Expectations for the Landscape

Expectations regarding the landscape of The Hague closely associate with expectations addressed on the other levels. This is because in order for niche and regime-based beliefs to exist, they receive support from external systems and norms. In addition, any expectations contrary to the current landscape makes way for niche transitions because, if they gain traction, these new ways of thinking can create small gaps in the status quo. For a successful transition, expectations concerning the landscape should support niche development and regime alteration. For example, many actors believe that **social** acceptance of circularity and sustainability, umbrella subjects that encompass CUA, will continue (see quote 1, Table 14). Without the engrained support of broader concepts, niche technology expansion would be impossible. Despite discrepancies on how long this will take and the complexities of changing personal beliefs, the network stands in support of behavioral change.

. Similar to expectations for the food system, actors also voiced that they believe the global **economic** market structure will shift away from just trading products to trading knowledge, experience and technology (see quote 2, Table 14). If this were the case, The Hague could become a center of expertise and experimentation for the region. Additionally, from an **organizational** standpoint, actors also believe that there will be a revitalization of rural areas in the future, blurring the line between cities and hinterlands (see quote 2, Table 14). When taken in tandem with the expectation that overpopulation and climate change will exacerbate current urban-based issues, CUA expertise can become even more necessary.

Table 14 Interview quotes related to expectations for the landscape of The Hague

Nr.	Quote	Interviewee
1	*"I really think we are at the top of the world. We have this wealth. We have everything we desire... I really think we have to distribute our knowledge."*	Annelies Goedbloed of HaagseZwam
2	*"You see the cities getting more rural, and rural areas are getting more urban. I really think there will be a revitalization of rural areas in the future."*	Pieter Veen of Circular Landscapes

5.4.5 Expectations Conclusion

In general, expectations signal that the CUA sector is not nearly represented enough physically, legislatively and economically. Those with hands-on experience in the CUA sector accept that they will probably not provide a

majority of urban food, which echoes the sentiments of circularity experts and municipality representatives. Communicating this expectation drives niche development forward as common goals are set and ways of getting there can begin to arise. On the other hand, few actors explicitly mentioned expectations regarding policies or legislation related to urban agriculture, circularity, or sustainability. If legislation was mentioned, it was often with uncertainty or doubt (see quote 16, Table 7; quote 5, Table 8; quote 1, Table 19). This could be because of the instability of politics and the often complete "change of hands" that occurs with each election. To them, there may be no value in developing expectations because political tides will inevitably turn. Many expectations seem to lack a sense of hope or positivity. This could be because actors, especially those representing the individual CUA initiatives, were voicing expectations about what will happen if The Hague continues on its same trajectory. However, coupled with potential network connections and the progressive learning that is already taking place, the more normative expectations, which are discussed more in-depth in the vision chapter, point to a high expansion potential of CUA in The Hague. This is especially true when considering the widely-shared expectation that sustainability and circularity will continue to be a part of urban development in the future. Expectations contribute to the vision formation as well as develop a platform on which actors can begin conversations around what is necessary to reach common goals.

5.5 Conclusions on the Potential for CUA's Expansion in The Hague

This chapter provides the answer to sub-question 2*: How is the idea of circular urban agriculture put in practice by the case study initiatives of The Hague and what is its potential for expansion?*

Overall, the case study initiatives do practice their own internalized forms of circularity. However, there is little to no circularity on a sector level, which leaves substantial room for improvement in the future. The CUA sector of The Hague has the potential to expand both in size and in impact. From a network perspective, new partnerships seem to be developing. When describing incorporating food cooperatives into their network composition, Menno Swaak of the Edible Park said in his interview:

> *"I see it as a turning point for local food. Not because of what we do, but because of this kind of community change. It goes in a certain rhythm. So, we started long enough ago now to match this rhythm. We can be in a situation where more people can see us, and more people and organizations can be integrated into how this will all work. And it will create a beautiful, healthy city as well… we want to create equality and fairness"*

Learning appears to be quick and impactful in the CUA sector. This could be because of the experimental nature of the practice, which requires significant "trial and error" applications. However, the learning lessons of all stakeholders seem to come back to one idea: that cooperation and transparency must be increased in order to grow the CUA sector of The Hague. If this is done in an effective way, CUA has the potential to grow into a more regime-based practice. The wide application of second-order learning by questioning the underlying drivers of problems and possible solutions further solidifies CUA's fight for growth and wider impact.

Finally, expectations regarding CUA, while slightly negative on the surface, are fairly consistent and shared across network boundaries. They also address all levels associated with the practice: the individual initiatives, the niche practice of CUA, the current-standing food regime of The Hague and the landscape of beliefs and ideals that surround and support the regime. With many stakeholders addressing the expectation that sustainability and circularity will become more integrated with society in the future, CUA's potential for expansion is definitely possible. In summary, despite the deeply-entrenched globally-based food regime, CUA has a chance to change, at least partly, the way The Hague grows, buys and disposes of its food. A visible and easily-accessible sector would help increase awareness and support a healthy future for the city. However, there is still a long way to go. Initiatives themselves and the sector as a whole have to expand their size, impact and circular practices, especially with regard to organic materials. By composting and reusing GFT-based nutrients, materials could be kept in and around The Hague, supporting a circular, interactive sector. Additionally, the food regime of The Hague and the influencing landscape must accept the CUA sector as a part of everyday life in order to grow from a niche to a regime. Positive behaviors and beliefs surrounding local food and material reuse must increase to create an environmentally, economically and structurally sustainable regime.

6. Vision for 2050

This chapter reflects many of the interview statements that could be classified as positive expectations, meaning they communicate a "best case scenario" mentality. While the expectations of the previous section more so communicate what they think "will" happen and could perhaps convey a somewhat pessimistic tone, the "could" and "should" expectation statements, which are often more optimistic and visionary, reveal potential improvements for future scenarios. As such, the vision section is a narrative based on statements given during interviews, industrial ecology knowledge and my own critical thinking. While they may not all be feasible, the main goal is to outline possibilities and create the backbone for pinpointing pathways necessary to reach a similar vision. Below are some examples of "positive expectations" that translate into vision formation. While not always explicitly quoted in-text, the ideas derived from these quotes drove much of the vision formation.

Table 15 Positive expectations that arose from vision analysis

Nr	Quote	Interviewee
1	*"[My aspiration for CUA is to] facilitate **UA to become a natural and integrated part of the urban environment**, interacting with the existing residential and industrial areas in the city."*	Kasper Lange, TUDelft
2	*"Circularity in The Hague, especially with organic streams, should be possible because of the high density. All flows are represented, it's a **matter of changing existing value chains**."*	Gerko Brouwer of Circulaire Zaken
3	*"We should have something like an **iconic vegetable** to sell at events and supermarkets. Like what The Hague is "known" for."*	Gerko Brouwer of Circulaire Zaken
4	*"I want to have **a new board** for the Edible Park Foundation that is more involved, as well as a **roundtable group** that can take projects and find connections. We need a team to bring stability and knowledge. That's what I want to form now. A group of people who really know what they're doing."*	Menno Swaak of Edible Park
5	*"I think we have to move towards is a situation where a **significant portion of our food is produced in a local area**."*	Menno Swaak of Edible Park
6	*"I can imagine the city as a special **food experience** landscape. All kinds of **connections** between food production and other functions."*	Pieter Veen of Circular Landscapes
7	*"I think one of the main shareholders that we're missing are not shareholders, but stakeholders, is the **Westland (and other rural farms)** ... So far, they're not really integrated in it."*	Luuk Rijkx of Urban Farmers
8	*"... **(local farmers) could have their own shops to connect with the city**. People should be more in **contact with nature**, like every neighborhood should have a community garden. There should be more attention to green spaces and **edible landscapes** in city planning. [We] need more **communication within the municipality and with people**. [It should be] more "**normal" to think about growing food locally** and behaving in a circular way. [We] might need to **change the name** of "urban agriculture."*	Toom Voorma of Municipality Den Haag

Taking these positive expectations as inspiration, I describe the landscape surrounding the vision first. Then, I present vision aspects with supporting quotes from several interviewees. This chapter also outlines drivers and barriers to CUA expansion, which is the overall goal of the future vision. Finally, I create short-term steps that, while not a full-fledged "pathway" to the future vision, could jumpstart CUA's growth in The Hague.

6.1 Criteria and External Variables to CUA in The Hague in the year 2050

In 2050, Dutch cities will comprise a high proportion of total residents due to urbanization, with 625,000 people living in The Hague alone (De Jong & Van Duin, 2011). Circularity will be a major part of The Hague's sustainable urban development fabric as it continues reaching for the goal of carbon neutrality. Despite positive policy and behavior changes, the city is still far from carbon neutral. The integration of circularity and local food procurement into The Hague's food system has been an important step toward carbon neutrality since shorter supply chains mean less emissions from transportation methods. In addition, soil preparation and fertilizer production have the largest carbon footprints of activities related to traditional agriculture, making CUA beneficial due to its decreased need for such practices (Hillier et al., 2009). The CUA farms will also create a "carbon sink" within The Hague, holding the biologically useful carbon within cities limits and reducing the spread of their negative impacts.

With population growth and increased awareness of healthy food, I assume an increase in grams of produce consumed per day to increase marginally. As a result of both phenomena, the demand for produce in The Hague will increase from 47,895 tons per year in 2018 to 62,734 tons per year in 2050 (RIVM, 2017). This increase I assume to stem from several factors:

1. The potential that European GDP could rise by as much as 11% by 2030, which could positively affect the amount of produce consumed in-place of cheaper processed foods (Rood et al., 2017 from Ellen MacArthur Foundation & McKinsey Center for Business and Environment, 2015);
2. Recent food consumption data reveals that the decline in fruit and vegetable consumption, as seen in previous decades, has stopped (RIVM, 2017);
3. Increased awareness of sustainability and environmental issues, which is predicted to continue according to previously-mentioned interviews and literature, will positively influence the consumption of healthy foods like fruits and vegetables, as well as increase the awareness of local and seasonal produce.

Under these assumptions and using current agricultural methods, The Hague would need to cultivate 786 ha of vegetable-producing land (excluding potatoes) and 585 ha of fruit-producing land to meet this demand. This and other statistics are shown below:

Figure 11 Future food system's land use if current agricultural techniques continue (calculated from Waginingen UR, n.d.)

Using more circular technologies and urban planning strategies, however, these numbers will diminish greatly in 2050. Vertical farming, aquaponics and permaculture offer opportunities to use previously unfarmable land and implement a sustainable activity without increasing the city's pressure on surrounding land (Goddek et al., 2015). This would be particularly beneficial because of the high need for fodder in the future as shown in Figure 11. The statistic in red communicates that 35-50% of animal and plant fodder would be required in the Netherlands to meet future population's requirements using current agricultural techniques. By implementing more circular techniques and using previously derelict spaces, The Hague and surrounding areas could use the land that is now freed up to produce its own fodder and reduce the amount of imported fodder, further embodying localness. Permaculture farms in the city will allow for multi-purpose green spaces, with recreation and food growing happening in the same vicinity and not requiring further land development. The implementation of edible landscaping on a majority of public land in 2050 also takes advantage of previously unused land and prevents agricultural sprawl. The very nature of nutrient circularity keeps soil healthy and also prevents the need for expanding to new land, as was once necessary when the soil was stripped of nutrients. Studies state that by relocating only 20% of food consumption to local, sustainable growth reduces carbon emissions by 50,000 tons per year (Jansma, Veen, Sukkel, & Visser, n.d.). In this vision of 2050, I assume that The Hague has surpassed this by producing 30% of its own produce in this manner (see quote 1, Table 10). With this, 18,820 tons of produced would be grown within the CLA sector every year come 2050.

The most impactful change from now to 2050 will be the redefinition of "urban" agriculture to include the surrounding agricultural area of Midden-Delfland. The main reason for this integration is that rural farmers and urban growers alike express an overall desire to work together for the betterment of the region despite resource competition-driven tensions. The over-arching term "urban agriculture" might not satisfy farmers in Midden-Delfland as they could believe it confuses customers who take "urban" to mean only from within the city limits. Therefore, the conglomeration of city-based farms and more rural farms of Midden-Delfland will be termed circular local agriculture, or CLA. As a result, the 30% local production rates will be possible. I predict that other cities like Almere that have been experimenting with urban agriculture for longer, could produce up to 50% of their own produce by 2050 (Jansma & Visser, 2011). However, Almere has fewer people and more open space, than The Hague, which could make attaining these levels easier for them. The incorporation of Midden-Delfland into the network of truly "urban" circular farms will be key to the development of CLA as part of the food regime of The Hague in 2050.

6.2 Technological Dimensions

Technologies associated with the now redefined CLA sector in The Hague will be aquaculture, vertical farming using sustainably-powered LEDs and permaculture. All Midden-Delfland initiatives, both outdoor and within greenhouses, will use permaculture techniques, making it the most widespread CLA practice in 2050. In addition, sections of large parks like the Haagse Bos and the Zuiderpark will also use permaculture techniques alongside recreational areas, even incorporating edible landscaping as part of public land use. Permaculture, while maybe the least "technologically-advanced method," serves the greatest variety of benefits by growing food, recycling nutrients, cleaning water systems and providing a natural retreat for urban citizens (Ingram, 2017). Permaculture is also the most visible form of CLA because it is practiced at ground-level in accessible areas and will make The Hague's residents and visitors alike feel

connected to nature and to their food. Fulfilling educational and mental health roles, alongside profitability, will only increase permaculture's importance to The Hague.

It is important to mention that high-tech solutions like aquaponics and indoor vertical farming work better in arid zones or non-productive areas because they do not have another path to become more self-sustaining (personal communication, Jansma, September 6, 2018). This could be especially true in the midst of future climate change predications. Permaculture takes advantage of "free" resources like the sun and the rain while more high-tech, external resource-driven solutions could be at the mercy of increasing energy prices. In addition, high-tech systems can be quite temperamental and grow a limited variety of crops. Therefore, the city will focus on permaculture and use high-tech solutions within already-existing buildings. These initiatives will and contribute to the food system of the city in 2050.

Most building-based CLA initiatives within city limits will use the less space-consuming and more high-tech practices of LED-focused vertical farming and aquaponics. Greenhouses in Midden-Delfland could also use these higher-tech alternatives, although many will simply rely on the sun's energy to grow crops and utilize circular nutrient and water practices like on-site composting and greywater treatment. The municipality will subsidize LED installation and maintenance for one year to monitor its efficiency and ensure a reliable system. Engineers will also likely develop ways to increase the grams produced per kilowatt hour, thus speeding up the municipality's payback return on investments.

While sometimes used together, LED lighting and aquaponics can stand alone. Aquaponics has been used for years in urban farms, but issues of profitability and maintenance costs previously stood in the way of impactful expansion. The municipality will subsidize aquaponics systems' installation and first year of operation, much like LED growing systems, to ensure stability before the initiatives completely take over costs. This technology directly incorporates circularity into its business model on multiple levels by providing nutrient circulation and wastewater treatment with for the fish and plants with minimal inputs and outputs besides some fish food. While the common crops currently grown using aquaponics are basil, cabbages, strawberries and peppers, I predict that agricultural researchers will discover efficient ways to grow more "substantial" vegetables using this technique by 2050. However, we are unable to predict the exact landscape into which CLA will develop or the technological advances possible by 2050, so the future success of aquaponics through the sale of fish alongside produce is unforeseeable.

Every CLA initiative in 2050, no matter the growing method, will have solar panels that provide at least 10% of their energy. I draw this number from previous trends, which state that capacity has been almost doubling every year in the last decade (Statistics Netherlands, 2010). If this trend continues, solar power will be a major player in the national energy grid in 2050, supporting the ability of smaller, more independent groups to produce a large portion of their own power at a relatively cheap price. This will be especially important for the initiatives using aquaculture or vertical farming as their energy requirements are typically higher than those of permaculture farms. The exact amount produced, however, depends on the location of the farm itself and the number of PV cells it houses. Any remaining energy needs will be fulfilled using a certified renewable provider.

In addition, all CLA initiatives will compost their organic waste on-site as much as possible in 2050. National policy currently prevents urban farms from using their own compost for growing produce that will then be sold. Whereas now policies require fermentation or municipality-regulated compost used for the selling of food, regulations in 2050 will allow CLA-based composting with closely-monitored systems to ensure safe nutrient recycling (see quote 2, Table 15). The onsite composting systems will vary from small, natural-cycle composting (used mainly with outdoor, city-based permaculture) to anaerobic high-tech digestor-composter combinations that also produce bioenergy (mainly used in building-based farms and Midden-Delfland). All leaders and employees of the CLA initiatives will be educated thoroughly on the rules accompanying the compost system. The municipality will also provide funding for the more complex composting systems and maintenance costs for a year because I predict that they will still be expensive and require close monitoring in the beginning to find their equilibriums. In the spirit of circularity, CLA initiatives will also use rainwater collection or greywater treatment technologies to diminish their water inputs. The reused water will fill on-site toilets and water the crops. The farmers will also be able to apply for municipal subsidies towards water treatment systems because they too will likely still be expensive to install and maintain. All water treatment will be certified by the municipality and open to investigation by city officials if quality is in question.

6.3 Social and Cultural Dimensions

Besides holding a food-producing role in society, the CLA sector will continue to have a social responsibility to their respective neighbors and communities in 2050. Each CLA initiative, whether low or high-tech, will strive for neighborhood integration (see quote 1, Table 15). As mentioned, this is more easily done with permaculture-based initiatives because they are more “out in the open” and their growing methods may be more familiar to customers. Even though the CLA sector will function more like a business sector than it does now, many CLA initiatives will still offer unpaid volunteer opportunities to further increase contact with community members. In addition, all forms of CLA will still arrange tours and open days to connect with the community. The CLA sector’s focus on sustainability and urban development inevitably makes it an educative force in The Hague. Working together, CLA initiatives will host events and workshops related to permaculture, vertical farming, aquaculture, solar power, wastewater treatment, composting, and circularity in general (see quote 8, Table 15).

Ideally, festivals will take place in The Hague by the year 2050 to increase the visibility of CLA and foster connections with The Hague. Those more associated with “natural systems” could take part in Permaculture Festivals organized by the Permacultuur Centruum Den Haag. Besides growing tutorials and healthy living workshops, these festivals give community members a chance to meet their local permaculture growers and develop a stronger connection with the city’s food system. There could also be Local Food Festivals, which would highlight all of the CLA initiatives in and around The Hague. CLA initiatives will open their doors for in-depth tours and educational programs. They will also have the opportunity to sell their produce directly to customers, creating a stronger bond between producer and consumer. Experts on other sustainable technologies like solar power and greywater treatment will also participate to raise awareness about the technologies and create connections with potential customers. All in all, the goal will be to better integrate CLA into the social fabric of The Hague in 2050.

The CLA sector will also play a role in primary school education by hosting school groups and teaching the children about farming, food and sustainability. Regularly-scheduled field trips will allow students to experience CLA first-hand and learn about from where their food comes. While not for selling, many schools will have their own gardens for growing fruits and vegetables, so students can see the lifecycle of the plants. The hope is that, with education from an early age, the sector will continue to grow and support a larger portion of The Hague's food system. The children would become lifelong supporters of CLA.

Above all, CLA customers will come from all different cultural and economic backgrounds with the opportunity to purchase local produce as a result of price regulations and subsidies supported by the municipality. While local and city-grown produce is only available to wealthier customers currently, the CLA-grown produce will now be on-par with, if not sometimes cheaper than, imported food sold in supermarkets. Although only 30% of produce bought will be grown locally in 2050, it will be more evenly-distributed throughout The Hague than ever before. As will be mentioned later, food cooperatives and distribution points will be strategically placed across the city to equitably serve its residents.

6.4 Organizational Dimensions

As mentioned, one of the most impactful organizational developments will be the formation of the CLA sector with city-based agricultural projects and Midden-Delfland (see quote 7, Table 15). Even now there is a huge potential for innovation in these more rural areas, with several urban farmers wanting to expand their experimental practices to the more rural farmlands. I believe the two groups will realize they have common goals and could create a new profitable network with equal opportunities for subsidies, innovation strategies and market access. By 2050, integrated CLA initiatives will see each other as partners aiming for a common goal rather than just market competitors. Despite the notable development of city-based farms, most of the CLA produce in 2050 will come from Midden-Delfland because of their ability to produce more consistently and at larger scales.

The addition of Midden-Delfland will also create hundreds of both low and high-skilled jobs and form a reliable backbone on which the CLA sector can continue to grow. Urban planners like Pieter Veen and municipality members like Tom Voorma recognize that very few young people are entering the agricultural sector because of high land costs and difficulty of integration without familial ties to the land. By 2050 and through a focus on local agriculture and circularity, the leaders of The Hague and Midden Defland will begin a partnership program between young entrepreneurs and older, more established farmers in the region. This will entail young entrepreneurs interested in circularity or sustainable agriculture being able to apply for a traineeship with a permaculture-focused farmer. Upon completion, the farmer can make the trainee his or her partner to eventually take over part of the farm. The program might add a layer of complexity to the organization of the CLA sector, but it will also forge intergenerational relationships that preserve agricultural practices and the sector as a whole.

In terms of governmental and leadership organization, the local government will appoint a fixed point of contact (perhaps coined Head of Communication) between the CLA farmers, citizens, consumers, retailers and the municipality itself. He or she will delegate tasks, accurately communicate information and distribute questions to their appropriate destinations for answering. This will hopefully happen before 2050 and be well-established. In addition,

there will be efficient and frequent communication between municipal departments involved in sustainability, urban development and agriculture. Currently, stakeholders are frustrated with the instability of their sector's organization caused by changing political power or lack of transparency. In 2050, these communication pathways will be protected from political overhauls with long-term research and financial agendas and complete transparency with all actors. Everything related to CLA will be under one portfolio, limiting confusion when problems arise. The municipality will hopefully earn the trust of all those involved in CLA with the support and transparency and that is lacking today.

Outside of the municipality, the CLA network will also have a board of representatives that encompasses neighborhood residents, local farmers, entrepreneurs in sustainability, already supporting or interested retailers and municipality members. Biannual meetings will communicate gains, losses and needs within the sector. The board will also arrange and participates in farmer trainings, infrastructural development, processing, marketing and quality control of produce (Van Veenhuizen & Danso, 2007). Hopefully this will limit roadblocks with municipal and national policies down the line.

Local food cooperatives will be staple of The Hague's CLA system in 2050 (see quote 7, Table 10). There will be at least one food cooperative in every neighborhood, with three mobile distribution carts that both pick up and distribute CLA-grown produce and participate in food sharing. Food sharing is the redistribution of food that is almost thrown away, like from weekly markets, supermarkets and restaurants. While this is currently happening on a small scale through Lekkernassûh, this practice will expand leading up to 2050. Food cooperatives will be marketplaces, community gathering areas, weekly local dinner spots and the hosts of sustainability workshops. They will be the stable "middle men" between farmers and customers because of their long history and their ability to create community. The local and national government must also find a way to incorporate local agriculture into supermarkets, like through creating a clearly-marked "local food" section or labeling CLA-produced food in a special way, for example. This will likely be difficult because of the number of parties involved, but the municipality could look into these possibilities before 2050. Overall, CLA should be a business-to-business venture in 2050 (see quote 1, Table 7).

Another major organizational change by 2050 will be interconnectedness of the initiatives themselves. The CLA sector will practice circularity *between* initiatives instead of just within themselves, thus truly becoming a circular sector (see quotes 2 and 6, Table 15). Recycling these elements between initiatives will reduce unnecessary importation and waste. There will also be an online platform, run through the municipality, for trading or buying products and materials within the CLA sector. While it will mainly cater toward the farmers themselves, the platform will also be open to the general public who are interested in gardening and connect producers and consumers even more. Organic material circularity will be fairly mature, but other forms of circularity, like exchanges of waste heat, water and labor, will also be developing in 2050. The reason for the slight development delay is the complexity of technologies and infrastructures necessary to exchange these materials. If transportation is necessary for material exchanges, it will all be done via electric vehicles or bicycles. Examples of the aforementioned circular trading routes is below:

Table 16 Possible material exchanges for CLA initiatives

Items Exchanged	Example
Energy	An initiative that produces too much PV cell-generated power for their own use can exchange it with another initiative
Water	Clean water from one initiative with a treatment facility can connect its greywater system with another initiative
Labor	Co-working is possible, which allows knowledge and skillsets to be exchanged
Crops/Seeds	Exchanges between an initiative that might have more capacity to grow or store seedlings than another

As mentioned, all CLA initiatives will compost their own GFT. If one initiative produces high-quality compost while another produces seeds, they will be able to trade or sell their organic materials to each other. Because all initiatives will follow the same protocol when it comes to organic inputs and quality of compost, there will be no threat of cross-contamination between farms. This "cooperative composting" will further diminish the need for fertilizer imports, increase carbon capture in the city and create strong and stable network connections between CLA initiatives. Unfortunately, I believe that some CLA organic waste will still enter the municipal waste stream via human error and be incinerated.

6.5 Economic and Structural Dimensions

Ultimately, the goal of the municipality and farmers will be to grow a commercially-healthy CLA market (Jansma & Visser, 2011). In 2050, CLA will improve several city-wide money-making factors, including supply-demand orientation, produce availability, cost balance of basic inputs and marketing toward the ever-growing "green "agenda (Van Veenhuizen & Danso, 2007). Customers will most likely pay less for CLA produce because of both municipal subsidies, which reduce the price of local produce, and reduced embedded transportation costs. However, CLA will still generate some revenue and societal value through guided tours and workshops. In combination, CLA will be a true business sector in 2050.

One of the main benefits of a local food system will be keeping The Hague's money within the city. Other entrepreneurs will hopefully join the circular market, realizing that consumers are more willing to pay top-dollar for high quality goods that are both environmentally conscious and locally-produced. In addition, CLA produce-based businesses such as juice makers, artisanal snack creators and farm-to-table restaurants will be even more popular in 2050 and create new opportunities for CLA initiatives and local businesses alike. This will continue to grow as The Hague makes a name for itself as an innovative green city.

Creating an immediately profitable CLA initiative is difficult because of high technological investments, often-intensive infrastructural preparation and product grow-time delay (Love et al., 2015). High-tech growing methods like aquaponics systems or climate-controlled atmospheres are both expensive to install and maintain as a small startup initiative. In addition, agriculture is not an "immediate gratification" sector, in that it often takes a few seasons to be profit-positive. However, the hope is that, by 2050, engineering and design advancements will decrease the complexities and expensive material needs of CLA-related technologies. This would be supported in-part by rising prices of energy and fertilizer alongside governmental policies encouraging reduced pollution, which would the cost

benefit of circular-based growing methods even more attractive (Cretella & Buenger, 2016). However, there will still likely be the need for financial support from the municipality or donors in the beginning. The extent of municipality assistance will depend on technological needs, development stage and the extent to which the initiative will increase the city's circularity or sustainability.

Structurally, CLA initiatives will be under their own individual management within the larger CLA sector. Each initiative should have something like a director of operations, a director of finances, a director of agriculture and a director of innovation who will always be looking for efficiency improvements. Sustainability or urban farming experts might also be brought in as consultants throughout the initiative's lifetime. There will also be employees and/or volunteers who create the backbone of each initiative. As mentioned, CLA initiatives will operate their sales through external entities like supermarkets, farmers markets and food cooperatives. Specific farms might be known for a certain crop, creating a "brand" for the initiative and making it that much more recognizable. Some local farm-to-table restaurants might also have main courses dedicated to specific farms, with every vegetable or fruit from that one dish being sourced from a single grower (see quote 3, Table 15). The structure of the CLA sector in 2050 could look something like this:

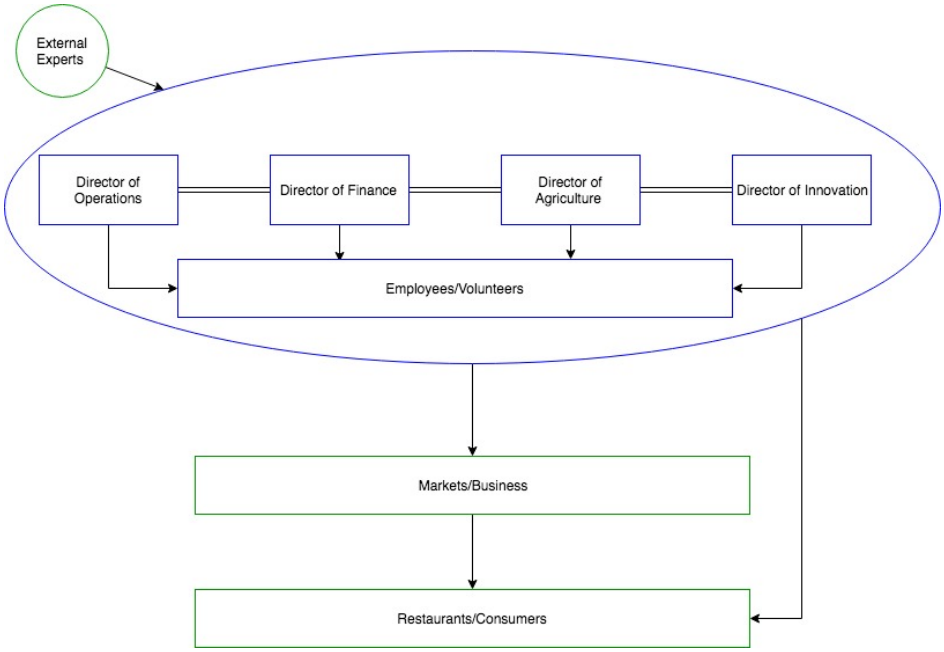


Figure 12 Individual initiative organization (blue) and interactions with outside forces (green) in 2050

6.6 Legislative and Policy Dimensions

The driving force of the CLA sector will be the law that all CLA produce must be grown organically. Due to the very core of urban design associated with circularity, residents will be in immediate contact with the farms whether they are customers or not. In addition, since CLA initiatives will trade materials and organic waste frequently, the use of chemical fertilizers, pesticides and herbicides will be prohibited to avoid harmful contamination.

Departments within the municipality will communicate and collaborate often on issues related to CLA in 2050. While currently, municipal leaders are more so stuck in their department's immediate concerns, they now communicate frequently through the main point of contact for CLA issues (see quote 15, Table 7). This could even result in some sort of "Bureau for Sustainability" that combines the interests of several departments with a stake in circularity, environmental protection, community engagement, or public health. A major part of their job would be to evaluate legislation and adapt it if necessary toward a more circular city. The responsibilities and legislatives measures of the involved municipal departments of 2050 could include:

Table 17 Potential roles and legislative measures of the municipality through department collaborations in 2050

Subsidies for building of infrastructures or circular technology implementation
Tax control for those who practice CLA or purchase its products (price controls)
Land management, like creating permanent areas of the city dedicated to CLA
Zoning laws that include CLA as a designated land use
Required trainings for CLA farmers on sustainable technologies, proper farm management and enterprise marketing
Policy to have fresh and local fruit and vegetables delivered to each municipal office once a week and to local schools
Installation and organizing the collection of food waste from neighborhood collection sites
Require local grocers to carry CLA produce
Appointment of circularity "consultants" to help CLA initiatives make the most of circular technologies
Looser regulations on compost: CLA initiatives can compost their own GFT to reuse as fertilizer (paired with a specialist to learn about quality and safety; subject to random checks)

One of the prominent changes to legislation will be regarding nutrient recycling. In general, most of the nutrient recycling will happen at the municipal scale through household, restaurant and company food waste. The implementation of new neighborhood GFT collection sites will allow residents to conveniently dump their food waste in supplement to municipal collection, assuming that at-home GFT collection still happens once a week in 2050. Although the municipality will extend the reach of its GFT collection program to reach almost all households, the convenience factor and constant reminder of GFT collection sites will be extremely useful. There will be three to four GFT collection sites in each of the eight neighborhoods of The Hague, which are assumed to stay the same. Ideally, municipal collection would happen two or three times per week to reduce the chance of any foul odors or mess. A map of the neighborhood GFT collection sites in 2050 is below.

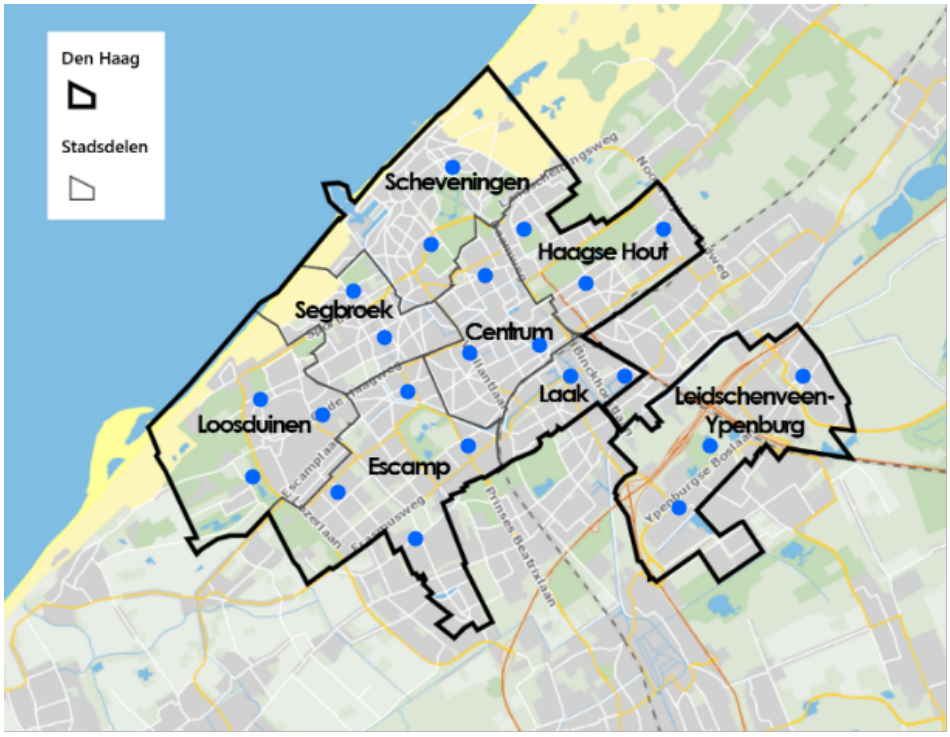


Figure 13 Map of neighborhood compost collectors (green dots) in 2050 (base image from ("Stadsdeel van Denhaag," 2018)

Whereas now there are multiple waste management companies in The Hague, especially in the business sector, there will only be one conglomerated waste management company in 2050 to streamline collection, transportation and disposal. All waste management, including general trash, recycling and GFT, will fall under this umbrella company. Ideally, the municipality or national government will have opened a composing facility in or near The Hague and Midden-Delfland that will deliver the nutrients back into the city, either to the CLA initiatives (creating sector-nutrient circularity) or landscapers/residents (creating city-nutrient circularity). The goal will be a 70% separation rate of produce into GFT in 2050. This is based on an increase from the current separation rate of 54% (The Netherlands Nutrition Centre Foundation, 2016). However, I assume that only half of the GFT will be converted into compost for fertilization because of the other possibilities for GFT reuse such as biofuels and biomass (Ellen MacArthur Foundation, 2017). These will still likely be globally-profitable outputs for the area, making its importance stick and taking away from compost production. However, the percentage of compost produced in 2050 and the fact that it is all delivered back into the food or city system will be a vast improvement.

6.7 Circularity Calculations in 2050

There are two sides to The Hague's food circularity specifically related to produce. One is the circularity of the CLA sector itself. The other, and perhaps more relevant to the municipal and national governments, is the circularity of the entire produce chain. While just presented as equations, the hope is that information will become available and make them useful for future scenario building.

6.7.1 CLA Sector Circularity

The WOI numerator consists of "waste exported," which in this case would be the GFT waste from the CLA sector that is *not* composted within its boundaries. If 90% of organic waste, or GFT, from local farms would be

composted on-site or at another farms, then 10% of the total GFT waste would be "waste exported." The denominator would be the sector-wide demand for compost. If this were the case, the WOI equation would be:

$$WOI = -\frac{.10 * total\ GFT\ waste\ of\ CLA\ sector\ (\frac{tons}{year})}{compost\ demand\ of\ CLA\ sector\ (\frac{tons}{year})}$$

If the compost demand for the now-expanded farming sector stayed the same as in chapter 4 for simplicity's sake, the WOI for CLA in 2050 would be:

$$WOI = -\frac{.10*60\left(\frac{tons}{year}\right)}{60\left(\frac{tons}{year}\right)} = -.1$$

This would be a huge improvement from the hypothetical situation in chapter 4, where half of the useful compost was sold and 10% of organic waste was simply discarded. The 2050 WOI is much closer to the circular point of "zero."

The SSI numerator for the CLA sector would be the amount of compost kept in the system, which is the remaining 90% of the GFT waste presented above. Again, the denominator would be the demand for compost in the CLA sector. Therefore, the SSI would be represented as:

$$SSI = \frac{.90*total\ GFT\ waste\ of\ CLA\ sector\ (\frac{tons}{year})}{compost\ demand\ of\ CLA\ sector\ (\frac{tons}{year})} * 100$$

If the compost demand for the now-expanded farming sector stayed the same as in chapter 4, the SSI for CLA in 2050 would be:

$$SSI = \frac{.90*60\ (\frac{tons}{year})}{60\ (\frac{tons}{year})} * 100 = 90\%$$

Again, this would be a monumental improvement compared to chapter 4, where the hypothetical system was only 40% self-sustaining. The SSI in 2050 means that the CLA sector would be able to provide 90% of its own demand for compost and there would be a dramatic decrease in the need for imported organic materials.

6.7.2 City-Wide Circularity

The DMI, specifically addresses changes in *imported* produce demands from 2018 and 2050. This is the most concrete calculation possible using my assumptions. The baseline demand for produce, which is represented by demand levels in 2018, is 47,895 tons of produce per year. The amount of imported produce is the same as the overall demand since there is no data on the percentage of produce demand being met locally. Therefore, I assume that the amount of

produce consumed from urban farms or Midden-Delfland is negligible. The minimized demand, which would be the amount of imported produce in 2050, would be 70% of the total demand since I assume 30% is produced locally. Therefore, the DMI for imported produce in the year 2050 would be:

$$DMI = \frac{47895-(.70*62734)}{47895} * 100 = 8.3\%$$

This means that, taking my assumptions into account, the demand for imported produce (non-CLA sector) would only decrease by 8.3%. This is slightly disappointing given that a city than can grow 30% of its produce would be an incredible feat. However, this equation assumed that there will be a fairly dramatic increase in produce consumption by 2050. There are debates on whether this is true, with some authors claiming that produce demand will actually *decrease* due to a continuing growth in demand for easy, fast and processed foods (RIVM, 2017). No matter which path wins outs, the DMI equation will be useful for policymaker in the future because emission rates or other negative consequences of food importation could be attached to this equation.

Despite their basis in assumptions, the equations presented above offer insights to The Hague's potential for a more sustainable food system. The city could implement more circularity within local food production, reducing the need for imported fertilizer or soil to grow its own food. Additionally, the city could implement more circularity within the entire food system by increasing food waste separation, composting for of this separated GFT and returning more of these nutrients to the area itself. By using the equations defined in the UHA framework, municipalities can both assess and predict their circularity, not only in the food sector, but beyond.

6.8 Drivers, Barriers and Steps to Vision 2050

In order to reach the goal of 30% locally grown produce for The Hague, there will obviously be barriers to overcome. On the other hand, there are also current situations that are driving this movement. In this chapter, I address these drivers and barriers to accomplishing the future vision outlined above. These come directly from interviews, literature and knowledge of industrial ecology. Ultimately, drivers and barriers help legitimize this research by concretizing what would foster CUA expansion. Both drivers and barriers can be **political, environmental, social, technological, economic, legislative,** or **organizational** following the PESTEL categorization method with my own addition of "organizational." These components offer realistic evaluations of what to encourage and what to avoid. I also present steps that could expand CUA related to the drivers and barriers in tables alongside direct quotations from interviews.

6.8.1 Drivers

Only a few **political** drivers arose from interviews. The one most commonly voiced was that the new alderwoman, who was previously the head of GreenPeace Nederlands, could be an indispensable part of CUA's growth in The Hague. All interviewees who mentioned her did so with fondness and hope, speaking to the positive impact good representation can have on niche expansion and urban sustainability as a whole. Her experience and desire to create a strong backing to sustainability in The Hague, alongside the municipality's desire to create more green spaces, could drive the CUA niche forward (see quote 1, Table 18).

From a **social** perspective, the residents of The Hague and academics from around the area are focusing more on the benefits of nature and careers that "create a better world" (see quote 2, Table 18). This mindset drives CUA's expansion because of its connection with nature, focus on sustainability and social benefits. Opposition to UA is declining, whereas in the past, stakeholders cite various instances of resistance from neighborhoods and other agriculturalists. In addition, people are opening up to local and healthy food in response to the growing awareness of food footprints, the benefits of a healthy lifestyle and the importance of community (see quote 3, Table 18). These changes in priorities and beliefs support a niche transition. The social benefit of giving people with a distance to the labor market work is another element that CUA currently incorporates and shows promise to encourage sector adoption. Tom Voorma of the municipality agrees and says that urban agriculture has to have "something extra" like social work or employment opportunities to really take advantage of the sector's total financial benefits (personal communication, August 7, 2018).

From a **technological** perspective, the Netherlands is highly saturated with knowledge related to urban development and sustainability. The Hague alone has three world-class universities and several innovation hubs within a 20 kilometers radius. With this wealth of information and experience, The Hague has the capability to incorporate innovative and promising CUA technologies with the help of surrounding institutions. Technological developments not solely related to CUA can also influence it growth. As a result of big data and efficient urban connectivity technologies, we can now organize cities in such a way that facilitates circularity and increases efficiency (see quotes 4 and 5, Table 18). These design choices also allow for links between work, recreation and food.

Technology also includes the development of infrastructure. Infrastructurally, the municipality is starting to design green recreation areas into urban development plans and slowly realizing their potentials for food production. Menno Swaak of the Edible Park know this first-hand as several municipality representatives recently took a tour of his initiative. "They (the municipality) have been working more and more on providing green spaces for people to recreate and spend their time," said Swaak. "They have become aware that things are changing and that maybe we could produce food in these areas" (personal communication, July 18, 2018). While support for these measures is still developing, the fact that the municipality realizes the potential for greenspace, edible landscaping and urban agriculture is promising. Additionally, The Hague is a decently large city with much of the necessary infrastructure for building-based initiatives already in place (see quotes 6 and 7, Table 18). The de Schilde building is an example of The Hague's potential to repurpose old buildings and incorporate them into the CUA sector. On the other hand, some city-based entrepreneurs are also looking to rural areas for experimentation with circular agriculture because of the ample space. The overlap of ambitions between urban and rural-based agricultural innovation drives the integration of The Hague with its surrounding farmland, which I believe is necessary for growing awareness and a successful CUA sector in this particular part of the world (see quotes 8 and 9, Table 18).

Related to **organizational** aspects, one circularity expert expressed his certainty that The Hague could a closed organic stream because of its high population density. He believes that all of the potentially beneficial closed loops are already present in the city, but that we must change the value chains to realize the benefits of The Hague's situation (personal communication, Gerko Brouwer, August 28, 2018). Organizational aspects also relate to individual

companies because circularity can also reduce raw material costs and encourage adoption (see quote 10, Table 18). Circularity is a growing trend in both the urban design and business sectors, both of which are present in CUA. Since profitability is one of the ultimate drivers of any niche's development, the promise of reduced prices through circularity may positively influence its appeal. As mentioned, CUA stakeholders also indicate an increase in cooperation and knowledge exchange over the last few years which could change the organizational structure of the sector as a whole (see quote 3, Table 18). Since collaboration was found to be one of the key components to CUA's success, a general willingness to cooperate can drive CUA growth.

Table 18 Interview quotes related to drivers of expanded CUA in The Hague

Nr.	Quote	Interviewee
1	*"They (the municipality) have been working more and more on providing green spaces for people to recreate and spend their time. They have become aware that things are changing and that maybe we could produce food in these areas."*	Menno Swaak of Edible Park
2	*"I'm starting to see more young people opening up to nature. And also, people in your position in higher education not caring so much about a career, but really about the good of the world. And that has changed."*	Menno Swaak of Edible Park
3	*"At that time, some people really didn't like us. I noticed a resistance to us… There's much more interest in local and healthy food [now]. There are more initiatives of citizens working toward this. There is also more cooperation and exchange, and I think that will help."*	Menno Swaak of Edible Park
4	*"Of course, we separated everything in urban development and it seemed to work to make things more efficient. But now, I think, through technology, this separation and scaling up isn't necessary anymore. You can do it with this big data, you can make smaller-scale connections. New technology makes it possible to make new connections in the city between working, eating, leisure… so, a more organic city experience. "*	Pieter Veen of Circular Landscapes
5	*The city, roads, agriculture, industrial parks and nature are all spatial functions, which are now separated because we thought they cannot function without negative impact on each other. We see them as separated and disconnected, but we need to be aware that everything is connected."*	Gerko Brouwer of Circulaire Zaken
6	*"We do not have to build the farms for this… we already have the space for them! What a coincidence! We can do this already."*	Annelies Goedbloed of HaagseZwam
7	*"I think there's just a lot of space in old industrial areas that are actually regentrifying. Which has a lot of potential on using these kinds of initiatives as well…"*	Luuk Rijkx of Urban Farmers
8	*"… people don't know how food is grown. So, having that in the city making them aware of it is very valuable. Besides the whole circularity part as well, to have that consciousness of what you're actually trying to do [is beneficial]."*	Luuk Rijkx of Urban Farmers
9	*Yeah, and I also think that new entrepreneurs who are active in urban food could also expand to the agricultural land around cities. I think there's a growing group of these people, because in the rural areas you have more space and more opportunities. There are a lot of ideas coming up, so I would expect more urban farmers to start with this idea."*	Pieter Veen of Circular Landscapes
10	*"… you're actually reducing some of your cost for the company because it's residual waste of the other one. Which you get as free goods which makes your business model better."*	Luuk Rijkx of Urban Farmers

All in all, The Hague does display some positive, though cautiously optimistic, movement toward CUA expansion. However, in order to truly expand, CUA needs more representation in local government. Policies aimed at supporting local initiatives and those willing to buy their produce are crucial. Thankfully, it seems like actors are willing to collaborate, but the municipality should meet them halfway with the financial support necessary to increase efficiencies and grow CUA sustainably.

6.8.2 Barriers

Unfortunately, there do seem to be more barriers to CUA expansion than drivers. Obstacles to development cover a wide range of topics because these challenges interact and can exacerbate each other. Most importantly, no interviewee believes that CUA or local agriculture will completely feed the city. Therefore, the main goal is to expand CUA's stake in the food sector. The municipality, citizens and local farmers must work together to overcome these

hurdles before they become insurmountable. While disheartening on the surface, these barriers could also be learning lessons for this and possibly other sectors hoping to become circular.

The **political** barriers to CUA expansion closely link to **organizational** barriers because the municipality is more or less responsible for the sector's management. One of the main barriers is that the municipality does not seem to know where circularity "fits" in their political agenda. This is not only due to circularity's inherent complexity, but also because circularity on a city level requires expertise in economics, sustainability, supply chain management and sometimes even chemistry that is found in different governmental departments. To fit circularity into the municipality's itinerary requires the involvement of these diverse departments and collaborative investigation of various policies. The fact that there appears to be little communication within the municipality, let alone with the farmers themselves, along with the presence of no real game plan and very little market protection, makes the political atmosphere a definite barrier to CUA's expansion (see quotes 1 and 2, Table 19).

From an **economic** point of view, the main barrier is the current cost of CUA produce. Without protection from the larger food regime and landscape pressures, urban farmers are either forced to charge higher prices for their goods or choose to take a loss. Annelies of HaagseZwam explained that, "you have to realize that I can't sell my mushrooms if they are twice the price… Because of the government and regulations, they are treated differently… But I refuse to ask for a high price… it's about the food. Honest food should be cheap." (personal communication, July 3, 2018). Those involved in CUA are often caught between running a business and "doing good." Several other actors also voiced the difficulty in creating a sustainable circular business network, especially for a sector like CUA that incorporates social aspects. The technology might be there to close loops, but the small scale of CUA does not allow economic competition with the large-scale agricultural companies that currently control the regime. One actor suggests that flexible business models are the way to go for CUA but reinforces that these models are difficult to maintain and often lead to business failure if not financed properly (see quote 4, Table 19). As with all businesses, profitability, financial continuity and reliable workers are key. A sector like CUA will probably always have a social component like volunteerism, education or helping those with a distance to the labor market. That, plus the fact that the sector also relies on natural and somewhat unpredictable cycles for production, means that financial stability could always be a challenge and stand in the way of expansion and is one of the main barriers according to researcher Kasper Lange (personal communication, August 23, 2018). Another economic barrier to CUA expansion is the cost of land needed to start or continue a CUA initiative (see quote 5, Table 19). When combined with the previously-mentioned high prices for technologies and lack of protection from market forces and, entering the CUA sector can become almost impossible for young entrepreneurs without high credentials, experience, or funds.

The **social** barriers to CUA development are both the most prominent and the most difficult to overcome. As stated again by Kasper Lange, "barriers are mainly socially oriented, networking, trust, formal and informal agreements (and) reputation," which can make or break the CUA niche in its fight to break into the food regime (personal communication, August 23, 2018). Commonly-kept values like wanting the same food all year round or only choosing the "prettiest" produce also impede niche development (quote 6, Table 19). Moreover, education and awareness of the issues associated with both the current food system and linear metabolism are key to CUA expansion. Several actors expressed that education and awareness regarding circularity and UA are lacking and

definitely impede the growth of the CUA sector in The Hague (see quote 7, Table 19). Without a strong vision of CUA's place in the social framework of The Hague, the city is missing out on valuable socially-beneficial opportunities that could be incorporated into policy or the municipality's future plans.

There are also several **legislative** barriers to CUA expansion which mainly concern a lack of transparency or awareness of legislation. As Annelies of HaagseZwam stated, "For every part, there is a law. And every law finds me." Regulations regarding CUA composting and the waste management system appear to be most troublesome. Legislation related to growing food using compost appears strict and is not communicated well to the CUA initiatives (see quote 8, Table 19). Without the ability to reuse organic waste or exchange it with another initiative, CUA will never truly take off and expand into a regime-type practice because the very core of its practice will be stifled. Another barrier is The Hague's waste management system, which is complex and decentralized. While household waste management is fairly consistent, although sometimes inconvenient and not represented equally across the city, companies are responsible for hiring their own independent waste management companies (see quote 9, Table 19). Legislation that puts this task in the hands of hundreds of companies, many of which are not currently motivated to separate their waste and are not rewarded for doing do, is an obstacle to CUA expansion. Finally, legislation pertaining to supermarkets hampers CUA's expansion into an every-day practice. The political and economic interests of large corporate grocers impede the incorporation of local produce because of quality and safety controls (see quote 10, Table 19). Without a marketplace for CUA produce, a lack of awareness and availability will persist, and the customer base will never reach a regime threshold.

Finally, the **organizational** components associated with CUA expansion fall under two categories: the physical organization of The Hague and the structural organization of the food sector itself. First, The Hague does not have many industrial or "producing" companies within its borders, making gaining those more abstract, yet extremely valuable, reusable inputs from local sources difficult (see quote 11, Table 19). This barrier mainly applies to the more high-tech, building-based CUA initiatives because more "natural" CUA practices often do not need huge amounts of electricity or heat. Making all material exchanges as streamlined as possible requires smart urban development schemes and interconnected organization. Second, the current regime is a global supply chain, making it almost invisible to the consumers who are now disconnected from production methods (see quote 12, Table 19). Consumers do not know where their food comes from, how long it took to get there or how much energy and natural resources were necessary. Without awareness, the food regime will continue "business as usual" without any consideration for potential new sustainable alternative like CUA.

Table 19 Interview quotes related to barriers toward expanded CUA in The Hague

Nr.	Quote	Interviewee
1	*"The Hague is a "circularity desert," not just with food but in other sectors… there is lots of interest in circularity, but no one to take the lead. [It is] very complex and involves communication, distribution, processing, disposal and selling in market. No policy arises from talks because they don't know where to start. Circular economy involves "economy" and the Urban Development Department. [They] don't know about analyses going on in other departments and don't know where circularity fits."*	Arn van der Pluijm of Haagsche Schil and Haagse Makers
2	*"I'm not getting the protection. And I really want to do something good. My food has to be safe. So, I really want to do a good job. Honestly."*	Annelies Goedbloed of HaagseZwam

3	*"… they invited people from Wageningen to advise them, but never asked us about our thoughts. They had open nights for everyone to give their ideas, but they never just sat with us to talk about it. I'm the one person here who has been working for 8 years and is here most of the time. I'm here at different times of the day and the year. I know what is happening here. So, that's the kind of experience they could use."*	Menno Swaak of Edible Park
4	*"Circularity is in a very early stage. From a technical perspective, a lot of cycles can be closed, and many initiatives have been created for the past years. But it seems to be very hard to create a sustainable social business network. Circularity means interdependency, and when one or more stakeholders quit, the circular network must be resilient enough to survive this loss. UA is mainly small scale, and therefore it can't simply compete with large scale agriculture companies. Therefore, is should focus on multi-scope and flexible business models, but these are not easy to maintain. Many circular concepts fail after a few years, mainly because of a lack of network resilience and financial problems."*	Kasper Lange of TUDelft
5	*"So, the biggest barrier is the fact that the land is too costly. Because, if you would want to start a farm, then no bank would finance that. It would be very hard to have a business model because the prices are much higher than would be reasonable from a productive side… that becomes a problem for the continuity of the farm."*	Pieter Veen of Circular Landscapes
6	*"…actually, people should be able to understand that we cannot eat everything the whole year round. I think that's the main issue."*	Luuk Rijkx of Urban Farmers
7	*"… they have no idea. That's the problem. They're not aware that this (buying fresh food) costs much more in the end (illness) than to prevent it… I think 90% of people are not really capable of thinking. They just go with what we are doing. So, the other 10% who are walking out in front, they have to do the good job. They have to say, "this is how we do it." To show what is forbidden or bad. [We have to] tell them about bad food."*	Annelies Goedbloed of HaagseZwam
8	*"I want [compost] to be collected for gardens, but they say "no, no this can't be done." And I say, "no, but this is good for the ground." And they say, "no you have to ferment it first and let the waste collector come get it. And then you have to pay for it…" I'm adding value to the ground, guys, come on."*	Annelies Goedbloed of HaagseZwam
9	*"Each [company] needs a contract, waste treatment companies are not really interested because they get more money from collecting non-separated waste and doing it themselves. We want to organize one contract and use one waste management company to increase efficiency, encourage separation and have companies rewarded for circularity"*	Gerko Brouwer of Circulaire Zaken
10	*"One thing I thought of as a main barrier could also be the structure of the supermarkets. They cannot sell local produce easily because it all has to be within their system and with guaranteed quality. If they get rotten food from a local producer, then the whole chain is broken. So, they have to have this controlling system."*	Pieter Veen of Circular Landscapes
11	*"The Hague does not have many producing companies in the borders, which might be an issue for gaining reusable inputs."*	Gerko Brouwer of Circulaire Zaken
12	*"Circularity in food is difficult because it is a global chain. Longer supply chains are invisible and [customers are] disconnected from the supply chain."*	Gerko Brouwer of Circulaire Zaken

6.8.3 Short-Terms Steps Toward Vision 2050

The drivers and barriers mentioned above set the scene for the future vision. It is important to note that, although some vision aspects may seem far-fetched, statements made by the stakeholders signal that they have the mindset and tools to work together and develop a feasible short-term game plan. Below, I present a list of short-term changes that could be made to grow CUA's stronghold in The Hague, which represent the most-mentioned vision aspects and those that could be seen as most feasible. Along with these steps, I present potential methods to accomplish them taken from my own experience with this thesis, to incorporate more of the backcasting methodology and provide a general pathway forward. While not completely in-depth, these steps and methods will at least provide a platform for future research and conversations between actors. Changes must begin quickly if The Hague wants to achieve carbon neutrality before 2040 and compete with other innovative cities like Amsterdam and Rotterdam. Shifting the food system of The Hague to one that is locally-driven and based in circularity can be a tremendous asset.

Table 20 Next steps toward CUA's future vision

Next Step	Potential Methods	Supporting Quote

Implement edible landscapes into public areas, especially parks	1. Introduce the idea of CUA with approachable small-scale edible landscapes 2. Organize educational events or signs showing what can be grown 3. Utilize already-existing structures, infrastructure or machinery to do so	*"What I think we really have to do is, quite quickly, change all the public green areas into edible landscapes in a way that it not only provides food, but also takes care of biodiversity and also cleans the water and soil. It has to be an, "and, and, and" situation. If not, if you just focus on one aspect, then you will hit a problem at some point."* - Menno Swaak of Edible Park
The municipality, residents, circularity experts and urban farmers collaborate and discuss ways to increase GFT separation.	1. More widespread collection of GFT waste from homes 2. Trial neighborhood compost centers or "worm hotels" 3. Free GFT containers 4. Educational labels on GFT containers	*"Should have neighborhood compost centers which reduce transportation and packaging. [There should be] subsidies for local programs. Citizens could bring compost to city farms and get receipt to get a deduction on waste tax because the city doesn't have to compost it, saves them money."* - Gerko Brouwer of Circulaire Zaken
Increase transparency and communication between municipality and urban farmers	1. Take advantage of local expertise gained from hands-on experience 2. Do not simply rely on academics for information about urban agriculture, but reach out to those who practice the technology in your area of reference	*"I had a two-hour session with someone from the municipality once, and we were able to share [some] information. But it was too short to look into the future. And the one who followed up after that person left, I had a 45-minute talk with. Which is ridiculous."* - Menno Swaak of Edible Park
Look into policies that would allow local reuse of nutrients and support those organizations already trying to compost local waste alongside reducing food waste in the first place	1. Research true dangers of locally-produced compost and review policies 2. Have a regulatory system for city compost with check-ups 3. Punish unsustainable behavior and encourage circularity for sectors, companies and customers 4. Slowly increase the amount of compost that comes back into The Hague 5. Subsidize composting technologies 6. Provide immediately-visible education on food waste and what can be composted	*"... if you have that in local neighborhoods being able to do that incorporate that, the separation of waste, there are some pilots doing that in neighborhoods. They try to do it and then sell the compost. There's one or a few that I saw coming up. But they're still grassroots."*- Luuk Rijkx of Urban Farmers
Increase communication between different municipality departments about sustainability	1. Be clear about where circularity fits with the business model and in the eyes of stakeholders 2. Ensure experienced leadership that organizes communication, distribution, processing, marketing and disposing in a circular way 3. Appoint main person of reference for CUA issues 4. Have one document or database for the CUA sector to reference regarding policies 5. Create a board that oversees circularity or urban agriculture that involves several relevant departments	*"It was clear that they know each other, but they don't collaborate often. They built a "facade" that they are doing stuff related to urban agriculture and circularity, but they actually don't know what they're doing."*- Arn van der Pluijm of Haagsche Schil and Haagse Makers
Blur the lines between "urban" and "rural" agriculture	1. Have open days between farmers	*"I also think that new entrepreneurs who are active in urban food could also expand to the agricultural land around cities."* - Pieter Veen of Circular Landscapes

	2. Have farmers from both areas be part of a board on CUA or regular meetings with the municipality 3. Create supply chains and material exchanges between rural and urban farms 4. Work with farmers, especially those from Midden-Delfland, and incentivize them to sell locally 5. Create an urban marketplace for more rurally-grown produce, either at weekly markets or in supermarkets	
Create connections between aspiring agriculturalists or entrepreneurs and rural farmers for mutual learning experiences	1. Support a mentorship program 2. Fund open visitation days on the farms for aspiring agriculturalists and entrepreneurs 3. Develop a land renting scheme for rural farms and interested renters	*"Many farms on the outskirts just stop because they don't have a daughter or a son to take over. If you could connect these entrepreneurs and the farmers and arrange something in terms of financial construction, or even the original farmers could perhaps teach the new ones…"* - Pieter Veen of Circular Landscapes
Increase investments in education and awareness-raising with regard to local food and circularity	1. Organize events and open days at urban and rural farms 2. Open a weekly stand to sell local agriculture at markets 3. Make local fruit available in schools and municipal cafeterias 4. Promote cooking classes using local produce 5. Target a younger generation who can teach from the "bottom-up," as well as becoming lifelong customers	*"Education is one of the things that's going to have to change. Yeah, and mindset. Which is very difficult to change… But that's also that's one of the nice things that we've noticed of people from rural areas. Some people in urban areas, they haven't seen a cow. And people don't know how food is grown. So, having that in the city making them aware of it is very valuable… If politics invests in education, and education can invest in these kinds of startups… and also see it for its educational value and not only as a monetary value."* - Luuk Rijkx of Urban Farmers

6.9 Conclusions on Vision 2050

This chapter provides the answer to the sub-questions *What could circular urban agriculture look like in The Hague in 2050?* and *What are the possibilities for bringing the CUA sector further toward this future vision?*

Adhering to interviews, external literature and industrial ecology knowledge, I create a future vision for CUA in The Hague in the year 2050. The major points of the 2050 vision are the integration of Midden-Delfland into the fabric of The Hague's local food system, organized marketplaces like food cooperatives for locally-grown produce, a centralized communication point within the municipality for all issues regarding the now-expanded CLA sector, reliable and consistent material flow documentation and stable inter-initiative material exchanges alongside individual GFT composting measures. While 70% of produce would still be imported along with almost all "processed" goods including dairy and meat, the increased financial and organizational backing behind local agriculture will undoubtedly stimulate discussions of a circular city. Using the UHA circularity-evaluating equations, the municipality will be able to keep track of the success of circular measures for both the CUA sector and the city as a whole. The regime-situated

CUA sector would bring advance carbon neutrality by diminishing raw material requirements, transportation-bound emissions and food waste-related nutrient inefficiencies. Furthermore, the success of The Hague's growing circular local food supply chain and its consistent data gathering regarding organic material flows could inspire other cities to do the same. The impact of closing multiple areas' nutrient supply chains and perhaps expanding to water, energy and even labor cycles could truly make a difference in the midst of climate change. Below is a summary of the Vision 2050:

Technological
Implementation of aquaponics, LED vertical farms and permaculture (most widely-practiced)
Widespread edible landscaping
Solar panel installations that provide at least 10% of CLA's energy needs
On-site composting facilities
Social/Cultural
Successful neighborhood integration and participation with CLA sector
Volunteer opportunities maintained
Tours and open days for educational purposes (resident, schools, municipal leaders, etc.)
Events and workshops around circularity and health food collaboratively organized by different farms
Produce more available, affordable and evenly-distributed throughout city to create a sense of equality around food
Organizational
"Urban" agriculture in The Hague now defined as city-based and from Midden-Delfland (possibly Westland if interested in local market)
New job creation at all experience levels
Point of contact and leadership board within the municipality with protection against changes in political power
More and greater impact of food cooperatives; grocery stores now sell and advertise local produce
CLA runs on a business-to-business rather than a business-to-customer model
Circularity in terms of organic material well-developed; heat, water and labor circularity in progress
CLA initiatives have interconnected supply chains; circularity is sector-wide and perhaps even extending to other sectors (ex: hospitality)
Economic/Structural
Customers pay less for local produce than imported produce because of subsidization and reduced hidden costs
CLA sector profits from selling produce, giving tours and hosting workshops (diverse business structure)
Initiatives turn a profit quickly because of technological advances and governmental support, but the municipality will likely have to financially support initiatives at the beginning to ensure success
Sector runs on an employment-based structure for stability, but still offers volunteer opportunities
Legislative
CLA sector is strictly organic (no pesticides or herbicides)
Interconnectedness and communication between relevant municipal departments (increased transparency)
Reevaluation of compost production and usage laws
Expanded GFT collection to cover more of the city; neighborhood collection sites managed by the municipality as supplement
A single waste management organization for increase efficiency
Policies and advertising to reduce food waste and encourage GFT separation

Table 21 Summary of Vision 2050

Overall, there are currently more barriers to CUA's dissemination in The Hague than there are positive predictors. The political and social landscapes of the city are the most important but also the most difficult aspects to change because they are deep-seeded, based on individual beliefs and the foundation for almost all actions in an urban environment. The learning lessons that come from evaluating the drivers and barriers to the future vision will help formulate a plan going forward. Much of the responsibility falls on the municipality as it will ultimately manage, enforce and assess any sector pushing for sustainable, large-scale circularity. However, cooperation and transparency are the glue that will keep the CUA sector growing further into regime territory.

7. Discussion

7.1 Limitations of Research

This thesis aims to assess the current state of the CUA niche, assess its potential for expansion, create a future vision, and address starting points for regime change. The information and analysis presented could inspire some practice shifts. However, there were some limitations, both in information gathering and framework-based evaluations.

First was the language barrier. While all of the interviewees spoke English well, some questions had to be rephrased or terminology explained. This also made transcribing the interview difficult. While I took great care to transcribe the conversations accurately, there were inevitably a few mistakes and misheard words. The transcription software used, HappyScribe, did not transcribe Dutch-accented English well. Therefore, I had to do them all individually. Thankfully, any necessary corrections were made by the interviewees upon sending them the transcripts. It is possible that some words were still misunderstood, although highly unlikely. In addition, some government documents regarding CUA-related policy were only available in Dutch. Due to time constraints, I was unable to translate all of them and, thus, could have missed valuable information. In addition, there may be some overlaps in findings with Dutch publications that would have enhanced this report.

For interviews, I initially wanted two with each stakeholder and a concluding roundtable discussion about the vision. Time and stakeholder availability quickly made it unfeasible for this thesis. Without a second interview, I was unable to dig deeper into the issues surrounding CUA like policy, supply chain gaps and business models. More in-depth or clarification questions could only be communicated via email, which, while sometimes useful, limited the amount of information I was able to gather. The single interview also limited the connections I was able to make with the urban farmers, which could have also hampered transparency in communication. Furthermore, a roundtable discussion would have brought direct network interactions to the forefront of the study and allowed a “first-hand” experience of the tensions and communication issues discussed in the interviews. It also could have allowed for the application of evaluative indicators to assess the vision’s strength, quality and feasibility. While these indicators were technically included in interview coding, it proved futile because there was no real evidential support brought about by discussion. Having more direct contact with and between initiatives would have only strengthened this thesis.

Also related to interviews, not all actors could meet in person and instead answered questions via email. This takes away from the quality of information as the nature of semi-formal interviews allows for discussion and conversation that could contribute to further information. Additionally, some talks with Relevant Actor Group members were less formal than intended and not recorded due to location restraints like noise. However, I asked the same questions, took notes during the meetings, wrote out the main points verbatim and coded them in the same manner as more formal interviews. I received good feedback from all interviews about the quality of my transcripts and notes.

As for the actual evaluation framework, the main limitation was the lack of data for UHA calculations. As mentioned in chapter 4, there was no data related to material flows of the CUA sector and very limited information from the individual initiatives. This could potentially have been resolved with a second interview, but I believe that the CUA initiatives simply do not track the flows of interest. My initial goal was to create a material flow visualization for the sector to show its extremely limited inter-circularity. While I had no physical data as proof, I did receive some verbal confirmation that very few, if any, materials are exchanged within the sector. There was also no literature, at least to my knowledge, on composting or organic material trading within The Hague's borders. While I did receive some data on energy and water use from Urban Farmers, there was no information included about outputs or waste, and therefore, could not be used to calculate or visualize flows. Nonetheless, all gathered data is included in a separate appendix.

For the UHA calculations, I had to make several assumptions, which is not ideal when trying to influence change. However, I did try to make a skeleton model for how initiatives or the municipality could calculate circularity, not just for organic matter, but for almost any material. Trying to represent three different circularity indicators (WOI, SSI and DMI) was overly ambitious. By only using Dutch averages for produce consumption and extrapolating them to The Hague and making my own scenarios, the quantitative aspects of this thesis suffered. While there is potential for future quantifications, the circularity measures of this thesis were far less meaningful than anticipated. This also stands for future vision calculations. While estimating the differences in yields, emissions and inputs between future CUA development and business as usual would have been far more concrete, inevitably, developments in 2050 are unknown and could have completely different outcomes. One major point of contention was the consumption and food trends of the future. Whereas I assumed that consumption of produce will increase due to the focus on healthy lifestyles, other believe that consumption will actually decrease. By siding with a consumption increase, I aim to see just how much of a difference that CUA could have on The Hague in the "worst case scenario." Along the same lines, I was also unable assess other development factors like land use, productivity of different technologies and space availability. This was due to both time limitations and uncertainty of the future. However, future research could focus on the visioning and backcasting parts of this thesis and go more on-depth to assess all aspects regarding the future of CUA.

With regard to the SNM framework, the division of evaluation levels was not as successful as hoped. The "individual initiative" and "CUA sector" levels ended up being very similar, especially for the learning evaluation. Furthermore, there was some debate on whether CUA could even be considered a niche, but rather an experiment, because of its extremely small scale and the thought that its practice was not really protected from the regime. This could have limited the quality of SNM assessment because networks, learning and expectations might have been less developed and, in time, could become more robust.

Finally, the vision for 2050 could have been improved and given more technical support with more time and a roundtable discussion. Conversation on aspects like potential space that could be made available, the best-case potential yields and the GHG emission reductions possible would be ideal. With these indicators, policymakers could be even more well-prepared for a food system shift. However, this was simply not possible in the time frame. Future students could build upon this thesis and create solid quantitative deliverables to encourage local, national and even

global policymakers to make sustainable city goals. However, as mentioned, we are unsure of the technologies that will be available in 2050. Developments not even yet considered could drastically alter the impacts of using circular technologies.

7.2 Novelty in Research

When addressing the barriers to UA implementation, Roemers (2014) mentions competition for land, lack of supportive legal frameworks and improper spatial planning as the main culprits. In addition, this thesis reveals that matching location to type of UA practice, connecting with the surrounding neighborhood and stable distribution sites are also major barriers to implementation and expansion. The results of this thesis develop the realization of challenges necessary to start changing the urban food scene. However, the true novelty of this thesis lies in connecting circularity with urban agriculture. The Dutch government, both locally and nationally, has published reports on circularity and urban agriculture, but few have explicitly integrated the two. Similarly, as mentioned in chapter 2's literature review, articles and case studies about both circularity and urban agriculture often focus on micro and meso-level initiatives, not macro-level, city-wide organizations. By combining circularity and UA on the rarely-addressed large scale, this thesis could be a learning tool for both The Hague and other circularity-aspiring cities.

The Dutch Ministries of Infrastructure and the Environment and Economic Affairs recently published a report entitled "A Circular Economy in the Netherlands by 2050: Government-wide Programme for a Circular Economy" that outlines a vision of a future-proof, sustainable city in which there is at least a 50% reduction in the use of primary raw materials. In agreement with this thesis, the Cabinet recognizes the importance of cooperation between parties (Dutch Ministry of Infrastructure and the Environment & Ministry of Economic Affairs, 2016). The national report also builds upon previously-published green programs and argues that policy pathways must be streamlined to accelerate a transition to a circular economy. However, the report is written from a national perspective, addressing the international, national and regional scales of impact from a birds' eye view. It would be difficult to adapt these findings to the city-scale because several policy changes would also be necessary within municipalities. Furthermore, the national report addresses circularity in food, construction, finances, education and the labor market (Dutch Ministry of Infrastructure and the Environment & Ministry of Economic Affairs, 2016). The breadth of subject coverage limits their ability to develop concrete steps to change, especially on the smaller city scale. However, this breadth is also useful when thinking about the systems thinking aspects of circularity.

Another unique point of this thesis is the evaluative integration of the environmental, social and economic aspects of the current food sector and CUA. The current RIVM report (2017) focusses on physical and environmental health while leaving out some important details regarding associated social health. Those who do address the social benefits of UA and CUA, like Rhodes (2013), Ambrona and Maletta (2014), or Cretella and Buenger (2016), focus mainly on increased food security, access to green space and "creative" community organization. From my interviews and in-depth analyses, I also bring the social benefit of employment for those with a distance to the labor market to the forefront. Others (Chivot, Auping, de Jonge, Rõõs, & Rademaker, 2016; Diaz-Ambrona & Maletta, 2014; Van Asselt et al., 2014) focus on the environmental sustainability of food system practices. This is especially true for reports on The Netherlands because of the country's expertise in greenhouse growing methods and prominence in the world food

market. While it makes sense to focus efforts on the most profitable agricultural practices, there are several missed opportunities when urban agriculture is left out of the development mix. This idea also plays into the thesis' assertion that a combined urban-peri urban food system would be best for the area, despite the seemingly strict barriers set between the two in other literature (like Roemers, 2014).

In addition, no previous study found, especially in the Netherlands, has combined circularity and urban agriculture with providing next steps of action. Many articles related to UA and CUA, like those published by the previously-mentioned Ellen MacArthur Foundation (2017), stop at simply assessing the current state rather than explicitly visioning it forward. This thesis offers a unique take on how cooperation between several relevant parties can charge a far larger system in the names of sustainability and livability. Furthermore, unlike the focus of authors such as Lu and Grundy (2018) or dos Santos (2016), this thesis addresses the possibilities of both high-tech alongside more nature-based CUA practices. Many publications seem to focus on one or the other rather than discussing how they can work in harmony. This unique aspect provides a broader range of possibilities for future food systems as opposed to putting faith in only one technology.

From a quantitative perspective, articles using the UHA framework often provide concrete numerical calculations of circularity because it is often used to assess solid, well-developed systems or incorporating other sectors like wastewater management (Agudelo-Vera et al., 2012; Leusbrock et al., 2015; Wielemaker, Weijma, & Zeeman, 2018). However, I did not come across the framework used as an evaluation of circularity within a niche sector. Additionally, no other report takes UHA and applies it to two different timelines for comparison purposes. Because of the outcomes of the 2050 vision, I was also able to provide a model for a more expanded UHA calculations in the future.

8 Conclusions and Recommendations

The circular economy is a worldwide sustainability phenomenon that promises to reduce inputs, increase the value of outputs and create partnerships that can withstand the test of a changing world. In the Netherlands, economists estimate that circularity could contribute an extra 7.3 billion euros in net added value to the Dutch economy alongside 50,000 jobs (Bastein, Roelofs, Rietveld, & Hoogendoorn, 2013). With these statistics in mind and considering the huge impact that the agriculture sector has on Dutch culture and economy, especially around The Hague, CUA has the potential to forge a new path toward sustainability. Goddek and colleagues (2015) argue that besides the obvious environmental benefits of CUA, the sector's profit margins would be even more attractive with its inherently low manufacturing costs (recycled resources) and short food distribution supply chain (locally-focused). These sentiments, along with the sector's social and physical health benefits, were supported and echoed widely across the CUA stakeholder network of The Hague and confirming its importance for future urban development considerations.

8.2 Conclusions

This thesis answers the question of *how can urban agriculture in The Hague become more circular?*

The importance and possible impacts of CUA become clear through circularity assessments, niche analysis, vision formation and possible short-term steps to embrace drivers and overcome barriers. The CUA sector of The Hague is currently underdeveloped despite the various organizations and municipal departments working towards local production, the circular economy and carbon neutrality. Several official publications and press releases from the municipality claim that circularity projects are moving forward, and that sustainability is within reach. However, many projects related to the circular economy either have not started, have started but are not yet finished, or have an unknown status because there is no data available (see Figure 14). This is especially true of "biomass and food" projects, which supports my discovery that, while the municipality sends a strong message that they prioritize sustainability, they lack the collaboration, clear plans for multi-actor involvement and policy investigations necessary to make a meaningful advancement in the field. Many circularity plans are on a national level, but The Hague has a large and powerful enough municipality to take matters into its own hands and be an example for the rest of the country. As stated by Pieter Veen, "If you look at it from a governmental perspective, it's your duty to see that these restrictions and rules are changed to promote [circular business models]. I think that is not happening quick enough."

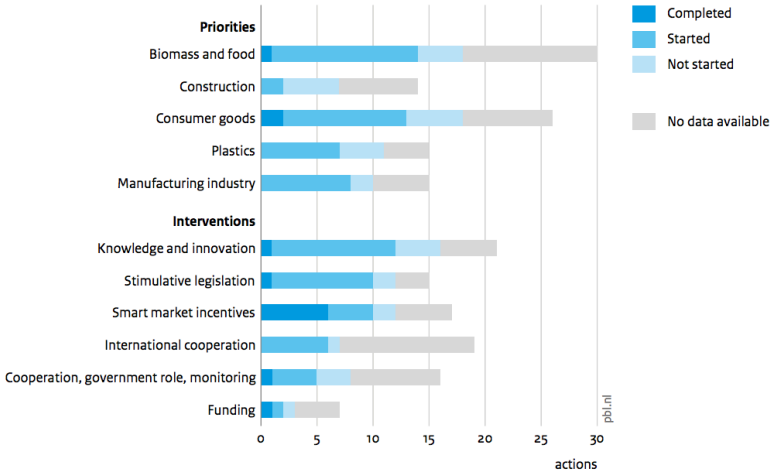


Figure 14 State of circularity projects in The Hague from Potting et al. (2018)

The CUA network of The Hague, like those of most circularity-based sectors, is extremely complex. I argue that the current state of circularity in UA at least at a sector-wide scale, is nonexistent in The Hague because of insufficient communication, policies and awareness. Some individual initiatives practice internalized circularity, but resource reuse on a larger scale and between initiatives must grow in order to move CUA from a niche to a regime practice. Interactions will continue to be limited and unproductive without transparency, communication and teamwork between all stakeholders. The current methods of arranging occasional meetings and partnering for small events is not working. There must be some form of authority to regulate, oversee and further the development of CUA. Multiple municipal departments should be represented and form a central point of communication for these urban farmers. Future vision creation reveals that policies related to CUA must be both transparent and open to review, and that accompanying changes in deeply-engrained social influences, such as beliefs about the sector's safety and importance, are necessary to create a more circular UA system.

Derived from the future vision development process, I argue that expanding the definition of "urban agriculture" to include the area of Midden-Delfland would not only ensure an adequate supply of local produce but allow for more robust and diversified material exchanges. Urban-rural relations could be educationally, economically and environmentally fruitful because farmers can share information, create a strong market and reduce the food miles and waste related to The Hague's food sector. The European Commission supports this claim by stating that local food systems could be successful through the "integration of environmental and climate priorities with the need to improve the competitiveness of the agri-food sector, and with the balanced territorial development which contributes to the creation of jobs" (European Commission, 2015). Transforming the scope of circular food production from strictly city-based to using all of the local resources available will result in a faster transition and a more stable sector in the face of sustainability challenges. In order to do this, however, the municipality and local farmers must work together. UA in The Hague could become more circular by combining permaculture and high-tech solutions based on specific neighborhood needs and markets. To further extend their circularity, these initiatives should be formed within already-existing buildings, reusing available space with the goal of experimenting toward the future vision.

Furthermore, waste management systems, especially those servicing businesses, lack transparency and efficiency. Regulations and collection methods are varied, vague and seemingly profit-driven. The future vision outlined in this thesis offers an extension of circularity in the UA sector through initiative-based composting, increased city-wide separation of organic waste and convenient neighborhood collection points.

The current CUA sector also relies too heavily on unstable customer bases like tours or educational visits. Urban farms must also have consistent, produce-buying customers to stay afloat and create a business model around more than just education and social services. Food cooperatives could be a huge asset for recruiting new customers because they make CUA produce more accessible. While employing those with a distance to the labor market or providing volunteer opportunities should be maintained and seen as a significant social benefit, as is seen in the future vision, a solid employee workforce might be necessary to legitimize CUA's growth into a regime. In-line with the future vision of The Hague, food cooperatives could also be the "testing site" of a more local food market to see how residents react to the CUA sector. From there, the local food market could expand into grocery stores or even their own marketplaces.

8.3 Final Recommendations

With global uncertainties on the rise, cities may need to become more self-reliant in order to protect themselves. CUA could be a promising future endeavor for The Hague as it fights for carbon neutrality and innovativeness amidst entrepreneurial cities like Rotterdam and Amsterdam. The sector could also be an example of efficient communication, well-managed material exchanges and social wellbeing for other sectors looking to become more circular. Here, I present an overview of recommendations for future decisions in the development of CUA as a regime.

8.3.1 Recommendations for Policy Makers

Recommendation	**Goal**
Implement edible landscaping in The Hague	Increase awareness of UA possibilities and get people used to the idea of food growing in the city
Increase breadth of GFT collection and provide educational stickers for collection bins	Make separating organic waste easier and more widely available
Implement trial neighborhood composting sites	Assess the possible success of locally-driven composting and educate residents on the process
Collaborate with CUA practitioners in The Hague for research opportunities on UA and circularity, not only universities	Take advantage of wealth of knowledge, much of which is location-specific, regarding the sector; increase communication between municipality and CUA sector
Review composting/organic waste policies and look into circulating The Hague's organic waste back into the city	Ensure that organic waste policies are suitable and encourage circularity in the city (to a safe degree); keep nutrients in a more closed loop
Investigate possibilities for punishing linear economy behavior	Use policies to discourage the "take, make, waste" mentality and encourage increased circularity
Create a central reference position in the municipality for urban agriculture and circularity projects	Streamline communication and knowledge regarding urban agriculture, circularity and the combination of CUA
Create a policy database for those practicing CUA	Increase transparency and ease of reference for policies pertaining to CUA
Experiment with local marketplaces or distribution centers for local agriculture	Assess the demand for local produce and try out locations that might work for future brick-and-mortar markets
Host meetings with urban agriculturalists and farmers from Midden-Delfland	Begin the conversation between these two sectors for potential future collaborations

8.3.2 Recommendations for CUA Sector Participants

Recommendation	Goal
Get involved with local distribution organizations or small neighborhood markets	Increase awareness and availability of UA produce and make connections with residents
Be open to collaborations with more rural farmers like those in Midden-Delfland, maybe by first co-hosting local food events	Increase attention to local food and make a starting point for future supply chain collaborations/exchanges
Host "open days" for surrounding neighbors	Allow those closest to the CUA initiatives, which could be their biggest customer base, to learn more about the initiative, sustainability and nutrition (could prevent the feeling of "gentrification")
Explore potential supply chain partnerships with rural farms or other industries	Identify the holes in the supply chain and where reuse could come into play
Monitor nutrient, water, energy and material flows within initiatives	Keep track of inflows and outflows to find places for either internal reuse or the potential to incorporate other initiatives' outflows as inputs; collectively could provide a supply chain map of the entire sector
Host educational events around food and circularity in partnership with other initiatives	Increase awareness city-wide regarding foundations of CUA; increase connectivity and communication of different initiatives

8.3.3 Recommendations for Future Research

Recommendation	Goal
Collect or personally record data for circularity assessments for the entire food system of The Hague and the UA sector	Quantify the current state of circularity and create a more defensible backbone on which to build future plans
Explore the potential of city and rural-based farms to collaborate and exchange materials	Provide concrete support for the creation of a local food system
Test farm mentorship programs to encourage local agriculture	Re-stimulate passion for agricultural professions and support innovation and collaboration between the city and rural areas
Host a roundtable discussion with urban farmers, rural farmers circularity experts, municipality members and community members	Amend and assess the future vision using more evaluations (feasibility, leadership potential, level of support…); create a pathway toward vision realization

9 References

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10 Appendices

10.1 Interview Questions

Red = cut out of shorter interviews

Intro Questions
Who are you? What is your role in this organization? What is your organization doing with urban agriculture and circular economy practices?

UA in The Hague

Urban agriculture would be considered a "niche" in The Hague, meaning that it exists in almost a protected realm that tests innovative options. The hope for many niches is that they will eventually transition into the more "everyday" regime practice and expand beyond the "activist" sphere. The niches often need to be protected from external market pressures and receive several forms of support in order to function in society. Do you see this pattern in urban agriculture in The Hague? What would be the structure of this niche in terms of protection and support?

What are the main developments that have occurred in urban agriculture in The Hague?

What are the main issues that occur in urban agriculture in The Hague?

Who are the main actors or key networks of urban agriculture in The Hague?

CUA in The Hague

1. Do you think urban agriculture is related to circularity? How?

2. What is your definition of circularity? What are the main developments dealing with circularity in The Hague? And how would you define circularity in the urban agriculture sector?

3. Referring back to the concept of a niche, circular urban agriculture is definitely still practiced on a small scale, almost occupying an incubation space. Do you see it as a separate entity from urban agriculture? Or do you think it is a sub-niche of "traditional" urban agriculture?
4. Do you see circularity already being practiced or pursued in urban agriculture? What are some examples, well-defined or emerging, in The Hague and what organizations are involved? What are some of their important actors?

5. Who all do you think is necessarily involved in a successful urban agriculture system that is focused on circularity? Do you think there is anyone missing from this list currently?

6. Since the birth of this movement, have you seen learning occurring within the field of circular urban agriculture? Either about technologies, marketing, production, or changing priorities?

7. What is the municipality's role in expanding circular urban agriculture?

8. What do you expect to happen in the future for circular urban agriculture? (What is likely to happen) Has this changed since the start of your organization?

9. What have you learned from your experiences with circularity and urban agriculture?

10. What are your aspirations for circular urban agriculture? (What is best case scenario) How would we get there? In other words, what are the steps you believe are necessary to achieve this vision?

11. How far could we get with enhancing circularity in urban agriculture and to what extent could circular urban agriculture feed the city of The Hague?

12. Are there any metaphors that you or your organization use to describe what you wish for regarding circular urban agriculture in The Hague?

13. Do you think other actors in the circular urban agriculture network share the same vision and goals?

14. For your vision to become a reality, what will need to change in the current set of "rules" regarding CUA?

Individual CUA Organization

1. Who are your main suppliers, customers, and partners?

2. How has your organization developed since its beginning and what were the main milestones in this development? How do you expect this to continue?

3. From your experience so far, could you provide an estimate of amount of energy, water, plastic, nutrients, and soil consumed and wasted/sent out in a month? What are the sources and final destinations of these flows?

4. We talked about the future of circular urban agriculture as a whole. Now, what do you think the future looks like for *your* organization?

5. What are the organization's ambitions for the future? In other words, is there a best-case scenario to which you are striving? Are there any metaphors used to communicate these ambitions within the organization or network?

6. What will need to change in order for these ambitions to become realities? What are the drivers and barriers you see currently that could inhibit this?

7. Do you have anything else you would like to add? Is there anyone else that you think would be integral for me to interview?

10.2 Interview Coding

Table 22 Interview codes as evaluated using atlas.ti online software

name	comment	occurrence
BARRIER:ECON	economic barrier to expansion of niche	33
BARRIER:ORG	organizational barrier to expansion of niche	14
BARRIER:POLITICAL	political barrier to expansion of niche	32
BARRIER:SOCIAL	social barrier to expansion of niche	31
BARRIER:TECH	technological barrier to expansion of niche	16
CIRCULARITY+UA	discussing circularity associated with urban agriculture	36
CUA-NICHE	language used to confirm the existence of CUA as a niche or not	26
CUA:EXP	expectations for the sub-niche of circular urban agriculture	14
CUA:LER	learning about aspects of the CUA sector as a whole	48
CUA:MFA:ENERGY		4
CUA:MFA:NUTRIENTS		2
CUA:MFA:ORGANICS		1
CUA:MFA:WATER		2
CUA:NET:COMPOSITION	how and to what degree actors are communicating and collaborating between CUA initiatives	32
CUA:NET:DYNAMICS	network growth or trust between CUA initiatives and all those involved	22
CUA:NET:INTERACTION	The communication and collaboration between CUA institutions and their overall network	23
CURRENT	Discussing current state of things (landscape)	70
EXP:ECON	expectations regarding the economic aspects of the future	1
EXP:ENV	expectations regarding the environmental harms/benefits	1
EXP:LEG	expectations regarding the future of legislation	1
EXP:ORG	expectations regarding organization	10
EXP:POLITICAL	expectations regarding political aspects of the future	1
EXP:POS	positive language about the future	14
EXP:SOCIAL	expectations regarding the social aspects of the future	7
EXP:TECH	expectations regarding the technological aspects of the future	9
IND:EXP	expectations for the future of individual organizations	11
IND:LER	learning about aspects of the individual organization since development	27
IND:MFA:ENERGY	individual organization's flow of energy	1

IND:MFA:NUTRIENTS	Individual organization's flow of nutrients	7
IND:MFA:ORGANICS	Individual organization's flow of organic material	16
IND:MFA:WATER	Individual organization's flow of water	7
IND:NET:COMPOSITION	completeness of inclusion, if desired actors are involved	17
IND:NET:DYNAMICS	network growth or trust within the supply chain network	14
IND:NET:INTERACTION	how and to what degree actors are communicating and collaborating	15
LAND:EXP	expectations for the landscape/outside forces influencing the food system	4
LANDSCAPE	descriptions/statements about the context in which the regime functions (outside influences)	31
LER:APP.SHIFT	shift in problem-solving approaches	17
LER:ECON	learning about the economic aspects	13
LER:ENV	learning about the environmental aspects like energy use, pollution, or emissions	5
LER:GOV	learning about institutional structures/legislation or the government's role	5
LER:INDUS	learning about the production and maintenance network	12
LER:MARKET	user or market characteristics and the meanings they attach to services	22
LER:PROB.SHIFT	changes in problem definition or priorities	14
LER:SOCIAL	learning about the social aspects like safety and communication	18
LER:TECH	learning about the design specifications, required technology, infrastructural requirements	19
PATH	Steps necessary to achieve actors' visions for the future of the CUA sector	78
PATH:ECON	a pathway that incorporates economic elements	8
PATH:ORG	a pathway that incorporates organizational elements	26
PATH:POLITIC	a pathway that incorporates political or legislative elements	20
PATH:SOCIAL	a pathway that incorporates social or behavioral elements	26
PATH:TECH	a pathway that incorporates technological elements	14
REG:EXP	expectations for the regime of the urban food system or traditional food procurement methods	8
REGIME	descriptions/statements about the current food system (the norm)	24
UA:EXP	expectations for the niche of urban agriculture	20
VIS	relating to vision	98
VIS:CONT	Similar ambitions (continuity) between actors in an organization's network	3
VIS:DB	Description of elements, both positive and negative, that would either facilitate or slow the vision (drivers and barriers)	56
VIS:EXPLICIT	The use of explicit words or images to describe the future vision	22
VIS:FEAS	The infrastructural, economical, and political feasibility of expanded CUA practices	4
VIS:INT	The integration of expectations to help shape future visions	10
VIS:LEAD	Voicing of who would be in charge (leadership) of this vision realization	10
VIS:LEG	legislative or political aspects in vision for CUA sector	15
VIS:ORG	institutional or organizational aspects in vision for CUA sector	65
VIS:RULES	Voicing of the rules or practices that would need to be changed in order to realize the vision	18
VIS:SOCIAL	cultural/behavioral aspects in vision for CUA sector	18
VIS:TECH	technological advancements in vision for CUA sector	20
VIS:TRANS	Contrast between current practices and the future vision (transformational)	47

10.3 Relevant Literature

The concept of urban circularity can be addressed in various ways. For example, keywords for documents pertaining to urban circularity are diverse, including ‘circular economy,’ ‘complex urban systems,’ ‘sustainable urban development,’ ‘closed-loop supply chain,’ ‘industrial ecology,’ ‘circular metabolism,’ and ‘cradle to cradle’ (Bulkeley & Betsill, 2005; *Circular economy The Municipality of The Hague*, 2017; Geldermans, 2016; Kennedy & Hoornweg, 2012; Pomponi & Moncaster, 2016; Prendeville et al., 2016; Webb et al., 2017).

Permaculture is one of the most popular forms of CUA because of its use of few resources, its low maintenance, and its “connection to nature” mentality. Articles related to permaculture include titles like:

Title	Author(s)	Keywords	Topics Covered
“Making food, producing sustainability”	Hirsch et al., 2010	sustainability, sustainable HCI, agriculture, fishery, food production, permaculture, urban agriculture	small-scale UA production; connections with the environment; interactions between environment, social, and economic sustainability

"Designing for grassroots food production"	Lyle et al., 2014	urban agriculture, grass roots community, food, gardening, urban informatics	Permaculture design and planning principles; encouraging urban residents to grow their own food; forming UA communities
Feeding and healing the world: Through regenerative agriculture and permaculture"	Rhodes, 2013	Carbon capture, desertification, forest garden, hydraulic fracturing, permaculture, regenerative agriculture, soil degradation, soil fungi, water treatment	Soil study; peak oil reserves; transportation transition; strengthening urban resilience; reducing energy use and other resources
"Readjusting to reality: Urban and peri-urban agriculture to ease the downward passage."	Atkinson, 2013	modern civilisation, end of oil, allotments, food miles, reuse of human waste, urban and peri-urban agriculture (UPA), community-supported agriculture (CSA), permaculture	The growth of innovative urban development; future visions for urban and peri-urban agriculture
"Designing for food security in a dryland metropolis"	Grichting, 2016	food urbanism, edible landscapes, drylands, food security	Creating productive landscapes; growing in harsh environments; edible landscapes
"Towards resilient agriculture and beyond: The promise of regenerative agriculture"	Milder, 2018	{thesis}	Regenerative agriculture; circular food systems; environmental impacts of agricultural supply chain; soil health
"Agricultural transition: Niche and regime knowledge systems' boundary dynamics"	Ingram, 2018	permaculture, knowledge systems, niche, regime, boundaries, innovation	Alternative agriculture's influence of Agricultural Knowledge Systems; boundaries between permaculture and mainstream agriculture

10.4 UA and Green Space Initiatives in The Hague

Formed with help of Stadslandbow Den Haag

name	type	address	year found
Imker I Kornoelje	Beekeeper	Kornoeljestraat 117	?
Imker Zuiderpark	Beekeeper	Anna Polakweg 7	?
Imker Reigershof	Beekeeper	Reigersbergenweg 282	?
Imker Mozartlaan	Beekeeper	Mozartlaan 170 z	?
Imker De Gagelhoeve	Beekeeper	Mient 210	?
Imker Kortenbos	Beekeeper	Kortenbos	?
Imkerij Haagse Honing	Beekeeper	Houtrustweg	2013
Imker - De gave bijentuin	Beekeeper	Valutapad	2015
Imker Landzigt	Beekeeper	Aristoteleslaan 143	?
Imker ATV Nooit Gedacht	Beekeeper	Laan van Wateringseveld 2	2010
Imker Stadsklooster	Beekeeper	Westeinde 95z	?
Imker Arjan de Haas	Beekeeper	Schenkkade 324	2017
ImkerHub	Beekeeper	Pippelingstraat 174	2017
Mens en Tuin	Care Garden	Hillenraadweg 35	1986
Haagsche Schil	Circularity	Stille Veerkade 19	2017
Nijkamphoeve	City Farm	Escamplaan 1750	2012
Stadsboerderij De Woelige Stal	City Farm	Herman Costerstraat 80	?
Stadsboerderij Op den Dijk	City Farm	Bovendijk 141-143	?
Stadsboerderij De Kakelhof	City Farm	Puccinistraat 215	?
Stadsboerderij De Reigershof	City Farm	Reigersbergenweg 280	1960
Stadsboerderij 't Waaygat	City Farm	Havenkade 75	?

Stadsboerderij De Molenweide	City Farm	Stuwstraat 31	?
Stadsboerderij De Gagelhoeve	City Farm	Mient 210	?
Stadsboerderij Schildershoeve	City Farm	Teniersplantsoen 83	?
Stadsboerderij De Herweijershoeve	City Farm	Anna Polakweg 7	?
Stadsboerderij 't Beestenspul	City Farm	Tivolistraat	?
Stadsboerderij Beestenboel Tesselweide	City Farm	Tesselsestraat	?
Stadsboerderij Landzigt	City Farm	Aristoteleslaan 143	?
Stadswijngaard	City Vinyard	waldorpstraat 555	2013
De Compostbakkers	Composter	Ametisthorst 9z	2015
Le Compostier	Composter	Van Brakelstraat	2017
Heilige Boontjes	Cooking School and Garden	Martinus Nijhoffweg 69	
Eetbaar park Zuiderpark	Educative Garden	Anna Polakweg 7	2010
Eetbaar park Nut en Genoegen	Educative Garden	Meppelweg 882	2010
Milieu Educatief Centrum Kornoelje	Educative Garden	Kornoeljestraat 117	?
Milieu Educatief Centrum Schildershoeve	Educative Garden	Teniersplantsoen 83	?
Milieu Educatief Centrum Reigershof	Educative Garden	Reigersbergenweg 282	1960
Milieu Educatief Centrum Zuiderpark	Educative Garden	Anna Polakweg 7	?
Segbroekcollege	Educative Garden	Goudsbloemlaan 131	2013
Eetbaar park proeftuin Madestein	Educative Garden	Loosduinsehoofdkade 1148z	
Haagse Eitjes	Egg Farm	valutapad	2017
Lekker Nassuh	Food Cooperative	Witte de Withstraat 127	
Uptown Greens	Food Grower	Televisiestraat 2 Unit 22	2018
De Groenteboerin	Food Grower	Bieslandseweg 1	
GREENS	Food Grower and Café	Kapelweg 18	2018
Kasserie Ock	Garden and Café	Monsterseweg 4	2017
Terras Beresteinlaan	Garden Teraace	Beresteinlaan	2017
Pluk! Den Haag	Growers + Café	Loosduinse Hoofdstraat 1184z	2012
ATV Florence Nightingale	Individual Plot Area	Dedemsvaartweg 70	1947
ATV Houtwijk de Noord	Individual Plot Area	Uithofslaan 32	1973
ATV 't Is Altijd Wat	Individual Plot Area	Uithofslaan	?
ATV Loolaan	Individual Plot Area	Ijsclubweg 5	1954
ATV Madestein	Individual Plot Area	Madepolderweg 59 C	1975
ATV Mariahoeve	Individual Plot Area	Isabellaland 2320	1984
ATV De Mient	Individual Plot Area	Poeldijkseweg 22	1965
ATV Nooit Gedacht	Individual Plot Area	Laan van Wateringse Veld 2	1969
ATV Nut en Genoegen	Individual Plot Area	Meppelweg 882	?
ATV Tuinderslust	Individual Plot Area	Arckelweg 25	1940
ATV Eigen Arbeid	Individual Plot Area	Zijdeweg 60	1917
ATV Buitenlust	Individual Plot Area	Julialaantje	1977
ATV De Uithof	Individual Plot Area	Jaap Edenweg 15	1969
VTV Westerduin	Individual Plot Area	Daal en Bergselaan 1	?
ATV De Wijndaeler	Individual Plot Area	Wijndaelerweg 12	?
Groene Schenk	Individual Plot Area	IJsclubweg	2014
ATV Zonneweelde	Individual Plot Area	Reigersbergenweg 282	1952
Schimmelweg	Individual Plot Area	Schimmelweg 505z	1989
Nijkamptuin	Individual Plot Area	Escamplaan 1750	2012
Leeuwenbergh	Individual Plot Area	Elzenlaan 5	1981
ATV De Groene Zoom	Individual Plot Area	Groene Zoom 17	1974
Hobbytuin Vereniging Van Swindenhof	Individual Plot Area	Van Swindenstraat	1989
ATV Essesteijn	Individual Plot Area	Schipholboog 1a	1977
ATV De Wijndaeler	Individual Plot Area	Wijndaelerweg 12z	?
ATV De Zonnegaarde	Individual Plot Area	Erasmusweg 872	1938

atv Arentsburgh Voorburg	Individual Plot Area	Arentsburghlaan 26B	
Nutstuin	Neighborhood Garden	Riviervismarkt 5	2011
Zeeheldentuin	Neighborhood Garden	Tasmanstraat	2014
Tuinen van Mariahoeve	Neighborhood Garden	Onyxhorst 5z	2012
Tuinen van Mariahoeve Catharinaland	Neighborhood Garden	Catharinaland 201z	2015
Tuinen van Mariahoeve Haverkamp	Neighborhood Garden	Haverkamp	2012
Tuinen van Mariahoeve Denenburg	Neighborhood Garden	Denenburg 240z	2012
Buurttuin Milieu Educatief Centrum Zuiderpark	Neighborhood Garden	Anna Polakweg 7	?
Moerwijk	Neighborhood Garden	Guntersteinweg 14	?
Assumburg	Neighborhood Garden	Guntersteinweg	?
't Gras van de buren	Neighborhood Garden	De Constant Rebecqueplein	2013
Stadsboerderij Jacobahof	Neighborhood Garden	Hillegondastraat 16z	1994
Jacobahof	Neighborhood Garden	Hillegondastraat 16z	2012
Keu's genoeg	Neighborhood Garden	Genemuidenstraat 208	2014
Newtontuin	Neighborhood Garden	Newtonplein	2011
Emma's hof	Neighborhood Garden	Galileistraat 36	2011
Drieluik	Neighborhood Garden	Kepplerstraat 59	?
Het Welpje	Neighborhood Garden	Roggeveenstraat 78z	2014
Lusthof XL Spinozahof	Neighborhood Garden	Spinozastraat 2z	2014
Lusthof XL Wagenbrug bakken buurttuin	Neighborhood Garden	Stationsweg 2	2013
Hof van Wouw	Neighborhood Garden	Lange Beestenmarkt 49	1647
Kesslerstichting Buurttuin	Neighborhood Garden	Viljoenstraat	2014
Margarethaland	Neighborhood Garden	Margarethaland 204 z	2014
Kamperfoeliestraat	Neighborhood Garden	Kamperfoeliestraat 170z	
Educatieve tuin Mozartlaan	Neighborhood Garden	Mozartlaan 170 z	
Groenteweg	Neighborhood Garden	Groenteweg 70z	
MOC Binnentuin	Neighborhood Garden	Teniersplantsoen 17	
Hildebrandplein	Neighborhood Garden	Hildebrand 66z	
De groene geest	Neighborhood Garden	George Bizetstraat 25	
Tuinvereniging Clingendael	Neighborhood Garden	Wassenaarseweg 261z	
De Duintuin	Neighborhood Garden	Markenseplein	2012
Grondige vlinders	Neighborhood Garden	Woonstede 48z	
Generatietuin Nieuw Waldeck	Neighborhood Garden	Georges Bizetstraat	
Duttendel Buurttuinen	Neighborhood Garden	Klattenweg	?
Foodscape Schilderswijk - Urbaniahoeve	Neighborhood Garden	Hennemanplantsoen	2013
Marcustuin	Neighborhood Garden	Jan Luykenlaan 92	2014
Kids op dreef	Neighborhood Garden	Riddersdreef 111z	2014
Staedion Dreeftuin	Neighborhood Garden	Riddersdreef 111z	2014
Tuin van Venen	Neighborhood Garden	Hoogveen 225z	2015
Oorden kids tuin	Neighborhood Garden	Het Oord 12	2011
Grootmoes tuin	Neighborhood Garden	Sterrenoord 95z	
Hangende tuinen van de Schilderswijk	Neighborhood Garden	Koningstraat 439	2015
Buurttuin Havenkade	Neighborhood Garden	Havenkade	1983
De Verborgen Tuin	Neighborhood Garden	Loenensestraat	
De Moeshorst	Neighborhood Garden	Onyxhorst	2016
Vlindertuin	Neighborhood Garden	Noorderbeekstraat	
Uitvindershof	Neighborhood Garden	Van Swindenstraat	2017
Woonstede	Neighborhood Garden	Woonstede 20-32 voorkant	2017
Binnenzijde	Neighborhood Garden	Binnenzijde, aan de achterzijde	2017
Hertenrade	Neighborhood Garden	Hertenrade 282	2017
Veldzicht	Neighborhood Garden	Veldzicht	2017

Stadszijde	Neighborhood Garden	Stadszijde 8	2017
Valkenbosgaarde	Neighborhood Garden	Valkenboskade	2017
Mozartlaan	Neighborhood Garden	Mozartlaan 170	
Guntersteinhof	Neighborhood Garden	Guntersteinhof	
Overbosch	Neighborhood Garden	Vlaskamp achter nummer 1a	
De Molenweide	Neighborhood Garden	Stuwstraat 31	
Waanzinnge Waldeck Tuin	Neighborhood Garden	Oude Haagweg 55	2018
Pandertuin	Neighborhood Garden	Binnendoor	
Het Schildershof	Neighborhood Garden	Meester de Bruinplein	2015
Eetbare Velden	Neighborhood Garden	Jenny Plantsoen	2017
Warmoestuin	Neighborhood Garden	Sionsweg	
Moe's Tuin	Neighborhood Garden	Poptahof	2005
Stadsakker Proeftuin Erasmusveld	Permaculture Expert	Noordweg	2017
Schooltuin Milieu Educatief Centrum Zuiderpark	School Garden	Anna Polakweg 7	?
Schooltuin Havenkade	School Garden	Vlaskamp 1	
Schooltuin Van Ostadestraat	School Garden	Van Ostadestraat	
Educatieve tuin Kortenbos	School Garden	Kortenbos	
Schooltuin Hildebrandplein	School Garden	Hildebrand 66z	
Schooltuin Erasmusweg	School Garden	Erasmusweg 872	
Schooltuin Landzicht	School Garden	Aristoteleslaan 143	
Schooltuin De Wonnebald	School Garden	Mozartlaan 189	
De Paradijsvogelkas	School Garden	Weidevogellaan 201	2015
Schooltuin Mozartlaan	School Garden	Mozartlaan	1983
Schooltuin De Geest	School Garden	George Bizetstraat	1984
Schooltuin Kamperfoeliestraat	School Garden	Kamperfoeliestraat	1970
Schooltuin Duivelandsestraat	School Garden	Duivelandsestraat	1970
Schooltuin Havenkade	School Garden	Havenkade	1983
Schooltuin De Molenweide	School Garden	Stuwstraat 31	
Noordzeeboerderij	Seaweed Farm (Organization Base)	Zeestraat 84	2017
Urban Farmers	Urban Agriculture	Televisiestraat 2	2013
HaagseZwam	Urban Agriculture - mushrooms and coffee grounds	Televisiestraat 2	2017