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Food Connects Washington DC in 2050—A Vision for Urban Food Systems as the Centerpieces of a Circular Economy

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Abstract: This article presents a vision for an urban food system in Washington DC in 2050 that serves as the centerpiece of a circular economy for the capital region of the United States. Food serves as the connecting link for an inclusive, adaptive, and resilient urban economy embedded in the region. This food economy values natural resources, cultural diversity, and commitment to nature-based innovations. The vision is the result of a three-pronged methodology of: (1) community engagement; (2) a thoughtful, process-focused transformation; and (3) the scaling up of existing urban food initiatives. We argue that small, hyperlocal, neighborhood-based initiatives can become crucial game changers and catalysts of change for entire neighborhoods, cities, and regions. Therefore, we propose a design-based approach to advance our 2050 vision of a circular food system. Our design-based approach consists of three building blocks: (A) systems thinking; (B) the ability to manage wins and tradeoffs; and (C) transitional leadership and cooperation. We explain these building blocks and the way in which they are incorporated in the 2050 vision of Washington DC. We further argue that the food economy is an ideal sector to embark on such a design-based approach due to its systemic nature, its critical position as an indispensable economic sector, and the complex connections it brings to multiple other sectors of the economy. An urban food system can therefore offer the ideal starting point for a transition towards a circular economy.

Keywords: urban food system; food economy; circular economy; urban sustainability; transitions; systems thinking; the ability to manage wins and tradeoffs; transitional leadership and cooperation



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1. Introduction

To sustain our planetary resources and processing capacities, we must change from a linear to a circular economy that patterns itself after nature and understands how nature works [1]. Food systems need to drastically change, as they are co-responsible for degrading ecosystems, reducing biodiversity, and accelerating climate change [2]. Instead, they need to be founded on principles of restoration and regeneration [3] such as minimizing the loss of resources, reducing emissions and waste, and respecting the material and energy cycles of nature, while creating healthy crops and improving biodiversity and animal welfare.

The Washington DC metropolitan area is a microcosm of many of the challenges food systems face worldwide. The DC region is growing, and land values are rising steadily. At the same time, the region (especially its urban core) is highly bifurcated. Although it is one of the most educated and affluent metropolitan areas in the United States, not everyone in the DC metropolitan area is receiving a fair share in the region's economic success. Food Apartheid neighborhoods, gentrification, new populations moving in and pushing up land values, traffic problems, an aging infrastructure, and the impacts of unsustainable practices are just some of the issues facing Washington DC as well as other, older cities in the United States of America and around the world. We use the term Food Apartheid rather than the more commonly used term Food Desert to avoid negative connotations with desert ecosystems that the term may carry.

The challenges that Washington DC faces point to the need for an urban food economy that addresses food access disparities, reduces pressure on the urban infrastructure, and improves the sustainability and resilience of food systems in high-population areas. The need for such a food system has been amplified worldwide during the COVID-19 pandemic. As food supply chains collapsed and migrant workers suffered exorbitant infection rates and mobility restrictions, the vulnerability of the highly centralized, highly global food system became plainly evident [4].

In this article we present a vision of a circular urban food economy in Washington DC in 2050. This vision is based on eight dreams that we developed for the city and each of its eight Wards, which form the city's administrative and geographic grid. The eight dreams seek to capture the full potential of an urban food system that effectively integrates improvements in health, employment, technology, infrastructure, and ecosystem services.

We explain our methodology in Section 2 of this article. Our methodological approach anchors our 2050 vision in community engagement, a thoughtful, process-focused transformation, and a wide array of existing small initiatives that contribute to the overall vision of a circular food economy.

Section 3 of this article expands the idea of a local food economy to the entire city and its eight Wards. We take the UDC Urban Food Hubs [5,6] and a 2018 study of local economic development opportunities in two of the most underserved Wards of Washington DC [7] as our starting points. The networked urban food system we envision, with its eight dreams that are anchored in the eight Wards, seeks to produce regional food, minimize waste, reduce transportation, maximize energy efficiency, reintroduce nature into the city, build on climate adaptation and mitigation, and improve the quality of life of urban residents from all walks of life.

The networked dreams of the eight Wards have their basis in local neighborhood-based initiatives that can become crucial game changers for entire cities and regions. We propose a design-based approach structured around three building blocks:

- A. Systems thinking: Improvements in food economies are inextricably linked to the environmental/physical and social/cultural context of local communities. The objective is therefore to improve not only economic outcomes, but also the social/cultural and physical/environmental context within which every food economic activity takes place. The urban food system is an ideal example to illustrate this principle since food incorporates a wide range of connections including diets, culture, economic livelihoods, sustainability, policy, and technology. While these connections are all intrinsically linked, we highlight some of them as key elements to explaining the effectiveness of circularity.
- B. The ability to manage wins and tradeoffs: Our 2050 vision can create win-win situations such as improved living environments for residents plus better urban resource management. However, it will not be without tradeoffs. We propose several ways to maximize wins and minimize tradeoffs and seek to engage those most impacted in resolving the tradeoffs which may arise.
- C. Transitional leadership and cooperation: Circular urban food economies demand not only new technologies but also new forms of knowledge production [8], socio-technical change [9], and new institutions [10]. We therefore propose to create an ecosystem of urban food leaders in the academy, the private sector, government institutions, and non-profit organizations that all work toward advancing the circular urban food system of the future. This network of leaders is positioned to not only collaborate within the Washington DC metropolitan region but can also advance its reach through networks of circular urban food systems beyond the region to facilitate the needed transition.

In Section 4 of this article, we address our design-based approach and its three building blocks and explain the way in which they are incorporated in the 2050 vision of Washington DC. We believe that these building blocks must be part of any design to maximize win-win

outcomes and minimize win–lose tradeoffs. In our conclusions we look at the way forward to further refine our design-based approach.

2. Methodology

Our 2050 vision is inspired by the award winning Urban Food Hubs work of the University of the District of Columbia and takes the UDC Urban Food Hubs Model developed in DC's Wards 5, 7, and 8 as its starting point [5,6]. Each Food Hub features 4 integrated components: Food Production, Food Preparation, Food Distribution, and Waste and Water Management to close the loop. Food Production takes place through bio-intensive methods, hydroponics and aquaponics; Food Preparation takes place in community kitchens that add value and offer nutrition education; Food Distribution takes place through farmers markets, community-supported agriculture (CSA) groups, restaurants, and niche markets; and Waste and Water Management activities close the loop through the use of composting, water harvesting, rain gardens, and other green infrastructure initiatives.

Our vision expands the Urban Food Hubs model to more fully develop its circular characteristics and systemic linkages to other sectors including water management, nature conservation, water management, green infrastructure, technology, and health-related fields. Crucial for our visioning process is the embeddedness of the local food system in the natural environment. Furthermore, the 2050 vision incorporates all 8 Wards in Washington DC and the region surrounding the city to engage consumers and producers and connect them in a comprehensive circular food economy.

While our 2050 vision and the eight dreams for the eight Wards of Washington DC are our creation, they are rooted in the stories of some of the city's local neighborhoods themselves. Starting in 2015, Sabine O'Hara and some of her students at UDC organized focus groups in two neighborhoods in Ward 7 and 8 to engage residents in writing a story about a sustainable future for their neighborhoods. The story was structured around 5 chapters: education, health, social and cultural amenities, environmental quality, and access to information and transportation [7]. The articulate and visionary stories that resulted from this community-based process formed the basis for our expanded 2050 vision of how food connects the eight Wards of Washington DC and even the surrounding DC metropolitan area.

Our approach illustrates how technocratic modes of circularity need to be enriched with bottom-up approaches [10]. We therefore created a vision based on Wards 5, 7, and 8 where the Urban Food Hubs of Washington DC are located, as well as the two Wards (Ward 7 and 8) where the story writing process took place. We adopted a three-pronged methodology of: (1) community engagement; (2) a thoughtful, process-focused transformation; and (3) the scaling up of existing urban food initiatives. This includes the community engagement of O'Hara and her students and their relations with the local stakeholders through both the story writing process and the Urban Food Hubs work in Washington DC. It also includes the thoughtful process-focused transformation facilitated by the interaction between different groups of actors including residents, community leaders, municipal agencies, entrepreneurs, students, and academics. This illustrates our approach of building on multiple small urban food initiatives to move toward building our vision on the existing assets of all the Wards in Washington DC. Partners from the Netherlands met with partners in Washington DC to start building a global (digital) network of related visions of transformative local food systems. The visioning process makes it possible to refine the feasibility, synergies, and tradeoffs of small local initiatives and identify emerging signals of change such as commoning [11], time banking [12], and gift economies [13].

The worldwide COVID-19 pandemic has made it challenging to navigate the engagement process of partners and stakeholders. However, it has also pointed the way toward future engagement and successful collaborations even in times of external shock events. The network we developed to support and critique the 2050 vision is diverse, multidis-

ciplinary, and reflective of the local and credentialed expertise necessary to successfully continue the transition process toward an urban circular food economy.

3. Eight Dreams Creating One Vision

The current reality of Washington DC is different from our 2050 vision of a circular food economy. The downtown area of the nation's capital is a major tourist destination and culinary mecca. Parts of Ward 2 and Ward 3 are home to some of the best-educated members of the workforce and those with the highest household incomes in the United States, with a wide range of amenities and access to services. In contrast, Wards 7 and 8, located east of the Anacostia river, have 1.5 full-service grocery stores for 70,000 residents, limited amenities, high unemployment, low household incomes, and low educational attainment. Sadly, the stark differences in socio-economic conditions also result in dramatically different health outcomes and life expectancies, following clear racial divides [14]. Wards with high incomes, high life expectancy, and low unemployment have predominantly white populations, while those with low incomes, low life expectancy, and high unemployment, have high percentages of non-Hispanic black populations (see Table 1).

Table 1. Demographic, socioeconomic, and health-related data for Washington DC by Ward.

Background Data	Ward 1	Ward 2	Ward 3	Ward 4	Ward 5	Ward 6	Ward 7	Ward 8
Total population	82,859	77,645	83,152	83,066	82,049	84,290	73,290	81,133
Children under 18	12%	5%	13%	20%	17%	14%	24%	30%
People over 65	2%	6%	13%	3%	2%	3.3%	0.3%	0.2%
Single-parent households	10%	3.8%	4%	19%	22%	11%	33%	39%
Black (non-Hispanic)	33%	10%	6%	59%	77%	43%	95%	94%
White (non-Hispanic)	40%	70%	78%	20%	15%	47%	2%	3%
Hispanic	21%	9%	8%	19%	6%	5%	2%	2%
Asian	5%	10%	8%	2%	2%	5%	0.3%	0.5%
Household income	USD 113,972	USD 209,147	USD 257,224	USD 123,353	USD 82,425	USD 140,853	USD 56,759	USD 45,239
Unemployment	5.1%	3.8%	3.7%	9.8%	14%	6.2%	19%	22%
Life expectancy	78 y	86 y	85 y	78 y	75 y	77 y	73 y	70 y

Our 2050 vision paints a future where Washington DC has overcome many of its disparities. Food serves as the connecting link for an inclusive, adaptive, and resilient economy that values its natural resources, cultural diversity, and commitment to nature-based innovation. Diets are largely plant-based and offer opportunities to share cultural roots; technology enhances natural resources and strengthens sink capacities rather than depleting them; economic activity is circular and based on principles of restoration and regeneration rather than exploitation; and policies emphasize regional collaboration to overcome rural–urban division. Urban and rural initiatives form an interconnected regional food system that builds upon natural and social characteristics and values. Figure 1 illustrates the 2050 vision of Washington DC and its eight dreams for the eight Wards.

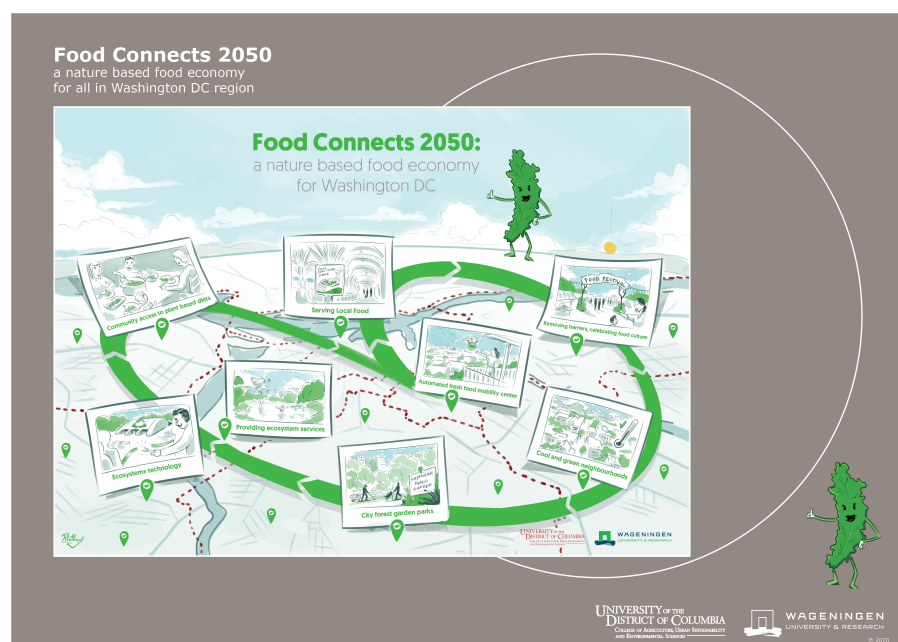


Figure 1. Food Connects 2050: a nature-based food economy for all in Washington DC.

Ward 1: Food connects the Wards

Come 2050, hundreds of drones have alleviated the traffic jams in downtown DC. They zip about making just-in-time deliveries of strawberries fresh from the urban farms in Ward 4 for the breakfast of the citizens in Ward 1. Seedlings for plant-based water filtration systems are distributed from Ward 7 to downtown offices. Personal “silent natural wing” drones surround tourists in the mall and entertain those waiting for entrance to one of the Smithsonian museums. The reduced traffic has opened former traffic lanes and pavements for added green space, bike lanes, and walking paths that make a meaningful contribution to reducing the summer heat in downtown DC.

Ward 2: Food connects the local economy, the region and the world

Visitors to the city in 2050 are proudly presented with a guide to plant-based regional cuisine in the area upon arrival at the airport or train station. Passionate youth movements started the revolution that brought about the change needed to implement a local and regional food economy. A network of hotels, government buildings, hospitals, community centers, and schools produces its own vegetables and fruits in energy-neutral climate rooms in Ward 2 and 5. They also buy vegetables and grains from the farms in the region and support outdoor food production in raised bed gardens and hoop houses that encourage wellness and collaboration. A new generation of students and employees are working in a circular food sector that features locally diverse and culturally sensitive cuisine.

Ward 3: Food connects people and the world

People living in the affluent neighborhoods of Ward 3 embrace and encourage the cultural diversity expressed in the food traditions of the other DC Wards. By 2050 food has become a vehicle for learning languages, traditions, poetry, and music, and food festivals highlight minority niches that give new residents and immigrants the opportunity to share their roots and traditions. All initiatives in the other Wards can come together and learn from each other. Future Urban Food Leaders meet in the Academia and Food Hubs to co-create the Vision with others in cities in the United States and the rest of the world.

Ward 4: Food connects people and nature

Ward 4 has long been a diverse neighborhood sometimes characterized by contrasts and contradictions. Its close connection to Rock Creek Park, the largest of Washington DC’s green spaces, makes it the perfect location for a wide variety of gardens and edible

landscapes. Grape arbors, medicinal herbs, berries, and ethnic crops serve as a rich source of vegetables, herbs, and fruits for communities throughout the DC metro areas. Various food production techniques are shared, and management practices constantly improve to increase soil quality, reduce nutrient loss, enhance freshwater reservoirs, and improve air quality. The proximity of DC to the diverse landscapes of the Mid Atlantic Coastal plains, the foothills of the Appalachian Piedmont, and the Folded Appalachian/Blue Ridge Mountains brings richness and diversity to the innovative gardens rooted in the diverse neighborhoods of Ward 4. Outdoor growing spaces are interspersed with cutting-edge soilless systems growing food at maximum efficiency in vertical systems that blend seamlessly into the formerly industrial landscape of Ward 5.

Ward 5: Food connects economy and nature

Ward 5 has become the lung of Washington DC in 2050. Its neighborhoods are dotted with urban forests featuring edible fruits and nuts. The highly productive urban treescaping emit oxygen and enhance the air quality of the city while also contributing to a much-needed cooling effect during the summer months. The more mature sections of the urban forests deliver sustainably harvested wood for wood products and a thriving artisan community. In addition to the edible forests, greenhouses, indoor climate rooms, and vertical farms are interspersed throughout the diverse neighborhoods of Ward 5. New attractive urban and peri-urban pathways with multifunctional green-blue veining provide a sustainable basis that links the city to the wider regional foodshed, based on a well-coordinated combination of urban agriculture, sustainable agriculture, and aquaculture that is informed by the culturally diverse dietary needs of the DC metro population.

Ward 6: Food connects natural resources and the world

The green-blue veining that characterizes Ward 6 combines multiple benefits of climate services, health, and food access, and is highly valued by residents as well as visitors to the region. In 2050 the Anacostia River is swimmable and fishable and provides many wellness- and food system-related resources to the city. Moreover, the river has become the centerpiece for state-of-the-art plant-based water filtration systems that have taken considerable pressure off the city's water treatment facility in blue plains. Excess water from the food production systems in Wards 4 and 5 is channeled to Ward 6 for filtration. Here, the water runoff is tested for nutrient content and any nutrient rich runoff is diverted for fertigation purposes to ensure all nutrients are used to their maximum. Some of the areas along the rivers serve as aquaculture centers for the city, raising fish as a high-end protein source for local households, restaurants, and food festivals. The fish refuse generated in the aquaculture centers is used as a nutrient-rich organic fertilizer for agriculture and gardening projects throughout the region. Nature trails serve as study areas and outdoor classrooms throughout the Ward. The widely admired landscape has become an exemplar for other cities, illustrating how an urban food landscape can positively contribute to environmental quality and biodiversity improvements in larger metro regions, the nation, and the world.

Ward 7: Food connects technology and economy

A nature-based lifestyle meets high-tech in Ward 7. By 2050, technological advances have merged with sustainable solutions to form the backbone of a thriving network of technology businesses. The Ward prides itself on its rich history of African American entrepreneurs, making it the perfect location for nature-based technology innovations within incubation support. Biomimicry techniques established in the Ward have made it possible to move the entire energy generation for 75,000 residents off the grid, making households independent of the local utility. Ward 7 also builds the sediment and plant-based living machines for the water filtration systems in neighboring Ward 6. STEM-focused technology entrepreneurship classes are a staple of businesses and training centers in Ward 7, and the Ward has become a mecca for small-scale green technology entrepreneurs from around the world.

Ward 8: Food connects people through culturally sensitive plant-based diets

The much-needed shift to personalized diets that embrace less meat and more plant and protein-based food while maintaining culturally embedded tastes and textures has been fully realized in Ward 8. Local community farms, restaurants, coffee shops, and music venues form a thriving network of culturally diverse go-to places in 2050. True to its rich African American history, hip-hop and bee bop are the beating heart of the food and people scene of Ward 8. Wellness is also an important feature of this culture, with exercise hubs and clubs all over the far south-east neighborhood of DC. Residents of all ages and backgrounds share their knowledge of healthy lifestyles and food cultures, and community-based greenhouses, incubator kitchens, and pickling and canning sheds dot Ward 8 neighborhoods. The public space surrounding these food and wellness hubs has contributed to shared expertise and increased safety and trust in this culturally rich community where native Washingtonians live alongside neighbors from every continent.

Figure 2 summarizes our eight dreams and illustrates how they form an integrated whole for Washington DC as well as a core for the larger DC metropolitan area.

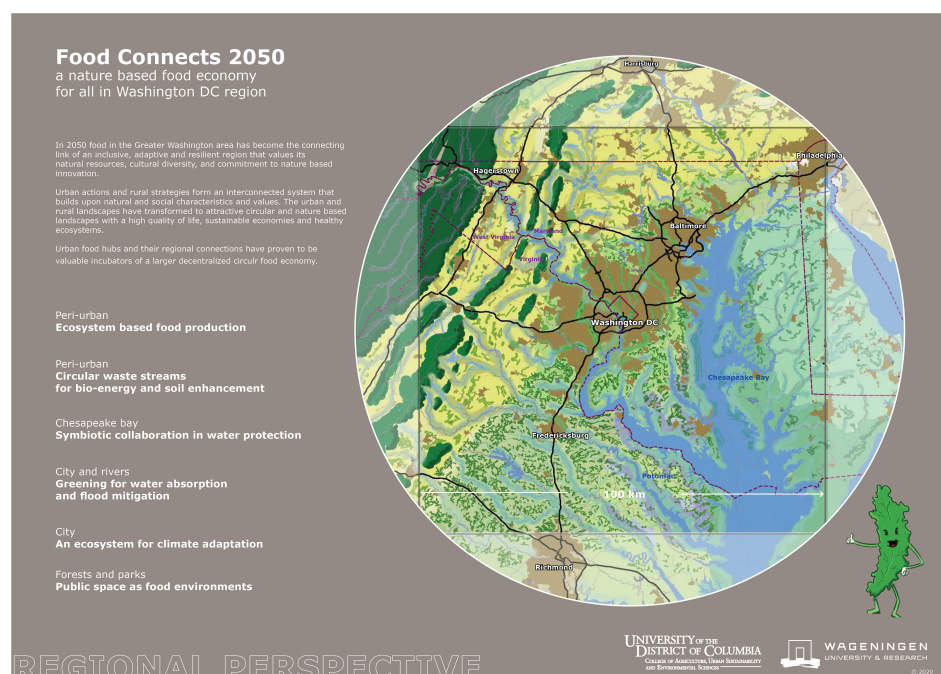


Figure 2. Food Connects 2050 and its regional reach.

4. Building Blocks of a Circular Urban Food System

Given its commitment to a decentralized urban food economy, our 2050 vision of a circular urban food economy in Washington DC has relevance far beyond the region and even the United States. It provides an inspiration for feasible scenarios and even a roadmap for a sustainable, resilient, and just food system that forms the core of a regional circular economy. While our vision of the food systems future of Washington DC and its eight Wards is not yet a reality, designing a future in which a vision can become a reality can form an important first step to collecting evidence of what is possible, feasible, and implementable.

Yet for even the most compelling vision to become a reality, a transition and regime change is needed [15]. Three building blocks stand out in this transition process. They are: (A) the need for systems thinking; (B) the ability to manage wins and tradeoffs; and (C) transitional leadership and coordination. We will discuss the relevance of these three building blocks for the transition towards a new circular urban food system in cities around the world.

4.1. Systems Thinking

Circularity implies that one looks at food from a systems perspective with the goal of closing water, nutrient, and carbon cycles. The results are reduced resource losses, lower negative climate impacts, and, ideally, strengthened ecosystem services. The integrated nature of circular systems also strengthens production cycles and linked networks in lieu of linear chains [16]. Our vision draws on four important characteristics of circularity. They are [17–19]:

- (1) Minimizing resource demand by recirculating resources and energy and recovering waste;
- (2) Creating circularity at multiple levels, in our case the neighborhoods, Wards, city, and region, and indirectly the nation and world;
- (3) Recognizing the importance of circularity as a part of sustainability science as ecosystem services are strengthened and restored; and
- (4) Connecting circularity to innovation as expressed in industrial ecology and related fields.

Necessary building blocks of such a circular food system include the efficient use of land, water, energy, and carbon; changes in consumer habits; and improved carbon sequestration and soil quality enhancement. All three of the core economic areas of production, resource allocation, and consumption are addressed in these building blocks of a circular food system, and yet they also move beyond the focus of standard economics [20]. Circularity must pay close attention to the sinks that buffer, absorb, and process the emissions and waste products that are the result of any production, resource use, and consumption process. Standard economics has consistently excluded these sink capacities [21,22]. As the examples of carbon sequestration and soil enhancement illustrate, attention to sink capacities is an indispensable dimension of a circular food system.

The food systems approach evident in our vision of the eight Wards of Washington DC connects several seemingly disparate spheres including diet, culture, economy, sustainability, policy, and technology. Systems thinking shifts the focus from food as a source of calories to food as a system that interacts with other systems. This makes it possible to analyze how each element within a system interacts with the others. The connectivity of food system elements is depicted in Figure 3, which offers a graphical representation of our conceptual food system approach [23].

The food system

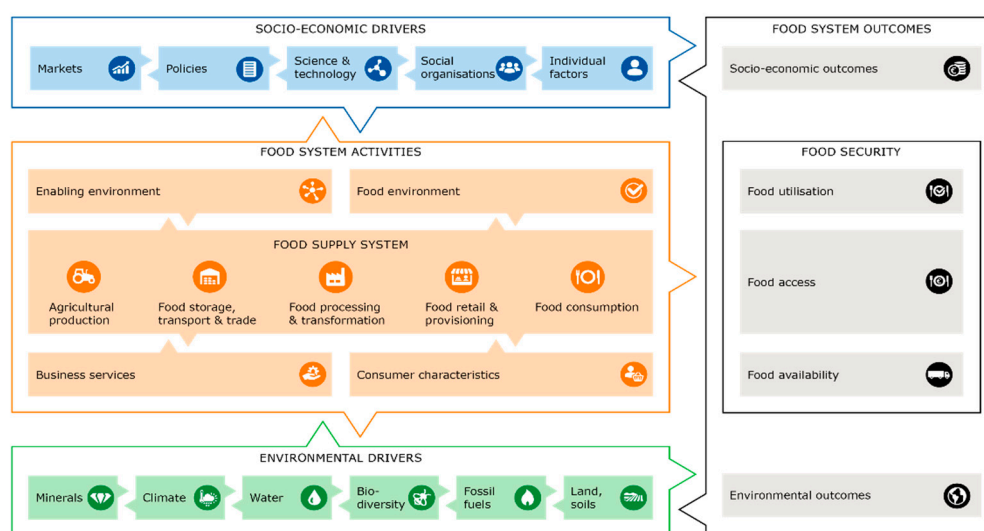


Figure 3. The Food System approach. Reused with permission from ref. [23]. Copyright Year: 2018, Copyright Owner: Siemen van Berkum.

We briefly address several aspects of the food system that are commonly treated as separate starting with the more familiar connection between food, diet, and culture.

4.1.1. Healthy Diets

Food and diets are closely linked. The lack of access to fresh unprocessed food characterizes diets that result in preventable illness rather than health [24]. Eight census tracts in Washington DC are considered food apartheid areas with no access to fresh unprocessed food within a 1.5-mile radius. These same neighborhoods are characterized by high incidents of obesity, diabetes, and hypertension. They are also home to the highest percentage of non-Hispanic black populations, while neighborhoods with high food security have predominantly white populations. This illustrates the prevalence of food injustice which has been amplified during the COVID-19 pandemic [4].

Addressing these disparities requires more than improved access to fresh food. It also requires better and culturally sensitive information about the benefits of unprocessed food and plant-based diets and their impact on health outcomes and the environment. Tasting events in local schools, libraries, and at farmers markets with information about vitamins, minerals, and balanced diets supported by teams of teachers, dietitians, agronomists, and data scientists can facilitate changes in dietary habits that are both healthy and affordable. The Expanded Food and Nutrition Education Program (EFNEP) which trains paraprofessional nutrition educators to share good dietary habits with their neighbors, are a viable starting point. These USDA-funded programs are offered through the land-grant university network in the United States including at the University of the District of Columbia.

4.1.2. Culture

The different food cultures of DC's diverse neighborhoods were once supported by a thriving network of small grocery stores and food carts [4]. Today, corner stores sell beer and beefaroni and other highly processed foods. Food can again become the key to a transition to culturally diverse shops and networks of local expertise where urban dwellers connect with each other and with their surrounding regions through food. Bringing more and better-appointed full-service grocery stores to food apartheid neighborhoods is a starting point. However, there are more powerful traditions that can be consulted. An example of a culture-based approach to systems thinking is the "Five Pillars" project, where two focus groups in Ward 7 (Deanwood) and Ward 8 (Congress Heights) engaged residents in writing a story about a sustainable future for their neighborhoods. The collective story starts with the statement that, by 2030, both neighborhoods will be "... thriving communities that are popular among residents and visitors alike" [7]. The mix of young and old, singles and families, diverse ethnicities, and cultures is prominent in this story and is referenced as giving the area its vibrancy.

The story takes pride in the African American heritage of the so-called "chocolate city" by envisioning a museum featuring African American inventors, scientists, and entrepreneurs. The story thus connects a rich entrepreneurial history to cutting-edge energy generation facilities, water filtration systems, and soilless food production facilities that the story envisions. Moreover, the story stresses the importance of social connections in the culturally diverse tapestry of a Washington DC that appreciates the diversity of its neighborhoods. At a time of growing divisiveness and extremes, a culturally aware food system can nurture the spirit of this story by giving it a larger context through a city and region-wide vision.

4.1.3. Economy

Disparity is the keyword describing the economic reality of Washington DC and most cities around the world. Food apartheid neighborhoods are only the tip of the iceberg and reflect the result of a dismantled small business infrastructure that once dotted DC neighborhoods with mom-and-pop grocery stores and food carts called "hucksters". With the demise of the DC Grocery Cooperative in the 1970s and the move of full-service

grocery stores to affluent neighborhoods, low-income neighborhoods were left without food access [4].

Yet while urban neighborhoods lack access to food, the agricultural sector of the surrounding areas also struggles. The aging population of farmers and the continued loss of farmland to urbanization, assert growing pressures on a resource strapped farm sector. An economy rooted in a localized and regionalized food system can strengthen both the urban core and its surrounding areas. Mark Winne describes the positive economic impact of creating food-based local economies even in unlikely mid-sized cities that are not known for their culinary prowess [25]. We expand the economic benefits of food to a coordinated food system where the urban core grows highly perishable, nutrient-dense crops, the peri-urban ring grows less perishable, high-demand high-revenue vegetables, and the rural ring grows grains and root vegetables that require scale and are better placed in areas where land value is lower. These distinct place-based options are linked to low impact technology, alternative energy, water management, and soil enhancements that close the loops of a circular food system where food connects to up- and downstream sectors that create indirect and induced economic benefits.

4.1.4. Sustainability

The current food system comes with many environmental challenges such as high freshwater use, declining soil quality, nutrient runoff, and a large energy footprint. It is also highly dependent on transportation. Significant food waste and loss along the food supply chain is responsible also for the waste of resources embedded in the wasted food. In addition, the continued encroachment of human habitation on food production and the encroachment of food production on wildlife habitats creates chain reactions of habitat extinction, species extinctions, and pandemic pressures [26,27]. A small example of these complex impacts are the aquatic systems of the Potomac and Anacostia rivers and the Chesapeake Bay. All show signs of eutrophication from nutrient runoff and other pollution pressures. Climate change adds vulnerabilities associated with limited crop diversity and thus limited adaptability.

At the same time, food production offers tremendous opportunities for climate adaptation and resilience. The green/blue infrastructure elements of our vision provide an example of a resilient structure that cherishes biodiversity and natural resources and can mitigate and adapt to climate change. Moreover, a decentralized circular food system takes local circumstances into account. This makes the system more adaptive to unforeseen shocks like the COVID-19 outbreak. Our vision also has shorter supply chains and a more plant-based diet, both of which reduce the carbon footprint.

4.1.5. Technology

The connections between food and technology are extensive and diverse. While DC has one of the largest densities of green roofs and LEED-certified buildings in the United States, it is still a long way from being carbon neutral. Technologies that work with nature (so-called “nature-based solutions”) can make cities more sustainable and reduce resource and pollution pressures on surrounding peri-urban and rural areas that sustain the population density of cities [28].

Closed-loop designs, which reuse everything from water to nutrients, waste, and energy, must become the new standard in technological innovation. In such designs, all materials are renewable and biodegradable, or even edible. Green infrastructure firms that produce food on green roofs, green walls, rain gardens, and green buildings are an expression of such nature-based solutions [29]. They are also linked to green data technology, where green building and infrastructure businesses stream data to analytics centers that optimize energy generation, and to plant-based water treatment facilities called “blue houses” or “living machines”. In our vision these facilities create green islands throughout the city. The application of big data and artificial intelligence is also highly relevant for agriculture and green infrastructure and can play an essential role in managing

nutrient use and water use efficacy in soilless food production systems like hydroponics and aquaponics.

4.1.6. Policy

As food systems become more decentralized, policies must adjust as well. Agriculture agencies focus mostly on rural agriculture and commodity crops. In the case of Washington DC, which is a city state, more than a dozen DC agencies have some connection to food and agriculture, but there is no department of agriculture. This demands significant coordination efforts to ensure that land-use pressures associated with resource use and population growth are properly considered. New institutional models are needed to coordinate food-related efforts across different governance levels and areas of responsibility. Cooperation between different governance levels will be an important place to start [30,31]. According to the recent report of the Greater Washington Board of Trade [32], there are many opportunities to link regional initiatives to the DC Wards. Climate and Food Policy initiatives of the DC Department of Energy and Environment, and the DC Office of Planning also recognize the advantages of regional collaboration [33,34].

Two abundant local assets of cities are waste and time. Waste streams of food, construction debris, household appliances, and furniture can be recirculated among citizens through a so-called “gift economy”, where resources that are considered as waste become gifts to be reused by residents and local stakeholders [13]. Time is also tradeable, as illustrated by time banking [12]. As members of a neighborhood contribute their time and work in urban food production facilities, community gardens, and grocery cooperatives, they can be compensated through local goods and services provided in the time banking community [12,35,36].

A highly restricted resource in cities is land. Policies must therefore focus on commoning, a land-use model that promotes the use of land and property for local community-based initiatives. Common properties can be public parks, abandoned buildings, rooftops, and empty lots awaiting development. The use of common land that is otherwise left abandoned can have significant potential for temporary contributions to a local food economy. Local governments can support practices like commoning by adopting policies that institute participatory governance processes that engage citizens in decisions about alternative land-use models [11].

4.2. Managing Wins and Tradeoffs

A circular food economy can create effective win–win situations, especially in the urban core of cities characterized by high density, space constraints, and ecosystem deprivation. Circular urban food production can increase permeable surfaces and green roofs can absorb storm water runoff, thus reducing pressure on urban storm water systems. Ideally, the Urban Food Hubs will comprise a cluster of green business opportunities that are ideally met from within the neighborhood where a Food Hub is located. The Urban Food Hubs can therefore create social–economic wins through job creation and food access, as well as ecological wins through improved storm water management.

Urban food also offers connecting links to a larger vision of regional food systems, as the neighborhood-based food initiatives connect activities at multiple governance levels, across sectors, and across demographics. The Urban Food Hubs model seeks to build a decentralized network of food-related businesses and civil society activities that improve food security, nutritional health, employment, and resilience, especially in neighborhoods and regions that have deficits on all counts. Examples of such food-connected activities comprise health-related businesses focused on dietary assessment and nutrition counselling; the growing of micro-greens and herbs for high-end restaurants; the production of ethnic crops for niche restaurants and grocery stores; the growing of food and horticulture plants on green roofs that serve as food production and event spaces; the raising of native plant seedlings for urban parks and rain gardens; the covering of roofs and walls of buildings with climbing plants like pole beans, squash varieties, and local ivy varieties that absorb

heat and improve air quality; and technology-related businesses to manage controlled environment agriculture systems. Inspired by the agro-ecology movement [37,38], this kind of connective food system combines urban solutions with larger regional objectives and will therefore create many win–win situations for the whole region, including a better quality of life, improved aesthetics, more access to nature and biodiversity, and better natural resource management.

However, implementing a circular urban food system will not be without tradeoffs. These tradeoffs will require constant monitoring and guidance so that the best possible outcomes can be attained. The transition will require stakeholders in food supply chains to adopt new practices or go out of business. The anticipated decrease in traditional farming and the commensurate increase in peri-urban and urban farming will have economic consequences for some rural areas. Innovative rural practices which can complement the new decentralized food system will offer win–win opportunities such as the production of forests or a focus on grains and root vegetables that are not viable in urban and peri-urban environments [39]. By forecasting potential change and communicating it in a timely manner, the transition can be less challenging. Further benefits can result from shaping desired outcomes in collaboration with affected stakeholders. Some perceived tradeoffs may therefore be resolved through coordination and planning.

Nonetheless, conflicts between urban, peri-urban, and rural food systems may be unavoidable. Potential friction points may, however, be channeled in a positive direction through a smart specialization approach. For example, highly perishable products can be grown in the urban core, while less perishable food plants can be grown in the surrounding peri-urban areas, and bulk crops like root vegetables and grains can be produced in the rural regions. This will lead to a multitude of benefits regarding the availability of fresh produce, improved diets, public health outcomes, and local employment in urban areas, while also reducing packaging, cold chain needs, and GHG emissions.

Three crucial factors in facilitating this kind of smart specialization and coordination will be communication, novel ways of governance, and new models of cooperation. First, one needs to invest in communication about how the bigger picture relates to real-time, concrete incentives for growers. Growing food crops in a way that respects nature and region-specific environmental conditions, both in the city and in the surrounding peri-urban and rural areas, will be the basis for a more diversified economy that makes regions more self-sustaining. Secondly, novel ways of governing economic development will be needed [40]. Two principal strategies of stimulating economic development are: (1) to attract outside businesses to relocate to communities in need of development; and (2) to grow businesses from within the community. The UDC Urban Food Hubs promote the latter by focusing on local entrepreneurship. Third, cooperative initiatives based on public resources and collaboration both in terms of its productive and consumptive contributions can be important vehicles for smart specialization and coordination. This is a critical component of our vision for 2050. Successful models of a sustainable economy can be based on new rules such as collective ownership and collaborative production and resource allocation strategies that expand and complement private ownership.

We expect some of local food economy schemes, for example farmers markets and community-supported agriculture (CSA) programs, to continue to increase in popularity. This has already been evident during the COVID-19 pandemic. The vulnerability of long food supply chains has certainly contributed to the growing interest in local food. Yet consumers also have also become increasingly concerned about where their food comes from and feel reassured by knowing who grows and processes their food. This has created a win–win situation of increased demand for local growers, and more reliable supply for consumers. CSAs offer additional benefits beyond connecting local demand with the food supply that produces it. Rather than charging a price per pound, CSAs charge their customers a flat fee at the beginning of the growing season. In exchange, CSA members receive a weekly delivery of in-season produce. This provides a risk-sharing model where consumers carry a part of the risk typically born by producers. If harvests are plentiful,

the weekly CSA delivery is generous. If harvests are poor, so is the weekly delivery of produce [41]. Those participating in a time-banking network may reap additional benefits if they can pay for their CSA share via time committed to their timebank. Some of the time-sharing options might include crop maintenance, harvesting, delivery of produce or supplies, and administrative and coordinating tasks.

Successful solutions seek to engage those most impacted in resolving the tradeoffs, which may arise. Monitoring potentially competing outcomes to guide decisions in a timely fashion is an important component of this principle that will ensure the best possible outcomes. Advanced planning and good communication are two top contenders in addressing tradeoff situations and resolving them to attain the best overall outcome.

4.3. Transitional Leadership and Cooperation

Our vision of a circular urban food economy reflects a niche of emerging urban food innovations [42]. Examples of such innovations include the urban food forestry networks, alternative food networks [43], urban food systems [25,44], and new circular economy models [10,45]. These innovations take place in a niche characterized by networks of actors who expressly counteract the highly centralized global food systems regime and may require protection as innovative disrupters. Within these niches of innovation, collaborators rewrite the rules about what can and cannot be done [46]. This includes commoning, time banking, and the gift economy, but also more traditional arrangements like cooperatives. Novel practices may focus on inclusion, participation, social diversity, and cohesion, but also on nature patterns circularity, restoration, and regeneration practices. These niches have also been framed as the re-localization, placemaking [47], and local (rural) development paradigm [7,39,48].

Existing institutions, including governments and markets, must rewrite their rules to advance these emerging circular economies. The rules of the market economy such as profit maximization, private property ownership, and economic growth are now deeply embedded in the current global food production and consumption networks [49,50]. For the vision of a circular food economy to become a reality, new rules are needed that reflect the values and priorities of prosperity for all, inclusivity, and circularity. These values and priorities must be actively incorporated and reflected in new institutional arrangements of government and market arrangements [51].

This requires nothing short of a regime change where actors start to break out of existing alignments. Innovation plays a crucial role within broader regime shifts and can serve as a mechanism for reconnecting disconnected and dissected entities. A decentralized and localized food system, for example, can reconnect growers and consumers and can shorten the distance between them as part of an alternative, critical urban development agenda. Yet for regime change to happen, adjustments need to take place between innovative new approaches, which are developed in a protected space, and the wider context for their application [52]. Governance structures can facilitate such broader niche formation beyond what can be achieved in local initiatives like the Urban Food Hubs [53]. New policies in the Washington DC Area, for example, are needed to create the necessary niches to test the applicability of the circular Food Hubs innovations and allow them to become more robust [4,54]. New governance structures will also be needed to move toward regionally based food systems that acknowledge ecosystem services and their relation to the regional food economies. As ecosystem services are restored and strengthened, those attending to these needed restorative activities must be compensated.

Given the multi-pronged transitions needed to move toward a localized circular food system, transitional leadership and new cooperative models will be essential. Transitional leadership is comprised of five key qualities including: (1) reflexivity of the current regime; (2) experimenting with new practices; (3) revival and mobilization of the local and credential knowledge needed; (4) integration of the ideas in the present regime; and (5) a learning process that enable an engaged actor to use his/her knowledge for 'new' developments [55].

We propose to build a network of Urban Food Leaders that connects entrepreneurs, government officials and academics that already contribute to a more just and sustainable food system. These leadership collaborations can bring together local leaders who are experts in their own neighborhoods with credentialed experts who can bring scientific and applied knowledge to the table. There are many examples of these type of networks [56]. In time they can develop niches for innovation and application that can transform the urban food regimes in communities around the world.

Within the networks of expertise epistemological change is needed as well. Understanding “what to know” and “how to know” about the food system of the future, for example, will require new lines of research that can address urban food economies, consumers behavior, risk perception and cultural barriers that may impede the adoption of new dietary habits [8,46]. To illustrate, it may be self-evident from a scientific perspective that a transition to a plant-based diet has health and environmental benefits. Without cultural sensitivity to food origins, however, it may prove impossible move toward diets that are less meat-intensive and more plant-based. Equally important will be new lines of research on the connections between nature-based solutions, geodata, artificial intelligence and circular food systems.

Knowledge production, learning and co-creation with a wide range of stakeholders of the new urban food economy form key aspects of transitional leadership skills [52]. Urban Food Leaders such as community workers, citizens, consumers, farmers, scientists, engineers, and retailers will be needed to strengthen circular food economy innovation in their own locale, to assess and improve local processes and to identify opportunities for scaling them. A viable model may be the development of learning ecosystems such as communities of practice [57], field laboratories [58], and “Green Circles”, where diverse actors collaborate to advance regime change towards a circular economy [59]. What is crucial is the improved exchange of knowledge between local and credentialed Urban Food Leaders to innovate and co-create urban food advances and learn how to scale them successfully into a new urban food regime.

5. Conclusions and Next Steps

This article presents a 2050 vision of a circular food economy in the capital of the United States, Washington DC. The local food economy of the city and its eight Wards becomes the linchpin for a coordinated transition toward a regional food system that builds organically on the hyper-local activities of the eight Wards. The vision demonstrates the potential of positioning a circular urban food economy at the center of a web of activities that integrate seamlessly with other economic sectors into a larger regional development vision with the urban scape as its centerpiece and starting point.

Our vision for Washington DC contains principles for shaping future food regimes. These include: (1) Creating living environments that are green, resilient, adaptive and productive; (2) Creating food production systems in the urban scape that are diverse, sustainable, and able to link urban, peri-urban, and rural communities; (3) Creating circularity by linking food economies to green technology, green infrastructure, and health; (4) Ensuring diets that are largely plant-based and have positive health impacts by addressing food security problems associated with too-much and too-little food; (5) Adopting nature-based technologies that replenish resources, restore ecosystems, and sustain ecosystems health; and (6) Respecting cultural diversity that embraces socio-diversity to stabilize communities in the same way that biodiversity stabilizes ecosystems [60].

Developing a circular urban food economy that reflects these principles creates a highly visible niche for food systems solutions comprised of a range of local innovations that link food to green infrastructure, training and testing facilities for urban agriculture, and improved public health outcomes [29]. This prominent niche incorporates new technologies, new rules, cultural practices, and food experiences of local stakeholders working together to improve socially and environmentally sustainable outcomes.

We advance the creation of such a visible food systems niche by developing a future vision of a circular food economy for Washington DC and its eight Wards. In designing this future vision, we move it closer to becoming a reality as it facilitates conversation, creative planning, and the advancement of small local innovations that contribute seamlessly to a larger vision of a new circular food economy starting in urban communities. Small, hyperlocal, neighborhood-based initiatives can therefore become crucial game changers for entire neighborhoods, cities, and regions as they engage community leaders, technical collaborators, and regional innovators to build a feasible vision and plan of action.

We focus on three building blocks needed in the transition from vision to reality. These are: (A) the need for systems thinking; (B) the ability to manage wins and tradeoffs; and (C) transitional leadership and cooperation.

Systems thinking responds to the global challenge of feeding a growing world population with healthier diets while also taking into account escalating constraints on natural resources, arable land and sink capacities that are under growing duress in light of climate change, biodiversity loss, freshwater depletion, and other intractable challenges.

While systemic innovations can create win–win situations such as better quality of life, more aesthetic urban spaces, better resource management, improved sink capacities and many more, it will nonetheless be necessary to manage trade-offs between the winners and losers of a new circular food system. Managing these trade-offs will require constant monitoring and guidance so that the best possible outcomes can be attained. As in any transition, it will be essential to carefully observe the social tipping points and use targeted incentives and policies to manage them [61]. This requires time, since people need to have opportunities to immerse themselves and experience how things evolve as they share their observations for further refinement and adaptation [30].

Even positive transitions with multiple win–win outcomes require attention and will not simply happen. Innovations are under the influence of existing “lock-ins” that render existing rules as unalterable [8]. Existing policies must therefore support the development of the innovative patterns needed to adjust to new outcomes. Transition leadership and cooperation are crucial elements needed to advance the systemic change that can create an environment where innovations are shared and tested in a learning collaboration of diverse stakeholders committed to regime change.

Transition management theories can benefit from our vision-based methodology in two ways: (1) it provides a road map toward a circular urban food economy that links improvements in natural, technical, and social as well as economic outcomes; and (2) it reflects the diversity of the ecological, social, and environmental fabric of a city in its diversity of outcomes. Ideally, our vision and the design-based approach it outlines will create a network of urban leaders with regionally based visions that can benefit from each other both in terms of the outcomes they envision and the processes to implement and update them.

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