Food Security:
The Urban Food Hubs Solution

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The Urban Food Hubs are centered on high efficiency food production systems, such as this hydroponics system located in a small greenhouse at the Muirkirk Research Farm.

In Brief

Food security demands a diversified food system that includes urban communities as locations for food production, food preparation, food distribution, and waste reduction/reuse. The Urban Food Hubs concept of the College of Agriculture, Urban Sustainability and Environmental Sciences (CAUSES) of the University of the District of Columbia (UDC) tests the feasibility of small-scale urban food systems that include these four key components. The heart of the CAUSES Urban Food Hubs are high efficiency food production sites that utilize bio-intensive, aquaponic, and hydroponic production methods. Co-located with these urban food production sites are commercial kitchens that serve as business incubators and training facilities for food processing and nutritional health related activities. Given their location in urban neighborhoods, the Urban Food Hubs also focus on waste reduction and reuse through composting, water management, and related approaches to minimizing pressure on urban land and infrastructure systems. In addition to improving food security, the Urban Food Hubs thus also contribute to job creation and urban sustainability in its economic, social/cultural, and environmental/physical dimensions.

Food security is a top priority for the United States and countries around the world. The U.S. Department of Agriculture defines food security as "...access by all people at all times to enough nutritious food for an active, healthy life."[1] Low food security refers to a diet of reduced quality, variety, and desirability for some populations. To achieve food security, food must be (1) readily available at all times to all people, and (2) be of sufficient quality and nutritional value to sustain a healthy and active life.

The U.S. food system is vulnerable by both measures. Some households do not have access to enough food and many others lack access to the right kind. In addition, the nutritional value of food has declined by almost 25 percent over the past 15 years.[2] One reason is that food is traveling across increasing distances. To accommodate the weeks spent in transport, produce is harvested long before it ripens and thus well below its peak nutrient density.

Populations in urban areas on the east coast of the U.S. are especially vulnerable to this phenomenon. The top food producing states are Texas (for animal products) and California (for produce). In addition to distance, local decisions related to purchasing power drive the access to nutritious food. Using Washington, D.C. as an example, there are eight census tracks in the city that qualify as outright food deserts (defined as fresh food being unavailable within a one-mile radius), partially due to distances from these top-food producing states. Of the 520 food retailers in D.C., 88 percent do not offer any fresh produce and only 12 percent offer an adequate variety of fresh food to support a healthy diet. Not surprisingly, nutrition-related health problems like diabetes, hypertension, and obesity are especially high in these food desert neighborhoods.[3]

As in most U.S. cities, Washington D.C.'s food deserts are not evenly distributed across the eight wards that make up its territory. The deserts are primarily located in Wards 5, 7, and 8, which are the wards with the lowest household incomes and the highest concentration of African-Americans. They are home to 32 percent of the D.C. population but less than 10 percent of its grocery stores. Ward 8 has the lowest median income with US$32,000 per year and 90 percent African-American residents. In comparison, Ward 3 has a median income of US$110,000 per year and an African-American population of 5 percent. Unemployment is 3.5 percent in Ward 3, compared to 24 percent in Ward 8.

Key Concepts

- **Food security demands a diversified food system that includes urban communities as locations for food production, food preparation, food distribution, and waste reduction/reuse.**
- **The Urban Food Hubs concept of the College of Agriculture, Urban Sustainability and Environmental Sciences (CAUSES) of the University of the District of Columbia (UDC) tests the feasibility of small-scale urban food systems that include these four components.**
- **The Urban Food Hubs are centered on high efficiency food production systems including bio-intensive, aquaponic, and hydroponic production, commercial kitchens that serve as training facilities, and business incubators.**
- **In addition to improving food security, the Urban Food Hubs contribute to job creation and urban sustainability in its economic, social/cultural, and environmental/physical dimensions.**

Food security levels across the U.S. are monitored through the annual Household Food Security Survey.[4] It indicates that 13 percent of D.C. households are food insecure and struggle with hunger; 19 percent experience food hardship and did not have enough money in the past year to buy food for themselves or their family; and 37 percent of households with children are unable to afford enough food. This is the highest rate of food insecurity among children across the entire U.S. Among the damaging effects of food insecurity are the following: impaired cognitive development, reduced school readiness, lower educational attainments, slower physical, mental, and social development, and overall health deficits.[5]

The U.S. food system is also highly centralized, which further adds food security risk. Of the two million farms in the U.S., less than half operate full time, 75 percent are considered 'very small'—cultivating five acres or less—and approximately 140,000 farms produce over 80 percent of all sales in agricultural products. Food processing statistics show even higher concentrations, with just a handful of companies processing the bulk of U.S. grain and produce. This centralization also demands energy.[6] Eleven percent of greenhouse gas emissions associated with the US food supply chain are transportation-related,[7] and global estimates suggest that agriculture is responsible for 25 percent of all CO_2, 65 percent of methane, and 90 percent of nitrous oxide emissions.[8]

To advance food security for the U.S. capital region, the College of Agriculture, Urban Sustainability and Environmental Sciences (CAUSES) of the University of the District of Columbia (UDC) developed its Urban Food Hubs concept. As one of the fastest growing cities in the U.S., and one of the most bifurcated, Washington, D.C. was an ideal location to develop and test the viability of urban solutions to food insecurity. The Urban Food Hubs consist of four components: (1) urban food production, (2) food processing, (3) food distribution, and (4) waste reduction/reuse. The aim is to increase urban food production, establish local food processing and food preparation to 'add value' to locally grown food, expand food-related business opportunities, improve nutritional health through

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Hydroponics systems, such as those pictured at the Muirkirk Research Farm, grow vegetables in nutrient-rich water instead of the traditional soil medium.

access to fresh food via innovative distribution systems including farmers' markets, food trucks, and collaborative models, and to improve productivity through composting and waste reduction and reuse.

Beyond the applicability within D.C., the Urban Food Hubs concept can serve as a model to address national and global needs for improved food security. Eighty percent of the U.S. population and over 50 percent of the world's population now live in urban areas. Food security therefore cannot be addressed without solutions that reimagine the food system as decentralized and urban. Such a distributed urban food system can offer better nutritional value and be more energy efficient and resilient.

What are the Urban Food Hubs?

The Urban Food Hubs are anchored in the five landgrant centers of CAUSES. In the tradition of the U.S. landgrant universities, the centers offer a range of community education programs including nutrition education, food safety certifications, master gardening and urban agriculture certificates, soil and water quality testing, assistance with farmers' markets, entrepreneurship classes, etc. The CAUSES landgrant centers partner with public schools, faith communities, nonprofits, and community volunteers to reach populations in all eight of D.C.'s wards.[9]

As part of their outreach, the Urban Food Hubs are designed to form a network of food security islands throughout D.C. In addition to improving food security, the network also aims to improve nutritional health and lower unemployment by supporting business development in the most underserved neighborhoods of the city. Each hub consists of four components:

- Food production through efficient urban agriculture including hydroponics and aquaponics;
- Food processing through commercial kitchens that serve as a business incubator;

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The Muirkirk Research Farm produces over 50 varieties of vegetables and herbs.

- Food distribution through networked farmers' markets, grocery stores, restaurants, etc.; and
- Closing the loop through waste reduction and reuse.

Since the food hubs form a network of urban sites, they stand in contrast to large-scale centralized urban agriculture concepts. For example, a recently launched 10-acre hydroponics facility on the outskirts of D.C. is slated to produce lettuce and create local jobs.

The hubs create a network of skills, jobs, and business ownership that broadens local food production. Given their distributed intensive production methods, they also maximize the use of photosynthesis and minimize entropy relative to the kilocalories of food produced. In contrast, large scale multistoried facilities require substantial energy input in the form of heat, air conditioning, and lighting, and are typically net-energy negative even before the substantial energy inputs associated with transporting food over long distances are added.[9]

Food Production through Intensive Urban Agriculture

The heart of the Urban Food Hubs is a highly efficient food production system that utilizes bio-intensive production methods including low-till box gardens, hydroponics systems, and neighborhood-based aquaponic systems. Box gardens can be installed on top of existing surface areas and can mitigate soil contamination in areas where soil quality may be an issue. One of the food hubs, which is located in a food desert neighborhood in Ward 7, uses 10 raised-bed gardens as the core of its food production system. By utilizing bio-intensive production methods, the gardens produced close to 10,000 pounds of produce and supplied a small farmers' market throughout the growing season.

A second food hub is in the process of installing two types of hydroponics systems in a small hoop house in addition to utilizing bio-intensive raised-bed gardens. Hydroponics refers to growing vegetables in nutrient-rich water rather than in soil. The method produces substantially higher yields by supporting a larger number of crop rotations. The necessary nutrient levels are maintained by monitoring the nutrient level in the growing medium (the nutrient rich water), adding liquid fertilizer as needed. Adding CO_2 to the hydroponic greenhouses can further increase efficiency. While the range of food plants that can be grown hydroponically is substantial, lettuce, leafy greens, and herbs tend to do especially well. The types of hydroponics systems utilized at the Urban Food Hubs were first successfully operated at the CAUSES research farm where they produced head lettuce, basil, Swiss chard, kale, cherry tomatoes, and cucumbers.

Aquaponics refers to a food production system that combines growing fish (aquaculture) and growing vegetables without soil (hydroponics). By using the excrement from the fish as fertilizer for vegetable production, aquaponics systems eliminate the need to add fertilizer.[9] To be usable as plant fertilizer, however, the nutrients in the fish waste must first be converted into plant-available nutrients. As the plants absorb nutrients, the water can also then be reused in the fish tanks.[11] Alternatively, the plants can be grown in soil that is irrigated with the nutrient-rich water from the fish tanks, a technique known as fertigation. The coproduction of vegetables and protein creates a number of benefits:

- Efficient water use: Aquaponics systems use only 10 percent of the water used to grow plants in soil, offering a 90 percent savings in water use.
- High productivity levels: Aquaponics systems can produce large amounts of vegetables without the need for commercial fertilizers.
- Reduced growing time: Consistent nutrient supply along with the greenhouse conditions enhance the growth of the vegetable plants and reduce growing time.

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CAUSES supports farmer's markets in food desert areas throughout the city in an effort to provide fresh, nutritious food to underserved areas.

- Reduction of waste: Because the fish waste is used as fertilizer for the plants, a minimal amount of waste leaves the facility.

The aquaponics system pioneered by CAUSES is installed in the hoop house, which is an easy-to-construct 20 by 40-foot lightweight greenhouse. Ideally it houses six small fish tanks that comprise one unit, powered by a highly efficient aeration device, a filter system that separates liquids from solids, and a biofilter system. The aerator emulsifies atmospheric oxygen with the water that circulates through the aquaponics system. The patented Flo-Vex device thus eliminates the need for mechanical compression and can be operated by a 3/4 horsepower pump. Given its high performance in maintaining the necessary oxygen levels in the fish tanks, the system can achieve a high fish stocking density that reduces water use per pound of fish, while maintaining the system's health and fish quality.

The plants in the aquaponics system are typically grown hydroponically in the nutrient-enriched water released from the fish tanks. To maximize flexibility, the system used for the Urban Food Hubs is configured as two connected loops: a fish loop and a plant loop. When the two loops are connected, the system resembles a common circular flow configuration. Since the two loops are connected manually, a wider variety of plants can be grown, including those that thrive when the flow beds are flooded less frequently rather than continuously. Furthermore, since one of the goals is to provide access to healthy food choices, the increased flexibility in vegetable production is an advantage. The system can support the sole production of lettuce as well as the production of a range of vegetables that are high in nutritional value.

The flexibility of the system also reduces energy use and operating costs. Both fish and plants can be rotated from cold weather species/crops in the winter months to warm weather options in the summer. Two variations of this highly efficient system, one using flow beds for

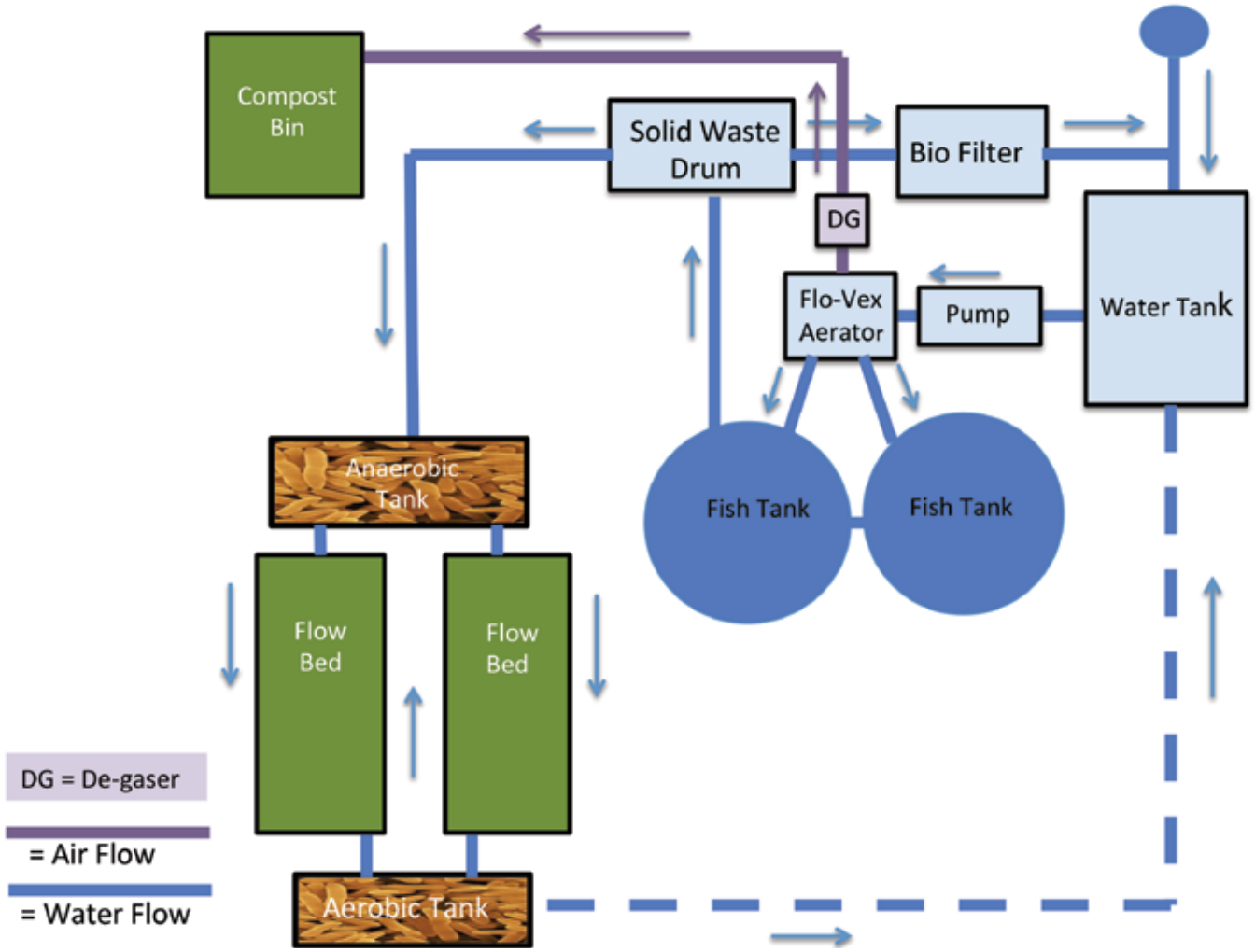

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Figure 1. Urban Food Hubs Aquaponics System.

vegetable production and the other using fertigation, have been successfully operated at the CAUSES research farm. The flow bed version can produce 1500 pounds of fish in two 500-gallon tanks, and approximately 10,000 pounds of vegetables, depending on the selected varieties. It operated throughout the unusually harsh 2013 to 2014 winter with only a water heater for the fish tanks. There was no additional heat and no fertilizer was added beyond the nutrients produced by the fish.

Figure 1 illustrates the urban aquaponics system. Water from a holding tank is pumped through a UV screen to kill bacteria that could be harmful to the fish; it then flows through the aeration device to ensure sufficiently high levels of oxygen in the fish tanks, through a waste filter to separate solids from liquids, and then to a biofilter that assists in the nutrient conversion process. The nutrient-rich water is then circulated into flow beds that hold the plants; a degasser evacuates the stream of gases to a compost bin to accelerate the composting process.

Various training events on high efficiency food production, including bio-intensive, hydroponic, and aquaponic techniques, are offered at the food hubs and at the CAUSES research farm. Training events range from short demonstrations to master gardening classes and certificate programs.

Food Preparation through Business Incubator Kitchens

The food preparation component of the Urban Food Hubs is centered on a commercial kitchen that can serve as a teaching and training facility to improve information about healthy eating, healthy food preparation, and age-appropriate diets. To maximize the capacity building benefits of the cooking classes, food demonstrations, and nutrition classes offered at the Hubs, CAUSES uses a train-the-trainer model whenever possible. This means that training is first offered to staff members of community partner organization as well as local residents. The partners then assume responsibility for providing additional training and education to local residents.

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The food distribution model supported by CAUSES aims to bring fresh food directly to the customer through neighborhood farmer's markets and produce trucks.

This train-the-trainer approach is especially valuable in a diverse community like D.C. Food is not only about nutrition but has social and cultural dimensions as well. It creates community and is often associated with cultural, ethnic, and class identities. By forming partnerships with neighborhood-based organizations and inviting their input and participation, the education programs and training events offered through the food hubs can address a broader range of cultural perspectives than what could otherwise be offered. To be successful, nutrition and food safety education must be culturally sensitive and aware of the social pressures and traditions associated with eating and food preparation habits. One successful approach is to modify family recipes and culturally significant dishes to meet improved nutrition standards and prepare them in a safe manner. Another is to provide self-monitoring devices that offer frequent feedback to improve awareness of eating habits. Much work remains to identify successful strategies that utilize food preparation to improve both economic and public health conditions.

In addition to serving as teaching facilities, the kitchens also serve as business incubators where those interested in launching food-based businesses can clean, process, and preserve the locally grown produce that can then be marketed to local farmers' markets, restaurants, and grocery stores. The kitchens are designed to be functional, energy efficient, and food safety compliant. Demonstration areas also provide visible workspaces, and well-defined workstations for receiving, storage, preparation, recycling, and other functional areas to provide training for proper food handling, food safety, and food management. Activities of the kitchens include the following:

- Nutrition counseling and nutrition education workshops
- Cooking classes and food demonstrations
- Certifications in food handling, food safety, and Hazard Analysis and Critical Control Point (HACCP)
- Entrepreneurship classes to launch food preparation and processing-related business
- Focus groups to identify determinants of safe food handling behaviors, risk perception, and beliefs that impede the adoption of safe food handling standards
- Better eating habits and reduced food-related illnesses, including focus groups to assess behavioral changes related to eating and purchasing habits

Nutrition education can also offer viable business opportunities. For example, recent changes in legislation allow dietitians to prescribe therapeutic diets in addition to physicians. This shift is consistent with the growing focus on health prevention and community health that offers new opportunities to qualified dietitians and nutrition educators.

Food Distribution through Farmers' Markets, Restaurants, and Food Retailers

The District of Columbia is home to 650,000 residents, with an additional 1.5 million living in the Washington Metropolitan area. Washington D.C. is also home to 30 farmers' markets and close to 50 community gardens. Yet there are many areas in the city that do not have access to affordable fresh fruits and vegetables. To reduce the number of food deserts and provide fresh, nutritious food to underserved neighborhoods, CAUSES supports several farmers' markets in food desert areas. However, it has proven challenging to attract a sufficient number of vendors to offer locally grown food especially in low-income neighborhoods that may lack the necessary purchasing power. This presents a viable business opportunity for small urban growers, especially where farmers' markets and ethnic food markets accept food stamps and WIC coupons.

Neighborhood stores and restaurants also offer viable market outlets. Particularly promising are venues in D.C.'s ethnically diverse neighborhoods. Food tastings conducted through the CAUSES Centers for Sustainable Development and Nutrition, Diet and Health indicate significant market opportunities especially for African crops including kitale, garden eggs, and potato leaves. High-end restaurants are also showing growing interest in ethnic produce, as well as in locally grown fish, greens, and herbs that are extremely fresh.

A new addition to the Food Hubs and the CAUSES research farm are produce trucks that are operated by the college and by local business partners. The food trucks make fresh produce available in food desert neighborhoods that lack access to public transportation. The principle behind this food distribution model is to bring fresh food to the customer instead of expecting the customer to come to local markets.

This points to another important function of food hubs, namely to connect small growers and producers of value-added food products with prospective buyers. The market research, marketing, presentation, packaging, and customer service skills necessary to successfully link producers and consumers can be offered at a hub. The hubs also serve as support networks, focus group facilities, and research bases to determine product mix, marketing and finance strategies, business plans, and data analysis to ensure proof of concept.

- Strategies to support local food retail through local and mobile markets
- Web-based portal and networking tool to link food producers, processors, and buyers
- Market research to assess opportunities in the food and hospitality industries
- Focus groups to determine the education delivery preferences of local populations

The food distribution component of the Urban Food Hubs adds much-needed knowledge that is necessary to create a resilient urban food system. Skills of fish and produce production and the value added through food preparation, processing, and preservation are only of value if they can find viable markets to generate revenue and living wages. Given the density of urban markets, the revenue potential is substantial, although there is a range of revenue models that must be considered in the context of each specific business plan. Maximizing revenue through hydroponic lettuce and herb production for high-end restaurants, for example, is one viable model; maximizing nutritional yield and embodied energy through a crop rotation that minimizes overall food imports is another model, and growing food that meets the therapeutic diet needs of a neighborhood with particularly high rates of diabetes is yet another model. The first model will most likely generate the highest monetary revenue; the second will reduce energy use and the indirect costs associated with transportation, CO_2 emissions, and other externalities;[12]

The hubs create a network of skills, jobs, and business ownership that broadens local food production.

Other distribution models include direct marketing efforts like farmers' markets and CSAs (Community Supported Agriculture), collaborative efforts with local food banks such as gleaning agreements and food collections, and seasonal delivery agreements with stores and restaurants. Food hubs therefore create an urban food network that offers both higher quality food to consumers and a more resilient food supply, which improves urban food security. Key food distribution activities include the following:

- Support services and training to launch food related business

and the third may significantly reduce health-related expenditures. All three can be economically viable, but the revenue streams from private and public-sector sources necessary to support the three models will vary considerably. In addition to private-sector markets, food systems policies are therefore indispensable to improve food security and resilience.

Waste Reduction and Reuse

Waste reduction and 'closing the loop' is an essential component of the food hubs. Urban soils generally need soil amendments and are rarely ideal for food production. Composting is key to improving the structure and organic content of the soil to create a sustainable food system. Even aquaponics and hydroponics systems generate some amount of plant material that can be composted, and each hub has some soil-based production along with the high-efficiency aquatic systems. Food waste from food preparation also forms a component of the waste stream.

Compost Taxi, a recent business start-up in the D.C. area, is an example of a successful business model based on reusing food waste. Compost Taxi picks up food waste from residential households for a monthly fee. Households who opt to join the program are typically conscious of the benefits of reusing organic materials and their food waste is virtually free of contaminants. Food waste from school cafeterias and other institutional facilities can also provide organic material that can be composted at the hubs or at the larger composting facility that is under development at the CAUSES research farm. A pilot program that collected food waste from D.C. restaurants and cafeterias showed high levels of contamination with eating utensils, packaging materials, and other noncompostable waste. The pilot concluded that a comprehensive training program for food service staff is needed to get higher quality compost.

The patented aeration device that is used for the aquaponics systems also provides benefits for the composting component of the hubs. As the Flo-Vex induces a low-pressure gas into the circulating higher-pressure water, it can channel airflow through a degasser into compost bins. Initial research suggests that the effective aeration achieved through the device speeds up compost production while alleviating the need to turn the compost. This results in significant space savings, which is critical in urban neighborhoods.

Water management is also an important focus of food hubs. By capturing rainwater and surface water run-off and by increasing permeable surfaces in urban neighborhoods, the hubs can contribute to improved storm water management. The aesthetic aspects of horticulture, rain gardens, and landscaping also add viable business opportunities and social benefits to urban neighborhoods. These broader benefits of food hubs can be significant and include neighborhood safety, walkability, and reduced storm water run-off.[9] Benefits of the waste reduction component include the following:

- Reduced waste generation and energy use
- Improved soil quality
- Reduced water use
- Reduced flooding through increased permeable surfaces
- Job creation for unemployed and underemployed populations

Every Urban Food Hub will be equipped with an alternative energy source consisting principally of solar and small-scale wind energy generators. The model for this integrated approach is the CAUSES Research Farm, which features a solar-powered groundwater well as the centerpiece of its drip irrigation, hydroponics, and aquaponics systems.

Community Partners of the Urban Food Hubs

To date, four Urban Food Hubs are in various stages of implementation. Local partnerships anchor the four hubs in their respective neighborhoods to ensure their long-term viability. In the tradition of the land-grant universities, CAUSES provides design, implementation, startup support, capacity building training, and ongoing research and education for the hubs. The ongoing operation of the hubs will be the responsibility of the community partners.

One of the hubs is operated in collaboration with Washington Parks & People (WPP), a D.C.-based nonprofit organization that began its work of reclaiming abandoned parks in 1990. WPP leads greening initiatives across the D.C. area, including city land reclamation, native species reforestation, watershed restoration, and green job training. The WPP Food Hub is located in Ward 7 in close proximity to a school and public housing complex.

A second partner is Mercy Outreach Ministry International (MOM), a nonprofit organization with more than 20 years of experience in working in underserved neighborhoods in Washington, D.C. as well as in Haiti. MOM's mission is to provide research, design, engineering, and self-sufficiency training to support economic development opportunities. MOM's goal is to construct 'Sustainable Urban Villages' in underserved urban locations, providing health and educational services in wastewater management, food safety, sanitation, and gardening.

The third hub is being developed in a residential neighborhood chiefly comprised of subsidized housing and easily accessible by Metro. The land was made available to CAUSES and its private-sector partner, Freedom Farms, by the District Department of Housing and Community Development for the purpose of developing an urban farm.

The location offers collaborative opportunities with local resident committees, a neighborhood school, and a local food bank. The location is also in close proximity to one of the satellite campuses operated by the UDC Community College.

A fourth hub will be implemented at the Bertie Backus campus of UDC in Ward 5. This satellite campus also houses UDC Community College programs and is located in close proximity to a Metro station. Two other food hubs in Ward 8 are under negotiation. One builds on an existing collaboration with THEARC (Town Hall Education Arts Recreation Campus), a nonprofit organization and community center that offers educational, health, recreation, and social service programs through collaborative partnerships. THEARC already operates a farmers' market and a youth gardening program, and the CAUSES Center for Urban Agriculture has installed a hydroponic system in one of the greenhouses operated by THEARC.

Figure 2 shows the distribution of grocery stores across the District. The location of the Urban Food Hubs and the UDC Research Farm are shown in Figure 3.

As Figure 3 shows, the Urban Food Hubs are located in some of D.C.'s most underserved food desert neighborhoods. The identified community partners bring long-standing relationships and diverse organizational characteristics to the project, which will also provide much-needed information about the characteristics of successful community partnerships that spur economic development and food security. Early indications suggest that the hubs can galvanize neighborhood activity and provide a sense of stability that goes well beyond their food security objectives.

Support for local business start-ups, which is an integral part of the Urban Food Hubs concept, can also play an important role in enhancing

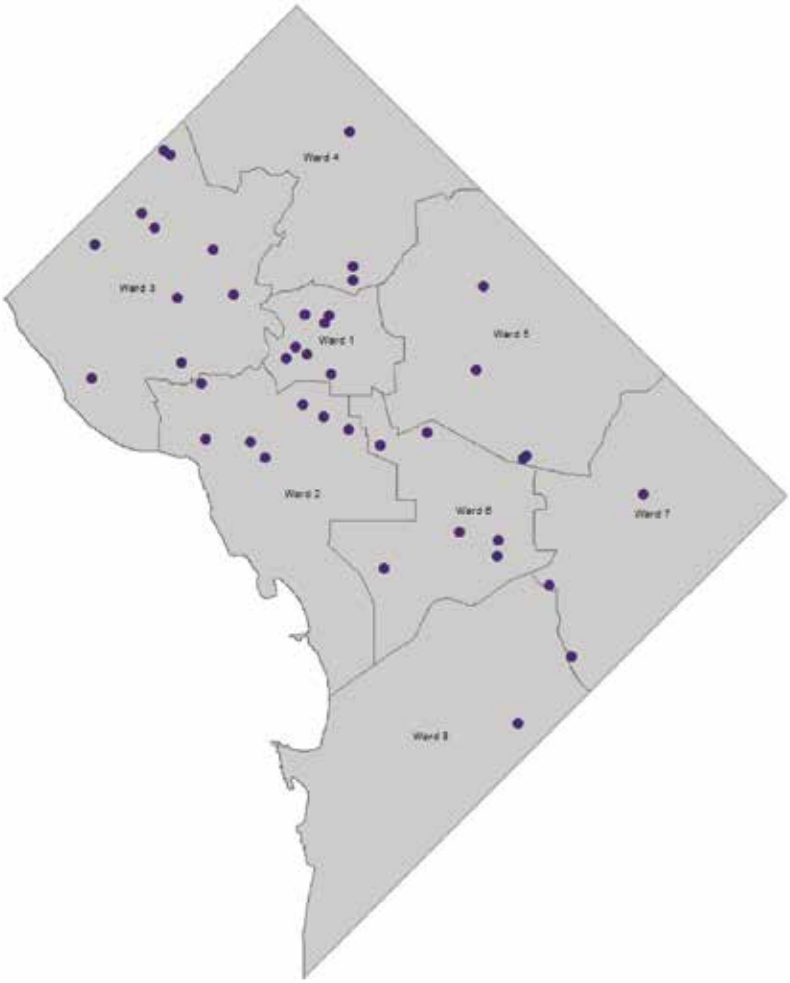

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Figure 2. Grocery Stores by Ward.

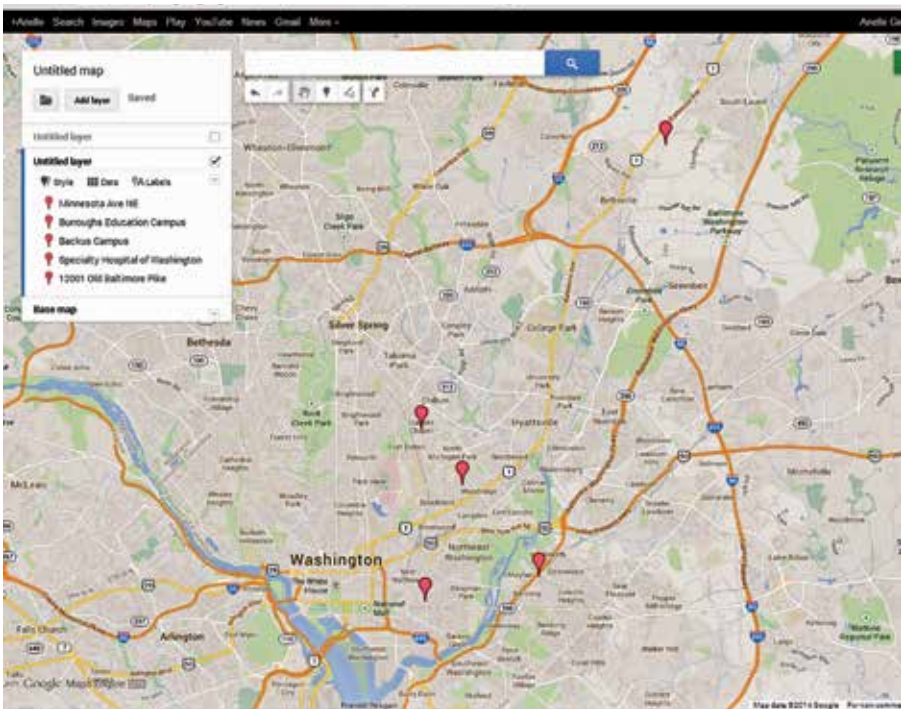

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Figure 3. Urban Food Hub Location.

the social fabric of the Food Hubs neighborhoods. An added component under consideration is a community-based revolving loan fund. Implementing such a fund can form a viable alternative to formal banking and development corporation options. This is especially relevant since by the end of the decade, 40 percent of the US workforce is expected to be made up of independent small business owners and freelancers, while the traditional model of work that relies on large-scale, centralized businesses will be in sharp decline. Food hubs can make a meaningful contribution in this changing landscape of work, while improving food security and related public health and urban sustainability goals.

The principle behind this food distribution model is to bring fresh food to the customer instead of expecting the customer to come to local markets.

The Role of Muirkirk Research Farm

The CAUSES Research Farm serves as the backbone of the Urban Food Hubs. The farm is an exemplar of sustainable urban agriculture. Located less than 30 minutes from the main campus of UDC, it serves as a research, training, and coordination facility for small-scale highly productive agricultural systems. A solar-powered groundwater well is the heart of the farm. It supplies drip irrigation to the fields and feeds various aquaponics and hydroponics systems. The farm does not produce any traditional cash crops, but offers over 50 varieties of vegetables and herbs, a fruit orchard, berry patch and several ethnic crop fields. Two of the aquaponics systems are housed in greenhouses and another innovative system is housed in an 8 by 40-foot standardized steel container. Six different types of hydroponics systems including pipe, ebb and flow, and drip systems are located in another small greenhouse.

Apart from its research and teaching function, the research farm serves an important stabilizer role for the Urban Food Hubs and their future business startups. New businesses can be vulnerable and may initially lack the capacity to reliably supply their market. This is especially true for the agricultural sector, which tends to be more vulnerable to severe weather, pests, and other natural factors that are difficult to control. The research farm has developed the capacity to grow year-round and to meet the needs of even highly specialized ethnic crops markets. It can therefore serve as a market buffer to ensure a steady supply of locally grown food while giving priority to small urban growers to meet local demand. The Food Hubs can thus connect local food producers and processors with urban markets with the Research Farm serving as a collaborative partner that reduces operational risk for small growers.

Conclusion

Achieving food security must be a top priority for the United States and countries around the world. As more and more people live in urban centers, food security solutions must be urban as well. The Urban Food Hubs concept developed by the UDC College of Agriculture Urban Sustainability and Environmental Sciences (CAUSES) in D.C. are exemplars of a distributed food system that can make a meaningful contribution to food security while also improving urban sustainability and its economic, social/cultural, and environmental/physical dimensions. Figure 4 summarizes the conceptual framework of the Urban Food Hubs and their key components: food production (source), food preparation and processing (prepare), food distribution, marketing and customer service (distribute), and waste management (recycle).[15]

While the recent attention to food security is important, not everything that improves food security necessarily meets the test of sustainability. Highly centralized food systems, including vertical urban systems, may increase food production and accessibility, but at the cost of higher rates of non-embodied energy that goes to transportation, heating and cooling of production facilities, commercial fertilizers, and pest control, rather than to food production. The Urban Food Hubs advance both food security and sustainability by offering a model for distributed urban food systems that lower entropy and increase embodied energy.

As the implementation and refinement of the Urban Food Hubs continues, dialogue with other urban communities will be of benefit. This is especially true for urban communities with highly prized land. These communities must meet food security and sustainability goals while competing for scarce land that is solely valued at its economic value without sufficient consideration of its social/cultural and environmental/physical value. Such urban communities face a far more intense battle for food security than shrinking urban centers where land is underutilized and where urban agriculture faces less intense land use competition.

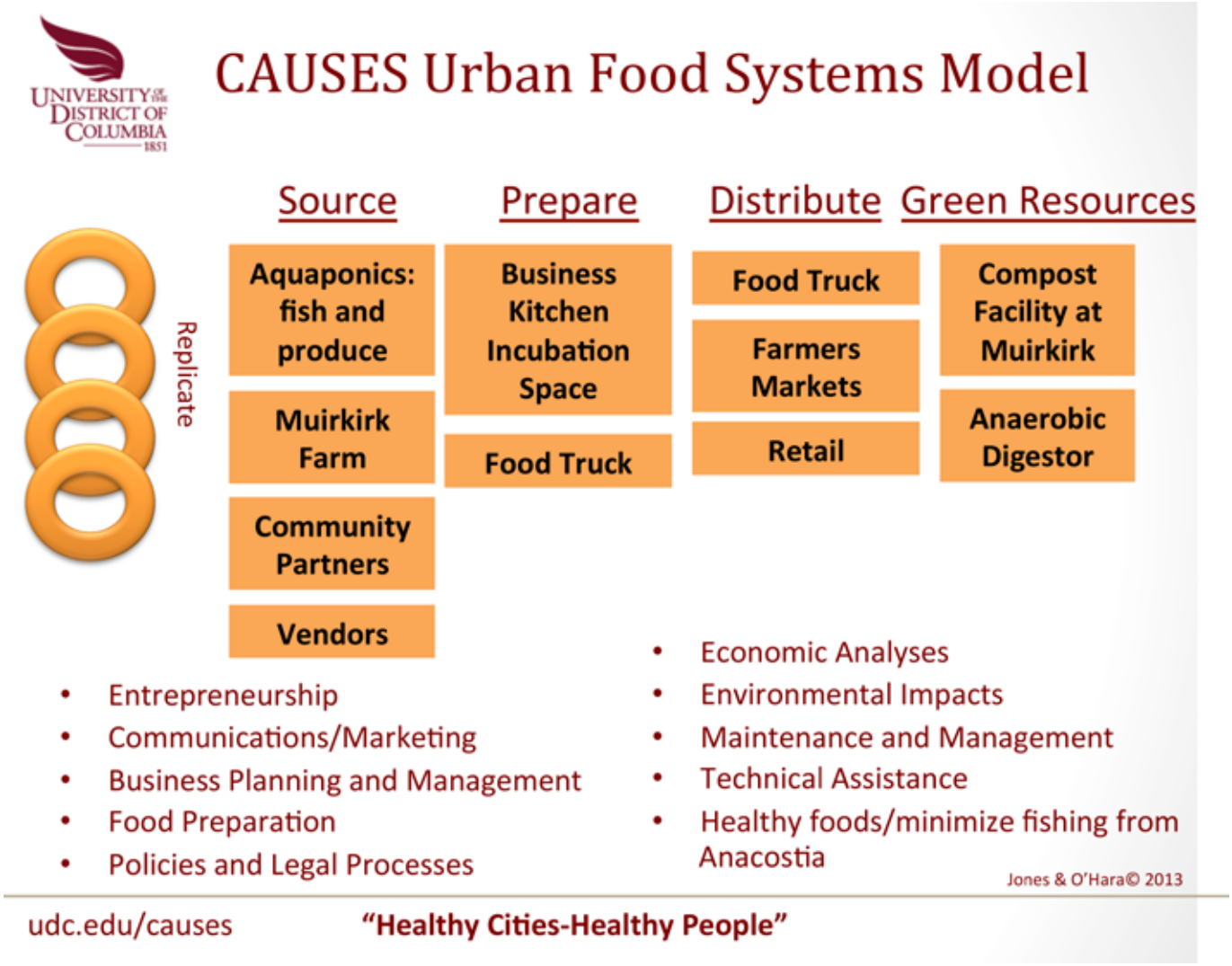

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Figure 4. Urban Food Systems.

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