Urban Farm Complex Research

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This document provides an in depth look at the possibilities for implementing an urban farm complex on the lot on Gordon Street. We begin with an overview of Wilmington's Socio-economic Demographics to frame the project followed by extensive research on each model. For some sections, we delve deep into the model and for others we focus more on case studies, best practices and other important information.

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Executive Summary

The need for jobs in Wilmington is apparent when comparing their unemployment rate to that of the state as a whole (6.7% vs. 4.8%) In addition, the Lower Brandywine Village as well as Northeast Wilmington are both identified as food deserts. A food desert is defined as a low-income area where residents live more than one mile from a grocery store.

Food Hub:

- A food hub will provide positive economic, social, and environmental impacts within the community.
- The average size of a food hub facility is 9,018 square feet (4x times the plot of land in Wilmington) and will create an average of 5 full time workers.

Urban Co-Op:

- An urban consumer cooperative involves consumers collectively purchasing goods at wholesale prices and requires community involvement to be successful.
- The main reasons why urban Co-Ops are unsuccessful are due to a lack of a popular base in the neighborhood combined with an economic hardship.

Grocery Store:

- The USDA completed a study that showed that it does not cost more to operate a grocery store that would provide to low-income customers than it would in other income groups.
- Opening a supermarket or grocery store is complex endeavor because many small convenience stores already exist in urban areas and residents are often unwilling to change their buying habits.

Combo Model:

- This model combines a food hub with a grocery store to help improve access of local foods to individuals that have limited transportation.
- Good Natured Family Farms is a great example of this model.

Green House:

- Prices and models for building an urban greenhouse differ depending on the size, and also vary in terms of start up costs and economic benefits.
- One acre of land is capable of producing 350,000 pounds of vegetables and herbs per year in a greenhouse.

Hydroponic Farm:

- Hydroponic farming is the growing of plants in a nutrient solution root medium without the presence of soil.

- The space requirements for hydroponic farms are flexible and the range of construction cost range from $4-$30 per square foot.

Overview of Wilmington's Socio-economic Demographics

Introduction

In 2013, The Wilmington Area Planning Council (WILMAPCO) completed a study of the region under their jurisdiction, which includes the entirety of New Castle County, Delaware; Wilmington, Delaware; and Cecil County, Maryland. The study sought to identify Environmental Justice areas with the region. Environmental Justice (EJ) entails fair treatment and meaningful involvement of people from all races, cultures and incomes regarding development of environmental laws, regulations, and policies. The concept of Environmental Justice is an outgrowth of Title VI of 64 Civil Rights Act (1).

WILMAPCO is primary a transportation planning council. The identification of Environmental Justice areas are important due to the fact that States expend about 80% of federal transportation funds on highway projects, leaving about 20% for mass transit and less than 1% for non-motorized projects. Such allocation of budget funds means low-income residents must either purchase a car that can eat up to 55% of low-income budgets or rely on a depleted public transit system (1).

WILMAPCO found that 70,000 people in the region live within EJ area. Of those 70,000 people, 20,811 live in significant EJ area and 48,829 live in moderate EJ area (1). WILMAPCO identified the income level of a moderate EJ area as $35,575 and the income level of a significant EJ area is $27,380. Most of the Northeast section of Wilmington (Riverside, Lower Brandywine Village) is either a moderate or significant Environmental Justice area (1).

What follows is a brief overview of the unemployment, transportation, and health status of Wilmington. The introduction concludes by presenting the Northeast section of Wilmington as a food desert and discussing Delaware agricultural productions.

Unemployment

The economic recovery has decreased unemployment across the United States over the last several years. 37,600 jobs were lost in Delaware from 2008 to 2009.

Delaware's current unemployment rate is 4.8% (2). Wilmington's current unemployment rate is even higher at 6.7%. On average, the unemployment rate in the US is between 5% and 6% (3).

Delaware's recovery has been strongest in the professional and business sector, which saw a 3.2% growth in employment from February 2014 to February 2015. This sector that saw growth includes law firms, engineering companies, and architectural firms. Over the same time period the Construction and Manufacturing saw meager growth at .1% and .2%, respectively (4).

Transportation

There is one bus route that primary serves the Riverside, Lower Brandywine Village area. DART's Bus Route 3 makes stops at 26th and Jessup St. On the weekdays it stops every half hour from 6:30 am to 7:30 pm. On Saturday it stops once an hour starting at 8:53 am and ending at 7:53 pm.

The average automobile per household rate in a moderate EJ area is 1.2 in a significant EJ area it is 1.1. As part of its EJ study WILMAPCO conducted a survey in which fewer EJ respondents (24% to 30%) said that the transportation system did not meet their travel needs. WILMAPCO notes the sample of respondents was not representative of EJ communities. In addition, there is no fixed bus route between Riverside, Lower Brandywine Village and any Low Wage Employment Center (1).

Health of Wilmington

Wilmington's Infant mortality rate is 14.8 per 1,000 live births. Delaware cancer incidence is 511 per 100,000. Delaware Life expectancy ranged from 72.5 for black males to 81.7 for white females (2010). Nine percent of all infants born in 2006- 2010 were of low birth weight (born at less than 2500 grams). Black mothers had a higher percentage of infants born at low birth weight than white mothers (13.6% versus 7.2%) (2). In addition to these general health indicators, Wilmington has a highly publicized crime problem.

Food desert locations in Wilmington

The United States Department of Agriculture defines a food desert as a residential area in which there is a poverty rate of at least 20% and 33% of residents are more than one mile from a grocery store (1). The Lower Brandywine Village and Northeast Wilmington are both identified as food deserts (1).

Overview of Delaware Agricultural Production

Delaware has 2,457 farms totaling 508,654 acres. The average size of a Delaware farm is 207 acres. Sussex County is the number one broiler chicken-producing county in the country (4). The market value of agricultural products sold is $1,283,472,000. The vast majority of the state's agricultural production comes from Sussex County ($921,129,000). Kent County comes in second ($227,727,000.00), followed by New Castle County ($75,158,000.00) (4).

A small portion of the state's agricultural production is based on crops ($429,323,000). Within Delaware's crop production, the number one product is corn for grain, followed by soybeans and wheat. Of Delaware's entire crop production, 40,684 acres account for produce production (4).

1. http://www.wilmapco.org/EJ/2013_EJ_T6_Report.pdf
2. http://www.delawareonline.com/story/news/2015/03/20/delaware-jobless-rate-down-february/25122707/
3. http://www.federalreserve.gov/faqs/economy_14424.htm
4. file:///Users/e9turkel/Downloads/G-MLR%20-%20Tom2015%20MLR%20pdf2015-02%20MLR.pdf

Model 1: Food Hub Overview

The term food hub describes a large variety of business and non-profit organizations that offer services to regional and local farmers and growers. Food hubs enlist numerous local producers in different ways; either through a producer-owned co-op or a supplier-owned brand to aggregate, distributes, and market local and regional produce. These services introduce regional and local farmers to markets that they would otherwise not have access to because it would be too costly or inefficient for either the producer or retailer (1). Wholesale buyers typically include grocery stores, bodegas, restaurants, and public institutions like hospitals and schools (3).

A key element of the food hub movement is that they have triple-bottom lines. A triple bottom line means that the business model is based around maximizing a mix of

three components. These components include positive economic, social, and environmental impacts within the community of operation. Food hubs take a values-based approach, which means they consider producers as valued business partners instead of interchangeable suppliers. The nature of the business partner relationship varies between food hubs. In some cases, food hubs buy produce directly from growers. In others, food hubs are negotiating prices on behalf of the growers. In every case, food hubs are working closely with producers to negotiate fair prices instead of taking the lowest possible price for produce.

There are three popular ways to organize a food hub, including hybrid markets, shipping point markets and wholesale/terminal produce markets. Hybrid markets combine wholesale and retail markets where growers and other merchants sell fresh products to businesses and individual customers. Shipping-point Markets offer fresh horticultural products that are cooled, graded, packaged and marketed to larger wholesale distribution centers and/or retail grocers. Wholesale/Terminal Produce Markets receive large quantities of fresh fruit and vegetables by rail, truck and air from around the world for sale to grocers, restaurants, institutions, and other businesses. Many food hubs employ a mix of these three operational models (2).

Despite differences in establishment, food hubs provide an opportunity for economic development in low-income areas. They provide this opportunity by presenting a solution to the disconnect between consumers who want local produce and local growers that do not have mechanisms to sell locally (2).

Case Study of The Common Market, Philadelphia, PA

The Common Market is a food hub that exemplifies a shipping-points market that uses a non-profit business structure. The Common Market is a Philadelphia-based food hub that aggregates food in their warehouse “from about 75 regional producers, and deliver(s) 6 days a week to almost 150 public and private schools, colleges and universities, hospitals, workplaces, grocery stores, nonprofits and faith institutions throughout the Delaware Valley” (6). The organization was launched in 2008 by Halie Johnson and Tina Rodriguez. Several years before the Common Market was launched, Johnson and Rodriguez lived in Strawberry Mansion, a low-income community in

Philadelphia. They worked with children in the community at an after-school program designed to encourage healthy eating. They soon realized that more was needed for a sustainable change. Prior to launching its operation, the Common Market conducted a feasibility study that included a demand analysis and a supply analysis.

The Common Market's Feasibility Study

The Common Market completed a demand analysis that involved surveys of super markets and sought to understand barriers confronted by sellers when selling produce regionally. The demand analysis concluded that sellers want product they can sell year round, preferred local to organic, and want to sell a variety of local products (1).

The supply analysis relied on surveys of growers and found that there were several key organizational, operational, and capital issues that could become the core around which the Common Market could focus their operation. On an organizational level, the Common Market could provide transparency, transportation services, professional sales representation, timely payments, and prompt and fair dispute resolution. Operationally, it could provide a facility to receive, store, prepare, assemble and ship products, as well as trucks to deliver and staff for logistics (2).

The feasibility study determined that a values-driven wholesale distributor of local food could create the necessary infrastructure to supply local wholesale food and incentivize regional farmers to sell more products regionally.

When considering the feasibility of a food hub in Wilmington, we must consider whether or not the demand for local products at a wholesale level exists, and whether or not local farms in the area are interested in selling their product to a food hub in Wilmington, Delaware.

In order to perform a demand analysis, one must survey potential wholesale buyers in the area. It may be most efficient to gather a list of grocery stores, restaurants, institutions, and food retailers, and design a questionnaire according to this list of necessary information put together by the Common Market Feasibility Study (5):

- Descriptions of how their businesses operate, including core values,

- Purchasing and replenishment processes, including factors involved in purchasing decisions, choosing suppliers, the mechanics of ordering and product delivery, and billing,
- Products (local) they use and those they would be interested in using, including quality and packaging requirements,
- Demographics of their customers, and
- Barriers to purchasing locally produced foods and the value components (if any) that enter into sourcing decisions (5).

The Common Market Feasibility Study also put together a similar survey questionnaire to perform a supply analysis on vegetable and fruit growers, dairy farms, and meat producers in the Philadelphia area. The questionnaire should obtain the following information from possible suppliers:

- Descriptions of their farming operations, including ownership, capacity, farming experience, and basic farming practices,
- Products produced on the farm, wholesale market readiness, potential or interest in producing new or different products,
- Current sales and marketing practices and experience and/or barriers to participating in the wholesale trade, and
- Interest in working with a business like the Common Market model.

The Food Hub Model at Work

Food Hubs are successful because they seize of the opportunity articulated by the Common Market's Feasibility study. Food Hubs present a solution to address the disconnect between consumers who want local produce and local growers do not have mechanisms to sell locally (2). Common Market addressed this problem by dealing directly with local growers and aggregating their produce to create a critical mass of regional produce that allows for wholesale distribution.

From a day-to-day perspective, the Common Market works because it has been able to build a network of regional suppliers and anchor customers. A big part of that was Halie Johnson's connection with Bob Pierson. Before joining the Common Market,

Pierson had been with an organization called Farm to City and brought with him many relationships with local produce growers. In part, the Common Market's ability to enlist regional growers was due to these relationships. Another reason was the Common Market commitment to paying a fair price for produce. Food Hubs tend to pay farmers better then other wholesalers because of the values-based businesses they run. The Common Market pays farmers faster then the other wholesalers they are competing against. It is able to attract and keep anchor customers, such as Wilmington Hospital and the Delaware Local Food Exchange, because they offer a safe, high quality product that delivers on consumer demand for local and regional produce (4).

The Common Market started off small by sharing a space with an organization called Share. The organization started off with one full-time employee. In their business plan the Common Market estimated they would sell $3,600 (225 cases) of food per week in 2009, $6,400 in 2009 (400 cases), $13,650 (852 cases) in 2010, and $20,480 cases in 2011(4).

In 2008 the Common Market sold $200,000 worth of product. In 2014, they sold $2 million worth of product. This is well above average for a Food Hub. In a USDA survey of 29 Food Hubs, the average annual sales were $871,900. The Common Market has seen constant growth every year it has been in operation, but that growth has been not consistent month to month. The growth started to level off 18 months ago (5).

The Common Market sells over 700 products available over the course of the year. They sell proteins as well, yogurt, eggs, chicken, grains, tomatoes, locally made sodas, frozen vegetables (spinach, sweet corn, green beans). September and October are biggest months, due to harvest and school goes into session (4).

Food Hub Considerations

According to research performed by the National Good Food Network (NGFN), the average size of food hub facilities is 9,018 square feet (7). The space we are working with is 34,848 square feet, or .8 acres, which is about 4 times the size of the average square footage.

Food hubs average five full time equivalent (FTE) workers (7). Ten W-2s were issued for each hub, which means that together ten individuals perform the work equivalent to 5 full time workers (7). This leads to the assumption that many workers are likely seasonal and part time. Almost all food hubs use volunteer labor, but do not track it (8). It is also important to consider job growth in partnering farms and potential programs. The growth of demand for local produce resulting from the implementation of a food hub will call for an increase in supply. Job growth will occur in the partnering farms.

Greenmarket Co. (NYC), for instance, has six full-time employees including an operations manager, program manager, sales manager, procurement manager, a truck driver for delivery and distribution, and a warehouse employee that receives farm products and prepares orders for clients (8). Greenmarket Co. is a food hub founded through GrowNYC, a non-profit organization dedicated to improving “New York City's quality of life through environmental programs that transform communities block by block and empower all New Yorkers to secure a clean and healthy environment for future generations” (8). Through Greenmarket Co., GrowNYC has implemented programs such as Youthmarket and FARMroots. Youthmarket is network of farm stands in NYC that are operated and managed by local youth and supplied by local farmers through Greenmarket Co. (8). The Youthmarket program improves access to fresh and sustainable food for residents in NYC while creating jobs and promoting skill development for youth in the area. FARMroots is a program designed to provide “both aspiring and established Greenmarket farmers with business technical assistance and training designed to ensure the long-term viability of participating farms and farmland” (8). They offer a wide variety of services that ultimately require the employment of trained professionals.

The main challenges to establishing a food hub in the area of interest is the expected high cost of building a warehouse facility that is equipped with refrigeration and freezer storage. The cost of obtaining capital, specifically distribution trucks, is also a challenge as well. Tuscarora Organic Growers (TOG), a food hub located in Pennsylvania, partners with a trucking company that handles about a third of TOG’s current deliveries (1).

1. http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5097957
2. http://www.cdfifund.gov/what_we_do/resources/CDFI%20Food%20hub%20webinar_07192012.pdf
3. http://www.greenmarketco.org/about.html
4. Phone conversation with representative from the Common Market
5. http://commonmarketphila.org/fresh/uploads/2014/10/CM-Business-Plan.pdf
6. http://commonmarketphila.org/intro/approach/
7. http://ngfn.org/resources/ngfn-database/knowledge/2013%20Food%20Hub%20Benchmarking%20Report.pdf
8. http://www.greenmarketco.org/about.html

Model 2: Urban Co-Op information

Since the creation of jobs is a high priority, a consumer cooperative would be a reasonable consideration. This type of cooperative involves consumers collectively purchasing goods at wholesale prices. Consumer cooperatives require widespread participation from the community.

One study of consumer cooperatives states that, “the average food co-op created 9.3 jobs for every million dollar in sales” (1). This being said, it is unclear how much revenue a food cooperative in this location would generate. Food co-ops impact the local community, more so than a typical grocery store, because they obtain more of their products locally and spend about 8% more on labor than grocery stores (1). These types of cooperatives have a very high economic multiplier. For example, for every $1,000 that a shopper will spend at a Co-Op, $1,604 is generated in the local community of economic activity (1).

Although cooperatives offer many benefits, they also come with some difficulties. Successful Co-Ops require a solid foundation of community organization, a complete feasibility study to ensure success, identification and utilization of technical assistance, strong management, member recruitment, and support from other Co-Ops is recommended to reduce start up costs. (2). One main problem that hinders success rate is start-up funding, which can be reduced by the support of existing co-ops (2). Another problems with urban Co-Ops is that the costs of running the stores in city areas is driven up due to higher insurance and property costs. In addition, better quality food is more expensive compared to that in the suburb communities (2).

Some unsuccessful co-ops include the Berkeley Co-Op, Dixon in New Haven, and the Metropolitan Co-Op in Cleveland. The underlying theme of failure in each of

these cases is an economic battle coupled with “a lack of a popular base in the neighborhood” (3). On the other hand, Cass Corridor in Detroit has been a successful Co-Op because of its aggressive outreach and education program. Other successful Co-Ops market their success to community involvement, volume purchasing, and management experience (3).

In conclusion, a Co-Op may, benefit this community economically. In order for this to be possible, the community’s time and effort is a necessity. It may be beneficial to speak to community member’s first hand either through a survey or interviews and determine their interest. In addition, experienced and qualified managers would be essential in the success of an urban Co-Op.

1. http://www.uwcc.wisc.edu/pdf/Healthy_Foods_Healthy_Communities.pdf
2. http://www.cooperativegrocer.coop/articles/2004-01-09/can-we-help-build-inner-city-co-ops
3. http://www.cooperativegrocer.coop/articles/2004-01-09/can-we-help-build-inner-city-co-ops

Model 3: Grocery Store information

Typical grocery stores may not contribute as many jobs as other alternatives because they rely more on automation as well as more centralized management (1). A grocery store will create approximately 5.8 jobs per million dollars made in sales. Nevertheless, Brown Supermarkets, located in a low food access area in West Philadelphia brought over 250 jobs to the community, including the hiring of those struggling with re-entry after incarceration (2). Additionally, this supermarket increased community involvement. This particular grocery store offers financial literacy classes, health education classes, and a variety of healthy foods to increase the population’s general state of health (3).

Another model for comparison may be that of Fare & Square in Chester. This model is membership driven. Membership is free and once accepted, they are encouraged to spend more at Fare & Square because they receive more rewards by purchasing more. Fare & Square’s focus was to eliminate food deserts and provide jobs for the local community. They have created about 45 jobs for people in Chester and hire locally whenever possible. This facility has only just celebrated their 1st anniversary so the long-term effects of this type of model are unknown (4).

On the subject of providing healthier food to the community, “initiatives in New Orleans and elsewhere have demonstrated some success with improving healthy food availability in small stores, and an intercept survey of customers at small stores suggests that customers would purchase more fruits and vegetables if available” (5). In addition, a study done by the USDA shows that it does not cost more to operate grocery stores that provide for low-income customers than it did for other income levels (6). This being said, opening a supermarket or grocery store can become a complex task because many small convenience stores already exist in urban areas (5). For example, in Oklahoma City, developers were hesitant to create a large supermarket because the inhabitants of the city were already content with shopping at small grocery stores, which they could walk to; hauling a large grocery load home from a large-scale grocery store is not something the shoppers were used to doing nor is it something they were capable of doing on foot (7). Parking space availability for customers is also a very important and often overlooked issue (8). Taking all of this into account, if increasing food access and bringing in revenue are top priorities, a supermarket may not be the best solution.

1. http://www.uwcc.wisc.edu/pdf/Healthy_Foods_Healthy_Communities.pdf
2. http://www.upliftsolutions.org/node/114
3. http://www.icic.org/connection/blog-entry/blog-can-grocery-stores-serve-as-community-anchors
4. http://fareandsquare.org/
5. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2869503/
6. http://www.ers.usda.gov/media/911472/aer839.pdf
7. http://www.lexisnexis.com/lnacui2api/results/docview/docview.do?docLinkInd=true&risb=21_T21766790944&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T21766790948&cisb=22_T21766790947&treeMax=true&treeWidth=0&csi=258809&docNo=3
8. http://smallbusiness.chron.com/necessary-items-starting-new-grocery-store-24021.html

Model 4: Combo Model: Food Hub and Grocery Store

A model that combines a food hub with a grocery store helps improve access to local foods to individuals that have limited transportation. The combination model would provide a facility for farmers to distribute, market and store their products while maintaining the advantage of a food hub in that it can distribute their products as a single pick up and drop off location (1). Below is an example of one particularly successful combination model.

Good Natured Family Farms, abbreviated as GNFF, is an alliance over 150 local farms and small businesses working together to bring farm fresh healthy food to the

Kansas City area. They market thirteen different product categories under one umbrella brand. GNFF also has a partnership with Ball's Food Stores, the largest regional grocery chain in Kansas City that operates twelve Henhouse Markets and sixteen Price Choppers stores. These grocery stores serve as a pathway to move a large volume of local food from the family farms to the consumers. To successfully place food from the farmers into the grocery store, GNFF has branded the products as "Good Natured Family Farms" products. This ensures that the products marked with this are from the local farmers. Currently, approximately 75 farms within a 200-mile radius of Kansas City supply GNFF-branded products. The producer sets the price, and then base price is marked up to add packaging, labeling, administrative and marketing costs. Afterwards, there is negotiation between GNFF and Ball's Food Stores for the final price.

The Good Natured Market at Harvest Learning Center is a partnership with Good Natured Family Farms and the World Harvest Ministries Church. The mission of this market is to provide healthy, local food at an affordable price to the members of the community. Only healthy food is available and it is sourced locally whenever possible because of the partnership with GNFF. Kansas City Good Food Hub is involved in supplying local foods to this market. The foods not sourced locally are purchased from wholesale sources. The church is located in the Ivanhoe Neighborhood of Kansas City, MO and provides healthy and locally grown foods to member families at a lower mark-up than the typical supermarket mark-up. The store accepts EBT and has a membership benefit card program. They are also able to match SNAP benefits dollar for dollar, up to $25.00. This pushes sales in the market and gives shoppers a free $25 to spend in the market each week.

For a $100,000 investment, the space was reconfigured to fit the needs of a food market. After reconfiguration, this market created 5 new jobs as the store is staffed with 5 people, 2 full time and 3 part time workers, all of which are minority workers.

The total cost of materials for the space, including shelves, long folding tables and baskets was about $1,500. The coolers cost about $3,100 and were installed by volunteers, which decreased total costs substantially.

The Ivanhoe Neighborhood of Kansas City, MO, is recognized as a food desert. This neighborhood has about 6,500 residents with no grocery store. The closest grocery store from this point is about a 3-mile drive. The market is a "year round food market with fresh, local produce, free range, and hormone/drug free meat and dairy, as well as staple goods." It is open from 12pm-6pm, 4 days a week. This location is a convenient, walk able location for many residents of the community. The market also takes phone orders and delivers groceries to those who cannot get to the market.

Marketing for the Good Natured Market includes advertising on the radio and announcements through the Church. It is convenient that the church-goers can go directly to the market after Church to purchase foods that they wish to eat.

1. http://www.chicagobusiness.com/article/20140409/BLOGS09/140409741/farm-to-market-food-hub-expanding-opening-retail-outlet
2. http://www.goodnaturedfamilyfarms.com/HarvestLearningCenter.html

Model 5: Green House Information

A greenhouse is a glass building in which plants are grown that need protection from the cold weather. The primary crops grown in greenhouses include peppers, tomatoes, cucumbers, lettuce, herbs, and strawberries (1). Prices and models for building an urban greenhouse vary greatly on size and therefore start up costs, and economic benefits. One particular greenhouse ran by "the Urban Farming Guys", combines an urban and low-income environment and proves to be very successful. They are involved in tilapia farming, hydroponics, and small community garden operations. Their mission statement is to "establish sustainable communities in the most difficult and overlooked places on earth." They want to create an environment where people can thrive with the businesses that exist in the community (2).

As far as land restrictions are concerned, on just one acre of land a greenhouse operation is capable of "producing 350,000 pounds of vegetables and herbs per year" (2). Since the plot of land in Wilmington is relatively small, these numbers seem promising. One potential way to increase profits would be to partner with local restaurants and markets that sell the food locally.

One website in particular may serve as a great resource. The website includes information on the process of building a greenhouse for commercial production as well

as the types of greenhouse systems, water issues, and many other topics of importance (3).

1. http://smallfarms.ifas.ufl.edu/crops/hydroponics/
2. http://theurbanfarmingguys.com/about
3. http://envirotechgreenhouse.com/blog/farming-of-the-future/
4. http://smartarchi.weebly.com/5-urban-greenhouses---how---solutions.html).

Model 6: Hydroponic Farm Information

Hydroponic farming is the growing of plants in a nutrient solution root medium without the presence of soil (1). It is not uncommon for a hydroponic farm to be enclosed within a greenhouse. The space requirements for hydroponic farms are flexible due to a higher intensity of production and the possibility of installing vertical hydroponic systems. Shelton Family Farms, a hydroponic farm in Jackson County, North Carolina, occupies about .5 acres, or 23,040 square feet (2). The annual yield of lettuce in the half acre of greenhouse space that is available is equivalent to the yield of 80 to 90 acres of field-grown lettuce (2).

The construction of a complete greenhouse/hydroponic farm includes site preparation, structure, heating and cooling equipment, thermostats and controls, irrigation system, nutrient tank or injection system, and a growing system (3). Construction costs vary depending on the design of the greenhouse. The most common and least expensive greenhouse design involves a double layer of ultraviolet light protected plastic over a metal frame made from either steel or aluminum pipes (3). In an economic study conducted by Jose G. Pena of Texas Cooperative Extension, the range of construction costs varied greatly with a range of $4.00 to $30.00 per square foot (3).

A wide variety of products can be grown using hydroponics, including tomatoes, basil, peppers, strawberries, pea shoots, leafy vegetables (lettuce, etc.), and cucumbers. Hydroponic products can be, and often are grown in a greenhouse year-round (4). However, because of the shorter length of daylights, production is often at its lowest during the winter months (3).

In an economic study conducted by Jose G. Pena of Texas Cooperative Extension, large-scale hydroponic greenhouse operators indicated that approximately 3 men per acre are needed to operate and maintain the greenhouse and 1 man per acre

is needed to package and ship the produce (3). However, this study was performed in 2005, and technology might have changed labor requirements since then.

In hydroponic systems, the nutrient water used as a growing medium is recaptured and recycle. As a result, water usage in hydroponic farms is significantly lower than that of conventional farming (6).

(1) http://afsic.nal.usda.gov/aquaculture-and-soilless-farming/hydroponics
(2) http://ncfieldfamily.org/farm/crops-forestry/hydroponic-farms-grow-fresh-produce-year-round/
(3) http://aggiehorticulture.tamu.edu/greenhouse/hydroponics/economics.html
(4) http://aggie-horticulture.tamu.edu/greenhouse/hydroponics/varieties.html
(5) http://www.sunaquagreenhouses.com/about.html
(6) http://boltonhydroponics.com/index.php?pr=Process