NC GROWING TOGETHER

Connecting Local Foods to Mainstream Markets

Siting and Cost Analysis for a Cross Dock Consolidation Center for Local Produce

In coordination with the North Carolina Growing Together project (2013-2017), individual supply chain scholars and teams of MBA students at the Supply Chain Resource Cooperative at NC State University's Poole College of Management have worked with NCGT staff and partner entities to investigate and address food business processes and supply chain issues across the local-to-mainstream supply chain.

This project report summarizes student team work on the supply chain problem of cost-effectively aggregating and distributing properly-cooled product from field to market. This project addresses this issue with an applied analysis of a small- scale infrastructure entity, a Cross Dock Consolidation Center (CCC). Cross docking refers to a distribution system where products received at a warehouse do not enter into the warehouse stock—for example, they are not moved by forklift in the warehouse "surplus" or "slots" for later retrieval—but are instead shipped as-is to another location.

The CCC discussed in this report consists of loading docks and coolers for aggregating and storing product, and provides an aggregation/cooling point from which wholesalers can collect product. The CCC does not perform the services of grading product or packing and repacking product, nor does it offer the service of marketing the product to various buyers. Thus it is unlike the typical "food hub" model, and the cost of building and operating the facility is concomitantly much lower than the food hub model (see http://www.wallacecenter.org/foodhubcollaboration/ form information on US food hubs). A CCC is a distinct type of infrastructure that could be ideal for rural areas, allowing small/mid-scale producers to consolidate product without the costs (investment and operating) required by a full-scale food hub.

The project uses GIS-based siting methodology and cost estimation for a CCC located in a seven-county area in southeastern North Carolina (designed to aggregate product from small/mid-scale producers in the geographic footprint of Fort Bragg, a North Carolina Growing Together partner). Analysis is conducted for investment and operating costs for different scenarios, and a layout of the proposed facility is provided. Specific results recommend an existing farm and structural upgrades to its facilities to serve the identified market. The discussed methodology can easily be adapted by others to address their own logistical needs. By efficiently siting a facility based on a set of criteria, and then costing out different options based on these sites, producers and existing wholesalers may be able to create win-win cross-scale exchanges of product using the Cross Dock Consolidation Center model. Additionally, government or foundation entities seeking to preserve working farm lands and the livelihoods of small and mid-sized farmers can use the CCC model as a relatively low-cost option to build local food supply chains. This type of infrastructure can provide economic opportunities for a new generation of smaller, diversified farms and their communities, and increase access to authentically local food for more consumers.

Suggested citation: *Hamilton, K., Howie, K., & Wagner, C. 2014. Siting and Cost Analysis for a Crossdock Consolidation Center for Local Produce. Center for Environmental Farming Systems, North Carolina State University, Raleigh, NC.*
For more information on NC Growing Together supply chain research, contact Research Coordinator rebecca_dunning@ncsu.edu, and see the project website: http://www.ncgrowingtogether.org/research/

Support for this work provided by North Carolina Growing Together, a project funded by the United States Department of Agriculture, National Institute of Food and Agriculture, grant #2013-68004-20363

INTRODUCTION

Despite growing demand for source-identified products such as locally sourced fruits and vegetables from family farms, challenges remain in cost-effectively aggregating and distributing these products from source to end consumer (Low & Vogel 20ll; Diamond & Bahram 2012). This paper summarizes an analysis of one food system infrastructure component—a Cross Dock Consolidation Center (CCC)—to bridge the geographic distance, dispersion, and scale differences that exist between these farms and the national and global wholesale produce industry. We present the methodology and results of two analyses: a simple and replicable GIS site-selection analysis to guide optimal siting of a CCC based on a set of criteria; and an estimate of the start-up and operating costs for a 2,500 sq ft CCC based on three investment scenarios.

The analysis was motivated by the stated desire of a North Carolina military installation to source produce from small and mid-sized farms[1] in counties surrounding its base and training areas. Given current contract provisions, product would move from farms to the base via the contracted wholesaler, which supplies fresh produce to base dining facilities. While the analysis was designed to address this particular scenario, the methodology can be applied to other locations and other end-markets.

LOCAL FOOD AND AGGREGATION INFRASTRUCTURE

Cross Dock Consolidation Centers can provide a low-cost alternative to the popular "food hub" model that includes the services of product repacking, marketing, distribution, and other functions. Food hubs have emerged over the past decade as an organizational model designed to aggregate and distribute source-identified product from small and mid-sized farms to various markets, including direct-to-consumer sales via box programs, retail storefronts, or online "virtual farmers markets;" restaurant deliveries, typically to higher-end restaurants; and deliveries to smaller independent grocery stores (Agricultural Marketing Center 2014; Wallace Center Food Hub Collaboration 2014).

An emerging trend among food hub operators and proponents of the model is to equip food hubs to work with institutional food service or retail grocery chain markets (Cantrell & Heuer 2014; Diamond & Barham 2012). A challenge to entering these markets is that the prices paid by these buyers are typically much lower than those received by growers in the direct-to-consumer, restaurant, or niche grocery market channels. At the same time, the higher overhead of a food hub model—which includes equipment and staff for repacking, marketing, sales, and distribution—increases the cost of the product. As a result, sales from small and mid-sized growers into institutional and retail grocery markets are often cost prohibitive (Gunter, Thilmany & Sullins 2012; Low & Vogel 2011).

The proposed CCC provides a low-cost alternative compared to a full-fledged food hub and can encourage transactions between local producers and food service and grocery buyers. The CCC performs only aggregation and cooling functions, and is coupled to the marketing, sales, and distributional capabilities of existing wholesalers. A CCC could be funded by a farmer cooperative, a wholesaler seeking to procure source-identified product from smaller farmers, or by community and regional economic development organizations that have identified food aggregation infrastructure as a strategy to revitalize local agriculture and the economies of rural communities (Borst 2010; e.g., Watt 2014).

[1] Small and mid-sized farms are classified as such using the USDA Economic Research Service definition: Small family farm occupation farms with annual gross sales under $350,000, and Midsize family farms with annual gross sales less than $1 million. Hoppe, R. and J. MacDonald. "Updating the ERS Farm Typology." 2013. U.S. Department of Agriculture Economic Research Service: EIB-110.

This paper presents an analysis of CCC's as a form of local food system infrastructure in two related sections. The first section outlines the methodology the researchers used to site the CCC based on a set of criteria. The second section presents the baseline investment and annual operating costs for a model facility.

SITE SELECTION METHDOLOGY AND RESULTS

Authors used a set of site selection criteria and the free online Quantum GIS program (QGIS.com) to determine an optimal location for the proposed CCC. QGIS is basic and business oriented, and a group of individuals with little to no experience with GIS could use QGIS to optimizing siting of a proposed CCC facility [2].

Site Selection Criteria and Analysis

Three site selection criteria drove the siting analysis. First, all participating farms are located in one of seven counties adjacent to a military base and its training areas in southeastern North Carolina. Personnel with the sustainability office on base expressed an interest in sourcing produce and other agricultural products from this 7-county area to meet objectives related to sustainable sourcing practices, to promote good community relations, and to slow the development of surrounding rural lands that are needed for troop training. The second and third criteria serve to minimize travel distances, minimizing the distances between farms, and the distance from the CCC to a major road. The latter criterion lowers the cost of pickup by the wholesaler. Major roads were defined as NC Highways, interstates and US Routes. Note that additional criteria could be added for other situations. For example, criteria can reflect the demand for or availability of different products at different farm locations or CCC capacity restrictions. Or, if a particular wholesaler is actively seeking to install a satellite CCC facility to support a centralized distribution operation, the GQIS analysis could be used to restrict or create a buffer of only the major roads that the wholesaler currently uses for distribution, thus lessening transportation costs through the use of backhauls.

The researchers identified 37 farmers in five of the seven target counties who had an interest in supplying fresh produce to a consolidation center. These farmers were identified through the network of farms and organizations associated with a USDA grant-funded project,[3] one objective of which is to connect small and mid-sized farmers to retail and wholesale markets by making use of existing aggregation and distribution infrastructure. While information from the National Agricultural Statistics Service and Census of Agriculture indicates there are dozens of other farms in each of the target counties, no list of these farms is readily available to enable a survey of farmer capacity or interest.

After loading the North Carolina county boarder maps and major roads maps into QGIS (these files are often available from county or state planning departments and can be used without cost), we uploaded and geocoded the location data of the farms. A resulting visual representation provided a clear understanding of the farmers' locations and proximity to each other, and revealed clustering of the data points in the east and west of the five-county area. We used that knowledge to guide our analysis to generate three siting options: one which

---

[2] The research team for this paper recommends that individuals wishing to replicate the siting methodology use an online tutorial such as: https://www.udemy.com/learn-to-use-qgis/?sl=E0EYdVw9RBMFLEwzBwZX&dtcode=p4l6i4td. Additionally, most county level Planning Departments have access to GIS and have trained individuals who can assist with your project.

[3] North Carolina Growing Together (ncgrowingtogether.com) is a USDA NIFA/AFRI funded initiative with a goal of bringing more locally grown foods into mainstream retail and food service to increase access to local foods and to strengthen the economics of small to mid-sized farming operations. The project is funded by the U.S. Department of Agriculture, National Institute of Food and Agriculture, grant #2012.68004.20363.

includes all 37 farm points, one for the eastern cluster, and one for the western cluster.

We overlayed 10, 20, and 40 mile buffers and included an overlay of vacant warehouses which could be leased and retrofitted. Like many other states, the North Carolina Department of Commerce provides public access to a database of vacant warehouse and building sites to permit businesses and individuals to search using selection criteria (AccessNC 2014). We ensured that each optimum point was located within 10 driving miles of a major road. The 10 mile buffer was determined as an acceptable distance for a wholesaler to drive off a major road in order to pick up produce from a supplier.

Discussion of Site Selection Results

As noted above, a visual representation of the data indicated eastern and western clustering; therefore, we ran three analyses to identify optimal points for "All Farms", "Western Region Farms," and "Eastern Region Farms." Results (Table 1) provide the latitude/longitude of the optimal point, the percentage of farms within each of a 10, 20, and 40 mile buffer around the point, the location of an existing vacant warehouse within 10 miles of the point, the three farms nearest to this point, and the greatest distance between farms. Nearby farms were specifically identified because of the possibility that one of these might host the CCC. An existing farm provides an attractive potential location for a CCC because of facilities that may already exist on farm and labor and oversight that could be utilized part-time for CCC operations.

The analysis helped pinpoint the best possible locations, and also helped researchers zero-in on a particular farm that emerged as one of the three farms closest to the optimal point for both the "All Farms" and "Eastern Region" option. This particular farmer (15 acres produce and 100+ in sweet potatoes) has a storage building and multiple market channels, including the produce wholesaler which currently holds the fresh produce contract for dining facilities at the military base. Researchers contacted this mid-sized family farm and used its actual infrastructure as a basis for estimating costs for one of the CCC start-up options, as explained below.

COST COMPARISONS FOR THREE SCENARIOS

Guided by the site selection results, the authors focused on three possible scenarios: (A) a new facility meeting specifications is constructed at/near the optimum identified site (B) an existing vacant warehouse near the optimum site is upgraded to meet specs, and (C) an existing farmer identified as being located near the optimum identified site upgrades his existing facility to meet CCC specs. Major cost considerations were broken down into two sets: Building and Equipment Startup Costs, and Annual Operating Expenses.

Building Specifications and Assumptions

A determining factor in the building cost was the layout required to efficiently yet cost-effectively receive, cool, and store product. We assume that the product is field-packed and delivered to the CCC by individual farms in non-refrigerated trucks before 10 a.m. (thus reducing on-site labor costs and ensuring product has a lower temperature for faster cooling). We assume that farmers use the same quality specifications and product packaging, that the product is labeled and dated and inventory operates on a first-in first-out system, and that wholesalers pick up produce between specified hours (to reduce on-site labor). A half-time manager operates the facility and records inventory in and inventory out, but does not function as the intermediary between farms and the wholesaler on ordering, quality concerns, etc. An average of 1,200 cases of produce are received and shipped weekly (2,400 maximum, 0 minimum, per day), moving from producer to wholesaler.

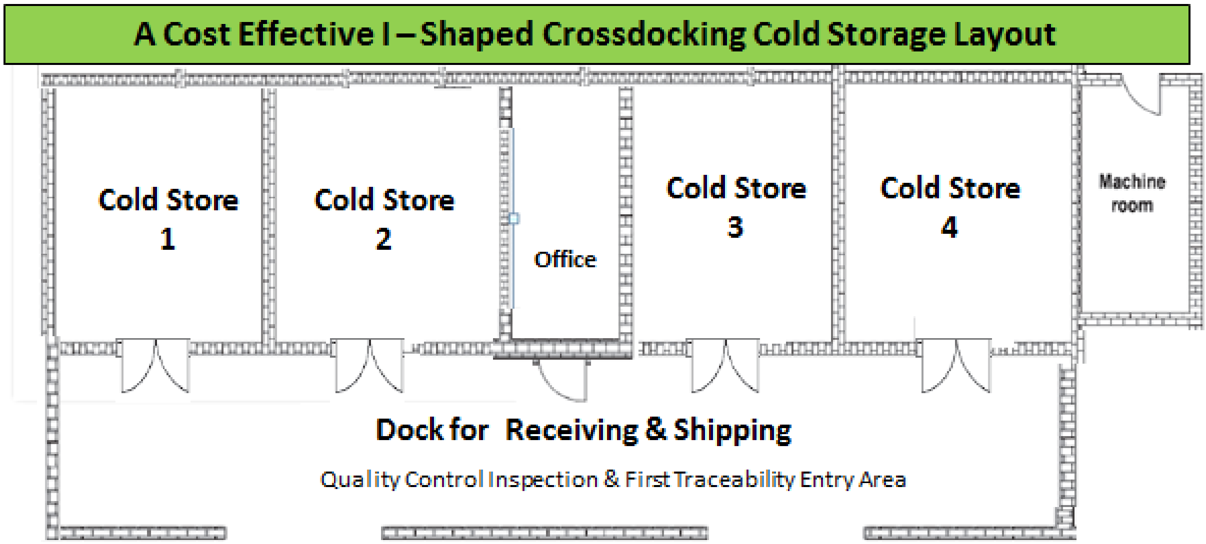
Table 1. Data Output from the QGIS Analysis to Identify an Optimal Site for a Cross Dock Consolidation Center in Southeastern North Carolina[a]

	All Farms	Western Region Farms	Eastern Region Farms
Optimum site location	<Latitude/ longitude>	<Latitude/ longitude>	<Latitude/ longitude>
% of farms within 10 miles of the optimum site	41%	49%	30%
% of farms within 20 miles of the optimum site	62%	85%	80%
% of farms within 40 miles of the optimum site	92%	100%	100%
Location of vacant warehouse within 10 miles of optimum point	<Latitude/ longitude>	<Latitude/ longitude>	<Latitude/ longitude>
Three farms closes to optimal point	<Names of 3 farms>	<Names of 3 farms>	<Names of 3 farms>
Greatest distance between farms	75 miles	27 miles	23 miles

[a] Note that actual geocodes and names of farms are not used due to privacy concerns.

Through online searches and consultation with a fresh produce handling expert we determined that a desirable size and configuration for a CCC building would include four coolers with different temperature points to accommodate different optimal temperatures for produce (P. Tripp, personal communication). For example, turnip greens should be stored at an optimal temperature of 42 degrees while potatoes should be at 55 degrees. Unlike a Food Hub model, which often grades and repackages product, the CCC would not perform these grading and repacking functions. Product arriving at the CCC would be field packed and ready for shipment to the wholesaler. The primary function of the building is thus to store and cool product, suggesting a low-cost streamlined design (Ahmed & Rahman 2012: 381-429; Bartholdi & Gue, 2004). The loading dock should be at ground level as this reduces the costs of finishing and safety features while allowing for rapid receipt of product from the various vehicles farmers use to transport their produce. The most cost-effective layout was determined to be an I-shaped facility (Figure 1).

Figure 1. Building Configuration for a Crossdock Consolidation Center



Building and Equipment Startup Costs

As noted above, we focused on three possible start-up options: (A) New-build, (B) Lease existing warehouse and upgrade, and (C) Upgrade and expand the existing infrastructure at a participating farm. Estimated building and equipment startup costs are given in Table 2. For all options we assumed 2,000 sq ft would be used for cold storage and approximately 500 sq ft would be used for office space and a machine room. We used construction cost estimate calculators for the area[4], personal communication with a building engineer and with a fresh produce specialist, and online cost quotes to generate the cost of building or upgrading for the three options. For Option A the building costs includes $165,870 for the building itself; and $38,696 for insulation upgrades, four Coolbots (storeitcold.com), and fans to move cool air through product for faster cooling. Option B assumes a leased warehouse, thus no building cost is included, but the same $38,696 in upgrades is included. For Option C, the warehouse building is owned and assumes a zero new construction value, but requires more upgrades to prepare the building for its use as a CCC, for a total of $59,223 in building costs.

The equipment costs of a pallet jack, forklift, shelving, and office equipment are assumed equal for Options A and B. For Option C, these items are already owned by the farm.

Annual Operating Costs

Table 3 summarizes the annual operating costs for each of the three CCC options. Wholesalers typically require *liability insurance* of $1-$3 million, estimated at a cost of $1,500 annually. The annual operating expenses for *equipment maintenance* plus warehouse repair and maintenance total $3,000 annually. *Utility costs* of $2, 500 annually assume Coolbots function for seven months of the year. *Property taxes* for Option A and C were based on county property tax records and *Miscellaneous supplies* valued at $1 800 include office

[4] http://www.reedconstructiondata.com/rsmeans/models/warehouse/north-carolina/fayetteville/; http://www.buildingsguide.com/faq/what-average-commercial-building-cost-square-foot). [Retrieved March 12, 2014].

Table 2. Estimated Building & Equipment Start-up Costs for a Crossdock Consolidation Center in Southeastern North Carolina

Building and Equipment	OPTION A New Construction	OPTION B Leased Vacant Warehouse	OPTION C Existing Farm, add on
Warehouse building construction	$165,870	$0	$0
Warehouse building upgrade	$38,696	$38,696	$59,223
Pallet jacks	$1,200	$1,200	owned
Forklift	$22,500	$22,500	owned
Shelving	$5,000	$5,000	owned
Office Equipment	$2,500	$2,500	owned
Total	**$235,766**	**$69,896**	**$59,223**

Table 3. Estimated Annual Operating Costs for a Crossdock Consolidation Center in Southeastern North Carolina

Operating Costs	OPTION A New Construction	OPTION B Leased Vacant Warehouse	OPTION C Existing Farm, add on
$2-3 million liability insurance	$1,500	$1,500	$1,500
Equipment maintenance	$2,000	$2,000	$2,000
Warehouse maintenance	$2,000	$2,000	$2,000
Utilities	$2,500	$2,500	$2,500
Misc supplies	$1,800	$1,800	$1,800
Property taxes	$992	$0	$992
Part time employee	$17,680	$17,680	$17,680
GAP/GHP Certification costs	$2,200	$2,200	$2,200
Depreciation	$6,786	$3,076	$6,786
Warehouse lease	$0	$16,620	$0
Total	$37,458	$49,376	$37,458

materials, boots, gloves, cleaning materials, etc. A *part-time employee* averages 20 hours per week across the year at $20 per hour, for an annual salary of $20,000. The facility must be Good Handling Practices (GHP) certified, with an estimated annual cost of $2,200. These costs are included for each of the three options. *Depreciation* cost is included both for the warehouse and equipment for Option A and C, and for the equipment alone for Option B. The annual *warehouse lease* cost is included only for Option B.

Based on the given criteria and the availability of an existing farm with some infrastructure near the optimal site, the selected option both in terms of minimizing investment and minimizing annual operating costs is Option C. Dividing the total operating costs by 60,000 cases that are estimated to move through the facility annually gives an estimate of $0.62 per case. As a note of comparison, the material cost of a produce cardboard packing case itself varies from $1.00 to $2.00 (depending on size and volume purchased).

SUMMARY

Cost-effective aggregation of product from small and mid-sized farmers, and the proper cooling of this product to extend shelf-life, are two prerequisites preventing successful local food supply chain linkages between smaller producers, intermediary wholesalers, and institutional and grocery markets. Food Hubs have emerged as one organizational form to aggregate and distribute local products. The typical Food Hub model subsumes the functions of the wholesaler, while ascribing to a mission of building value-chain linkages from producer to consumer that share risk and equitably and transparently compensate producers. County and regional economic development officials and foundations have turned to the model as a means to catalyze the economies of rural communities hurt by the decline of rural manufacturing and loss of farmers and farmland. Yet the all-inclusive Food Hub model has a costly investment and operating structure, and may only work for farms near the metropolitan areas where consumers and intermediaries are willing to pay higher prices for “locally-sourced” product.

The Cross Dock Consolidation Center as discussed in this paper provides one low-cost alternative for sourcing local product, with the assumption that the costs of any re-packing, sales, marketing, and distribution fall to an existing produce wholesaler. The CCC is an infrastructure component that can enable more small and mid-sized farmers to sell their product locally. Those interested in exploring options in their own areas can work with a GIS-trained individual in a local planning or economic development office, or utilize, as the authors did, the free online program QGIS. Context-specific information, such as the existence of vacant warehouses or farms with existing infrastructure, can be input as siting criteria to yield an optimal location. It is important to note that the assumptions used in siting the facility, and those used in generating cost estimates for startup and operations, should be based on practical, not idealized, criteria. Additionally, questions about the legal structure of the facility, and the points at which ownership of product is transferred from producer to wholesaler, should be resolved in advance of a financial investment.

By efficiently siting a facility based on a set of criteria, and then costing out different options based on these sites, producers and existing wholesalers may be able to create win-win cross-scale exchanges of product using the Cross Dock Consolidation Center model. Additionally, government or foundation entities seeking to preserve working farm lands and the livelihoods of small and mid-sized farmers can use the CCC model as a relatively low-cost option to build local food supply chains. This type of infrastructure can provide economic opportunities for a new generation of smaller, diversified farms and their communities, and increase access to authentically local food for more consumers.

REFERENCES

AccessNC | Search for N.C. Business Locations & Facilities. 2014. http://www.thrivenc.com/accessnc/search. [Retrieved February 25, 2014].

Agricultural Marketing Service – Home: www.ams.usda.gov/AMSv1.0/foodhubs. [Retrieved February 5, 2014]

Ahmed, J., & M. Rahman. 2012. Handbook of Food Process Design. Oxford: Blackwell Publishing Ltd.

Bartholdi, J. J., and K. Gue. 2004. "The Best Shape for a Crossdock." Transportation Science 38:2.

Borst, A. 2010. "Cooperative Food Hubs Fill the Missing Middle Helping Small Producers Tap Local Markets." Rural Cooperatives, Nov. – Dec.: 20-23.

Cantrell, P. and B. Heuer. 2014. "Food Hubs: Solving Local: Small-Farm Aggregators Scale up with Larger Buyers." Wallace Center at Winrock International: ngfn.org/solvinglocal. [Retrieved March 15, 2014]

Diamond, A., and J. Barham. 2012. "Moving Food Along the Value Chain: Innovations in Regional Food Distribution." U.S. Department of Agriculture, Agricultural Marketing Service: http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=stelprdc5097504 [Retrieved February 12, 2014]

Gunter, A., D. Thilmany, and M. Sullins. 2012. "What is the New Version of Scale Efficient: A Values-Based Supply Chain Approach." Journal of Food Distribution Research 43:1.

Low, S., and S. Vogel. 2011. "Direct and Intermediated Marketing of Local Foods in the United States." U.S. Department of Agriculture, Economic Research Service. ERR-128.

Tripp, P. 2014. Personal Communication. Produce Safety Coordinator, Carolina Farm Stewardship Association, Pittsboro, NC, January 23.

Wallace Center Food Hub Collaboration: www.wallacecenter.org/foodhubcollaboration. [Retrieved February 2, 2014]

Watt, D. 2014. "Food Hub Linked to Economic Growth." The Telegraph*:* www.thetelegraph.com/new/new/667733/Food-hub-linked-to-economic-growth. [Retrieved May 24, 2014].