



# **“Vertical Farms, Urban Restructuring and The Rise of Capitalist Urban Agriculture ”**

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***Lindsey Sarann Hallock***  
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Members of the Examining Committee:

Dr. Bram Buscher  
Dr. Max Spoor

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***Inquiries:***

International Institute of Social Studies  
P.O. Box 29776  
2502 LT The Hague  
The Netherlands

t: +31 70 426 0460  
e: [info@iss.nl](mailto:info@iss.nl)  
w: [www.iss.nl](http://www.iss.nl)  
fb: <http://www.facebook.com/iss.nl>  
twitter: [@issnl](https://twitter.com/issnl)

***Location:***

Kortenaerkade 12  
2518 AX The Hague  
The Netherlands

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## *List of Acronyms*

CEO	Corporate Executive Officer
DBCFSN	Detroit Black Community Food Security Network
LED Lighting	Light-Emitting Diode Lighting
PPA	Produce Purchase Agreement
UA	Urban Agriculture
UN	United Nations
WTO	World Trade Organization
ZFarming	Zero-Acreage Farming

## Abstract

This paper seeks to examine the rise of vertical farms, and the ways in which they advance the corporate food regime and encourage urban elite consumption. It will discuss two contemporary 'localizing' trends: the call for local food systems and local urban restructuring in the era of neoliberalism. I argue that the intersection of these two trends, spatially and temporally, created market opportunities for capital to appropriate social movement demands for local agricultural production, and encouraged the rise of capitalist forms of local food production (vertical farms). I will first introduce the vertical farm concept and currently operating vertical farms referred to throughout the paper. Then, using a theoretical tool developed by Robbins (2013), I will differentiate these farms as local food projects that *reproduce* the capitalist industrial system, rather than challenging it. In the third chapter, I discuss the analytical frameworks used in the paper: uneven geographic development and food regime analysis. The next chapter discusses how class struggle produced the calls for local food movements, as a response to inequity in the global corporate food regime. I then detail how devalued built environments and labor surplus, characteristics of cities under "actually existing neoliberalism", facilitated corporate appropriation of the local foods concept by producing profitable conditions for capitalist urban agriculture, which was hailed as local economic development. In the last chapter, I will discuss how these farms serve to reproduce troubling trends in the corporate food regime, and signify new developments in capital's ability to standardize the food cultivation process, and to incorporate it into factory like production systems.

## Relevance to Development Studies

Vertical Farms have been praised as a much-needed form of local economic development in devalued urban areas of the United States. Advocates maintain that they bring job and educational opportunities, revalue abandoned properties and encourage other investment in the area. Individuals interested in starting vertical farms have prioritized access to large public grants and city-owned land. At the same time, urban municipalities are reforming zoning legislation and allowable building height limitations to encourage entrepreneurial urban agriculture. As a result, the physical and social landscapes of urban areas are rapidly changing as devalued urban areas are transformed into production landscapes geared toward elite food consumption. These patterns should leave us with questions. Who is benefitting from these forms of development and who is being harmed or marginalized? How do these farms fit in with greater patterns of capitalist accumulation and geographic restructuring? This paper serves to show that vertical farms are an illustration of the ways in which capital produces underdevelopment at one point in time, only to redevelop and profit from it in another.

## Keywords

Vertical farms, local food movements, capitalist agriculture, actually existing neoliberalism, uneven geographic development, urban restructuring

## Chapter 1: Introduction

2040-2050, most scientists agree that 80% of nine billion people will live inside cities, and already today we are using 80% of the arable land that we have on the whole planet. If you put these two development curves together, then you easily realize that what will happen is that we have to grow food, large-scale, inside the city. The city is a dense environment, land is really expensive, so if you want to grow in the city then you have to grow vertical, and to grow vertical you have to develop new solutions, and that is what we are doing.

-Hans Hassle, CEO of Plantagon International<sup>1</sup>

### The Capitalist Food System and the Rise of Local Urban Agriculture

The globalized nature of the capitalist food system has, by now, been well documented and researched. As Friedman and McMichael (1989) have illustrated in their work on food regimes<sup>2</sup>, the capitalist food system, to an extent, has always been globalized, gradually expanding from early colonial settler states exporting grain to industrializing England, to regimes based on U.S food aid exported to most of the Global South during the 1950's and 60s (Friedmann and McMichael, 1989). Today's food system, what McMichael (2005) refers to as the Corporate Food Regime, is an extension of those patterns, characterized by agri-business domination, an international division of labor in agriculture, a liberalized world food price and a global supply chain (McMichael 2005). As McMichael (2005, 2009) details, the rise of the corporate food regime roughly corresponds with the rise of neoliberalism. Castree (2010) generally defines neoliberalism<sup>3</sup> as “an approach to the conduct of human affairs in which the so-called ‘free-market’ is given priority”, and is characterized, among other things, by policies that encourage: “privatization, marketization, state roll back or deregulation, market-friendly re-regulation, market proxies in the residual governmental sector, the encouragement of ‘flanking mechanisms’ in civil society and the creation of ‘self-sufficient’ individuals and communities” (Castree 2010, p. 1727-1728). As neoliberalism gained traction, calls to liberalize the agricultural trade gained more traction as well and were eventually realized through the acceptance of the Agreement on Agriculture in the WTO.

The damaging effects of such a system have also been well documented. Capitalist industrial agriculture is credited with immense gains in global food supply, as well as unprecedented low prices, but, as Weis (2010) writes, “the celebrated efficiency of industrial capitalist agriculture must also be seen to depend on an array of un- and undervalued costs” (Weis 2010, p. 316). These costs are externalities, created by the system, but which are not included in the world food price. As such, the market mechanism fails to signal destructive or irrational patterns of consumption, and outsources the costs to the environment, the state or individuals. These externalities manifest as increased rates of diabetes and cardiovascular disease (Caraher and Coveney 2003), which states and individuals pay for through insurance premiums and increased health costs. We also see increased food safety scares and epidemics of E. Coli as a result of the conditions of intensive livestock production, which also lead to increased greenhouse gas emission and rapid developments in climate change (Weis 2010). In addition to environmental and public health concerns, the system produces socio-economic externalities as well. The commoditization of food, and its distribution

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<sup>1</sup> Link TV (2013)

<sup>2</sup> This concept will be discussed further in the “Analytical Frameworks” chapter.

<sup>3</sup> This is not to be confused with neoliberalization, the process, or “actually existing neoliberalism” as discussed by Brenner and Theodore (2002). The definition used here represents the model of neoliberalism, and as Castree (2010) notes, there is no place in which this model exists purely.



through the price mechanism, leaves 842 million people without enough to eat, the vast majority of which live in countries that are net agricultural exporters ([www.wfp.org/hunger/stats](http://www.wfp.org/hunger/stats)), accessed 05/10/13). Commoditization has also subordinated food to the logic of capital accumulation, “the accumulation of profit to invest in production (or trade, or finance) in order to make more profit”(Bernstein 2010, p. 124), which, in turn, has led to increased corporate dominance over all aspects of the food supply chain, a profitable market in food futures contracts and increased speculation (Newman 2013), and sudden food price increases (McMichael 2009).

These externalities have not gone unnoticed, however, and have spurred the formation of thousands of food movements. These movements range from transnational peasant based coalitions fighting against land dispossession such as La Via Campesina, to urban-based movements such as Food Justice ([foodjustice.org](http://foodjustice.org)) fighting for equitable access to healthy foods in marginalized urban neighborhoods. A common theme, however, that runs through most of these movements is the call for the re-localization of the food system. Advocates of these efforts argue that, under the industrial food system, “food is progressively transformed into a highly branded, packaged and de-spatialized commodity, and severed from time, space and culture (or season, landscape and meaning)” (Weis 2010, p. 317). Therefore, as a response to the globalized and homogenized nature of the food system, the local movement seeks to bring food closer to the consumer, to ensure community food security and affordable access to fresh food, and to cut down on individual “food miles” that are driving environmental degradation through increased use of fossil fuels for transport. Urban agriculture has become an integral tool for the localization movement. As rates of urbanization continue to rise (UN 2007), “local” increasingly means “urban” for much of the world’s population, and, as a result, advocates of local food systems argue that urban agriculture efforts need to find ways to “scale up” in order to provide sufficient food for urban demand. It was in this context that the vertical farm first came to prominence. As a form of urban agricultural production that is highly technological, its advocates argue that it is capable of producing the amount of food demanded by urban populations in an ecologically sustainable way. As such, advocates of these farms maintain that they represent new, ecological and local alternatives to the industrial food system.

Urban agriculture thus became synonymous with radical efforts to localize and transform the capitalist food system, a subversive and political act against the globalizing tendencies of a system based on neo-liberal market mechanisms. However, as McClintock (2013) covers in detail, not all forms of UA challenge the system, some actually serve to mitigate discontent with the capitalist food system and therefore reproduce it. Pudup (2008) writes, “In the case of potato patch and depression era gardens, for example, community gardens were intended to substitute for the inability of unemployed workers to purchase their means of subsistence by allowing them to grow their own food” (Pudup 2008, p. 1229). These gardens thus served to help the system weather crises and steer attention away from structural flaws in its operational logic. Robbins (2013) echoes this sentiment when she writes, “it is unclear if localization can necessarily be equated with a democratized food system or if all attempts at localization can be viewed as direct critiques of the industrial model” (Robbins 2013, p. 10).

This paper will illustrate how vertical farms, *rather than challenging* the capitalist system, actually serve as *an example* of capitalist local urban food production. Capital has repeatedly shown an ability to accommodate challenges to the system by appropriating social movement demands and using them in new methods of accumulation. Friedmann (2005), however, reminds us that capital cannot appropriate *any and all* challenges, “the response is selective, choosing those demands that best fit with expanding market opportunities and profits” (Friedmann 2005, p. 233). How, then, did market opportunities arise for vertical farms and the rise of capitalist urban farming, especially when, as Bernstein notes, capital has historically been so reluctant to invest directly into the

farming process (Bernstein 2010, p. 89)? I argue that in order to understand how vertical farms came to be a viable form of accumulation in urban areas, we must look at the social and physical landscapes of urban areas. This paper will seek to examine how certain landscapes, particular to urban areas under neoliberalism, have created conditions that facilitate the rise of vertical farms.

## **The Urban Scale Under Neoliberalism**

The rise of neoliberalism in the 1970s and 1980s did not only affect the food system, it had impacts at all scales and across all sectors. As Harvey writes, the year 1972 marks the beginning of the transition into:

“a quite different regime of capital accumulation...the new regime is marked by startling flexibility with respect to labor processes, labor markets, products and patterns of consumption...[and] has entrained rapid shifts in the patterning of uneven development, both between sectors and geographical regions” (Harvey 1989, p. 256)<sup>4</sup>.

He notes that characteristics of this time, such as “unemployment, rapid shifts in spatial constraints and the global division of labor, capital flight, plant closings” (Harvey 1989, p. 259), have, however, put *particular* pressure on urban municipalities as the employment base decreases, workers leave and tax revenues drop. Brenner and Theodore (2002) have also discussed the impacts “actually existing neoliberalism<sup>5</sup>” has had on cities. They argue that “cities-including their suburban peripheries-have become increasingly important geographical targets and institutional laboratories for a variety of neo-liberal experiments”

These patterns have had transformative affects on the institutional, social and physical landscapes of cities under advanced capitalism today by destroying previous landscapes and creating new ones. As capital transferred to other geographies with more advantageous tax or labor conditions, industrial cities in North America experienced rapid devaluation in the built environment in the form of abandoned warehouses and foreclosed areas of working neighborhoods (Harvey 1989, 2008); increased unemployment and stagnant (or decreasing) wages (McMichael 2009) and the rolling back of public social services, such as subsidized food provisions (McMichael 2009). In their place have come the creation of “privatized spaces of elite consumption” and “the construction of large-scale megaprojects intended to attract corporate investment”; expansion of informal economies and labor conditions; and the “expansion of community-based sectors and private approaches to social service provision” (Brenner and Theodore 2002, p. 369-371).

As such, “local” solutions to patterns of globalization not only dominated discussions of the food movements mentioned in the previous section, they simultaneously became a survival strategy for cities suffering under neoliberal geographic restructuring. Cities thus became “entrepreneurial” in that localities felt the need to market themselves as unique, with favorable “business climates” in order to attract capital investment; or as a “good living environments” with innovative and fashionable places for consumption in order to attract residents and income. This paper argues that responses of “localization” to consequences of global capitalist patterns, in both food movements

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<sup>4</sup> Smith (1984) defines uneven development as: “the systematic geographical expression of the contradictions inherent in the very constitution and structure of capital...it is not just a question of what capitalism does for geography but rather of what geography can do for capitalism” (Smith 1984, p. 4).

<sup>5</sup> Brenner and Theodore (2002) use the concept ‘actually existing neoliberalism’ to distinguish between the pure ideology of neoliberalism and reality, in which neoliberal projects are shaped according to “the legacies of inherited institutional frameworks, policy regimes, regulatory practices, and political struggles” (Brenner and Theodore 2002, p.351).

and city planning, have created market opportunities for vertical farms. Through an examination of the intersection between calls for local foods and calls for local urban economic development, I will answer the following question: *how have class struggle, devalued built environments and depressed labor markets, characteristic of contemporary cities, led to the rise of capitalist urban farming in the form of vertical farms?*

## **Organization and Argumentation**

The last sections of the introduction are dedicated to issues of methodology and operationalization and the scopes and limitations of this paper. Chapter two will introduce the history of the vertical farm concept as well as brief introductions to currently operating vertical farms that are referenced throughout the paper. It will then use a theoretical tool, developed by Robbins (2013) in order to differentiate vertical farms as a capitalist form of local production. Chapter three will give more information on the analytical frameworks used in this paper: ‘glocalization’ and uneven geographical development as well as food regime analysis. Chapter four thus addresses specific conditions of the urban form under neoliberalism and the rise of vertical farms, and is divided into three sections. The first section will address class struggle and the local foods movement. It will argue that low-income urban populations, dependent on wages to purchase food, have suffered from decreases in employment rates and wages, typical of the neoliberal period; as well as from increased health costs from the processed foods typical of the corporate food regime. These concerns fueled calls for local, healthy foods and the redistribution of land for local forms of urban agriculture. The second section will examine how individuals interested in profiting from the popularity of local urban agriculture were thus able to establish large urban farms in devalued warehouses at low costs, aided by municipal governments desperate to encourage new forms of “local economic development”. The third section will address conditions of labor, and will note that the availability of new labor-displacing technologies in addition to labor surpluses in these urban areas are able to ensure that vertical farms have the lowest possible costs of production. Chapter five will then discuss how these farms create spaces of elite food consumption, attractive to wealthy individuals able to afford branded local foods, and thereby contribute to the reproduction of the corporate food regime and urban restructuring under geographies of actually existing neoliberalism. Finally, a conclusion chapter will repeat arguments made throughout the paper and give possible areas of future research on vertical farms, which are desperately under-addressed in the social science literature.

## **Operationalization and Methodology**

The literature on neoliberalism is vast, and its impacts have been examined on various sectors of the economy as well as in the literature on sociology, political science, international relations, just to name a few. In the course of these studies, several scholars, such as Swyngedouw (2004) and Brenner and Theodore (2002), have pointed out that neoliberalism, as an ideology that purports the ability of the free market to “operate according to immutable laws no matter where they are ‘unleashed’” (Brenner and Theodore 2002, p.349), does not exist in a pure form anywhere in the world. As with other ideologies, the policies and discourses that neoliberalism produces must be filtered and altered according to previously existing political, social and economic landscapes. While there are recognizable patterns produced by neoliberalism, which will be discussed in this paper, there are also differences (subtle and non-subtle) in the landscapes produced. Brenner and Theodore (2002) refer to this phenomenon as “actually existing neoliberalism”. With that understanding, I will use the words “neoliberalism” and “actually existing neoliberalism” interchangeably.

The focus of this paper is commercial-scale, for-profit vertical farms. As alluded to previously, however, urban agriculture and vertical farms are extremely differentiated, and not all forms serve to reinforce the corporate food regime. It is, therefore, required that I specify my object of analysis. The notion of a commercial-scale vertical farm was first introduced by Dr. Dickson Despommier, and his book, “The Vertical Farm: Feeding the World in the 21<sup>st</sup> Century”, is widely recognized as the inspiration for the vertical farms currently running today. He envisioned vertical farms as complexes of city buildings, containing their own plant nurseries, administrative offices, grow areas, monitoring buildings and distribution centers. These farms are meant to be highly technological, utilizing complex water recycling and nutrient transportation systems, as well as rotating systems allowing the plants to catch natural sunlight. While we do not have something of this scale yet (though we are close when one looks closely at the designs for Sweden’s Plantagon Vertical Farm), there are a number of enterprises that utilize many of the structures and technologies Despommier called for. These are the farms I will be discussing.

As these buildings require new engineering and construction innovation, most of the literature and thus, most of the labeling, has been done on a scientific basis; distinguishing various forms by architectural or engineering characteristics. Despommier defines vertical farming as “cultivating plants or animal life within skyscrapers or on vertically inclined surfaces” (Despommier 2010), but others have differentiated the concept into terms such as “Building-Integrated Agriculture”, which “is the practice of locating high-performance hydroponic greenhouse systems on and in mixed-use buildings to exploit the synergies between the building environment and agriculture-like energy and nutrient flows” (Caplow 2009). Specht et al. introduced the term “ZFarming”, “to describe all types of urban agriculture characterized by the non-use of farmland or open space, thereby differentiating building-related forms of urban agriculture from those in parks, gardens, urban wastelands, and so on” (Specht et al., 2013). As I am the one of the only scholars to discuss these farms from a political economy perspective, and as I am trying to distinguish capitalist farms from non-capitalist farms, I chose to use Despommier’s original definition, but to further distinguish between farms based on the level of technological innovation. As Bernstein argues, “a characteristic tendency of modern capitalist agriculture is to try and bring farming in line with industrial production: to *simplify, standardize* and *speed up* its natural processes as much as possible” (Bernstein 2010). Thus, I differentiate between a rooftop farm utilizing traditional soil based cultivation with low levels of industrial inputs, and rooftop farms with climate-controlled greenhouses utilizing soil-less cultivation methods. While the former may also be considered “vertical farms”, they are outside of the technological visions Dr. Despommier had, and, except for their exotic locations, are pre-capitalist modes of production.

The importance of verticality here should not be underestimated. While urban farms that utilize some of this technology have existed for sometime<sup>6</sup>, they have, until now, remained on the ground level and extend horizontally. While these enterprises are also interesting, they are not practically possible in many mega-cities of the world. The fact that vertical farms are able to gain scale by growing up, rather than out, will allow this technology to extend into areas of cities that would not be able to house such large, horizontal urban farms. When considering the possibilities of capitalist urban agriculture in the future, the difference between horizontal urban farms, based on the ground, and vertical farms able to fit into dense city spaces, is significant. I, therefore, focus on farms, as noted above, that are either inside of buildings, or on top of them and, thus, have a fixed space.

Due to the fact that social science scholars have not yet engaged with these new forms of UA, this paper will focus on the forces contributing to their rise, forces directly linked to greater patterns of

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<sup>6</sup> For example: see peri-urban agriculture around The Hague, The Netherlands

capitalist development, rather than a detailed examination into the operations of any given farm. As such, this paper will address multiple examples of vertical farms, rather than one in particular, that are located in countries of advanced capitalism, the majority of which are located in the United States. As a citizen of the United States, I have a more intimate knowledge of the ways in which the state and capital work together in order to achieve certain goals and the mechanisms through which this occurs, which has undoubtedly led to me to focus on farms in that country. That being said, this technology is rapidly expanding and there are projects appearing in Asia, Europe, as well as plans for Africa. Some of these will be mentioned, while others will be excluded. As there are multiple farms, in multiple locations, addressed here, as well as limits on research time, the research conducted was limited to the use of secondary data such as newspaper articles, blogs, promotional videos, previously conducted interviews and academic journals.

## **Scope and Limitations**

This paper serves as a preliminary look into vertical farms: the conditions which led to their viability as an entrepreneurial project, and the ways in which they fit in with broader patterns in the capitalist food system. The paper bridges a gap between urban studies literature and agrarian studies literature, which are both necessary in any study of urban agriculture. However, due to limits on space, and the sheer complexity of the topic, there are debates and topics that I will not be able to address in full. One such topic is the role of the state. This paper will touch on the ways in which municipal and national governments have encouraged urban agriculture and vertical farms, in the hopes of local economic development, by reforming zoning legislation and providing public grant money. However, the role of the state in city land planning is a vast topic (and an important one) and requires a paper of its own.

Another topic that I will not be able to address in full is the ecological impact of vertical farms. While I touch on it briefly, a detailed examination of the ecological impacts of these farms will need to be longitudinal in nature due to the rapidly evolving nature of the technology and the length of time required to examine impacts on the environment. That being said, with time, studies on waste recycling, water use and nutrient cycles in vertical farms will be necessary.

The final topic that requires more space is the level of financialization integrated into these enterprises. While I do discuss the ways in which vertical farms generally reproduce patterns of financialization in the food retail sector, I am not able to go into great detail. Due to the fact that these enterprises are not publicly traded on the stock market, there are limits as to how much financial information they are required to publish. Most of what is known about investors, partnerships and such are from information on the companies' own websites, given in interviews or pursued by journalists. There are emerging ties between agri-business corporations and some of these enterprises, and those ties must be more critically examined as more information is released.

While there are limitations to this paper, it is meant to be a preliminary look into a rapidly growing trend in urban agriculture. As studies of vertical farms are limited in nature, I feel the most important piece of the puzzle to address now are the forces encouraging them and the ways in which they become physically embedded into the urban landscape. This paper seeks to do that by examining the class struggle, built environment and labor conditions necessary for vertical farm viability, and by examining the more macro-forces of the corporate food regime and neoliberalism that drive the ideology behind vertical farms.

## Chapter 2: Vertical Farms: The Way to a Local Food System?



**Figure 1: Design for The Plantagon Vertical Farm, currently under construction in Linköping, Sweden. Source: Inhabitat.com, Schwartz 03/06/11**

### What is a Vertical Farm?

In his 2010 book, “The Vertical Farm: Feeding the World in the 21<sup>st</sup> Century”, Despommier argues for a more environmentally sustainable, urban-based food system founded on the establishment of large-scale, vertical urban farms. While he is certainly not the first to advocate for the benefits of urban greenhouses, his book (based off an idea he first openly voiced in 1999) is widely credited for stimulating the contemporary discussions on the possibility of “scaling-up” urban agriculture. As he describes the concept on his blog “The Vertical Farm Project”:

The concept of indoor farming is not new, since hothouse production of tomatoes, a wide variety of herbs, and other produce has been in vogue for some time. What is new is the urgent need to scale up this technology to accommodate another 3 billion people. An entirely new approach to indoor farming must be invented, employing cutting edge technologies. The Vertical Farm must be efficient (cheap to construct and safe to operate). Vertical farms, many stories high, will be situated in the heart of the world's urban centers. If successfully implemented, they offer the promise of urban renewal, sustainable production of a safe and varied food supply (year-round crop production), and the eventual repair of ecosystems that have been sacrificed for horizontal farming.

At the heart of his argument is distance: cities have become far too distanced from their resource bases. Employing the concept of bio-mimicry, “copying what nature does best”, Despommier asserts: “When seen through the eyes of the ecologist, the city fails to meet even the minimum standards of the simplest of ecosystems. Everything that the city consumes comes from outside its limits: energy, water, food, dry goods...” (Despommier 2010, p. 34). His solution thus mimics calls for food re-localization by social movements, but in the form of “ ‘high-tech’ greenhouses on top of each other” that utilize “hydroponic and aeroponic farming methodologies” (Despommier 2010, p. 23). The ideal urban vertical farm, according to Despommier, would:

Include a building for growing food; offices for management; a separate control center for monitoring the overall running of the facility; a nursery for selecting and germinating seeds; a quality-control laboratory to monitor food safety, document the nutritional status of each crop, and monitor for plant diseases; a building for the vertical farm workforce; an eco-education/tourist center for the general public; a green market; and eventually a restaurant. (Despommier 2010, p. 179)

A vertical farm of this size and scale has not yet appeared, and, in fact, very few currently operating vertical farms are housed in buildings built specifically for that purpose<sup>7</sup>. The idea, however, has rapidly taken off, and vertical farms have gone from small-scale projects based on rooftops, or in basements, to fully operating plant factories in less than five years.

### **The PlantLab and The Foundations of the Vertical Farm Industry**

The PlantLab in Den Bosch, The Netherlands is widely considered to be the first farm utilizing vertical farm technology of the sort Despommier called for. While the PlantLab itself mainly focuses on research and development, rather than commercial cultivation, their work has been integral to the success of more recent enterprises described below, as well as to the expansion of large-scale indoor farming operations in the future. A brief examination into the work of the PlantLab thus gives us an introduction to the level of technological sophistication commercial vertical farms currently utilize, as well as an indication of where the industry is heading.

Working with the goal of creating a “revolution in growing”, the Plant Lab is on the front line of large-scale indoor farming innovation. They specialize in three main areas of development, as well as recently signing a deal with the Swiss seed company Syngenta for research into indoor seed experiments (PlantLab.nl, accessed 05/10/13). The first development is extensive research on LED lighting in agriculture. As the company website explains: “LED only emits one color of light. No energy is wasted with light spectra that are not used or less used by the plant. This means we can provide exactly the colors that the plant needs for photosynthesis” (plantlab.nl, accessed 05/10/13). Light is perhaps the most important factor in any effort to grow inside, not only because plants require light in order to grow but also because lighting is a vertical farm’s highest cost. The company, however, citing Haitz Law<sup>8</sup> argues that the cost of LEDs are decreasing, which will, in turn, allow the price of the product to decrease as well.

The second area of development the PlantLab works on is the construction of mathematical models for optimal nutrient-dry matter-seed ratios. Having conducted research into the growth patterns of plants by studying a variety of conditions in fields all over the world, the Plantlab has “distilled hard patterns from the countless measuring data that forms the basis for growth models. Depending on the ultimate objective, we combine these growth models with economic calculation models” (plantlab.nl, accesses 05/10/13). As a result, the PlantLab is able to combine preferred profit and growth objectives of the customer with available space and resources in order to suggest the optimal business strategy, known as their “Plant-ID”

The final area of development is innovation in automation, climate control, and sensor technologies. These technologies are already utilized in countless greenhouses and indoor farms around the

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<sup>7</sup> Notable exceptions are the Plantagon project in Linköping, Sweden (see Figure 2) and SkyGreens in Hong Kong.

<sup>8</sup> Organic Lighting Systems Inc, defines Haitz Law as “Every decade, the cost per lumen falls by a factor of 10, the amount of light generated per LED packages increases by a factor of 20, for a given wavelength of light” (organiclighting.com/2012).

world, in order to ensure stable growth conditions twenty four hours a day, 365 days a year. These technologies both cut down the growth season of the plants and ensure the maximum output from every “harvest”. The company argues that this technology, when used together in one of their “Plant Production Units”, is able to ensure that large-scale production is characterized by: “higher production, Local for local production, customized production and quality, higher space, energy and carbon efficiency, low levels of contamination and pesticide usage, and the ability to produce sustainably everywhere” (plantlab.nl, accesses 05/10/13).

### **Rooftop Vertical Farms**

The commercial rooftop greenhouse was the first commercially viable instance of a vertical farm. Gotham Greens in Greenpoint, Brooklyn, NY (See Figure 3), was the first commercial-scale rooftop farm in the United States, and began construction in 2008 on a 15,000 square foot rooftop over an old bowling alley. As they were the first in the United States, the necessary permits, zoning, environment and sanitation, required several years for approval, but they were able to begin operation in 2011([gothamgreens.com/our-philosophy/](http://gothamgreens.com/our-philosophy/), accessed 25/10/13). The first greenhouses focused on greens and culinary herbs, selling exclusively to markets such as Whole Foods as well as restaurants in New York. Due to the success of the first greenhouse, however, the company is constructing two more greenhouses, another farm in Brooklyn, NY (to be atop a Whole Foods Market) and one in Queens, NY, where they hope to experiment with tomatoes and perhaps even strawberries. All of Gotham’s greenhouses utilize the climate control technology, such as the kind developed by the PlantLab, as well as sophisticated hydroponic (soil-less) cultivation methods, which they claim reduce the use of pesticides and water.

Gotham Green’s success has sparked more interest in the field, by other potential urban farmers, but also by those hoping to provide services for those farmers. BrightFarms Inc is one such company, and it “finances, builds and operates such ventures....spending about \$4 million to construct a 100,000-square-foot hydroponic greenhouse on a roof in Sunset Park, Brooklyn, that is scheduled to open early next year” (Pasquarelli 2013). The company already has a functioning greenhouse in Philadelphia, a contract for Washington D.C. and plans for construction in Indianapolis (Shipman 2013).

### **Indoor Vertical Farms**

While rooftop greenhouses are still the more popular models, indoor vertical farms have begun to appear as well, such as FarmedHere in Chicago, IL (see Figure 2) and The Plant, also in Chicago. These two vertical farms are currently operating in warehouses measuring over 90,000 square feet. In addition to growing and selling produce, these enterprises have also entered into other areas of the supply chain. FarmedHere produces its own vinaigrette in addition to its packaged greens and herbs. The Plant has marketed itself as a “vertical farm and food business incubator”. One-third of The Plant houses “aquaponic growing systems, and the other two-thirds will incubate sustainable food businesses” ([plantchicago.com/about](http://plantchicago.com/about), accessed 20.09.13). Despite being a new business, The Plant already has many tenants including a kombucha tea brewer, a fish farm, a “vermiculture green-tech venture” known as “Nature’s Little Recyclers” and two bakeries ([plantchicago.com/Businesses](http://plantchicago.com/Businesses), accessed 10.10.13).

While the models are different in size and location (outside vs. inside), both models employ highly sophisticated technology controlling climate, plant nutrition and water intake. Both models entail extremely high upfront costs (ranging from one to four million dollars depending on size) and, as a



result, sell premium, value-added products to supermarkets and restaurants under the “local produce” tag.



Figure 2: FarmedHere Inc, Bedford Park, IL, USA. Source: Huffington Post 2013



Figure 3 Gotham Greens, Brooklyn, NY, USA. Source: GothamGreens.com

## Differentiating Vertical Farms as Capitalist Local Food Projects

Robbins (2013) addresses various food localization efforts in more detail, and offers a tool to help differentiate local food systems. The goal of such a tool is to “analyze their characteristics and broadly classify them along a range where local food systems within the food sovereignty framework occupy one end and local food systems within the industrial capitalist framework the other” (Robbins 2013, p. 31). She argues that the examination of the scale, method and character of any given project allows us to navigate the tensions between industrialism and agrarianism in local food systems. If local food production, of the kind discussed in this paper, is to offer a real alternative to the industrial food system, Robbins suggests that the project must lie closer to the food sovereignty end of the spectrum, a project which democratizes the food system and brings producers and consumers close together, while enhancing the relations between food and the environment.

### *Scale*

The first differentiating factor Robbins addresses is scale, differentiating between “scale as size” and “scale as level”. Rather than defining scale as the amount of land cultivated, she echoes Bernstein’s (2010) contention that, “capital intensiveness is a more useful descriptor since farm area does not indicate the number of farm labourers needed or the capital required to start and maintain the operation, essential relations in capitalist farming” (Robbins 2013, p. 32). From this perspective, despite the fact that urban vertical farms use a small amount of land relative to rural industrial agriculture, the fact that they are able to produce thousands of pounds of food per day with little (or no) labor, makes them large-scale as well. Large-scale is often linked to capitalist agriculture, due to the fact that the low price of food commodities requires large-scale production in order to be profitable. It is also widely assumed that large-scale is more productive<sup>9</sup>, and thus necessary for fighting hunger. This claim, however, is a source of debate<sup>10</sup>

Robbins also discusses scale as level, “In this version of scale, small-scale means producing for a household or a market within the community and large-scale means producing for levels further up the scalar chain, such as international markets” (Robbins 2013, p. 33). From this perspective, vertical farms are neither large-scale nor small-scale, but fall somewhere in between. While the Plantagon in Sweden intends to export its food to Asian markets, it is the exception in that most vertical farms are producing for their local communities. All of the vertical farms discussed in the first section of this chapter, produce solely for local consumers, restaurants or supermarkets. This implies a certain level of “embeddedness” in that middlemen in the supply chain are removed, and, theoretically, consumers could go to see where their food is being grown. However, embeddedness also implies that these enterprises are firmly within the local economy, and this is more difficult to argue in the case of vertical farms. Investment into these farms comes from various places, rarely from local sources. In some cases, farms receive funding from international private equity firms, and investment capital can be sourced from all over the globe. In this case, at least some of the profits will have to leave local circulation and go back towards paying shareholders.

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<sup>9</sup> Robbins (2013) discusses the debate between scale and productivity in detail.

<sup>10</sup> This debate has its origins in the difference between those who agree with Chayanov and the possibilities of small-scale agriculture, and those who agree with Lenin and the necessity of large-scale agriculture. For information see: Bernstein (2010).

## Method

Method is the second differentiating characteristic in Robbins' framework. Here, she distinguishes between conventional production, characterized by the "use of a range of technical and synthetic interventions to increase productivity and control weeds and pests", and traditional production, characterized by organic, agroecological methods, "deeply rooted in traditional practices and scientific knowledge of ecological processes" (Robbins 2013, p. 34). Advocates of hydroponic systems argue that the system's sustainability mostly comes from its ability to save and use recycled waste water for organic irrigation without fertilizer or pesticides, however, in a recently published literature review covering hydroponic/aeroponic techniques, the authors note that "no promising concepts can be found in the literature that allow for the production of effective nutrient solutions for hydroponic systems from organic matter. Existing hydroponic projects mainly use industrial fertilizers to optimize yields" (Specht et al. 2013). Even if technical solutions are found to irrigation problems, the effects of bio-standardization through technology are the same as those produced by the monocultures fertilizers are intended to support. At the moment, not all crops are capable of being cultivated under hydroponic/aeroponic systems. Specht et al. write "Hydroponic techniques are best suited economically and logistically to a range of vegetables that include leaf crops, vine crops, or culinary herbs", but "the limitations of indoor farms are apparent in the production of cereals, feeds, root vegetables, and fruits trees. Cattle, horses, sheep, goats, and other large farm animals also seem to fall outside the paradigm of commercial urban agriculture" (Specht et al 2013,). This brings into question the type of seeds/varieties capable of germinating under conditions, and thus the ability of the systems to nurture local forms of biodiversity or non-genetically modified plants. Certainly, the recent deal between the PlantLab in Den Bosch and Sygenta signifies that genetically modified organisms might be integral to the expansion of this industry. Is it truly local production if the kinds of food being produced would not be capable of growing in these locations under traditional forms of cultivation?

## Character

The final characteristic Robbins uses to differentiate local food production is character. On one end is the capitalist character based on industrialism or, "a way of thought based on money capital and technology", and on the other end is agrarianism, "a way of thought based on land" (Robbins 2013, p. 35). While this can be similar to method, especially when referring to use of technology, it also refers to motivation of the business. Vertical farms not only continue to reify food as commodity, an item to be bought and sold through the price mechanism, they encourage commodity fetishism by promoting their goods under the "local" term appropriated from social movements. They are quite literally, industrial farming factories that have taken the standardization of plant growth to new levels. As Bernstein (2010) notes, a "tendency of modern capitalist agriculture is to try and bring farming in line with industrial production: to *simplify*, *standardize* and *speed up* its natural processes as much as possible" (Bernstein 2010, p. 90).

When seen all together, commercial vertical farms are clearly local manifestations of the capitalist industrial food system, rather than actual alternatives to it. These farms do address notions of distance in a shallow way by addressing geographical distance between producer and consumer, but they fail to address other forms of distance, such as that between agriculture and nature. These, in turn, also address some of the environmental consequences of the current system by reducing

“food miles” and recycling water and waste (and even this claim is contested<sup>11</sup>). However, the overall concept is to avoid making the soil worse, rather than trying to make the soil better. While Despommer (2010) argues that these farms would allow rural lands to lie fallow, current trends in agrarian studies would suggest otherwise. In all reality, vertical farms could take some pressure off of rural lands for growing food so that they might, in turn, produce more food or fuel crops. While vertical farms do make some reforms, ecologically, they fail to address much needed socio-economic reforms by continuing to work in the logic of accumulation.

## **Chapter 3: Analytical Frameworks**

### **“Glocalization” and Patterns of Uneven Geographic Development**

In his book *Uneven Development: Nature, Capital, and the Production of Space*, Smith (1984) argues that the restructuring of geographic space is necessary for the continual reproduction of capitalism. He writes:

Capital is continually invested in the built environment in order to produce surplus value and expand the basis of capital itself. But equally, capital is continually withdrawn from the built environment so that it can move elsewhere and take advantage of higher profit rates (Smith 1984, p. 6)

As a result of this process, landscapes around the world are continuously shaped and reshaped as development in one location leads to underdevelopment in another. “Development” in the capitalist sense, Smith (1984) argues, is thus the production of space in capital’s own image, the creation of landscapes conducive to the accumulation of profit. Harvey (2008) argues that as capital finds new areas for development, and thus areas where there are higher profit rates, a process of “accumulation of dispossession” typically accompanies. In urban areas, it manifests as gentrification or urban redevelopment schemes, where capital is able to “capture valuable land from low-income populations that may have lived there for many years”, but are assumed to be incapable of using the land for its “best and most profitable” use (Harvey 2008). Swyngedouw (2004) discusses how these patterns in the production of space also lead to the reconfiguration of scales of governance. He writes, “as soon as the Westphalian order was completed by the mid 20<sup>th</sup> century, it had already begun to transcend itself as national boundaries became more porous and both sub- and super-national scales of governance and organization became more prominent” (Swyngedouw 2004, p. 32). Swyngedouw refers to this division of governance between sub-national and super-national as “glocalization”. As a result of this process, localized entities, such as corporations or urban municipalities, must increasingly have a global outlook, but at the same time, global patterns are also received, filtered and thus differentiated through unique local frameworks.

These theories are integral to an understanding of the rise of vertical farms. As will be discussed in further detail in chapter 4, vertical farms are located in and on top of the abandoned built environments of previous rounds of capital accumulation: the factories built during the era of Fordism and mass production and the buildings constructed during the property booms of the 1990’s and 2000s (Harvey 2008). The low cost of rent, due in part to subsidizing grants from local

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<sup>11</sup> See Specht et al. (2013) for a comprehensive literature review of the potential and limitations of current hydroponic/aeroponic technologies.

municipalities but also because these areas are intensively devalued<sup>12</sup>, attracted corporate investment because of the potential for higher profits, including individuals interested in vertical farming. This also should give cause for concern, however. Advocates of vertical farms encourage entire urban areas to base their food supply on local vertical farms (Despommier 2010), but as uneven development tells us, these farms are just as capable as other forms of industrial production of leaving when profit margins decrease and opportunities arise elsewhere.

Harvey's concept of 'accumulation by dispossession' has historically applied to urban agriculture and continues today. Community gardens in New York, for example, have been repeatedly shut down when developers expressed interest the property (Staeheli et al, 2002). Today, urban agriculture finds itself on both side of the relationship. Other forms of capitalist urban agriculture have already been accused of landgrabbing<sup>13</sup> in Detroit (Thompson 2012). Vertical farms in particular echo this pattern when they advance gentrification by entering into agreements with high-price supermarkets, such as the Whole Foods-Gotham Greens agreement in Brooklyn, and, generally, taking advantage of the low prices of urban neighborhoods without providing a product or service that can be used by these neighborhoods due to price exclusion. These examples mirror trends of landgrabbing and dispossession that characterize the capitalist food system under the corporate food regime (McMichael 2012).

## **Food Regime Analysis**

First introduced by Friedmann (1987) and developed extensively by others (McMichael and Friedmann 1989, 2005, 2009, 2011; Araghi (2010); Campbell and Friedmann, Burch and Lawrence 2011) food regime analysis is a framework that "combines political economy, political ecology and historical analysis to explain how particular relations of food production and consumption are central to the functioning and reproduction of global capitalism" (Holt Gimenez and Shattuck 2011, p. 110). A "food regime" is defined here as "a rule-governed structure of production and consumption of food on a world scale", and the concept thus serves to link regimes of capitalist accumulation with regimes of food relations.

The first food regime (1870-1930) was embedded in the British colonial system. By providing cheap wage-food for industrializing Europe through the creation of a class of family farmers specialized in commercial, export-oriented farming in the settler colonies, the first regime encouraged the rise of national economies and an international division of labor. The second food regime was defined by a period of US hegemony after World War II (1950s-1970s), and a system of protective subsidies enacted globally after the price drop during the previous decades of war and economic crisis. The surplus of grain and livestock encouraged by government subsidies was sent as wage subsidizing "food aid" to third world industrializing countries in the hopes that these new nation-states would turn to capitalist markets, rather than the Soviet Union. Agribusiness corporations became increasingly specialized into input and output services, providing industrial fertilizers, machinery as well as processing and distribution services to new commercial farmers (The Green Revolution) in Africa, Asia and South America.

The 1970's ushered in the acceptance of neoliberal ideologies, and developments in the food system since that period have mirrored neoliberal policies in other sectors. There is a debate over the

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<sup>12</sup> The City of Detroit, MI had pieces of property for sale for less than 100\$ at one point (Spector and Goldscheine 2012).

<sup>13</sup> The Hantz Deal in Detroit involved Hantz Farms' purchase of hundreds of acres of city property in order to start a tree farm (Thompson 2012).

existence of a stable, third food regime<sup>14</sup>, but most scholars agree that the defining characteristic of this moment in the food system, is its globalized nature and the level of corporate control over it. As McMichael writes:

The 'corporate food regime' (1980s-present) specifies a neoliberal project of agricultural liberalization via structural adjustment mechanisms and WTO rules encouraging universal agro-exporting and requiring states in the global South to open their economies to the Northern-dominated international food trade, dismantle farm sector protections and adopt intellectual property protections. All of these rules have institutionalized market and property relations privileging agribusiness in the name of production 'efficiencies', 'free trade' and global 'food security' (McMichael 2012, p. 682).

The use of a "world-price" mechanism to distribute increasingly speculative food commodities, however, has actually contributed to rising rates of food *insecurity* (McMichael 2009). As neoliberal policies, discussed in this paper previously, contributed to increased income inequality so a two-tiered food market arose to serve it. Increasingly, high-income populations have their choice of fresh, and certified<sup>15</sup>, foods distributed through supermarkets, while low-income populations are increasingly forced to buy the highly manufactured, lower quality foods in their price range.

As McMichael (2009) notes, the deep injustice, as well as the instability, of such a system came to surface during the price increases of 2007-2008, and the corresponding urban food riots. He writes, "the neo-liberal process of casualization of labor, and the global wage relation, is now manifest in growing public disorder as food price inflation further devalues wages" (McMichael 2009, p. 284). The urban food riots brought much needed attention to the subject of food inequality, but they also showcased mass discontent over the capitalist food system, a discontent that has been consistently fueling the rise of food movements such as the local food movement.

Food Regime analysis thus serves as useful context to vertical farms in two ways. The concept of the corporate food regime, characterized by supermarketization and value-added, branded foods for elite consumption, allows us to link the neoliberal restructuring of the food system with neoliberal urban restructuring. As cities feel pressure to market themselves as "good living environments", the existence of high end grocery stores selling local food products from innovative urban farms will help them in their endeavor. Secondly, the concept allows us to link local instances of social movement calls for affordable, local and fresh foods, with greater patterns of neoliberal labor-disciplining policies. As urban areas see increased rates of unemployment or casual employment, more of the population becomes food insecure and thus more likely to call for change in the food system.

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<sup>14</sup> There are some scholars, such as McMichael (2005,2009) and Burch and Lawrence (2011), who argue the current period is a stable corporate food regime. Friedmann (2005), however, argues that we are still in a period of challenge and transition, as constant "naming" continues to plague the system.

<sup>15</sup> Certification and labeling systems, as privatized forms of food regulation, are an interesting part of the current food regime and have been extensively discussed in the literature around food regimes. For more information, see: Friedmann (2005); Guthman (2007) Campbell (2009);



## Chapter 4: The Rise of Vertical Farms

### Class Struggle and Local Food Movements

As has been discussed previously, neoliberal policies and projects implemented over the past several decades have had devastating impacts on low-income urban populations, manifested as higher rates of unemployment and a decrease in wages. Neoliberal policies in agriculture have greatly contributed to these patterns. Corporate domination over the food chain has increased concentration in agricultural lands and liberalized the world food price, the displaced or impoverished peasantry often left for urban areas to find wage jobs (McMichael 2009). This, in turn, has created a growing supply of labor, and has put downward pressure on wages. In 2012, the unemployment rate in the United States was at 8.1% (US Department of Labor, 2013). While this seems low when one considers the global standard, it has to be considered in conjunction with a federal minimum wage of \$7.25 per hour, and patterns of decreasing wages in non-minimum wage jobs. The New York Times reports that “real earnings of the median male have actually declined by 19 percent since 1970” (Greenstone 2012). These patterns deeply impact food security, as the majority of the population in countries of advanced capitalism work in non-agricultural jobs, and are thus more likely to depend on wages to buy food. Allen and Wilson (2008) write that, in 2006, 35.5 million Americans were already food insecure, however by 2012, that number had risen to 45.1 million individuals (FeedingAmerica.org, accessed 04.11.13). As a result, an increasing percentage of wage laborers have limited food choices and rely on canned, boxed, frozen and/or highly processed foods, which are known to lead to increased rates of obesity, diabetes and cardiovascular disease (Caraher and Coveney 2009).

As Harvey writes, “The central point of tension between capital and labour lies in the workplace and is expressed in struggles over the work process and the wage rate”, but *displaced class struggle* also exists when tension “ramifies and reverberates throughout all aspects of the system of relations which capitalism establishes” (Harvey, p. 125). Struggles over insufficient wages and limited access to healthy foods should thus be understood as an example of displaced class struggle. As the state began to implement neoliberal policies and roll-back social services, low-income neighborhoods and communities began to form their own organizations dedicated to fighting food insecurity. One such movement is the food justice movement, which is an urban movement focused on equal food access and the growth of local food systems. As Wekerle (2004) notes of the history of food movements: “While originating in community responses to economic downturns in the mid-1980s...there has been a transition to a focus on the right to food...This involves an explicit critique of the global food system and a theoretical framing of local initiatives as both the practice of democracy and as means of de-linking from the corporate global food system” (Wekerle 2004, p. 378-379). The right to food became a rallying call for food justice movements in low-income communities, and community urban agriculture became a practical platform through which the right to food could be ensured. Local food systems and urban agriculture thus came to symbolize community empowerment.

Harvey suggests that the concept of ‘community’ can be used as a weapon in class struggle in that “the institutions of community can be captured and put to work for working class ends...[and] then become a springboard for class action” (Harvey, p. 128). Indeed, these movements quickly became institutions of urban communities, providing food as a sort of shadow state<sup>16</sup>. Community gardens became a place for social interaction, nutrition training and a source of neighborhood pride. In

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<sup>16</sup> For this reason, urban agriculture often comes under criticism as it implicitly helps to reinforce the capitalist food system by mitigating popular discontent and encouraging community organizations to fill in spaces left absent by the state. For a detailed examination of this debate, see McClintock (2013).

order to grow the movement, these organizations started to re-appropriate public land for gardens and to clean up abandoned lots. As Malik Yakini, director of DBCFSN wrote on his blog, “It is on the land that we build, grow and create community. As we struggle to foster food security, food justice and food sovereignty the question of land, who ‘owns’ it, who controls it, and who benefits from it, must be in the forefront of our discussions” (Yakini 2012).

However, as the movements grew and urban agriculture became a noticeable trend, community organizations increasingly had to fight harder for access to land. As Staeheli et al. (2002) note in their discussion over community gardens in New York, community gardens are often built on city-owned property, bought or rented after the properties fell into tax-arrears or mortgage foreclosure. During this period, when developers and investors have no interest in the property, the city is happy to allow low-income communities to work the ground and maintain it. We see this today in “greening” programs in Detroit, where residents are allowed to rent properties and are paid (at extremely low rates) to take of them. However, as soon as the city finds “more productive uses” for the land, community gardens often lose their rights. As Staeheli et al. document, “Giuliani [mayor of New York at the time] was threatened by the gardens as sites of mobilization and empowerment for people opposed to his policies” (Staeheli et al. 2002, p. 200) and, simultaneously, gardens began to be sold or denied access. These patterns fit well with neoliberal discourses on private property and land markets as the most efficient organization of space. In the wake of the housing crisis 2007-2009, local governments often bought up abandoned lands in the name of guarding against speculation. More typically, however, it is a tactic used to control city land purchases and ensure the land is being used in the “most productive” ways, code for prioritized access to investors and developers. Urban agriculture and local food movements continued to gain ground, however, in urban areas desperate to fill empty lots and rooftops.

## **The Devalued Built Environment and the Vertical Farm**

As Robbins (2013) writes, quoting Harvey (2006), “the drive to accumulate surpluses results in appropriation, through the process of commodification, of material objects and abstracts ideas (‘creativity’ for instance) that are not generated by capital” (Robbins 2013, p. 34). Calls for local food systems, within a globalized food system governed by the logic of accumulation, have not been easy to appropriate. As stated previously, the low price of food makes the role of scale extremely important in achieving profitability in agriculture, and, until vertical farms, capital has seemed to prefer to stay either upstream or downstream of the actual cultivation process (Bernstein 2010). Previous attempts to appropriate local foods came in the form of localized supplying by corporations, notably Whole Foods but also lower-quality stores such as Walmart. Locally sourced foods could be sold at higher prices, due to their higher ecological value, but they were not easy to source in mass. Locally sourced foods must abide by the seasons, thus tomatoes, for example, could not be sourced locally in the winter. It also shrinks the supply pool, which threatens supermarkets’ ability to keep things on the shelf. Thus, in order to successfully appropriate actual local production, interested individuals would need to find two things: growing spaces in the urban physical landscape and new technologies to lengthen growing seasons. This section will focus on the physical landscape of the built environment, and the next section will address labor and technology.

As Smith (1984) explained in his work on uneven geographic development, capitalism is constantly producing new (relative) spaces in its search for new forms of accumulation. The built environment is intimately linked to this process. According to Harvey, the built environment is a “complex composite commodity comprising innumerable different elements- roads, canals, docks and harbours, factories, warehouses...schools and hospitals, houses, offices, shops etc”(Harvey, p.115). Among other things, the built environment under capitalism is used to accommodate and organize



production and consumption in ways advantageous to capital. Necessarily, this environment is made of fixed capital, requires large and long-term investment and is difficult, and expensive, to alter once in place.<sup>17</sup> This fact is often problematic, as technical innovation, institutional change or economic incentives elsewhere can render the built environment insufficiently productive, encourage capital flight and thus devalues the fixed capital involved. As Harvey (1989, p. 116) explains it: "The devaluation of capital in the built environment does not necessarily destroy the use value- the physical resource- which the built environment comprises. This physical resource can now be used as "devalued capital" and as such it functions as a free good which can help to reestablish the basis for renewed accumulation". Under patterns of "actually existing neoliberalism", processes of devaluation and revaluation in the built environment have manifested as "the destruction of working class neighborhoods", and revaluation of those neighborhoods through the creation of new large-scale development projects intended to attract local investment or privatized areas of elite consumption (up-scale apartment buildings for instance) for needed tax revenues.

The rise of vertical farms mimics these patterns. As urban agriculture and the call for local food systems became more significant, individuals seeking to profit from its popularity looked to these devalued spaces. In other words, vertical farms only became potentially viable once this devaluation in the built environment had taken place. Urban rent is often extremely high and, despite the fact that vertical farms require much less space than traditional forms of agriculture, they still require quite a bit of space relative to the average urban enterprise in order to gain the scale required to be profitable. BrightFarms' greenhouses average at 100,000 square feet (Black 2013), and Gotham Greens is located on top of an old bowling alley. FarmedHere, located in an old warehouse, hopes to expand to 150,000 square feet by the end of 2015 (Irvine 2013). While this might still seem prohibitively expensive, considering the cost of their product, the combination of extremely low prices and financial help from local governments makes it possible. As Lightfoot (CEO of BrightFarms) notes, "If you're willing to locate in places that need jobs and economic development, there's an enormous amount of space in every city in the country" (Gunther 2013).

Many of these projects could not have come to fruition without public-private partnerships in the form of urban development corporations, public grants for entrepreneurs or land bank authorities. Detroit, Michigan ([detroitlandbank.org](http://detroitlandbank.org), accessed 14.10.13) and Chicago, Illinois have decided to form land banks in order to buy, organize and categorize vacant properties so that the city might gain more control over large-scale development patterns and the decisions over how to use the land "most productively". As the website for the Detroit Land Bank Authority states:

The DLBA is dedicated to returning Detroit's vacant, abandoned, and foreclosed property to productive use. We stimulate neighborhood stabilization and economic growth through the acquisition, management, and disposition of tax reverted and vacant properties...by working collaboratively with community stakeholders, developers, and other governmental agencies in a transparent and fiscally responsible manner ([detroitlandbank.org/about](http://detroitlandbank.org/about), accessed 14.10.13)

As implied above, devalued built environments, and thus vertical farms, are overwhelmingly located in low-income or minority neighborhoods<sup>18</sup> where land is cheaper, space more abundant and there exists related and necessary services such as industrial transportation and low cost labor.

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<sup>17</sup> Harvey goes into great detail on the ways in which investment into the built environment proceeds. The state has a critical role in this process, and private investment into the built environment is often a secondary form of investment for over-accumulated surplus (Harvey 1989).

<sup>18</sup> This quite obviously has implications for the evolution of gentrification.

It is important to state again, here, that while current urban conditions incentivize agricultural enterprises into these parts of cities, the nature of the technology employed allows for easy mobility should conditions change. While these farms are housed either in, or on top of, a local building, the actual production is not, in any way, attached to the ground. Should the rent or taxes rise, the technology change, or the public subsidies or consumer demands decrease, it is quite simple for capital to move elsewhere, as it does in other sectors under uneven geographic development.

## **Labor-Displacing Technologies and the Vertical Farm**

As discussed extensively thus far, the labor market under neoliberal policy regimes has been characterized by massive surplus and depressed wages. This is both an advantage and a disadvantage. While low labor costs certainly constitute one aspect of a “good business climate” that cities increasingly seek to use in investment attraction strategies, depressed wages also mean less consumption and less tax revenue. In other words, capital must find a balance between a wage rate that allows for the maximization of profit but also fuels enough demand for sufficient consumption.<sup>19</sup> In the globalized economy of today, this problem has been addressed by relocating production activities to geographies of cheap labor, while centers of consumption are based in geographies of high-income. The global food system mirrors this international division of labor in that such low prices are a result of the fact that most of the world’s food production is cultivated by a global peasantry which reproduces itself through subsistence farming on the side and receives extremely low, if any, wages. Agro-input and agri-output companies are, therefore, able to make a profit off of value-added services such as seed and fertilizer sales or manufacturing of processed foods while still maintaining low enough prices for consumers in high-income areas. Non-peasant farmers, such as those in advanced capitalist countries, rely on a system of intense subsidies or non-farm income. The instability of this kind of system is evident in repeated food crises and consistently high levels of hunger in countries that produce the world’s food. How, then, are urban farms, such as the ones discussed in this paper, able to remain profitable in countries that have higher wage requirements?

In general, these farms do not require a large labor force. They do employ a relatively small number of employees, when compared to traditional agriculture, and it thus helps that many advanced capitalist countries are currently experiencing high numbers of unemployment. Gotham Greens employs around 20 employees in its greenhouse and BrightFarms Inc. maintains that their greenhouses create 25 jobs. However, other vertical farms outside of the US, such as the Plantagon in Sweden and SkyGreens in Hong Kong, are already almost completely mechanized, clearly the future trend in the industry. A few employees are required to run the business aspects of the farm, as well as someone who is capable of running and monitoring the technology, but most of the jobs are rotating/harvesting positions. These are full-time wage labor jobs, which is quite different than the labor model of traditional, commercial-scale farms that depend on large numbers of seasonal labor. The farm is capable of employing so few, because, on any given day, not that many plants require harvesting. However, their ability to harvest every day of the year allows them to produce enough to supply supermarkets and restaurants. The technology that allows for these developments also renders the stability of these positions rather precarious, as the technology of vertical farming is rapidly evolving toward full mechanization. Plantagon, for instance, has patented a technology that allows the plants to rotate on a conveyor belt system that follows the light of the day. It is quite possible that, in the near future, these farms could be completely mechanized. As the owner of Green Spirit Farms in Michigan says: “We cut out the risk of traditional farming, the labor, and most of the equipment costs” (Smiechowski 2013).

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<sup>19</sup> This is one of the major contradictions of capitalism and the source of repeated periods of over-accumulation and crisis.

The obvious key, therefore, to the low labor costs of vertical farms is the use of labor-displacing technology. While these farms are not yet able to be the sole suppliers for large supermarket chains such as Whole Foods and others, their production is substantially more than that of your local community garden. BrightFarms suggests that their greenhouses are capable of producing around “1m pounds of tomatoes, lettuce and herbs annually” (Gunther 2013); FarmedHere expects to be producing 900,000 pounds of greens annually by the end of 2014 (Spector 2013). This kind of intensive production in such small spaces is possible due to technological innovation, mainly hydroponic and aeroponic growing systems<sup>20</sup>. Hydroponics, a system that FarmedHere’s CEO decided to use, means that “the plants in her farm grow without soil, instead using mineral-rich water that comes from tanks filled with Tilapia Fish” (Spector 2013) and, because the plants are stacked on top of one another, there is actually 140,000 square feet of space in the 90,000 square foot warehouse. While most facilities are currently using hydroponics, aeroponics is marketed as the next step. According to Despommier, “Aeroponics...takes hydroponics and ‘kicks it up a notch’. Small nozzles located under the plans spray a nutrient laden mist onto the roots, supplying them with everything they need” (Despommier 2010, p. 165). The plants are able to grow year round and in almost any conditions. In the case of Gotham Greens:

“The computer that monitors the climate knows exactly how much heat or cool air to provide, turning on lights during cloudy days and opening side vents instead of roof vents when it rains. Gotham is sustainable even down to the “beneficial insects” it uses instead of pesticides. When a crop-eating bug is found, Puri unleashes its natural enemy—ladybugs, for example, eliminate the threat of aphids” (Halsey 2013).

This type of technological development in agriculture is only the most recent step in a long history of labor displacing technological innovation in the sector that has served to gradually industrialize and standardize food production. Mechanized systems such as these do not require intimate knowledge of soil conditions, biodiversity or seed saving, the cultivator is thus an appendage to, rather than a shaper of, the growing process.

Given food’s vital role in the reproduction of labor, what implications does this have for the ability of labor to be consumers of food commodities? The most obvious contradiction is that the food produced by these farms is far too expensive for most of the world’s working class to afford. Gotham Greens, for example, sells its produce on freshdirect.com, a delivery service in New York City, for 3.99\$/4.5oz (128g). The ability to sell at these prices not only relies on a market which values locally produced food to the extent that it is willing to pay those prices, it also relies on other local capitalists to maintain a wage rate high enough to allow for their workers to buy it. While some enterprises are considering exporting their products (the Plantagon), current enterprises rely on the local labor market to consume their products. It follows that these farms are most likely only able to succeed as local forms of production if there is a sufficient high-income population to support it. As such, these farms clearly constitute new and innovate places of elite consumption attractive to urban municipalities under neoliberal urban restructuring *and* enterprises that are further contributing to the two-tiered food system characteristic of the corporate food regime. Chapter five will thus discuss these connections in more detail, in order to illustrate the ways in which vertical farms contribute to the reproduction of the capitalist system.

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<sup>20</sup> Provide more information and sources on hydroponics and aeroponics here

## **Chapter 5: The Reproduction of Capitalism and Vertical Farms**

### **Vertical Farms and Urban Restructuring**

As discussed previously, patterns of geographic restructuring resulting from neoliberal initiatives have put increased pressure on urban municipalities to market their local spaces. While this manifests as marketing urban areas as “good business climates”, it also manifests as marketing consumption opportunities. As Harvey argues, “The city has to appear as innovative, exciting, and creative in the realms of life-style, high culture and fashion” (Harvey 1989, p. 48). Brenner and Theodore (2002) refer to these processes as “re-representing the city”. They entail marketing techniques in “postwar image of the industrial, working-class city is recast through a (re-)emphasis on urban disorder and economic decline” and new discourses focused on “the need for revitalization, reinvestment, and rejuvenation” are seen as attractive.

Vertical farms are mediums of this discourse. Vertical farms such as the Plantagon in Sweden or Gotham Greens in Brooklyn have brought a lot publicity and interest to areas that were deeply devalued in the recent past. Accordingly, local governments and community groups regard these enterprises as stimulators of much needed community development. In addition, as Despommier argued, “showcasing the virtues of urban high-rise agriculture with the vertical farm and demonstrating its essential contribution to sustainability...will generate much welcomed tourist dollars” (Despommier 2010, p. 229). Marjora Carter, a prominent individual in the food justice movement, even argued that despite its potential for bringing new forces of gentrification, “this productive commercial activity [vertical farms] will be a welcome relief from the type of economic development we generally see driven into low-income neighborhoods-low wage retail, waste handling facilities, stadiums and jails” (Despommier 2010, p. xvii). Vertical farms and urban agriculture, city officials hope, will bring in related service businesses, new inhabitants and new tax dollars.

They have been used as environmental marketing tools, examples that big mega cities of the future are making important steps in “greening” the city<sup>21</sup>. In this way they mitigate popular discontent spurred by bouts of food safety scares and generally rising healthcare costs, by convincing people that these enterprises have the potential to lessen the ecological externalities associated with urban life. They are integral to ideas in “New Urbanism” ([newurbanism.org](http://newurbanism.org)), a movement that seeks to create “livable sustainable communities” based on the idea of urban villages integrated with nature. As such, they create the impression that capitalism, and its market mechanism, is capable of addressing its own externalities, and that corporate food enterprises are capable of creating healthy, local food systems.

### **Vertical Farms and the Corporate Food Regime**

Burch and Lawrence (2009,2013) have done extensive work in documenting the increasing corporate influence over the global food chain, and argue that the defining characteristic is “a shift in the locus of control over the establishment and management of such chains from the manufacturing sector to the retail sector dominated by the large global supermarkets chains such as Wal-mart, Tesco and Carrefour... ‘the new masters of the food system’” (Burch and Lawrence 2009,

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<sup>21</sup> For an example, see the Detroit Future City Project

p. 268). This manifests as the increasing dominance of “supermarket own brands” (Burch and Lawrence 2005); cases in which supermarkets have gotten into banking by offering credit cards and loans; and the extension of supermarkets into real estate and private equity worlds by “leveraging retail property in order to raise investment capital” (Burch and Lawrence 2013, p. 276). Until the rise of vertical farms, these forces were absent from urban agricultural production. Sovereign wealth funds, hedge funds and banks were mostly making large-scale investments into vast areas of rural agricultural land (McMichael 2012), buying majority shares in food processing companies or investing in large supermarket chains. While financial investment in vertical farms is small in comparison with flows of financial capital in rural agriculture, the enthusiasm of supermarkets, such as Whole Foods and A&E, to become directly involved in local production is troubling.

There are several ways in which vertical farms are linked to the financialization of the food chain. The most apparent is the creation of the Produce Purchase Agreement (PPA) model, a way for many potential greenhouse owners and managers to find funding for the high start up costs (1\$-4\$million) of a relatively small vertical farm. Devised by Paul Lightfoot, the CEO of BrightFarms (a greenhouse construction and management company), the model is based off the “electricity industry, which finances power plants by borrowing against long-term contracts” (Gunther 2013). In short, BrightFarms hires a potential manager of a greenhouse, and then enters into an agreement with a supermarket chain, such as A&P and SuperValu who have signed on thus far. The supermarket agrees to buy produce from the farm for the long-term, which then allows BrightFarms to raise private funds and debt off of guaranteed revenue. The company, by May 2013, had “PPAs worth 70\$m in future revenues” (Gunther 2013), and “has deals to build in seven more cities that include Oklahoma City, St. Louis, St. Paul and Washington D.C.” (Black 2013). Gotham Greens, the rooftop greenhouse in Brooklyn, NY, has also just partnered with Whole Foods to build a 20,000 square foot greenhouse on top of its new store in Gowanus, Brooklyn. The products will be distributed to all of the Whole Foods in New York City (Sustainable Business News 2013).

While Whole Foods Market has not yet signed a PPA, they have their own program for providing credit to potential vendors called the “Local Producer Loan Program”. Invoking the neoliberal discourse of self-responsibility, the Whole Food website describes the loan as:

Putting the money where our mouths are by providing up to 10\$ million in low-interest loans to independent local farmers and food artisans. We’re proud to support small producers who need a hand, not a handout, to help them make their dreams a reality (wholefoodsmarket.com, accessed 20.10.13).

The loans provide anywhere from \$1,000 to \$100,000 at a 5%-9% interest rate, but applicants are allowed to apply for additional financing “if initial loan is in good standing after one year” (wholefoodsmarket.com). And, in fact, FarmedHere in Chicago was a recipient of this loan. Jim Slama, the president of familyfarmed.org (another source of agricultural finance) says, “FarmedHere was a logical vendor for Whole Foods...Their product is organic, high-quality and beautifully packaged, which is just what Whole Foods is looking for in their local program” (Benenson 2013). Supermarket-based credit programs are not, in and of themselves, a problem. However, as Burch and Lawrence (2009) point out, supermarkets (such as Tesco in the UK) often purposely delay payments to suppliers in order to hold money, and access “finance capital at zero cost- capital which can then be used to earn interest when applied within their banking system” (Burch and Lawrence 2008, p. 277). Not only does this exploit small suppliers, this also allows them to be more profitable, which is thus turned into increased opportunities for more accumulation.

The benefit of not engaging in a PPA is the ability to supply more than one market, as FarmedHere does, but it also becomes more difficult because the potential vertical farm owner must then piece together funding on his/her own. As a result, the “Good Food Financing Conference” was founded, in order to create a “place to connect with funders and local food entrepreneurs, food businesses that participated in the 2012 conference have raised over \$3 million in debt and equity capital” (goodfoodfestivals.com, accessed 15.10.13). In the same conference, FarmedHere was able to raise \$1 million in financing and over \$500,000 in loans. The result of both of these models, however, with out without the PPA, is that, increasingly, urban agriculture is become a financial playground for investors.

There are, of course, other investors into vertical farms aside from supermarkets such as venture capitalist funds and private investment companies. BrightFarms, for example, lists NGEN Partners and Emil Capital Partners as members of their investment team. NGEN Partners focuses on “sustainable” investment opportunities, evident in their published portfolio, and are involved in health food enterprises, such as Bare Snacks, as well as energy and water companies. Emil Capital is involved in BrightFarms in addition to two “healthy” beverage companies named “Cheribundi” and “Balance Water Inc.” and a coffee and chocolate chain store known as “2 beans”, among others. Eric Haley, co-founder of Gotham Greens, also works for private equity fund in the Manhattan, NY known as Corporate Fuel Partners. Due to the fact that these are not publicly traded companies, vertical farms are not required to publish detailed financial information which makes it difficult to find patterns of financial and investment activity, outside of what they offer voluntarily or what journalists find separately. However, the important thing here is that capital from other areas of the industrial agricultural sector is beginning to flow into capitalist urban agriculture, thus giving it potential to expand further. And indeed, when one considers how the number of vertical farms has multiplied rapidly in just a few years, and plans for new farms are continuously being announced, it seems that these farms will expand further.

However, I also argue that vertical farms not only reproduce the corporate food regime, they also represent new innovation in capitalist agriculture, innovation that could take the corporate food regime into new territory. Vertical farms have managed to subordinate agricultural cultivation to the same conditions of standardization and automation has other forms of industrial production. The ability to liberate agriculture from the land has the potential to subject agriculture to the same liberalized geographic flows that create uneven geographic patterns in other forms of capitalist development. As conditions in the built environment and labor markets change, capital investment in vertical farms could easily leave for more suitable conditions. In other words, vertical farms represent a ‘local’ food system that is, in reality, more able than most forms of agriculture to move anywhere, and everywhere, else.

## **Conclusion and Areas of Future Research**

This paper has examined new forms of urban agriculture, vertical farms. It has sought to consider two contemporary trends, the movement to localize food and urban restructuring meant to attract local economic development, and has suggested that the intersection of these two patterns encouraged the rise of capitalist, local urban agricultural production. In Chapter two, it examined vertical farms in more detail by exploring the history of the concept and examining specific enterprises involved and the models they have followed. It then sought to differentiate these projects from other local food systems, such as those discussed in the Food Sovereignty literature, as manifestations of capitalist industrial agriculture. In Chapter three, it discussed theoretical frameworks important for understanding vertical farms. It argued that these farms follow historical patterns of uneven geographic development by profiting off of devalued built environments left

behind by previous accumulation, but I also suggested that these patterns also predict that these farms will leave these areas as conditions for profit become less favorable. I also discussed food regime analysis, and the ways in which the concept of the food regime allows us to link neoliberal impacts on urban areas and neoliberal impacts on the food system. This therefore gives us a better understanding of the forces driving localization efforts, and, thus, a better understanding of why capital would be interested in accommodating local demands. Chapter four sought to look at the rise of vertical farms in detail. It argued that the call for local food systems was fueled by inequality in the food system under the global corporate food regime, and thus should be understood as a form of class struggle. The next section argued that, as capital became interested in appropriating demands produced from the class struggle over food, the devalued built environment of low-income urban populations provided a space for it to do so. I then discussed how labor conditions under neoliberalism, high unemployment and decreased wages, allows vertical farms to employ cheap wage labor. However, I also noted that, more important for vertical farms, was the development of labor displacing technology, which allows them to hire fewer workers in the first place. Chapter five then discussed how these farms encourage urban restructuring around elite consumption, and how they reproduce and advance capitalist agriculture and the corporate food regime.

As mentioned previously, these farms are young but are also relatively unstudied in the social science literature and there are many topics that can be pursued. In the field of urban studies, scholars should consider how these farms continue to blur the line between conceptions of the rural and the local. They should also continue to consider how city plans around the integration of nature and agriculture lead to gentrification and exclusion, and study how vertical farms reproduce this trend. In the field of political science, they provide interesting examples of the state continuing to act on behalf of capital. The ways in which municipalities re-appropriate land and prioritize large-scale developments continue to be opaque. How are decisions made about land use, and are these processes exclusionary? How are states reacting to the popular discontent created by these land decisions? In the field of agrarian studies, there is also much to examine. Do these land deals constitute urban landgrabbing for agricultural purposes? What does it mean for the future of agriculture that food production is now potentially subject to patterns of flexible accumulation? What impact do these farms have on regional rural-based producers? As one can see, there is still much to be discovered. This paper has thus served as a preliminary introduction the farms, their operations and the urban landscapes that facilitate their rise.

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