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Vertical Farming: A Bottom-Up Approach

Michael Martinez*

ABSTRACT

The twenty-first century will require innovative solutions to address the effects of climate change. Vertical farming is one solution that could help conserve a significant amount of freshwater and reduce the agricultural industry's overuse of pesticides and intensive tilling practices, which contributes to soil erosion and pesticide runoff. There has been significant investment in vertical farming in every region of the United States; however, the cost to produce foods with vertical farming remains more costly than traditional farming, which is in large part due to the substantial amount of electricity needed to power all the technology required to grow crops indoors. Leafy greens are the predominant crops grown with vertical farming and Arizona and California are the primary producers of leafy greens, specifically lettuce and spinach. California is also a major producer of kale, strawberries, and tomatoes, which can also be grown with vertical farming. The widespread introduction of vertical farming could have a negative economic impact on Arizona and California's current agricultural industry. Additionally, Arizona and California have access to a substantial amount of solar energy and are simultaneously experiencing a decades-long drought. These circumstances present Arizona and California with the opportunity to benefit greatly from the utilization of vertical farming. Accordingly, the state and local governments in Arizona and California should subsidize the installation of rooftop or onsite solar projects for vertical farms because it will reduce the cost of produce grown with vertical farming and prevent an increase in greenhouse gas emissions compared to vertical farms that must rely on fossil fuels for their energy needs. Although vertical farming may address some important environmental concerns, it will likely fail to address social and economic concerns related to food affordability and food accessibility and may even accelerate gentrification. However, these unintended consequences can be addressed with a bottom-up approach that prioritizes low-income and other historically marginalized communities, rather than profit.

To fight gentrification is to fight American thinking.

—Peter Moskowitz¹

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¹ Peter Moskowitz, HOW TO KILL A CITY: GENTRIFICATION, INEQUALITY, AND THE FIGHT FOR THE NEIGHBORHOOD 122 (2017).

INTRODUCTION

The human population is estimated to reach 9.7 billion by 2050.³ During that same year, the United States' population is expected to reach 434 million.⁴ Most people, 68% globally and 89% in the United States, will be living in urban areas by this time.⁵ According to the Food and Agriculture Organization of the United Nations, "the world will need to produce about 50% more food by 2050 to feed the growing world population, assuming no changes occur in food loss and waste."⁶ Meanwhile, people around the world will be enduring the impacts of climate change, such as extreme heat, natural disasters, drought, and rising sea levels because of the increase in greenhouse gas emissions.⁷ Climate change and population growth are expected to increase the likelihood of water shortages in the United States.⁸ According to a 2015 report by the United States Department of Agriculture, climate change is likely to hinder progress made on addressing global food security because of production disruptions which will limit availability and increase costs.⁹ Given the foreseeability of these kinds of catastrophes, many are rushing to create new technology that allows us to adapt to the Anthropocene, also known as the current geological age in which human activity has significantly impacted the Earth's climate and ecosystems.¹⁰

One such technology being explored is Controlled Environment Agriculture (CEA), also known as vertical farming, which is "an advanced and intensive form of hydroponically-based agriculture where plants grow within a controlled environment to optimize horticultural practices."¹¹ The predominant benefits of CEA are that it uses significantly less water and

³ UNITED NATIONS, *WORLD POPULATION PROSPECTS 2019: HIGHLIGHTS 1* (2019), https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf [<https://perma.cc/68P9-JKB3>].

⁴ *Id.* at 12.

⁵ Center for Sustainable Systems, *U.S. Cities Factsheet* (2021), <https://css.umich.edu/publications/factsheets/built-environment/us-cities-factsheet> [<https://perma.cc/T87H-BCG9>].

⁶ *The State of Food Security and Nutrition in the World: Transforming Food Systems for Affordable Healthy Diets*, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, 102 (2020), <https://www.fao.org/3/ca9692en/CA9692EN.pdf> [<https://perma.cc/HW8A-L4WJ>].

⁷ *Climate Change and Health*, WORLD HEALTH ORGANIZATION (Feb. 1, 2018), <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health> [<https://perma.cc/K8RC-XSSL>].

⁸ Thomas C. Brown, Vinod Mahat, & Jorge A. Ramirez, *Adaptation to Future Water Shortages in the United States Caused by Population Growth and Climate Change*, EARTH'S FUTURE 1 (Feb. 5, 2019), https://www.fs.fed.us/rm/pubs_journals/2019/rmrs_2019_brown_t001.pdf [<https://perma.cc/TMF8-UG5L>].

⁹ M.E. Brown et al., *Climate Change, Global Food Security, and the U.S. Food System*, U.S. DEPARTMENT OF AGRICULTURE ix (Dec. 2015), <https://www.usda.gov/sites/default/files/documents/FullAssessment.pdf> [<https://perma.cc/LKK5-XMQG>].

¹⁰ See Katie Pavid, *What is the Anthropocene and Why Does It Matter?*, NATURAL HISTORY MUSEUM, <https://www.nhm.ac.uk/discover/what-is-the-anthropocene.html> [<https://perma.cc/C8J8-DVVW>] (captured Feb. 14, 2023).

¹¹ *Controlled Environment Agriculture*, CORNELL COLLEGE OF AGRICULTURE AND LIFE SCIENCES, <https://cea.cals.cornell.edu/> [<https://perma.cc/GE82-KKYZ>] (captured Feb. 14, 2023).

space than traditional agriculture. Additionally, food can be grown year-round with the help of LED lighting in CEA. As of 2022, there is at least one large-scale CEA operation in each of the thirteen most populous states in the country.¹² This technology is expected to grow rapidly within the next few years, reaching a market value of \$18.9 billion in the United States by 2028, thanks in part to great investment being made by large companies and wealthy individuals.¹³

CEA has the potential to alleviate food insecurity if it is utilized in hot and arid regions of the country, such as Arizona and California, where water is scarce and solar energy is plentiful. Accordingly, the state and local governments of Arizona and California should subsidize the installation of rooftop or on-site solar projects for CEA farms. The use of solar energy would greatly reduce the cost of growing food on CEA farms because electricity comprises a significant portion of the total expenses. Based on the limited coverage of previous studies on CEA, it seems unlikely that CEA operations in other parts of the country will help make food more affordable. CEA in other parts of the country—those that receive more rainfall but have less solar energy available—does little to address food insecurity and may create conditions that lead to gentrification and displacement.

I. CEA

Our current agricultural system is vulnerable to the effects of climate change.¹⁴ In recent years, there has been a greater push to prepare for these occurrences through market forces.¹⁵ One example is the transition to CEA from traditional farming. CEA is often referred to as vertical farming because food is grown vertically, using towers or shelves, which allows farmers to grow much more food on less land than horizontal

¹² *US States – Ranked By Population 2023*, WORLD POPULATION REVIEW, <https://worldpopulationreview.com/states> [https://perma.cc/NEL7-VRW3] (captured Feb. 14, 2023); Elizabeth Yurina, *Repurposed Vertical Farms: Adaptive Building Reuse for Vertical Urban Agriculture*, https://web.mit.edu/nature/projects_12/pdfs/Yarina_RepurposedVerticalFarms.pdf [https://perma.cc/C9JG-HTC2] (captured Feb. 14, 2023); *7 Ways Urban Agriculture Can Transform Unused Spaces*, AGRITECTURE, <https://www.agritecture.com/blog/2021/10/11/7-ways-urban-agriculture-can-transform-unused-spaces> [https://perma.cc/8QZB-PNWC] (captured Feb. 14, 2023).

¹³ Ricky Stevens, *The Influx of CEA Investment: Where Has the Money Gone?*, AGRITECTURE (Dec. 5, 2022), <https://www.agritecture.com/blog/2022/12/5/the-influx-of-cea-investment-where-has-the-money-gone> [https://perma.cc/8U6N-LXV9]; Marqual IT Solutions Pvt., Ltd (KBV Research), *North America Indoor Farming Market Size, Share & Industry Trends Analysis Report By Component, By Facility Type (Greenhouses, Vertical Farms), By Crop Type, By Country and Growth Forecast, 2022-2028* (Apr. 2022), [https://perma.cc/NM4Y-JRE7].

¹⁴ Gerald C. Nelson et al., *CLIMATE CHANGE: IMPACT ON AGRICULTURE AND COSTS OF ADAPTATION* vii (updated Oct. 2009), <http://ebrary.ifpri.org/utills/getfile/collection/p15738coll2/id/130648/filename/130821.pdf> [https://perma.cc/GU9C-F85Y].

¹⁵ *How Hydroponics is Helping to End World Hunger*, EDEN GREEN TECHNOLOGY (Oct. 5, 2020), <https://www.edengreen.com/blog-collection/why-hydroponics-is-helping-end-world-hunger> [https://perma.cc/6GN2-VVJX].

agriculture.¹⁶ With CEA, vertical farmers are able to grow crops “indoors year-round by controlling light, temperature, water, and oftentimes carbon dioxide levels.”¹⁷ Some experts believe that CEA has the potential to mitigate food shortages in the future because of the many benefits that this technology offers.¹⁸ The main benefits of CEA farming are that 1) it has the potential to supplement the agricultural industry in the cultivation of food; 2) it requires less land and water than conventional agriculture, 3) it can increase the amount of food grown without pesticides; 4) it allows for food to be grown year-round without disruptions from pests and weather-related events; and 5) it decreases food miles, or the distance food must travel from farm to market, because food can be grown in urban and peri-urban areas.¹⁹

The three most predominant soilless forms of CEA are hydroponic, aquaponic, and aeroponic farming systems.²⁰ Hydroponics is the cultivation of plants using just water and nutrient fertilizer.²¹ Aquaponic systems combine fish farming, often known as aquaculture, and hydroponics.²² The fish waste provides an organic food supply for the plants, while the plants act as a natural filter for the fish's water.²³ Aeroponics is similar to hydroponics, except instead of growing the plants in water, nutrient-rich water solution is misted on them frequently.²⁴ Most indoor farms (49%) use hydroponics, followed by aquaponics (15%), aeroponics (6%), and hybrid systems (6%).²⁵ Approximately 24% of CEA farms still use soil, yet they continue to maintain environmental control within a closed system.²⁶

¹⁶ Luis Villazon, *Vertical Farming: Why Stacking Crops High Could Be the Future of Agriculture*, SCIENCE FOCUS (Sep. 24, 2022), <https://www.sciencefocus.com/science/what-is-vertical-farming/> [https://perma.cc/N3Q5-TS8T].

¹⁷ Sarah Federman & Paul M. Zankowski, *Vertical Farming for the Future*, U.S. DEP'T OF AGRIC. (Oct. 25, 2021), <https://www.usda.gov/media/blog/2018/08/14/vertical-farming-future> [https://perma.cc/ZZ4U-2573].

¹⁸ Valentina Lagomarsino, *Hydroponics: The Power of Water to Grow Food*, HARVARD UNIV., SCIENCE IN THE NEWS (Sep. 26, 2019), <https://sitn.hms.harvard.edu/flash/2019/hydroponics-the-power-of-water-to-grow-food/> [https://perma.cc/J2H5-RLS2].

¹⁹ *Rationale for Vertical Farms*, VERTICAL FARM (Aug. 2015), http://www.verticalfarm.com/?page_id=36 [https://perma.cc/BGA3-M3VF]; Luis Villazon, *Vertical Farming: Why Stacking Crops High Could Be the Future of Agriculture*, SCIENCE FOCUS (Sep. 24, 2022, 11:00 AM), <https://www.sciencefocus.com/science/what-is-vertical-farming/> [https://perma.cc/N3Q5-TS8T].

²⁰ JOHN McDONNELL ET AL., INDOOR SOILLESS FARMING: PHASE I: EXAMINING INDUSTRY AND IMPACTS OF CONTROLLED ENVIRONMENT AGRICULTURE 7 (May 2020), [https://perma.cc/43CE-AVUP].

²¹ Ali AlShrouf, *Hydroponics, Aeroponic and Aquaponic as Compared with Conventional Farming*, 27 AM. SCI. RSCH. J. FOR ENG'G, TECH., AND SCI., 247, 248 (2017).

²² *Id.* at 249.

²³ *Id.*

²⁴ *Id.* at 248-249.

²⁵ McDonnell et al., *supra* note 19.

²⁶ *Id.*

The largest drawback to CEA is the cost of energy, “representing around 25% of operating costs for vertical farms.”²⁷ However, with the advent of LED grow lights, vertical farming has become possible because they use considerably less energy and generate far less heat than earlier grow lights.²⁸ The cost of energy is not expected to decline any time soon; therefore, many CEA researchers are trying to increase the energy efficiency of LED grow lights to help lower the cost of indoor agriculture.²⁹ There are rather straightforward improvements that may be utilized to cut electricity expenses.³⁰ For example, reflectors can be placed to increase the light ratio and improve the quality of light, which will reduce unnecessary cost and heat within the system.³¹ Cities and states throughout the country need to anticipate the effect that CEA farms and the additional energy needed to power them will have. Many states are attempting to reduce their greenhouse gas emissions.³² However, CEA farming has the potential to make that more challenging given its high energy consumption.

Currently, produce cultivated in CEA systems is more expensive than conventionally grown agriculture, even when factoring in shipping costs.³³ This is primarily the result of high energy and labor costs.³⁴ CEA farms suffer from substantial input expenses, which can be a significant barrier for businesses seeking to enter the vertical farming market.³⁵ Additionally, the variety of foods that are grown vertically is rather limited, with the majority of CEA farmers cultivating leafy greens and tomatoes, representing 57% and 16%, respectively.³⁶ While it is possible to grow any plant indoors, few are economically feasible, with common characteristics being small growing habits, prolific production, and rapid growth.³⁷ Recently, producers have begun growing strawberries in CEA systems, including berry giant, Driscoll’s.³⁸

²⁷ *Id.* at 8.

²⁸ *Id.*

²⁹ *Id.*

³⁰ *Id.* at 12.

³¹ *Id.*

³² *U.S. State Greenhouse Gas Emissions Targets*, THE CENTER FOR CLIMATE AND ENERGY

SOLUTIONS (updated Aug. 2022), <https://www.c2es.org/document/greenhouse-gas-emissions-targets/> [https://perma.cc/Z2V2-LB8J].

³³ *Id.* at 8.

³⁴ *Id.*

³⁵ *Id.*

³⁶ *Id.* at 13.

³⁷ *Part 1: Food Crops*, VERTICAL FARMING, <https://www.verticalfarming.com/food-crops/> [https://perma.cc/W7P8-B9P6] (captured Feb. 14, 2023).

³⁸ Amy Sowder, *2022 Year in Produce: Controlled Environment Agriculture, or CEA*, THE PACKER (Dec. 29, 2022) <https://www.thepacker.com/news/industry/2022-year-produce-controlled-environment-agriculture-or-cean> [https://perma.cc/WA4S-J3QX]; Samantha Oller, *Driscoll’s, Plenty Partner on Vertical Farm for Strawberries*, FOOD DIVE (Mar. 15, 2022), <https://www.fooddive.com/news/driscolls-plenty-partner-on-vertical-farm-for-strawberries/620369/> [https://perma.cc/3EXN-EG3B].

California is one of the largest producers in the country for leafy greens (lettuce, kale, and spinach), strawberries, and tomatoes.³⁹ Arizona also makes significant contributions to the market for lettuce and spinach.⁴⁰ Arizona and California's markets thus have the potential to be significantly impacted by the proliferation of vertical farms in other parts of the country. Additionally, Arizona and California are faced with extreme pressure from the federal government to be proactive in coming up with solutions to water shortages caused by drought. CEA offers Arizona and California a path forward to preserve a significant portion of their agricultural industry, while addressing issues caused by drought and climate change.

II. HOW CLIMATE CHANGE WILL IMPACT OUR CURRENT AGRICULTURAL SYSTEM

By 2050, 593 million hectares of land (roughly double the size of India) “needs to be transformed into agricultural land to meet the projected calorie needs of the global population.”⁴¹ Currently, an average of 70% of global freshwater usage goes towards agricultural production, which is largely due to unsustainable irrigation practices, such as diverting large amounts of water to naturally arid regions.⁴² Approximately 38% “of earth’s non-frozen land is used for growing food,” and that percentage is expected to rise.⁴³

The United States Forest Service recently released a study modeling freshwater supply and demand across the 204 water basins in the contiguous United States.⁴⁴ The Forest Service researchers describe how irrigated agriculture is the primary user of the freshwater supply in most basins, “often accounting for over 75 percent of annual consumption.”⁴⁵ Based on the Forest Service’s future models, irrigated agriculture will be the primary source of water transfers to more high-value sectors, such as the industrial and energy sectors, because of agriculture’s lower value on the water in comparison to these other sectors.⁴⁶ This raises concerns about food security for the researchers. Policymakers in most states, especially

³⁹ Sonny Perdue and Hubert Hamer, *2017 Census of Agriculture*, 1 NASS 549, 550, 561, 565 tbl.29, 601 tbl.33 (2019), https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf [<https://perma.cc/8N7Z-7H49>].

⁴⁰ *Id.* at 550, 561 tbl.29.

⁴¹ Camille Boylan, *The Future of Farming: Hydroponics*, PRINCETON UNIVERSITY, STUDENT CLIMATE INITIATIVE (Nov. 9, 2020), <https://psci.princeton.edu/tips/2020/11/9/the-future-of-farming-hydroponics> [<https://perma.cc/TP58-WGN7>].

⁴² *Water in Agriculture*, WORLD BANK (Oct. 5, 2022), <https://www.worldbank.org/en/topic/water-in-agriculture> [<https://perma.cc/2NF8-T9YK>].

⁴³ Boylan, *supra* note 40.

⁴⁴ Thomas C. Brown, Vinod Mahat, and Jorge A. Ramirez, *Adaptation to Future Water Shortages in the United States Caused by Population Growth and Climate Change*, EARTH'S FUTURE 2 (Feb. 5, 2019), https://www.fs.fed.us/rm/pubs_journals/2019/rmrs_2019_brown_t001.pdf [<https://perma.cc/TMF8-UG5L>].

⁴⁵ *Id.* at 9.

⁴⁶ *Id.*

those “in the Southwest, the middle to southern Great Plains, and Florida,” must soon figure out how to delegate the limited water supply.⁴⁷ The Forest Service researchers project that the areas of greatest water shortages will tend to be the areas with extensive irrigation use, which suggests that water shortages could be avoided by reducing agricultural irrigation.⁴⁸

Although today’s modern agricultural practices have had many benefits, they have also resulted in long-term environmental devastation as a result of poorly managed irrigation and cultivation methods.⁴⁹ Modern agriculture in the United States still relies heavily on tillage-plowing to prepare the soil for seeding, weeds, and pest control. In turn, this affects soil health, water pollution, energy and pesticide use, and carbon sequestration.⁵⁰ In 2019, agricultural activities contributed to 10% of the 6,558 million metric tons of carbon dioxide equivalents emitted by the United States.⁵¹ The 2017 Agricultural Census found that large farms with 1,000 acres or more represent only 8.5% of the total farm population but are responsible for half of the total market value of agricultural products sold.⁵² Of the 900 million acres of farms, approximately 640 million acres, or 71% of the total acreage, is owned by the same 8.5% of large farms.⁵³ These same farms are the predominant users of intensive tillage practices.⁵⁴ In fact, intensive tilling practices were used on 80 million acres of cropland in the United States, with 71% of that acreage owned by that same 8.5% of large farms.⁵⁵ Of the 14.7 million acres of land where chemicals were used to control growth, thin fruit, ripen, or defoliate, approximately 84% were owned by the same group of large farms.⁵⁶ Additionally, of the 253 million acres treated with commercial fertilizer, lime, and soil conditioners, the same large farms were responsible for treating approximately two-thirds of the total acreage.⁵⁷

Regardless of location, agrochemicals, particularly fertilizers, are employed in practically every major farming system, which is largely due to mono-cropping, the practice of growing a single plant species on the

⁴⁷ *Id.* at 9-10.

⁴⁸ *Id.* at 10.

⁴⁹ Dickson Despommier, *The Vertical Farm: Feeding the World in the 21st Century*, RATIONALE FOR VERTICAL FARMS (last visited on Feb. 14, 2023), http://www.verticalfarm.com/?page_id=36 [https://perma.cc/AWR5-9TBD].

⁵⁰ Economic Research Service, *Climate Change*, UNITED STATE DEPARTMENT OF AGRICULTURE (last visited on Jan. 8, 2023), <https://www.ers.usda.gov/topics/natural-resources-environment/climate-change/> [https://perma.cc/M4UZ-J3L2]; *Id.*

⁵¹ *Sources of Greenhouse Gas Emissions*, U.S. ENVIRONMENTAL PROTECTION AGENCY (Aug. 5, 2022), <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#agriculture> [https://perma.cc/X2L2-V3GK].

⁵² Perdue and Hamer, *supra* note 38 at 18 tbl.9, 90-91 tbl.71.

⁵³ *Id.*

⁵⁴ *Id.* at 102-03 tbl.71.

⁵⁵ *Id.*

⁵⁶ *Id.* at 102-03 tbl.71.

⁵⁷ *Id.* at 100-01 tbl.71.

same land year after year.⁵⁸ Mono-cropping has become prominent because of the constant desire for cash crops, particularly for large factory farms, that often “extract more nutrients from the substrate than it can provide.”⁵⁹ To combat the vulnerability of mono-cropping, farmers use pesticides, herbicides, and fertilizers, which typically contain unhealthy levels of chemicals and other heavy metals, and run off into nearby water sources due to the volatilization and overuse of these agrochemicals.⁶⁰ Agricultural runoff “is generally acknowledged as the most pervasive and destructive form of water pollution, degrading virtually every freshwater aquatic environment that borders on human habitation.”⁶¹

The pesticides that many large farms rely on have an impact on climate change during all stages of production, transportation, and use.⁶² Carbon dioxide, methane, and nitrous oxide are the three main greenhouse gases released during the production of pesticides.⁶³ According to soil scientists, the public’s health will be adversely harmed within fifty years—if “current rates of soil destruction” continue from causes such as erosion, desertification, and chemical pollution.⁶⁴ Unfortunately, climate change is likely to increase the use of pesticides by the agricultural industry because of the expected increase in global temperatures, which will create imbalances in the earth’s natural systems, “causing more outbreaks and damage from unwanted pests and weeds.”⁶⁵ As a result of climate change and pesticide use, food crops are likely to become less nutritious and deficient in essential minerals.⁶⁶ Each year, the United States uses more than a billion pounds of pesticides, with agriculture making up 90% of total pesticide usage.⁶⁷ Around 70% of the non-organic produce sold in the United States contains residual amounts of potentially harmful pesticides.⁶⁸ Even modest amounts of pesticides can accumulate in the body over time and lead to a variety of illnesses such as allergies and

⁵⁸ Despommier, *supra* at 48.

⁵⁹ *Id.*

⁶⁰ *Id.*; Clementine Derumeaux, et al., *Pesticide exposures for residents living close to agricultural lands: a review*, 134 ENVIRON. INTL. (2020).

⁶¹ Despommier, *supra* at 48.

⁶² Sharalyn Peterson, *Pesticides and the Climate Crisis*, NORTHWEST CENTER FOR ALTERNATIVE TO PESTICIDES (last visited Nov. 26, 2021), https://www.pesticide.org/pesticides_and_climate_crisis [<https://perma.cc/BYN2-RFBG>].

⁶³ *Id.*

⁶⁴ *Id.*

⁶⁵ *Id.*

⁶⁶ *Id.*; E.g., Walter Crinnion, *Organic foods contain higher levels of certain nutrients, lower levels of pesticides, and may provide health benefits for the consumer.*, 15 ALTERN. MED. REV. 1, 4-12 (2010); Yu-Han Chiu, et al., *Association between intake of fruits and vegetables by pesticide residue status and coronary heart disease risk*, 132 ENVIRON. INT., <https://www.ncbi.nlm.nih.gov/pmc/articles/pmc6754761/>, (2019); Helena Sandoval, et al., *Intake of fruits and vegetables according to pesticide residue status in relation to all-cause and disease-specific mortality: Results from prospective cohort studies*, 159 ENVIRON. INT., 107024, (2022).

⁶⁷ Peterson, *supra* note 60.

⁶⁸ *See Id.*

hypersensitivities in the short-term and damage to the immune and nervous system, reproductive abnormalities, and cancer in the long-term.⁶⁹

Unsustainable irrigation and tilling practices and the overuse of pesticides are just a few of the major issues with our current agricultural system. The agricultural industries in Arizona and California are not immune to these issues and face the added challenge of dealing with extreme heat and drought concurrently. However, CEA can help to address these issues by allowing for current agricultural land to be used more sustainably while avoiding any loss in food production.

III. THE AGRICULTURAL INDUSTRY IN ARIZONA AND CALIFORNIA

In 2017, Arizona ranked twenty-eighth and California ranked first for total market value of crops sold in the United States.⁷⁰ California sold \$33.3 billion of crops in 2017, while Arizona sold approximately \$2.1 billion.⁷¹ In Arizona and California, an average of 74% and 80% of total water usage goes towards agriculture, respectively.⁷² This is a significant amount of water going towards agriculture, especially in the face of impending water shortages due to a decades-long drought and orders by the federal government to reduce their water usage from the Colorado River.⁷³ In 2022, the federal government ordered Colorado River Basin states to reduce their allotment by two-to-four million acre-feet, which is approximately 650 billion to 1.3 trillion gallons, annually.⁷⁴ To put this in perspective, the federal government is calling

⁶⁹ *Id.*

⁷⁰ *2017 Census of Agriculture State Profile, Arizona*, UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE STATISTICS SERVICE (last visited Feb. 15, 2023), https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/Arizona/cp99004.pdf [<https://perma.cc/HLE3-NCCS>]; *2017 Census of Agriculture State Profile, California*, UNITED STATES DEPARTMENT OF AGRICULTURE, NATIONAL AGRICULTURE STATISTICS SERVICE (last visited Feb. 15 2023), https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/California/cp99006.pdf [<https://perma.cc/DA7L-ERC4>].

⁷¹ *Id.*

⁷² *Agriculture Water Use Efficiency*, CALIFORNIA DEPARTMENT OF WATER RESOURCES (last visited Feb. 15, 2023), <https://new.azwater.gov/conservation/agriculture> [<https://perma.cc/W7U3-FYVY>] <https://water.ca.gov/Programs/Water-Use-And-Efficiency/Agricultural-Water-Use-Efficiency#:~:text=Yet%2C%20considering%20that%20agriculture%20accounts,use%20efficiency%20can%20be%20significant.> [<https://perma.cc/MVB7-XPBQ>].

⁷³ *The Colorado River Basin's Worst Known Megadrought was 1,800 years ago, Scientists Discover*, ADVANCING EARTH AND SPACE SCIENCE (Jun. 9, 2023), <https://news.agu.org/press-release/the-colorado-river-basins-worst-known-megadrought-was-1800-years-ago-scientists-discover/#:~:text=The%20ancient%20drought%20around%201%2C800,period%20in%20the%20western%20US&text=WASHINGTON%E2%80%9494The%20ongoing%20severe%20drought,of%20its%20historic%20average%20flow.> [<https://perma.cc/CFV5-MGTU>]; *Colorado River Drought Contingency Plan*, NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM (last visited Feb. 15, 2023), <https://www.drought.gov/colorado-river-drought-contingency-plan#:~:text=Since%202000%2C%20historically%20dry%20conditions,fold%20over%20the%20past%20decade.> [<https://perma.cc/2ALJ-BXJ5>].

⁷⁴ Shelle Jackson, *States fail to reach agreement on cuts in Colorado River water use*, ALLEN MEDIA BROADCASTING (Jan. 31, 2023), <https://www.kvoa.com/news/local/states-fail-to-reach-agreement->

for a 15% to 30% reduction in the 13 million acre-feet used in an average year.⁷⁵ To achieve these results, Arizona and California should turn to CEA, which uses 60% to 90% less water than traditional agriculture. Interestingly, California is the nation's largest agricultural producer of leafy greens by weight, followed by Arizona; together comprising nearly 90% of the national market.⁷⁶ "The vast majority of lettuce produced in the [United States] shifts seasonally between Arizona and California over the course of the year."⁷⁷ Arizona is most productive in the winter months and California's Central Valley is the primary producer of lettuce during the summer months, which allows lettuce to be grown year-round.⁷⁸

In 2017, Arizona and California harvested 72,411 and 250,157 acres of lettuce, respectively.⁷⁹ If Arizona and California utilized CEA to grow crops like lettuce, they could conserve a significant amount of water while avoiding major disruptions to their agricultural industries. Additionally, CEA would help to avoid disruptions to the American public which relies heavily on these two states to supply lettuce nationwide. Lettuce typically requires 14 inches of water per acre, or 380,156 gallons of water per acre.⁸⁰ If lettuce was grown with CEA, assuming a 90% reduction in water usage, that would lead to the conservation of approximately 342,140 gallons of water per acre.⁸¹ If Arizona and California were able to use CEA to grow all their lettuce, they would conserve over 100 billion gallons of water per year.⁸² If other produce which can be easily grown with existing CEA technology (such as kale, spinach, strawberries, and tomatoes), were also transitioned from traditional agriculture to CEA, it would result in significant water conservation.

Below is a graph showing California's and Arizona's share of the total acres of select crops harvested compared to the remainder of the United States.⁸³ California holds a significant share of the national market for harvested crops that could easily be grown with CEA, such as leafy

on-cuts-in-colorado-river-water-use/article_5b8643a4-a1a5-11ed-b79a-b3f209ecd788.html
[<https://perma.cc/XB2V-PCXN>].

⁷⁵ Alastair Bland, *California, other states reach impasse over Colorado River*, CAL MATTERS (Jan. 31, 2023), <https://calmatters.org/environment/2023/01/california-colorado-river-water-2/> [<https://perma.cc/MW73-FGN6>].

⁷⁶ Ashley Kerna, Dari Duval, and George Frisvold, *Arizona Leafy Greens: Economic Contributions of the Industry Cluster*, THE UNIVERSITY OF ARIZONA, COLLEGE OF AGRICULTURE & LIFE SCIENCES, AGRICULTURAL & RESOURCE ECONOMICS (2017), [https://economics.arizona.edu/arizona-leafy-greens-economic-contributions-industry-cluster#:~:text=Together%2C%20Arizona%20and%20California%20account,counties%20straddling%20the%20Colorado%20River](https://economics.arizona.edu/arizona-leafy-greens-economic-contributions-industry-cluster#:~:text=Together%2C%20Arizona%20and%20California%20account,counties%20straddling%20the%20Colorado%20River.). [<https://perma.cc/FQ9N-D7ZB>].

⁷⁷ *Id.* at 2.

⁷⁸ *Id.* at 17.

⁷⁹ Perdue and Hamer, *supra* note 38 at 550 tbl.29.

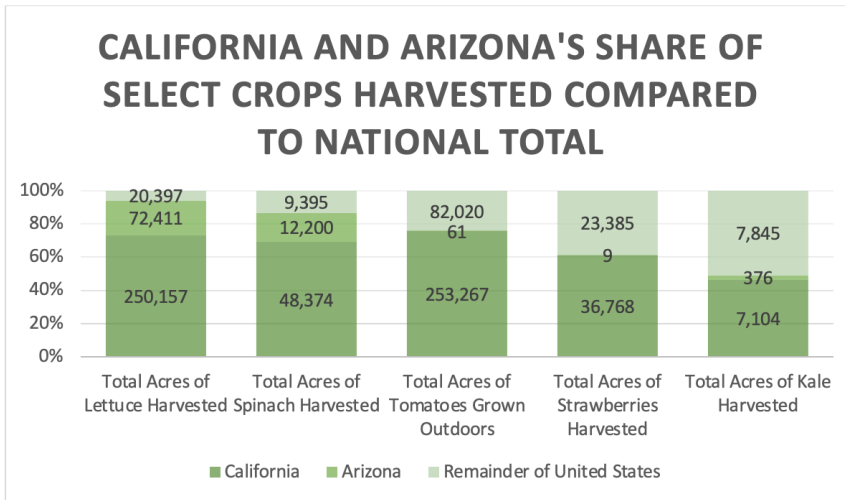
⁸⁰ See Charles F. Nicholson, et al., *Food Supply Chains in Cities 33-68* (Palgrave Macmillan, Cham, 2020).

⁸¹ See *Id.*

⁸² See *Id.*; Perdue and Hamer, *supra* note 38 at 550.

⁸³ Perdue and Hamer, *supra* note 38 at 549, 550, 561, 565, 601.

greens, strawberries, and tomatoes. Arizona holds a significant share of the remainder of the U.S. market for lettuce and spinach. Arizona and California would see some of the greatest impact to their agricultural industry with the widespread introduction of CEA. Additionally, although Arizona is not a major producer of kale, strawberries, or tomatoes it is still a great candidate for adding these crops to their agricultural profile because of its access to plentiful solar energy—thus, making production of these crops more economically viable.



In 2017, organic crop sales made up a small portion of both Arizona's and California's total crop sales, approximately 4.6% and 8.5%, respectively.⁸⁴ One major benefit of CEA is that there is virtually no need for pesticides, which has resulted in vertical farmers requesting USDA organic certification to the dismay of many traditional farmers. Regardless of the approval for organic certification, there is a clear path forward to transition away from our overreliance on pesticides by utilizing CEA. In fact, leafy greens, strawberries, and tomatoes make up 6.2% (595,670 acres) of total cropland acres in California.⁸⁵ Similarly, lettuce and spinach make up approximately 6.6% (84,611 acres) of total cropland acres in Arizona.⁸⁶ If Arizona and California were to transition these crops from traditional agriculture to CEA, it would have a significant impact on the amount of organic crop sales for both states. Additionally, less pesticide usage benefits not only the consumer of the produce but also the surrounding environment and community.

⁸⁴ *Id.* at 654.

⁸⁵ *Id.* at 549, 550, 561, 565, 601.

⁸⁶ *Id.* at 550, 561.

Tilling, or turning the soil to prepare for sowing seeds, has been the conventional practice of the modern agricultural system.⁸⁷ However, tilling can often be damaging to soil, causing erosion and greenhouse gas emissions.⁸⁸ Recently, there has been a greater push to reduce the frequency and intensity with which farmers till to allow the soil to better retain its nutrients and aid in carbon sequestration.⁸⁹ In 2017, 20.1% of total cropland in the United States used intensive tillage practices.⁹⁰ That same year, intensive tillage practices were used on approximately 24.7% of California's and 30.9% of Arizona's total cropland, respectively.⁹¹ CEA has the potential to reduce Arizona and California's reliance on intensive tillage practices, given that crops can be grown indoors with little to no soil. A reduction in the use of intensive tillage practices may help prevent the desertification of agricultural land in these two states, by allowing for the topsoil to be spared for the benefit of their local ecosystems.

CEA could reduce the United States' overreliance on pesticides and intensive tillage practices while also conserving millions of gallons of water per year. The benefits of transitioning from traditional agricultural production to CEA would be especially significant for both Arizona and California.

IV. VERTICAL FARMING AS A SOLUTION IN ARIZONA AND CALIFORNIA

Currently, CEA uses much more energy and, subsequently, has higher greenhouse gas emissions than traditional agriculture, even when transportation costs for traditional agriculture are accounted for.⁹² However, Arizona and California are uniquely positioned to benefit from CEA because they are major producers of the crops that can be grown through CEA. Arizona and California are the first and fifth sunniest states in the United States, respectively.⁹³ In fact, the California-Arizona border is the sunniest region in the United States.⁹⁴ Arizona and California's abundant sunshine, need to conserve water, and prominence in growing crops that can be grown with CEA gives them a unique opportunity to reap the greatest benefits from CEA while also being able to conserve water and prevent a dramatic negative effect on a significant portion of their agricultural industry. Arizona and California should transition their leafy greens, strawberry, and tomato crops from traditional agriculture to CEA because they can invest in powering their CEA farms with solar energy,

⁸⁷ *Soil Tillage and Crop Rotation*, UNITED STATES DEPARTMENT OF AGRICULTURE (updated Apr. 2020), <https://www.ers.usda.gov/topics/farm-practices-management/crop-livestock-practices/soil-tillage-and-crop-rotation/> [<https://perma.cc/B99Y-YLAU>].

⁸⁸ *Id.*

⁸⁹ *Id.*

⁹⁰ *Id.* at 58.

⁹¹ *Id.* at 643-44.

⁹² Nicholson, *supra* note 79.

⁹³ World Population Review, <https://worldpopulationreview.com/state-rankings/sunniest-states> [<https://perma.cc/C8LQ-6BM2>].

⁹⁴ N. Ariz. Solar Elec., <https://www.solar-electric.com/learning-center/solar-insolation-maps.html> [<https://perma.cc/8CNB-CD9Y>].

which will help to lower costs, decrease food miles, and decrease greenhouse gas emissions compared to CEA farms that rely on fossil fuels.

Arizona's and California's local and state governments should be incentivizing CEA farmers to open and expand their businesses in both states. CEA farmers would likely be motivated to centralize their businesses in Arizona and California if each state offered a subsidy program that incentivized the installation of rooftop or on-site solar. Although a reduction in food miles is one of the major benefits of CEA farming because it allows food to be grown closer to urban areas where much of it is sold, other states are not uniquely poised to benefit from CEA farming in the same way Arizona and California are. Arizona and California hold a significant proportion of the market for produce that can be successfully grown with CEA, which also means they are more likely to be impacted if CEA farmers begin opening vertical farms in other states. Additionally, Arizona and California receive an abundance of sunlight, which gives them the ability to benefit from the use of solar energy, whereas other states, such as Washington and Oregon, are less likely to benefit in a similar way. Another benefit of CEA farming is that it uses significantly less water than traditional agriculture. This is especially important for Arizona and California because both states divert the majority of their freshwater resources for agricultural production and have been and likely will continue to experience severe drought. Other states that have a much more temperate climate and have access to plentiful freshwater resources are in a less dire position than Arizona and California.

If Arizona and California were able to incentivize CEA farmers to open their operations in these states, then it would likely help to reduce the cost of food grown with CEA because these producers would be able to take advantage of significantly lower energy costs, which is an important aspect to consider as CEA becomes more prominent. CEA could greatly benefit from the use of renewable energy given that energy use is a significant determinant of the production cost for produce grown with CEA.

Although renewable energy sources are expensive, many CEA farms are testing out renewable energy.⁹⁵ According to Dr. Bruce Bugbee, Professor of Environmental Plant Physiology, one acre of an indoor farm would require five acres of solar panels to power the lighting.⁹⁶ Fortunately, the price of solar panels is rapidly falling while their effectiveness and energy outputs are rising. The trade-off may change in

⁹⁵ *Indoor Soilless Farming: Phase 1: Examining the Industry and Impacts of Controlled Environment Agriculture*, WORLD WILDLIFE FUND 14 (May 2020), https://files.worldwildlife.org/wwfemspod/files/Publication/file/84omrzpdge_WWW_SoillessAg_Phase1_Final_Report_Full_051320.pdf?_ga=2.261318733.1187285002.1637978843-1409608863.1637978843 [https://perma.cc/43CE-AVUP].

⁹⁶ *Id.*

the future, but it heavily depends on a farm's location and the renewable energy sources that are available.⁹⁷

Since the Industrial Revolution, human activities have accelerated the production of greenhouse gases, causing the Earth's climate to change.⁹⁸ Some have turned to CEA as a solution to the many challenges that climate change may bring to the food production system. However, CEA is not a favorable solution if it relies on fossil fuels to power the technology that is required to cultivate food in a controlled environment. Arizona and California will benefit the most from CEA over many other states because of the solar energy available to them and because they already have the infrastructure in place to transport produce. These two states also have a lot to lose if they do not find ways to adapt to a changing climate because their agricultural industries are likely to suffer substantially due to drought and mandates by the federal government to reduce their water usage.

V. CEA AND GENTRIFICATION

CEA has the potential to supplement the current agricultural system. However, food grown with CEA is currently more costly than traditional agriculture, which makes CEA less accessible to those with a lower income.⁹⁹ This is why the state and local governments in Arizona and California should subsidize the installation of solar panels at or near CEA facilities so that CEA producers can lower their costs by saving on electricity. Without subsidization, CEA farmers will need to purchase their energy from electric utilities, will not be able to reduce their electricity costs, and will be forced to rely on fossil fuels as a main source of their energy in many instances. In order to reduce costs, some vertical farmers are targeting large, abandoned buildings to convert into vertical farming facilities as a way to save on some of the upfront costs.¹⁰⁰ Although this is a resourceful way to use existing infrastructure, it is also one of the first steps in the gentrification process.¹⁰¹ Gentrification is the process of renovating a neighborhood, district, or city and as a result, attracting more

⁹⁷ *Id.*

⁹⁸ *Causes of Climate Change*, U.S. ENVIRONMENTAL PROTECTION AGENCY (updated Aug. 19, 2022), [https://www.epa.gov/climatechange-science/causes-climate-change#:~:text=Burning%20fossil%20fuels%20changes%20the,into%20the%20atmosphere%20every%20year](https://www.epa.gov/climatechange-science/causes-climate-change#:~:text=Burning%20fossil%20fuels%20changes%20the,into%20the%20atmosphere%20every%20year.). [<https://perma.cc/W8EH-WF6E>].

⁹⁹ McDonnell et al., *supra* note 19 at 8.

¹⁰⁰ *Agrotonomy, Converting an Existing Building into a Vertical Farm* (Mar. 19, 2021), <https://agrotonomy.com/converting-an-existing-building-into-a-vertical-farm/> [<https://perma.cc/MXF7-D2FH>]; See Sara Cifani, *How Aerofarms Transforms Newark's Industrial Buildings into Vertical Farms*, BUDGET DUMPSTER (May 26, 2017), <https://www.budgetdumpster.com/blog/community/newark-nj/aerofarms-vertical-farms/> [<https://perma.cc/3KZF-TMW3>].

¹⁰¹ *Gentrification and Neighborhood Revitalization: WHAT'S THE DIFFERENCE?*, NAT'L LOW INCOME HOUS. COALITION (Apr. 5, 2019), <https://nlihc.org/resource/gentrification-and-neighborhood-revitalization-whats-difference> [<https://perma.cc/2NXR-FE2Z>]; *Gentrification Encyclopedia Entry*, NAT'L GEOGRAPHIC, (last visited Feb. 15, 2023), <https://www.nationalgeographic.org/encyclopedia/gentrification/> [<https://perma.cc/K2NG-MWSS>].

affluent residents and businesses, leading to the displacement of low-income residents.¹⁰² “Food retailers that market sustainable, healthy products to higher income consumers signal that the community is changing and may cause nearby property values to increase.”¹⁰³ The business model for many CEA companies is to renovate already existing facilities, such as large warehouses and factories in urban and peri-urban areas.¹⁰⁴ Many vertical farming companies are targeting the outskirts of major United States cities so that they may take advantage of lower rental prices, but still be close enough to access all the major markets.¹⁰⁵ Many vertical farming companies are striking deals with the country’s largest retailers, which should create some skepticism for any environmentalist who also cares about the social impacts of green solutions, like CEA.¹⁰⁶ Without considering the social impacts CEA farms can have, such as increasing gentrification, a sound environmental solution to conserve water and more efficiently grow produce may unintentionally create further harm.

The Urban Food Policy Institute reports that food can contribute to gentrification in multiple ways.¹⁰⁷ Policies that generate incentives for new supermarkets to set up in low-income communities may not only increase food accessibility, but also make the neighborhood more appealing to wealthy outsiders.¹⁰⁸ In their report, the Urban Food Policy Institute said: “[c]ity officials and developers know that urban amenities—from movie theaters to specialty grocers—increase the prices of nearby residential units. One study found that a specialty grocer with services like a butcher, bakery, and florist generates price premiums averaging 17.5%.”¹⁰⁹ This trend, known as the “Whole Foods Effect,” contributes to the gentrification and displacement of low-income residents.¹¹⁰ According to a survey conducted by the real estate website Zillow, “the typical home near either Whole Foods or Trader Joe’s costs more and appreciates twice

¹⁰² *Id.*

¹⁰³ Nevin Cohen, *Feeding or Starving Gentrification: The Role of Food Policy*, CUNY URB. FOOD POL’Y INST. (Mar. 27, 2018), <https://www.cunyurbanfoodpolicy.org/news/2018/3/27/feeding-or-starving-gentrification-the-role-of-food-policy> [<https://perma.cc/J7UT-JTVZ>].

¹⁰⁴ See Agrotechnology, *Converting an Existing Building into a Vertical Farm* (Mar. 19, 2021), <https://agrotechnology.com/converting-an-existing-building-into-a-vertical-farm/> [<https://perma.cc/MXF7-D2FH>].

¹⁰⁵ Jesse Klein, *What 8 Indoor AG Companies Plan for 2021*, GREENBIZ (Jan. 6, 2021), <https://www.greenbiz.com/article/what-8-indoor-ag-companies-plan-2021> [<https://perma.cc/PGX3-QCL9>].

¹⁰⁶ Russel Redman 1, *Whole Foods, Amazon Fresh, FreshDirect Step Up Distribution from Aerofarms*, SUPERMARKET NEWS (May 13, 2021), <https://www.supermarketnews.com/produce-floral/whole-foods-amazon-fresh-freshdirect-step-distribution-aerofarms> [<https://perma.cc/8QAB-L2H8>].

¹⁰⁷ Cohen, *supra* note 102.

¹⁰⁸ *Id.*

¹⁰⁹ *Id.*

¹¹⁰ *Id.*

as much as the median U.S. home.”¹¹¹ This survey is an example of how the gentrification of food and housing are interwoven.

According to Duke University’s World Food Policy Center (WFPC), decades of racialized disinvestment in America’s urban centers laid the groundwork for the gentrification and displacement that is occurring today.¹¹² The lack of investment in urban centers depreciated real estate values to low levels making it profitable for investors to reenter the market and begin generating profits from the cheap real estate stock.¹¹³ During the early 1990s, many local governments introduced a series of incentives for downtown development projects that established the framework for a more favorable investment climate in urban areas.¹¹⁴ These incentives from local governments have led to an increase in urban migration, along with an increase in jobs and premium real estate near urban centers, which some CEA companies are hoping to take advantage of.¹¹⁵ Arizona and California have access to solar energy, putting them in the best position to utilize solar-powered CEA to grow produce that is affordable. Other states that are utilizing CEA are less likely to be able to provide produce at an affordable cost and will likely have to market their produce as worthy of a higher price or take advantage of lower real estate in urban areas, which may signal to wealthier outsiders that the area is gentrifying.

Gentrification can also contribute to the inequities marginalized communities face by influencing the food amenities available, such as grocery stores. The social impact of how CEA does or does not contribute to food accessibility should also be considered. In the United States, a significant amount of food is wasted every year.¹¹⁶ The United States Department of Agriculture (USDA) estimates that the value of uneaten food at the retail and consumer levels to be “around \$161.6 billion in 2010 dollars annually,” which represents a loss of about 31%, or “133 billion pounds out of 430 billion pounds” of food produced in the United States.¹¹⁷ The USDA estimates that 33.8 million people, 10.2% of U.S. households, were food insecure at some point in 2021.¹¹⁸ Hunger and food insecurity in the United States is not due to a lack of food, but rather the “symptoms of policy choices and an economic system that prioritizes the needs of

¹¹¹ *Id.*

¹¹² World Food Policy Center, *Gentrification and the Future of Food Justice*, DUKE UNIV., <https://wfpc.sanford.duke.edu/durham-food-history/gentrification-future-food-justice-2000%E2%80%932020> [https://perma.cc/9R48-ZTBZ].

¹¹³ *Id.*

¹¹⁴ *Id.*

¹¹⁵ *Id.*

¹¹⁶ Travis Minor et al., *Economic Drivers of Food Loss at the Farm and Pre-Retail Sectors: A Look at the Produce Supply Chain in the United States*, U.S. DEPARTMENT OF AGRICULTURE (Jan. 2020), <https://www.ers.usda.gov/webdocs/publications/95779/eib-216.pdf?v=5805.9> [https://perma.cc/MM4C-GDDG].

¹¹⁷ *Id.*

¹¹⁸ *Reduce Wasted Food By Feeding Hungry People*, U.S. ENVIRONMENTAL PROTECTION AGENCY (updated Apr. 3, 2023), <https://www.epa.gov/sustainable-management-food/reduce-wasted-food-feeding-hungry-people#sources2> [https://perma.cc/T8DB-C52N].

corporations and the wealthy over those of the general population.”¹¹⁹ For example, the United States’ economic system allows for grocery store chains, such as Whole Foods or Trader Joe’s, to decide where to locate and conduct their business.¹²⁰ This policy choice has resulted in the tendency for grocery stores “to avoid or leave low-income communities with perceived low demand, limited purchasing power, and higher operating costs,” which is referred to as supermarket redlining.¹²¹ Conversely, supermarket greenlining refers to grocery stores that market healthy and organic foods and target “gentrifying neighborhoods for new stores, signifying environmental privilege and leaving low-income residents with reduced access to reasonably priced food and welcoming shopping spaces.”¹²² The lack of access to affordable and healthy foods, particularly fresh fruits and vegetables, in a geographic area, whether because of supermarket redlining or greenlining, is known as a food desert.¹²³ Supermarket redlining and greenlining is a symptom of gentrification and one of the potential causes of food deserts.

Food deserts are geographic regions where residents have limited access to affordable and healthy foods, particularly fresh fruits and vegetables.¹²⁴ Food deserts are disproportionately prevalent in high-poverty regions and create obstacles making it difficult for low-income communities, families, and children to maintain good health practices.¹²⁵

The USDA identifies food deserts by locating communities that qualify as either low-income or low-access census tracts.¹²⁶ To be considered a low-access census tract, at least 33% of inhabitants must travel a burdensome distance to reach the nearest grocery shop.¹²⁷ The distance that is considered burdensome depends on whether the census tract is determined to be urban or rural, with at least one mile in urban areas and at least ten miles in rural areas being considered low-access, respectively.¹²⁸ To be considered a low-income census tract, the local poverty rate must be at least 20% or the median family income must be less than 80% of the statewide median family income.¹²⁹

¹¹⁹ Arohi Pathak, Ryan Richards, & Marc Jarsulic, *The United States Can End Hunger and Food Insecurity for Millions of People*, THE CENTER FOR AMERICAN PROGRESS (Aug. 11, 2022), <https://www.americanprogress.org/article/the-united-states-can-end-hunger-and-food-insecurity-for-millions-of-people/> [<https://perma.cc/ZGV7-XX2A>].

¹²⁰ Cohen, *supra* note 102.

¹²¹ *Id.*

¹²² *Id.*

¹²³ *See Id.*

¹²⁴ *Food Deserts in the United States*, THE ANNIE E. CASEY FOUNDATION BLOG (Feb. 13, 2021), <https://www.aecf.org/blog/exploring-americas-food-deserts> [<https://perma.cc/AH8T-JFSJ>].

¹²⁵ *Id.*

¹²⁶ *Id.*

¹²⁷ *Id.*

¹²⁸ *Id.*

¹²⁹ *Id.*

In 2017, nearly 39.5 million Americans, 12.8% of the population, lived in low-income and low-access areas.¹³⁰ According to the USDA, “[l]imited access to nutritious food and relatively easier access to less nutritious food may be linked to poor diets and, ultimately, to obesity and diet-related diseases.”¹³¹ CEA advocates are hopeful that CEA farming may be able to assist in resolving the country's food insecurity issue. However, the widespread use of CEA will likely not address the root cause of food deserts or food insecurity in the United States, and it is possible that CEA farming may increase the country's existing inequities by accelerating gentrification. Nevertheless, the CEA farming industry is expected to see continual growth over the next decade.¹³² Consequently, Arizona and California are in a unique position to benefit from CEA during a time when their agricultural industries are threatened by climate catastrophe. Using solar energy to power CEA farms in Arizona and California could help to reduce the cost of produce grown with CEA. If the cost of produce grown with CEA is reduced, then there is the potential for a greater proportion of food grown in the United States to be pesticide free, which has positive benefits for consumers and those living near agricultural fields who are more acutely exposed to pesticidal drift.¹³³

VII. CONCLUSION

Vertical farming is expected to grow over the next decade. It is important that cities learn how to use CEA to help address social failures such as food deserts or at the very least minimize harm by deterring any policies that increase gentrification and displacement. As cities begin to take climate change seriously and look for ways to reduce carbon emissions, the renewable energy market will become an optimal solution for powering vertical farms that are extremely energy dependent. While vertical farming would normally be financially inaccessible, renewable energy has the potential to make vertical farming much more inexpensive if CEA farms are able to power their facilities with renewable energy that they own. Cities and states, especially those in Arizona and California, should subsidize on-site renewable energy projects so that vertical farmers can make their food more affordable. Arizona and California have access to an abundant amount of solar energy that could be better utilized by providing electricity to CEA farms. Additionally, Arizona and California

¹³⁰ *Id.*

¹³¹ United States Department of Agriculture, *Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences* III (Jun. 2009), https://www.ers.usda.gov/webdocs/publications/42711/12716_ap036_1_1.pdf?v=3480 [<https://perma.cc/323Y-W5CF>].

¹³² *US Vertical Farming Industry Overview*, Mordor Intelligence, <https://www.mordorintelligence.com/industry-reports/united-states-vertical-farming-market> [<https://perma.cc/W3JM-DVMU>].

¹³³ Clémentine Dereumeaux et al., *Pesticide exposures for residents living close to agricultural lands: A review*, ENVIRONMENTAL INTERNATIONAL (Jan. 2020), <https://www.sciencedirect.com/science/article/pii/S0160412019314898> [<https://perma.cc/DYM3-TYAR>].

can conserve their freshwater in the face of drought and water shortages, which are expected to affect their agricultural industries given that a large majority of their freshwater is used for agriculture. By increasing the accessibility of vertically farmed foods, cities can begin to better address some of the inequities related to the access of healthy foods.