2020

Cuba's Agroecological Revolution: Implications for Widespread Adoption

Cooper Olds

Cuba's Agroecological Revolution: Implications for Widespread Adoption

By
Cooper Olds
May 2020

A Senior Thesis Submitted to the Faculty of Vassar College in Partial Fulfillment of the Requirements for the Degree of Bachelor of the Arts in Science, Technology, and Society

Advised by Jim Challey and José Perillan

Acknowledgements –

This thesis would never have been finished without the advice and support from a long list of wonderful people who I would like to thank.

To my readers Jose Perillan and Jim Challey, thank you both for your advice and encouragement throughout this entire process. Jim, your feedback and critiques of my writing have been invaluable in helping me reach this final state and my thesis is far better off as a result of your support. Jose, thank you for all the advice and encouragement you have given me throughout this process and for the past three years as my major advisor. The three classes of yours that I have taken are among my favorite college courses and are the reason I became an STS major in the first place.

To Pinar Batur, thank you for starting me down the agriculture road. Your intro sociology class my sophomore year opened my eyes to the problems that inspired my thesis and completely changed the trajectory of my life. Your classes have blown my mind, terrified me, and inspired me to do something about the problems in the world and I am so grateful I put up with those 9 am class times back in the spring of 2018.

To the Science, Technology, and Society program and professors, thank you for providing me with a major that perfectly combines all my interests. The ability to take a wide and multidisciplinary focus to my education has been a wonderful gift and more than worth all the hassle of explaining what STS actually is to the non-initiated.

To my friends, thank you for providing me with a home away from home. Your love and support have been so deeply appreciated and I can't even begin to put into words how grateful I am for you all.

And of course, to my family, thank you for instilling in me a great curiosity for the world and a love a learning. I love you all.

Table of Contents –

Part 1 – Introduction to Agroecology and Contextualizing the Cuban Case

Introduction –

Why Look at Food Production?:

It has become increasingly clear over the past 40 or so years that the way we conceive of agriculture today is not up to the task of meeting food production moving forward. We now know industrial agriculture plays a very large role in the production of climate change,[1] is very poorly situated to adapt to the resulting impacts of a changing climate,[2] and has had a largely detrimental impact on the lives of small farmers throughout the world.[3] Agriculture as it exists today is also operating on a very short timeline, with a senior UN official within the Food and Agriculture Organization (FAO) suggesting that current trends will lead to a loss of the world's top soil within 60 years.[4] On top of all of this, there are also serious concerns over its capacity to simply produce enough food. Janet Ranganathan's article "The Global Food Challenge Explained in 18 Graphics", published by the World Research Institute, suggests that a swelling global population, estimated to hit nearly 10 billion by 2050,[5] will no longer be sustained by the contemporary mode of agricultural production.[6] These concerns are felt very uniformly across

[1]Global Greenhouse Gas Emissions Data," Environmental Protection Agency, September 13, 2019, https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data.

[2]"Climate Change and Agriculture," Union of Concerned Scientists, March 20, 2019, https://www.ucsusa.org/resources/climate-change-and-agriculture.

[33]Chris Arsenault, "Why Are Most of the World's Hungry People Farmers?," World Economic Forum, May 28, 2015, https://www.weforum.org/agenda/2015/05/why-are-most-of-the-worlds-hungry-people-farmers/.

[4]Chris Arsenault, "Only 60 Years of Farming Left If Soil Degradation Continues," Scientific American (December 5, 2014), https://www.scientificamerican.com/article/only-60-years-of-farming-left-if-soil-degradation-continues/.

[5]"Growing at a Slower Pace, World Population is Expected to Reach 9.7 Billion in 2050 and Could Peak at Nearly 11 Billion Around 2100," United Nations Department of Economic and Social Affairs, June 17, 2019, https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html.

[6]Janet Ranganathan, "The Global Food Challenge Explained in 18 Graphics," World Resources Institute, December 3, 2013, https://www.wri.org/blog/2013/12/global-food-challenge-explained-18-graphics.

many of the world's left-leaning organizations and corporations. However, where food sovereignty[7] and agroecology scholars – figures like Miguel Altieri and Peter Rosset, whose work I will be referencing often throughout my paper – differ from more the mainstream thinkers working largely within the dominant globalist neoliberal paradigm, is the approach they take to remedying this problem. Where the globalist scholarship often argues for a doubling down of green revolution of ideals, placing a reliance on rapid enhancement of agricultural technologies like genetic engineering, agrochemicals, and high-tech agricultural machinery,[8] the agroecology scholars argue for a fundamental restructuring of the ideals of agriculture. Moving away from the desire to dominate and control nature towards the idea that farming must be done in accord with the natural ecology of the land, they argue, will result in a more productive form of agriculture, that is simultaneously much more considerate of the natural world in which it exists.

Introducing the Cuban Context:

The decision to take this passion for agroecology and a more sustainable and resilient food system, and analyze it through the context of modern Cuban agriculture derives from the fact that Cuba, since the early 1990s has been widely recognized as having the most sustainable national agriculture sector in the world, one which is specifically predicated on the theory of agroecology. Though many countries and sub-national regions and communities have been very successful in resisting or moving away from the industrial mode of production, Cuba is more or less the picture child of nationally mandated agroecological development. Despite the reality that the rapid changes were brought about by necessity more than anything else, and the fact that

[7]Food Sovereignty, as defined in the "Declaration of Nyéléni" made at the Forum for Food Sovereignty in Sélingué, Mali, on the 27th of February, 2007, is "the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems."

[8]The Bill & Melinda Gates Foundation, "Agricultural Development: Strategy Overview," *Global Development Program*, August 2011.

Cuba exists within a very different context that much of the rest of the world, I hope to unpack from this case lessons and strategies that can be applied on a broader context to help facilitate similar shifts towards agroecology around the world. However, throughout this analysis, it is important to keep in mind some of the central principles of agroecology: The importance of "reliance on the knowledge and wisdom of locals and farmers as a key input," and "promotion of participatory methods in research and in extension and implementation processes."[9]

Regardless of the success of a policy or practice in Cuba, or of its apparent universality, it is critically important that each facet of the transition that occurred in Cuba is understood within the Cuban context. Likewise, should any of the ideas or practices used in Cuba be applied elsewhere in the world, it is critically important that their implementation be understood within the context of that specific country, region, or town. As an example, it is not enough to simply take the urban agriculture model Cuba has used to such great success and apply it somewhere completely different, say New York City. Almost every factor imaginable that goes into urban agricultural production in Havana is different from the factors which would be required to produce food in New York City. This is not to say urban agriculture can or should not be explored as a possibility in New York or anywhere else. In fact, I would argue the opposite, that we should be looking to expand urban production of food everywhere. However, every city, and every set of factors it brings along with it, must take a unique approach to urban agricultural development, and must rely on the innovation and experimentation of the local population. This basic fact of agroecology stays the same at every level of implementation. Through my investigation of Cuba and its agroecological revolution, I have found that a decentralization of

[9]Miguel A. Altieri, "The Principles and Strategies of Agroecology in Cuba," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) xiii.

technologies and power structures was the essential element in creating a productive and successful shift towards agroecology. I choose to highlight this decentralization, a rather vague and unspecific solution to the problem of agroecological adoption, to reinforce the idea that there cannot be one single solution. If we look to decentralize our agricultural industries moving forward, rather than instituting specific universal policies and practices, I think we can begin to make real progress on the front of agroecological adoption.

Chapter 1: Theoretical Foundation of Agroecology –

Environmental Consequences of Industrial Agriculture:

The desire to change agricultural systems towards something more sustainable stems from little known facts regarding industrial agriculture and its environmental impacts. While many people do not even think of agriculture when talking about the production of climate change, in reality, it is responsible for approximately one quarter of all fossil fuel emissions globally, and in the US where we consume more fossil fuels per capita than anywhere else in the world, agriculture still makes up nearly 20 percent of all our emissions.[10] On top of this, agricultural activities are responsible for 70% of all freshwater use and have significantly altered over 40% of earth's surface land. Taking into account projected population growth and increased input demands for industrial agriculture as a result of increasingly degraded lands, all of these numbers will increase well beyond current levels, which are already far from sustainable. Research and emissions modeling suggests that by 2050 the agricultural emissions required to feed the global population alone, will total more than our entire carbon budget as outlined by the Intergovernmental Panel on Climate Change (IPCC) Special Report 15, which defines the maximum amount of carbon we can emit while limiting warming to the 1.5°C threshold compared to pre-industrial temperatures.[11]

The fact that industrial agriculture can only produce more food through technological advancements, which require high levels of external inputs, or an expansion of land under production, make it a fundamentally unsustainable system. This is especially problematic in the face of the climate crisis. As we are already struggling to feed the global population via an

[10]"Global Greenhouse Gas Emissions Data," Environmental Protection Agency, September 13, 2019, https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data.

[11]Tristram Stuart, "Food: How Much Does the World Need?," World Economic Forum, May, 7, 2015, https://www.weforum.org/agenda/2015/05/food-how-much-does-the-world-need/.

industrial system, projected population growth and changing weather patterns – according to a 2011 National Academy of Sciences report entitled "Warming World: Impacts by Degree" shows that for every 1 degree Celsius that temperatures rise, global food production will fall by 5 to 15 percent[12] – make clear that our belief in the industrial system to meet future demands is misguided at best.

The specific practices used in industrial agriculture are also causing serious problems for our future productive capacity. Intensive chemical pesticide and herbicide use is actually harming our efforts to control pests and maintain consistent harvests. Very similar to what we have seen with antibiotic resistant bacteria – a problem contributed to by industrial production of livestock through the addition of antibiotics to feed, which accounts for nearly 40 percent of all antibiotics produced[13] – intensive pesticide and herbicide use has contributed to the rapid rise in resistant pests and weeds, making it increasingly difficult and expensive to manage pests in the industrial system. An article from PBS states, "Rachel Carson predicted such resistance in her groundbreaking book Silent Spring, published soon after the chemical insecticide glory days of the 1950s. And the problem is getting worse. Farmers in the U.S. lost about seven percent of their crops to pests in the 1940s. Since the 1980s, some 13 percent of crops are being lost -- and more pesticides are being used."[14] Despite industrial agriculture's repeated attempts at increasing production through intensive chemical use, it seems that their strategies are simply making matters worse in the long run, with estimates anywhere between 500 and 1000 as to the number of individual pest species which have adapted resistances to one or more pesticides.[15]

---

[12]"Warming World: Impacts by Degree," (The National Academy of Sciences, 2011), 6.

[13]"The Hidden Costs of Industrial Agriculture," Union of Concerned Scientists, July 11, 2008, https://www.ucsusa.org/resources/hidden-costs-industrial-agriculture.

[14]"Pesticide Resistance," Evolution: Library, Public Broadcasting Service, https://www.pbs.org/wgbh/evolution/library/10/1/l_101_02.html.

[15]G. Tyler Miller, *Sustaining the Earth*, 6th ed. (Pacific Grove, CA: Thompson Learning, Inc., 2004) 211-216.

Ecological Impacts of Intensive Chemical Use:

Unfortunately, while intensive pesticide use has seemingly only increased the problems posed by pests on farms, it has also led to the significant weakening and rapid decline we have seen in bee and other pollinator populations in recent years. Numerous studies have come out in the past decade linking neonicotinoid use, the world's most widely used pesticide,[16] with bee population decline. However, in the US, very little has been done to regulate their use, while the European Union has banned the three most prominent and damaging neonicotinoid pesticides.[17] Much of this comes down to the political clout pesticide producers like Monsanto have in the US, gained through their Super PAC spending, totaling over half a million each year since 2010, when studies into the dangers of neonicotinoids began to make serious headlines.[18]

Another issue Rachel Carson brought up in *Silent* Spring, which has been more or less ignored by industrial agriculture, is the danger of chemical laden farm runoff. As a result of the intensive irrigation and poor soil management practices which contributed to dense and compacted topsoil, high volume rainfall events commonly lead to significant levels of runoff, not only eroding soil, but also washing away large amounts of chemicals in the process. Just as in the 60s, when Carson's pleas to save bald eagles and other birds of prey were integral to the banning of DDT, much of this toxic runoff ends up in surface water like rivers and lakes, and through a process of bioaccumulation, has the potential to destroy entire ecosystems near industrial farms. Agricultural runoff, specifically in the form of chemical fertilizer, has also had a detrimental impact on many lakes and rivers, and has been largely responsible for algal blooms which

[16]Ola Lundin et al., "Neonicotinoid Insecticides and Their Impacts on Bees: A Systematic Review of Research Approaches and Identification of Knowledge Gaps," *Plos One* (August 27, 2015).

[17]"Neonicotinoids," Food Safety, European Commission, January 14, 2020, https://ec.europa.eu/food/plant/pesticides/approval_active_substances/approval_renewal/neonicotinoids_en.

[18]"Monsanto Co: Total Contributions," OpenSecrets.org, https://www.opensecrets.org/orgs/totals.php?id=D000000055&cycle=2014.

destroy large amounts of aquatic life.[19] This fertilizer runoff has also had a damaging impact on the ocean in the form of oceanic dead zones, where excessive nutrient pollution depletes the oxygen concentration in the ocean, making it uninhabitable for marine life.[20]

These, however, are just the surface level impacts of agrochemical runoff. As a result of our insistent, intensive agrochemical use, we have also succeeded in poisoning huge amounts of our groundwater reserves. This is a major problem as groundwater reserves provide over half of the world's drinking water, and over 40 percent of all water used for irrigation.[21] Furthermore, once a groundwater aquifer is contaminated, it becomes nearly impossible to remove the contaminating chemicals, rendering the aquifer more or less useless for a significant period of time.[22] We are already faced with concerning levels of pollution in over 20 percent of groundwater samples taken in the United States,[23] a number that will only increase as pesticide and chemical fertilizer use continues, creating greater problems of water scarcity in the future in conjunction with climate change driven water scarcity.

Social Implications of the Industrial Agricultural Paradigm:

The advent of the green revolution and the spread of industrial agriculture across much of the world has also had somewhat subtler, but still destructive social impacts, particularly in more rural areas of the world. Studies have shown a correlation between living near an industrial farm and experiencing a downturn in overall quality of life, particularly as a result of regular exposure

[19]"Understanding Algal Blooms," St. John's River Water Management District, https://www.sjrwmd.com/education/algae/.

[20]"What Is a Dead Zone?," NOAA's National Ocean Service, March 14, 2019, https://oceanservice.noaa.gov/facts/deadzone.html.

[21]"Water for a Sustainable World: Facts and Figures," *The United Nations World Water Development Report 2015*, 2.

[22]Kimberly Mullen, "Information on Earth's Water," National Groundwater Association, https://www.ngwa.org/what-is-groundwater/About-groundwater/information-on-earths-water.

[23]"The Quality of the Nation's Groundwater," United States Geological Survey, January 21, 2015, https://www.usgs.gov/news/quality-nation's-groundwater.

to harsh chemicals and widespread degradation of land.[24] Through a process of industrialization, large farms, and farming all together requires far less labor today than it did in the past. While this is seen as a positive for many wealthy farm owners and investors, for the rural lower class it has been a devastating change. In the late 1800s, in the US, more than half of the population was engaged in agriculture,[25] whereas today, that number has fallen to just above one percent.[26] For rural populations, there are often few occupations available other than farming, and a decline in agricultural opportunities has played a very large role in creating the rural exodus we are seeing today, overcrowding cities, putting serious strain on infrastructure, and contributing to phenomena like urban heat islands, making urban areas disproportionately susceptible to the impacts of climate change.[27] Though the proportion of farmers in the global south remains very high, as industrial practices continue to make farming unprofitable for poor small farmers and overall degradation of rural areas make them less desirable, rural populations will continue to dwindle and agribusiness will consolidate more and more land into massive farms, exacerbating many of the issues described above.

Trade liberalization, which accompanied the Green Revolution to many parts of the world, has also been a large problem for rural farmers. Many rural communities have historically worked the land collectively, never defining individual ownership. Unfortunately, post-liberalization, many states and multinational corporations did not see the land as owned under this collective system. Much of this land, particularly in the global south, has been purchased by

---

[24]"Factory Farms Destroy Communities," Socially Responsible Agricultural Project, https://sraproject.org/factory-farms-destroy-communities/

[25]Patricia A. Daly, "Agricultural Employment: Had the Decline Ended?," *Monthly Labor Review*, November 1981, 12.

[26]"Ag and Food Sectors and the Economy," USDA Economic Research Service, September 20, 2019, https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/.

[27]"Heat Island Effect," EPA (Environmental Protection Agency, April 23, 2020), https://www.epa.gov/heat-islands.

large companies, with little to no compensation going to the farmers who had lived and worked on it in the past. This process is often referred to as "land grabbing".[28] These land grabs have pushed a huge number of small farmers off of their land in recent years, with the roughly 2.5 billion former collective land owners now owning the rights to only one-fifth of their historically used land.[29] On top of this, large corporations are specifically targeting land in countries with weak governance structures to enable cheap and hassle free acquisition of huge areas of land, relying on bribes and direct payment to government officials, further cutting small farmers out of compensation for their land.[30]

Finally, through high levels of subsidized industrial production, sometimes bordering on overproduction, countries can often import staple foodstuffs like corn and rice at a much lower cost than nationally produced crops, driving prices down significantly.[31] Again, while this may benefit certain populations, for rural farmers it is something of a death knell. Unrealistically low prices – made so low as a result of huge foreign subsidies – force small farmers to produce at a loss, leading them into a cycle of debt, and ultimately bankruptcy in many cases, further driving the rural exodus I mentioned before. A perfect example of this is the impact the North American Free Trade Act (NAFTA) had on small farmers in Mexico. Following the opening up of trade, corn and other staple crops heavily subsidized by the US government flooded Mexican markets at extremely low prices. This pushed corn and other food prices so low that many small farmers were producing at costs over what they would receive in markets, forcing them out of business. Between 1994 and 2013, roughly 2 million small farmers in Mexico were forced to abandon their

---

[28]Fred Pearce, *The Land Grabbers: The New Fight Over Who Owns the Earth* (Boston: Beacon Press, 2013).

[29]"Land Grabbing," Global Agriculture, https://www.globalagriculture.org/report-topics/land-grabbing.html.

[30]Ibid.

[31]Masanobu Fukuoka, *The One-Straw Revolution* (Rodale Press, 1978) 105.

farms and homes and sought work in cities or as migrant farm labor, adding further to Mexico's already swollen urban and food insecure populations.[32]

The Paradox of the Green Revolution:

Despite the purported successes of the Green Revolution and industrial agriculture more generally – the Green Revolution has been celebrated by many for lifting one billion people out of hunger, with its pioneer, Norman Borlaug even winning the 1970 Nobel Peace Prize for his contributions to the world food supply – over 1 billion people still do not have enough food to eat,[33] more than half of whom are small farmers themselves.[34] We may be producing far more food than ever before, however, the systems in place are woefully inefficient when it comes to the distribution of food and meeting the demands of a global population. We produce over 3,000 calories of food, per person, per day globally, and yet, hunger and malnutrition still plague many regions in the global south, as well as many low-income communities in the United States and other countries in the Global North. This occurs because the industrial agricultural system centralizes production in massive, monoculture farms, often far removed from the cities, or even the countries the food is intended to feed. Globally, hundreds of millions of tons of food are moved between production, processing, and finally distribution and consumption each year. Food miles, as they have come to be known, have skyrocketed in the past 40 years, leading to a swollen agricultural carbon footprint as well as massive food waste.[35] Transporting most raw food items thousands of miles around the world before processing and distribution has

[32]Laura Carlsen, "What We've Learned from Nafta," The New York Times (The New York Times), November 24, 2013, https://www.nytimes.com/roomfordebate/2013/11/24/what-weve-learned-from-nafta/under-nafta-mexico-suffered-and-the-united-states-felt-its-pain.

[33]Vandana Shiva, *Who Really Feeds the World? The Failures of Agribusiness and the Promise of Agroecology* (North Atlantic Books, 2016) ix.

[34]Chris Arsenault, "Why Are Most of the World's Hungry People Farmers?," World Economic Forum, May 28, 2015, https://www.weforum.org/agenda/2015/05/why-are-most-of-the-worlds-hungry-people-farmers/.

[35]Vandana Shiva, *Who Really Feeds the World?*, 106.

precipitated nearly 40% food waste globally, almost all of which occurs between production and distribution, amounting to approximately $750 billion dollars in wasted food each year.[36]

Another massive problem which accompanied the Green Revolution and the technologies it spread around the world, is the fact that industrial agriculture is unavoidably input intensive. This means that the model of industrial production is not possible without the introduction of external inputs to the agricultural system. In fact, the entire system is predicated on the idea of increased inputs for increased outputs. These inputs most commonly take the form of chemical fertilizers, pesticides, herbicides, machinery, water, and energy, however, together, all of these inputs require significant capital investment into the farm. While this is less of a problem, though still catastrophic for many small farmers in the United States and other highly industrialized nations whose farmers typically have access to greater volumes of capital, in much of the global south, the capital demands on small farmers have created systems of perpetual debt and economic destitution. Following the 2007-8 food crisis, which saw global food prices reach unprecedented highs, making it nearly impossible for small farmers and low income populations in the global South to feed themselves and their families, there was considerable unrest throughout the world and a major spotlight was shown on the crisis of farmer suicide. The phenomenon, which is at its strongest in India, started to become increasingly worrisome in the 1990s with small farmers committing suicide, often by drinking pesticides, in response to their inability to repay loans taken out to afford chemicals and genetically modified seeds. Between 1995 and 2013, nearly 300,000 farmers committed suicide in India, with a yearly average of just over 15,000 cases.[37] It is also incredibly important to note that this crisis is not bound to the

[36]Dr. Mohamed Behnassi. “Vulnerability of Food Systems and Food Security in Morocco.” Class lecture, Climate Science and Policy from IHP Climate Change, Marrakech, Morocco, November 2, 2018.

[37]P Sainath, “Have India's Farm Suicides Really Declined?,” BBC News (BBC, July 14, 2014), https://www.bbc.com/news/world-asia-india-28205741.

Indian context. Recent CDC figures showing a 34% increase in farmer suicides between 2000 and 2016 in the US, placing the farmer suicide rate at 1.5 times national averages, sparking serious concern for many in the country.[38]

I hope, here, I do not come across too harshly against Norman Borlaug and other pioneers of the Green Revolution. I truly believe they were trying to help others and fix what they saw as a critical issue in agriculture and could not have intended or predicted the fallout. However, I also want to push back a bit on these people and bring to light the degree of neo-colonial superiority they felt in doing their work. In a video produced by the Word Food Prize, an award established in 1986 by Borlaug and others, Borlaug talks about his early years in Mexico saying, "When I arrived in Mexico, no trained people, nobody knew how to do anything."[39] Borlaug was incredibly dismissive of Mexican farmers and thought of himself as smarter and more capable than the people he was working with. For this reason, there was little room for interaction between small farmers and the agricultural researchers, and I think this has played a major role in the negative outcomes of the green revolution. Rather than working collaboratively with farmers in the regions they were trying to help, Green Revolution technologies are highly prescriptive and assume a level of superiority over local peasants and small farmers.

Precision Agriculture as a Potential Sustainable Path Forward for Agribusiness:

It would not be fair to say that the intentions of the agroindustry are all bad, however, and a number of technological innovations have been made recently with the express goal of lessening the environmental impacts of large-scale agriculture and better preparing farms for the

[38]George Jared, "CDC: 'Farm Stress,' Suicides a Rising Rural Health Concern," Talk Business & Politics, May 14, 2019, https://talkbusiness.net/2019/05/cdc-farm-stress-suicides-a-rising-rural-health-concern/.

[39]*Norman Borlaug: A Lifetime Fighting Hunger, YouTube* (World Food Prize, 2009), https://www.youtube.com/watch?v=m2TmEdiXTvc.

onset of climate change. The most common and promising of these technological developments is actually a combination of a number of technologies typically referred to in aggregate as "precision agriculture". Through the incorporation of satellite and aerial imagery, soil quality and plant health information, weather predictions, topographical mapping, and many other forms of agricultural data, precision agriculture aims to improve the farmer's decision making capacity through the use of a wide range of high tech monitoring and measuring equipment with the end goal of improving yield and quality of harvests. This is all done while minimizing extraneous inputs to the farm through the use of precision fertilization and pesticide application, further improving economic outcomes for farmers.[40]

The concept originated in the United States, with the term first appearing in the title of a 1990 workshop sponsored by Montana State University. By 1996, the term had achieved prominence over similar terms like "site-specific agriculture" and it was being recognized nationally and internationally as an exciting new agricultural paradigm.[41] In 1997, the National Research Council, in their consensus study report *Precision Agriculture in the 21st Century*, defined the practice as "a management strategy that uses information technologies to bring data from multiple sources to bear on decisions associated with crop production."[42] The study went on to state that precision agriculture is composed of three main components: "capture of data at an appropriate scale, interpretation and analysis of that data, and implementation of a management response at an appropriate scale and time."[43] The shift towards precision agriculture, more than anything else, was about a change in the scale of farm management.

---

[40]Arama Kukutai, "Can Digital Farming Deliver On Its Promise?," PrecisionAg, April 28, 2016, https://www.precisionag.com/digital-farming/can-digital-farming-deliver-on-its-promise/.

[41]M.A. Oliver, "An Overview of Geostatistics and Precision Agriculture," in M.A. Oliver, ed., *Geostatistical Applications for Precision Agriculture* (Springer, 2014) 4.

[42]National Research Council, *Precision Agriculture in the 21st Century: Geospatial and Information Technologies in Crop Management* (Washington, DC: The National Academies Press, 1997) 17.

[43]Ibid.

Moving towards incredibly high-resolution farm data has allowed farmers to improve intra-field variation of their management practices, drastically improving the efficiency of industrial farming, creating both economic and environmental advantages over the pre-existing system.

Problematizing Precision Agriculture in the Context of the Global South:

High levels of research and development have gone into the production and dissemination of new precision technologies in the past 25 years and the sector has grown remarkably, particularly in the highly developed countries of the global north. Despite the apparent successes of this new agricultural revolution, many have raised serious concerns over the viability of precision agriculture outside of the highly industrialized nations of the global north. The largest cause for concern stems from the size of the capital investments associated with setting up a precision agriculture system. A relatively straightforward GPS mapping system runs at around $30,000, add on hydraulic tractor steering for $7,000, and an automated sprayer for $7,500,[44] and the initial investment cost for a functional precision agriculture system is right around $45,000. I hope it is fairly obvious that this sort of investment cost is entirely out of reach for the vast majority of farmers in the world, and especially those living in parts of the world most likely to be adversely affected by climate change. Even if subsidies or some other form of drastic price reduction were put in place, many still have concerns over data privacy issues. As Billali and Allahyari write in their paper "Transition towards sustainability in agriculture and food systems: Role of information and communication technologies," "large companies are able, thanks to feedback loops on equipment they sell, to collect a large amount of data about farms and this represents a big concern for farmers. Agro-chemical multinationals that possess data on a large number of farms in different countries may use them to create a monopoly on market of

[44]Marvin T. Batte and Mohammad Reza Ehsani, "Precision Profits: The Economics of a Precision Agricultural Sprayer System," (OSU: Columbus, OH, 2005) 4.

staple crops with implications in terms of food security and farmers' livelihoods in developing countries."[45] It is also important to acknowledge that, similarly to other revolutionary agricultural technologies, business as usual adoption of precision agriculture technology will reinforce rural power structures and further disadvantage peasant farmers. While wealthy and powerful farmers are able to invest heavily in precision agriculture systems, increasing their profit margins, poor farmers who cannot afford the systems will be left in the dust so to speak, eventually going out of business in the face of high-tech competition, and allowing for further consolidation of land under a small number of wealthy elites.

Agroecology as a Solution to the Failings of Industrial Agriculture:

In response to the increasing clarity of the future of the industrial mode of agricultural production, many food sovereignty scholars branched out to look more specifically at alternative, sustainable modes of agricultural production. Though many specific models have emerged in the years since, a very successful blanket category has risen up as the dominant idea in sustainable agriculture. This method is known as agroecology, summed up most succinctly as an ecological approach to agriculture.[46] The aim of agroecology based farms is to utilize the natural ecosystem of the farm to improve the quality of the farm, reducing needed inputs to the agroecosystem, and increasing productivity while reducing environmental harm. As Altieri writes, "The emphasis is on the design of complex agroecosystems that take advantage of ecological interaction, and synergisms between biotic and abiotic components – mechanisms by which soil fertility

[45]Hamid El Bilali and Mohammad Sadegh Allahyari, "Transition towards Sustainability in Agriculture and Food Systems: Role of Information and Communication Technologies," *Information Processing in Agriculture*, Vol. 5, No. 4 (2018), 459-460.

[46]"What Is Agroecology?," AgroEcology Fund, https://www.agroecologyfund.org/what-is-agroecology.

enhancement, biological pest control, and higher productivity can be achieved through internal processes."[47]

Through the application of this theory, farms benefit in a number of ways over the industrial norm. Most notably, through agroecological implementation, a farm foregoes the need for the vast majority of external inputs used on industrial farms. This low-input model makes farming significantly less expensive and eliminates exposure to potentially highly toxic chemicals. Agroecological farms also must be quite a bit smaller than large scale industrial farms, and so the need for heavy machinery and large-scale infrastructure is eliminated, further reducing the economic strain placed on the farmer. In fact, small farms governed by agroecological principles seem to be economically superior to most industrial farms. Although an industrial set up is typically the most efficient means of producing a large quantity of a single cash crop, agroecological farms are able to produce a much higher quantity and quality of calories per land unit area.[48] Though this may not be as profitable within a globalized market, I would argue that we need to reorient our agricultural ideals towards optimizing food production over capital gains, making agroecology much more "profitable" than industrial farming. Beyond this, agroecology creates much more stable farms and consistent returns, eliminating many risks related to crop failure and drought which could cause bankruptcy and destitution for an industrial farm.

Most industrial monocultures producing corn or soy, are not actually producing for human consumption. Globally, over 90 percent of the corn and soy produced goes towards the production of animal feed to be used in intensive animal production, or towards the production of

---

[47]Altieri, "The Principles and Strategies of Agroecology in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance,* xii.

[48]Matt Liebman, "Polyculture Cropping Systems," in Miguel A. Altieri, *Agroecology: The Science of Sustainable Agriculture*, 2nd ed. (CRC Press, 2018), 206-7.

biofuels,[49] which have been subject to serious criticism in recent years for being energy inefficient, meaning they require more energy to produce that they themselves produce when burned.[50] In fact, as Vandana Shiva writes, "from less than 30 percent of the world's arable land, small-scale farmers produce 70 percent of the food eaten in the world. Agribusiness, on the other hand, uses 70 percent of the world's arable land to produce a mere 30 percent of the food."[51] To those who question how we will feed the world without industrial agriculture, Shiva answers, we are already feeding the majority of the world through small scale production, and that most industrial production serves little more purpose than to put money in the pockets of the fossil fuel and agrochemical industries.

Adaptive and Mitigative Potential of Agroecology:

Agroecology is also an incredibly powerful tool in the fight against the climate crisis. It allows agriculture, an industry currently responsible for one quarter of all global emissions, to move towards becoming a carbon neutral or even carbon negative industry through its mitigative capacity, and through the application of many central agroecological practices, can partially, or even fully adapt our farms and food systems to climate change, ensuring our ability to feed a swelling global population in the future. The practice of minimizing, or even eliminating the process of tilling plays a crucial role in both adapting[52] to and mitigating[53] climate change. A

[49]Vandana Shiva, *Who Really Feeds the World?*, 87.

[50]Craig Hanson, "Biofuels Are Not a Green Alternative to Fossil Fuels," World Resources Institute, September 26, 2018, https://www.wri.org/blog/2015/01/biofuels-are-not-green-alternative-fossil-fuels.

[51]Vandana Shiva, *Who Really Feeds the World?*, 63.

[52]Climate adaption, according to "Climate Change Adaptation and Mitigation," NASA, February 6, 2020, https://climate.nasa.gov/solutions/adaptation-mitigation/., is the process of "adapting to life in a changing climate – involves[sic] adjusting to actual or expected future climate." In terms of agriculture, this means adapting to the predicted increses in irregularity of rainfall patterns, drought, desertification, and an increase in pests and plant diseases.

[53]Climate mitigation, according to "Climate Change Adaptation and Mitigation," NASA, February 6, 2020, https://climate.nasa.gov/solutions/adaptation-mitigation/., is the attempt to reduce climate change by "reducing the flow of heat-trapping greenhouse gases into the atmosphere, either by reducing sources of these gases or enhancing the 'sinks' that accumulate and store these gases."

study by Mangalassery et al. entitled "To what extent can zero tillage lead to a reduction in greenhouse gas emissions from temperate soils?" found that, "potential CO2 fluxes under zero tilled soil ranged from 47 to 216 mg m-2 h-1 with a mean value of 141 mg m-2 h-1 whilst under tilled soil it ranged from 119 to 236 mg m-2 h-1 with a mean value of 171 mg m-2 h-1," and, "potential CH4 fluxes were generally positive and higher from tilled soils (0.044 mg m-2 h-1 or 0.22 ng g-1 soil) compared to zero tilled soil (0.018 mg m-2 h-1 or 0.09 ng g-1 h-1 soil)."[54] This is essentially a very technical way of saying that under a zero-till system, both carbon dioxide and methane emissions are considerably, and consistently lower than under a conventional tillage system. When all greenhouse gas emissions were analyzed together, the study concluded that, "tilled soil produced 20% greater net global warming than zero tilled soil indicating a potential for zero tillage system to mitigate climate change after only 5 to 10 years since conversion."[55]

This incredible capacity to store carbon in the soil in the form of soil organic matter (SOM) is also one of the key adaptive properties of agroecology. Critically, as Ratan Lal points out in his paper "Soil Carbon Sequestration Impacts on Global Climate Change and Food Security", "once sequestered, C [Carbon] remains in the soil as long as restorative land use, no-till farming, and other RMPs [Recommended Management Practices] are followed."[56] This is critically important because, for each ton increase of SOM, composed mainly of plant residues, microbial life, and humus, in degraded cropland, average crop yield for staple crops like wheat and maize increase by as much as 40 kg/hectare.[57] To contextualize this increase, average productive farmland has between 3 and 6 percent SOM, meaning degraded land should be

[54]Shamsudheen Mangalassery et al., "To What Extent Can Zero Tillage Lead to a Reduction in Greenhouse Gas Emissions from Temperate Soils?," *Scientific Reports*, Vol. 4, No. 1 (April 4, 2014), 3.

[55]Ibid., 6.

[56]Ratan Lal, "Soil Carbon Sequestration Impacts on Global Climate Change and Food Security," *Science*, Vol. 304, No. 5677 (June 11, 2004), 1625.

[57]Ibid., 1623.

expected to have less, let's say 1-2 percent.[58] Next, the average hectare of land should have roughly 2,026,000 kg of soil in total, or simply 2,026 metric tons, keep in mind these are all very rough estimates due to the variability of different soils and regions, but for now this is the simplest way to estimate.[59] Doing some very simple math shows that highly fertile land will have anywhere from 60 to 120 metric tons of SOM, while degraded lands will have far less, anywhere from 20 to 40. I am sure there are some diminishing returns as more and more SOM is added to the soil, however, over a farm sized area of land, a 20 to 100 ton increase in SOM will boost yields very considerably, especially in a small-subsistence farm context where even small deviations in yield can have significant consequences.

Another massive benefit derived from no-till systems that employ other techniques like maintaining cover crops or some form of groundcover, which also aids in increasing SOM, is that the soil is able to retain much more moisture than other low-carbon soils. Mangalassery et al. found that, at a depth of 0-10cm, zero-tilled soils had, on average, 31.29% soil moisture, while conventionally tilled soils had 26.98% soil moisture, and at a depth of 10-20cm, zero-tilled soils had 27.90% soil moisture, while conventionally tilled soils had just 24.96% soil moisture.[60] To contextualize this difference a bit more, each 1 percent increase in SOM, translates to a roughly 50,000 gallon increase in the soil's water holding capacity per hectare.[61] This increased moisture percentage and water holding capacity that accompanies it can have a massive impact, especially

[58]Megan Fenton, Carl Albers, and Quirine Ketterings, "Soil Organic Matter," *Agronomy Fact Sheet Series*, Vol 41 (2008), 1.

[59]Lara Bryant, "Organic Matter Can Improve Your Soil's Water Holding Capacity," NRDC, December 15, 2016, https://www.nrdc.org/experts/lara-bryant/organic-matter-can-improve-your-soils-water-holding-capacity.

[60]Shamsudheen Mangalassery et al., "To What Extent Can Zero Tillage Lead to a Reduction in Greenhouse Gas Emissions from Temperate Soils?," 2.

[61]Lara Bryant, "Organic Matter Can Improve Your Soil's Water Holding Capacity," NRDC, December 15, 2016, https://www.nrdc.org/experts/lara-bryant/organic-matter-can-improve-your-soils-water-holding-capacity.

in arid climates where rainfall events are projected to become more infrequent and more significant.

Through management and cultivation of high quality, carbon dense soil, farms can protect themselves from the threat of prolonged dry periods and drought without having to rely on irrigation, something which will become increasingly unreliable as water becomes a scarcer resource. Additionally, an improved water holding capacity means that during those high-volume rainfall events, the soil is able to absorb significantly more than an industrial farm's soil could. This means that no-till farms experience significantly less water runoff and erosion, as well as being able to store that water until a later date when it is needed by the plants. No-till soils are often more porous than conventionally tilled soils as a result of reduced heavy machinery use, meaning they are better able to filter excess water down to underground reserves. This process minimizes aquifer depletion and makes low intensity irrigation much more sustainable than the high-volume irrigation often employed on industrial farms.

Chapter 2: History of Cuban Agriculture –

Pre-Columbian Period:

Cuba, throughout its history has hosted a number of different political and agricultural structures. From the pre-Columbian period to Spanish colonialism, American neocolonialism to Castro's socialist government, to the post-Soviet, and then post-(Fidel)Castro governments, nearly each step has accompanied a radical shift in agricultural production. In the years leading up to the arrival of Columbus and the Spanish conquistadors, the island of Cuba was inhabited by two disparate ethnic groups: the Guanahatabey and the Taíno. The Guanahatabey, isolated to the far western tip of the island, were archaic hunter-gatherers who, according to all modern evidence, did not engage in any form of agricultural cultivation. Instead, they relied heavily on foraging and fishing to meet their food demands.[62] In contrast, the Taíno, divided into two local groups – the Ciboney and the Classic Taíno – employed agricultural systems of ranging sophistication, enabling the expansion of Taíno settlements throughout the rest of the island. The Ciboney, who occupied much of central Cuba, used simple slash and burn techniques to clear forest land for cultivation of staple crops like cassava, maize, and sweet potato, as well as other vegetables including peppers, squash, beans, and fruits. Additionally, the Ciboney were accomplished fishers and relied heavily on fish and mollusks for animal protein.[63] The Classic Taíno, who inhabited only the easternmost side of the island, are speculated to have arrived from Hispaniola and Puerto Rico, bringing with them a more advanced cropping system known as a *conuco*. A *conuco* is a field of mounds approximately three feet high and nine feet in circumference arranged in rows, used to prevent erosion and improved soil drainage specifically

[62]Irving Rouse, *The Tainos: Rise & Decline of the People Who Greeted Columbus* (New Haven: Yale University Press, 1992) 20.

[63]Ibid., 18.

in the cultivation of tubers such as cassava and sweet potato.[64] These *conuco* fields allowed for consistent and efficient tuber production, drastically improving the food security of Classic Taíno both in Cuba and the rest of the Greater Antilles.

Spanish Colonial Period:

Starting shortly after Columbus's first voyage in 1492, the Spanish began an aggressive colonial conquest of Cuba, taking land, suppressing the native Taíno peoples, and more or less wiping out the Guanahatabey. By the late 1700s, nearly 650,000 enslaved people had been brought to Cuba from western Africa, allowing for the creation of a large plantation-based agricultural sector, laying the foundation for massive sugarcane production in Cuba.[65] This system lasted for approximately 100 years until the abolishment of Cuban slavery in 1886, followed by the War of Independence against Spanish colonialism, which lasted from 1895 to 1898. In this short time span, the number of farms in Cuba fell from 90,700 to 60,711, with an average size of 58 hectares.[66] As Funes writes, "Those with less than 13 hectares predominated, occupying approximately 50 percent of the agricultural area of the country. Large farms of more than 135 hectares were largely devoted to sugarcane and livestock production."[67]

Post-Colonial Cuba:

Following the Spanish colonial period, American investors moved into Cuba and began to buy up much of the best agricultural land, exploiting the labor of the rural low and middle class for foreign gains. On the eve of the Cuban Revolution, "thirteen American sugar companies owned 117 million hectares of land, with an estimated 25 percent of total arable land under

---

[64]Ibid., 12-3.

[65]Fernando Funes, "The Organic Farming Movement in Cuba," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 3.

[66]Ibid., 3-4.

[67]Ibid.

foreign control," while "The rural middle class, lower middle class, and *campesinos* who owned their own land, had approximately 2.5 million hectares. Overall, 9.4 percent of landowners had 73.3 percent of the land."[68] This level of dominance led to sugar exports totaling more than 75 percent of all Cuban exports and was built upon the exploitation of poor Cubans. At the time, the average agricultural worker in Cuba earned just 300 Cuban pesos per year, with 60 percent of them living in palm huts with dirt floors.[69] On top of that, "only 11 percent consumed milk, 4 percent meat and 20 percent eggs while the main staples of their diet were rice, beans, roots, and tubers. Forty-three percent were illiterate and 44 percent never attended school."[70]

The entirety of the pre-revolutionary period is defined by rampant inequality in Cuba's agricultural sector. Following the end of the period of slave labor, a semi-feudal system was implemented on most large plantations which sought to emulate some of the structures of slavery through the creation of company store coupon systems, similar to those used in coal mining towns in the United States, and use of the army for labor control and regulation.[71] Farmers themselves received a relative pittance for their crops, while intermediaries, who took the produce to retail markets, made as much as 30 times profit on what they paid to farmers.[72] While foreign, and wealthy owners controlled most of the land, large farms and plantations produced almost exclusively for export leaving *campesinos*[73] and other small farmers with the responsibility to produce food for domestic consumption. However, the productive capacity of small farmers was well below demand, mandating sizable imports in order to feed the Cuban

[68]Armando Nova, "Cuban Agriculture Before 1990," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 27.

[69]Ibid., 28.

[70]Ibid.

[71]Ibid.

[72]Ibid.

[73]Campesino is the Spanish word for peasant farmer, used most commonly throughout Latin America to define the role of rural small farmers, typically employing traditional agricultural methods.

population, most frequently arriving from their main buyer of sugarcane and processed sugar, the United States.[74] All of this culminated in creating an economy which was hugely dependent upon American investors and businesses, who sought to exploit the Cuban economy and its small farmers to achieve massive profits. With all of this in mind, it is no wonder that Fidel Castro, Che Guevara, and the leadership of the 26th of July Movement were able to foster so much support for their revolution.

Agriculture in Cuba under the Castro Regime:

What followed the revolution was a series of two sweeping agrarian reforms, in 1959 and 1963 respectively, which consolidated more than 70 percent of Cuba's arable land under government control, totaling over 5.5 million hectares.[75] The government took control of the land previously held under foreign ownership and redistributed a sizable portion of it – over 1 million hectares – to those who had been working the land.[76] In addition to the nationalization of agricultural land, the new Castro government sought to bring newfound diversity to Cuban agriculture. This process proceeded very well in the first few years following the revolution, with many staple vegetable crops seeing very significant increases in production. However, as Nova writes, when "the ex-Soviet Union and the rest of the socialist countries in Eastern Europe decided to purchase Cuban sugar in bulk… This led to a decision to reconsider the reduction of area devoted to sugarcane, thus prolonging our dependence on a one-product farming system."[77] The Soviet Union and other key members of COMECON (The Council for Mutual Economic Assistance) began to buy Cuban sugar in massive quantities as it represented a high quality alternative to the Eastern European beet based sugar. One of the reasons the Cuban government

[74]Ibid., 29.
[75]Ibid.
[76]Ibid.
[77]Ibid.

was willing to abandon their initial plans of diversification was the heavily subsidized price they received from COMECON. By the eve of the economic collapse, Cuba was being paid 51 cents per pound of sugar, over ten times the global market price of 5 cents per pound.[78]

This extraordinary price was reinvested with great success by the Cuban government in developing key infrastructure in Cuba and pushing it towards contemporary ideals of industrial modernism. The government formed 272 "People's State Farms", the majority of which were dedicated to sugarcane production through an intensive industrial model.[79] The individual inputs required for this industrial practice were imported extensively from the Soviet Union and other COMECON countries, and throughout the 70s and 80s, Cuban agrochemical use paralleled, or even exceeded, American agrochemical use per land unit area.[80] This development was made in the hopes of reaching a ten million ton harvest of sugar by 1970.[81] This target, ultimately was not met, however, sustained annual harvests in the 7-8 million ton range marked tremendous improvements over pre-Revolution figures,[82] which typically ranged anywhere from 1 to 5 million tons between 1900 and 1959.[83] This sustained production, supported by a massively inflated export market, allowed for rapid and widespread development in many sectors throughout Cuba. By the 1980s, per capita food energy and protein consumption were among the highest in Latin America, life expectancy was 75 years, and child mortality only 13.6 in 1000,

[78]Juan Alberto Simón Reardon and Reinaldo Alemán Pérez, "Agroecology and the Development of Indicators of Food Sovereignty in Cuban Food Systems," *Journal of Sustainable Agriculture*, Vol. 34, No. 8 (2010), 913.

[79]Nova, "Cuban Agriculture Before 1990," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 30.

[80]*The Power of Community: How Cuba Survived Peak Oil*, Directed by Faith Morgan, United States: AlchemyHouse Productions Inc., 2006, at 16:20.

[81]Juan Valdéz Paz, "The Cuban Agrarian Revolution: Achievements and Challenges," *Estudos Avançados*, Vol. 25, No. 72 (2011), 77.

[82]Ibid., 80.

[83]Nova, "Cuban Agriculture Before 1990," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 36.

leading both categories in Latin America, in addition, the literacy rate of 92.4% was nearly at United States levels.[84]

Early Signs of Failure in the Intensive Mode of Production:

It is important to acknowledge, however, that not everything was working perfectly in the years running up to the economic collapse. As early as the 1970s, the Cuban government was aware of certain deficiencies in the new industrial mode of agricultural production.[85] Signs that the intensive model was leading to degradation of arable soils – most commonly in the form of erosion, poor drainage, and increased salinity or acidity – led to several research centers shifting their focus to finding alternatives to the high input model, most often in the form of sustainable input substitution technologies.[86] In addition, or perhaps as a result of this, by the mid to late 80s, there was a marked downturn in overall production for a significant number of major crops. As Nova writes:

> This came about in an intensive development model, based on high levels of external inputs and a high external dependency (mainly machinery, fuel, and agrochemicals); similar to the situation faced by other countries applying the same productionist model. Furthermore, the quantities produced were not sufficient to fully cover the demands of the population with any economic effectiveness. Meanwhile a very significant proportion of arable land was used for export production, and many soils had begun to show signs of degradation (salinity, erosion, acidity, poor drainage, etc.). These factors already made it important to carry out economic, structural, technical, and organizational transformations in Cuban agriculture. The events that occurred in the Eastern European countries only made the task more urgent.[87]

While the situation that transpired following the economic collapse was certainly enough to demand a widespread and immediate transition away from the industrial model of production, it

---

[84]Ivette Perfecto, "The Transformation of Cuban Agriculture After the Cold War," *American Journal of Alternative Agriculture*, Vol. 9, No. 3 (1994), 99.

[85]Funes, "The Organic Farming Movement in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 6.

[86]Ibid., 11.

[87]Nova, "Cuban Agriculture Before 1990," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 38.

is not enough to assume everything was wonderful right up until the Soviet Union began to fall apart. The steady degradation of agricultural land and downturn in productivity in the 70s and 80s prompted the government to begin to investigate alternative methods of agricultural production. These 10-20 years of research were also integral to the rapid shift that followed the economic collapse. Certain mechanisms and technologies, which had been researched and refined for years were ready for rapid deployment when imports stagnated and fell, and without these technologies it is likely that Cuba would have suffered far more than it already did.

Onset of the Special Period and its Impacts:

Despite the government's recognition of certain failings with the industrial model of agriculture in Cuba, the system as a whole was still very far from being sustainable in the long run. As Ivette Perfecto writes in her article "The Transformation of Cuban Agriculture After the Cold War", "many of these achievements were shaky, resting as they did on a dependent and unsustainable agriculture."[88] When the Soviet Union and the rest of the Eastern Block began to fall apart in the end of 1989 – marked most notably by the fall of the Berlin Wall in November of that year – the trade relations that Cuba was so utterly dependent upon vanished almost overnight. Cuba lost access to nearly all of the pesticides, herbicides, fertilizers, machinery, and fuel its agricultural sector was dependent on – by 1990, Cuba had access to just 25% of the fertilizers and pesticides it had had just one year earlier, and had to make do with little fuel, and almost no spare parts for tractors and other agricultural machinery – and had a very limited global market to sell the sugar it was able to produce.[89] As a result, Cuba suffered an incredibly devastating economic collapse, which would come to be known, along with the austerity measures implemented by the government to address the worst impacts of the collapse, as "The

[88]Perfecto, "The Transformation of Cuban Agriculture After the Cold War," 99.
[89]Ibid., 98.

Special Period in Time of Peace", or simply the Special Period. This period was typified by shortages of most necessities and the stagnation or even collapse of key industries and infrastructure throughout Cuba.

Almost all of this struggle was caused by a system utterly dependent on high levels of imports, faced with few to no imports available. As Funes writes, "Prior to 1989 more than 85 percent of our trade was with socialist countries in Europe, and a little more than 10 percent with capitalist countries. Cuba imported two thirds of its foodstuffs, almost all of its fuel and 80 percent of its machinery and spare parts from socialist countries."[90] Cuba lost access to most of its food – in the pre-collapse period, food imports from the Soviet Union and other COMECON countries represented more than 50 percent of all domestic consumption in Cuba[91] – and nearly all of its capacity to produce its own food within the industrial context of Cuban agriculture at the time, with domestic agricultural output falling by 54% between 1989 and 1994.[92] Despite strict rationing under Special Period mandate, in that same time period, total food consumption on the island fell by 34% from an average of 2,908 calories/day to just 1,863.[93] This reduction culminated in the Cuban population losing an average of 20 lbs. per person in just five years.[94] Despite these struggles, due to the stringency of the economic barriers placed on Cuba by the United States in the form of an embargo, known as "The Blockade" in Cuba, food imports still represented only 16 percent of the reduced total amount of imports in 1990, reaching nearly 30%

[90]Funes, "The Organic Farming Movement in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 6.

[91]Arcadio Ríos, "Mechanization, Animal Traction, and Sustainable Agriculture," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 156.

[92]Reardon and Pérez, "Agroecology and the Development of Indicators of Food Sovereignty in Cuban Food Systems," 914.

[93]Ibid.

[94]*The Power of Community: How Cuba Survived Peak Oil*, at 11:10.

by 1995.[95] It also became increasingly difficult to feed livestock, reducing egg production to such an extent that most hens were slaughtered for immediate consumption rather than trying to maintain an egg laying population.[96] Dairy production also took a massive hit, especially in provinces such as Havana,[97] specialized in its production, where annual production fell by 260 million liters.[98]

Beyond food, Cuba's economy as a whole also suffered massively. As a result of the end of trade relations with the Soviet Union and the rest of the Eastern Bloc, "there was a 75 percent reduction in imports and 79 percent in exports."[99] These reductions played a major role in Cuba's total GDP falling by 40% in a matter of five years. To put this in perspective, the Great Depression resulted in a 25% decline in GDP in the United States,[100] and the Great Recession of 2008, a measly 4.3 percent.[101] By 1993, capital circulation was so far behind the currency supply that the average Cuban had over 15 months' worth of wages on hand, but could simply not find enough goods in stores to spend their salaries, and by 1998, the budget deficit had reached 559.7 million pesos.[102] Transportation in the country also took a massive hit as fuel imports fell by 67 percent.[103] Public transportation became one of the only ways to get around, and many vehicles were converted to maximize the number of passengers they could accommodate. One example of

---

[95]Marcos Nieto, "Cuban Agriculture and Food Security," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 47.

[96]Ibid., 45.

[97]Havana province is the second westernmost province of Cuba in the area surrounding, but not including the capital city of Havana, which is its own province.

[98]Marta Monzote, "The Integration of Crops and Livestock," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 195-6.

[99]Nieto, "Cuban Agriculture and Food Security," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 41.

[100]Michael Lucci, "Illinois' Economic Growth Is Worse than during the Great Depression," Illinois Policy, June 13, 2017, https://www.illinoispolicy.org/illinois-economic-growth-is-worse-than-during-the-great-depression/.

[101]Robert Rich, "The Great Recession," Federal Reserve History, November 22, 2013, https://www.federalreservehistory.org/essays/great_recession_of_200709.

[102]Nieto, "Cuban Agriculture and Food Security," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 41.

[103]Perfecto, "The Transformation of Cuban Agriculture After the Cold War," 99.

this is the "Camels" – converted trailer flatbeds pulled by semi-tractors that can hold up to 300 passengers each – which became ubiquitous in urban centers like Havana.[104] The Cuban government also imported over 1 million bicycles from China and manufactured another half million to distribute around the country in an effort to alleviate some of the stress on the new public transportation system.[105] Countrywide blackouts were also very common throughout the Special Period, as a lack of imported fuel could leave the country without power for as long as 16 hours in succession.[106]

[104]*The Power of Community: How Cuba Survived Peak Oil*, at 38:10.
[105]Ibid., at 12:45.
[106]Ibid., at 11:30.

Part 2 – A Changing Agrarian Structure

It was in response to this crisis that, in early 1991, the government officially declared the Special Period in Time of Peace, introducing strict peacetime austerity measures with the intent to minimize the impact of the economic collapse. More importantly to this paper, however, the Special Period also marked a distinct shift in the way the Cuban government and non-governmental organizations (NGOs) thought about agriculture. Sweeping agrarian reforms were implemented and a fundamentally restructuring of agricultural infrastructure and mechanisms throughout the country was undertaken with the aim of moving towards, "a low external input form of agriculture, while at the same time boosting production."[107] The process was holistic, not relying on any one policy or initiative, but rather incorporating a widespread array of changes at just about every level of the national agricultural industry. Changes were made through a restructuring of the distribution and content of agricultural education and research, a reframing of the structures of land ownership and the formation of agricultural cooperatives, and a promotion on urban agricultural development with an emphasis on local consumption. These changes, made in conjunction with an institutional embrace of a transition away from the pre-existing industrial mode of production in favor of one predication on self-sufficiency and the use of agroecological practices, led the government and NGOs to institutionalize agroecology in Cuba, writing it into national law and encouraging, or in some cases even mandating its use.

[107]Funes, "The Organic Farming Movement in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 7.

Chapter 3: Research, Education, and the Spread of Agroecology –

Expansion of Pre-Collapse Research:

As I mentioned earlier, the downturn in agricultural production during the late 70s and 80s, and the subsequent research efforts to find suitable, sustainable input substitution technologies played an integral role in accelerating the shift towards agroecology. Despite the importance of this work, however, before the Special Period, a very small number of researchers and research institutes had adopted an agroecological vision, and it wasn't until 1992, when a group of professors and researchers came together to discuss the necessity of implementing agroecological practices, organizing the First National Conference on Organic Agriculture and forming the Cuban Organic Farming Association (ACAO) in the process, that the idea of building a national conscience surrounding the need for sustainable farming practices centered on agroecology came to the forefront of scientific and political thinking.[108] Just 10 years after this first meeting was held, the Cuban Ministry of Agriculture (MINAG) and other key government ministries like the Ministries of Education and Higher Education (MINED and MES respectively) hosted 17 fully functioning research centers and 38 experiment stations dedicated to research into agroecological practices and other appropriate technologies tailored to each region and province throughout Cuba, employing nearly 800 researchers and 168 PhDs in different fields.[109] Successful research projects from these institutions, specifically those looking at sustainable substitutions for pesticides and/or herbicides, are often ported over to one of the 276 Centers for the Production of Entomophages and Entomopathogens (CREEs) established by MINAG and MINAZ (Ministry of Sugar) since the onset of the Special Period.[110] These centers,

[108]Funes, "The Organic Farming Movement in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 11.
[109]Ibid., 6.
[110]Ibid., 17.

distributed in a decentralized fashion throughout the country, specialize in artisanal, small scale production of locally specific biocontrol agents intended to combat pests and diseases affecting the region.[111] In addition to the CREEs, a number of industrial-scale plants have been repurposed or built for the purpose of higher volume production of more widely applicable biocontrol agents, resulting in over one fifth of Cuba's agricultural land being protected by domestically produced biocontrol agents by 2000, covering a wide variety of crops.[112]

Changes in Pedagogical Approach to Agricultural Education:

While this institutional response to the depleted supply of agricultural inputs was hugely important to the rapid adoption of agroecological practices, Funes argues that the most influential group in the spread of agroecology was Cuba's *campesino* population. He writes, "while there are many research centers studying these topics, with important results, it has been the *campesinos* who never abandoned these practices who have made the greatest contributions."[113] It was the work of Cuban *campesinos* throughout the 20th century that broke through to Cuban government officials and NGO leaders sparking a change in the way agriculture was framed in Cuban education. In his chapter on "Agroecological Education and Training" in Cuba, Luis Garcia identifies the critical difference between industrial agriculture and agroecology, the realization of which has been crucial to Cuba's educational successes, when he writes:

> While at first glance the essential differences between agroecological and conventional agricultural education are in the course content, the real contrasts and contradictions are in the basic philosophy of science. Conventional agronomy assumes you can break down any system to its basic production factors, separate and study them independently, and then reassemble your findings such that the total is equal to the sum of its components. Agroecology assumes that the interrelatedness of each production factor to the others is so profound that to study

[111]Ibid., 16-17.
[112]Ibid., 17.
[113]Ibid.

> them you must take an interdisciplinary, holistic, and systemic approach. Thus, changing the content has required creating a new educational methodology.[114,115]

Without this recognition, an agroecological shift would likely not have been possible, and most certainly not so rapidly. The change in pedagogical approach to agricultural education in Cuba not only prepared students to apply the new model of agriculture, but also began to fundamentally restructure the way Cuban people thought about agriculture. The dominant hegemony of industrial agriculture began to be slowly replaced by a counter-hegemonic agroecology, and along with it, a more sustainable and just national food system.

Shifting Institutional Structures:

Following this shift in the pedagogical approach to agriculture, many institutions began to reform the structure of their agricultural education programs, starting with oldest agricultural school in Cuba, the Agrarian University of Havana (UNAH). Almost immediately following the onset of the Special Period, UNAH created courses intended to provide an updated education to their graduates and many other professionals as soon as possible.[116] A new education center, the Center for the Study of Sustainable Agriculture (CEAS), was formed to serve as a central hub for new research and education projects, and by the end of the 90s, agroecological theory had been introduced to every single undergraduate agriculture program in the country, with existing masters and doctoral programs received a similar deluge of new agroecological content.[117] However, education reforms were not isolated to just Cuban universities. As Garcia writes, "In

---

[114]Luis Garcia, "Agroecological Education and Training," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 104.

[115]It is for this reason that I would argue agroecology is the most Science, Technology, and Society approach to agriculture, and a large reason why it is such an appealing system to me. Through the application of an ANT-adjacent look at the microcosm of the farm, agroecology defies the lab based Mertonian ideal and demands on-site innovation and discovery.

[116]Garcia, "Agroecological Education and Training," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 93.

[117]Ibid.

Cuba we have seen that it is critical to offer new training to the directors of state agricultural enterprises, policymakers and production managers, to the members of agricultural cooperatives, and to the general public in rural areas (estimated at more than two million people) … The public must not only be educated in their role as consumers, but also with regard to their direct role in urban gardening and farming."[118] To achieve this, since the beginning of the Special Period, approximately 100,000 people have attended some form of agroecological training each year, and over 1,000 attend a under-grad or graduate level agroecology course.[119] This level of exposure to agroecological ideas has played a critical role in garnering support for the shift and facilitating more widespread adoption.

Agroecological ideas and principles have also been introduced at earlier stages in the education system. Elementary school students are introduced to agroecological concepts through formal schooling as well as extra-curricular and club activities.[120] Cuba's rural vocational high schools, known as Agricultural Polytechnic institutes (IPAs) have also played a major role in providing early agroecological education to the future farmers and agronomists of Cuba. The program has seen rapid expansion since the beginning of the Special Period, growing from 55 to 143 schools between 1990 and 1996, at which point there were over 40,000 students enrolled.[121] Each school has its own agroecological experimentation area designed to give students practical experience with on farm innovation. These fields are also used to produce food for the school, often meeting most or all of the school's food demands. Some schools even run their own CREEs and sell biocontrol agents to local farmers, generating revenue for school financing and

[118]Garcia, "Agroecological Education and Training," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 94.
[119]Ibid., 95.
[120]Ibid., 96.
[121]Ibid., 98.

other projects.[122] With regard to actual coursework, students spend at least half of their "in-class" time completing practical, hands-on training exercises, with an important stress placed on "learning by doing."[123]

Peer-to-Peer Education Systems:

Despite the successes of these institutional changes, government and NGO leaders in Cuba quickly realized that "it would be nearly impossible to meet the challenge of educating millions of people by taking a conventional approach to agroecological education, especially given the innovative, constantly growing nature of this field."[124] Educational outreach had to be extended, crucially, to farmers and *campesino* leaders around the country, a process which was largely undertaken by Cuban NGOs. Throughout the 90s, "several thousand… received agroecological training at the National School of the National Association of Small Farmers (ANAP), where the curriculum was developed in collaboration with CEAS."[125] ANAP, the Cuban grassroots branch of the global peasant's movement La Via Campesina,[126] is one of the largest and most influential NGOs in Cuba, and has played a central role in the dissemination of agroecological information and training throughout Cuba. In conjunction with the training the group provides to *campesino* leaders around the country, it has also developed and spread a highly successful *campesino-á-campesino* (CAC – meaning farmer-to-farmer or peasant-to-peasant – is a peer-to-peer framework for agricultural education within a community)

[122]Garcia, "Agroecological Education and Training," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 98.

[123]Ibid., 104.

[124]Ibid., 105.

[125]Ibid., 95.

[126]La Via Campesina is a grassroots movement with 182 membership organizations representing 81 countries that advocates small family-farm based sustainable agriculture and is responsible for coining the term "food sovereignty." https://viacampesina.org/en/

educational framework, which has played a central role in spreading agroecological knowledge to diverse populations and regions throughout Cuba.

CAC strategies are particularly potent when used in agroecological contexts, due to the importance of local realities and the fact that "local knowledge and ingenuity of farmers must necessarily take a front seat"[127] in the development and application of agroecological practices. It is for this reason that ANAP leaned so heavily on the CAC systems which had been developed in other parts of Latin America during the 80s and 90s. The initial step in setting up the system required recruiting "promoters", "farmers who are[sic] recognized by their peers for the successful innovations and agroecological practices employed on their own farms and their desire and ability to teach others,"[128] with the intent that their farms would serve as classrooms for the other farmers in their communities. One key facet of ANAP's CAC model is the principle that promoters "receive no compensation other than the satisfaction of helping others and the status of being considered a good role model."[129] This is so important because of the perception it gives off to other farmers in Cuba. If promoters were paid for their work, other farmers would not believe in the technologies being presented, assuming instead that the promoters adopted agroecology simply as a means to secure a salary.[130] The next role in the CAC system is that of the "facilitator". Instead of assuming an on-farm presence, the facilitator is responsible for managing the logistics associated with organizing workshops, matching struggling farmers with a promoter who has a solution to whatever problem is being faced, and arranging farm visits. Again, unlike the promoter, the facilitator is a paid position, "hired and paid by each cooperative

[127]Peter M Rosset et al., "The Campesino-to-Campesino Agroecology Movement of ANAP in Cuba: Social Process Methodology in the Construction of Sustainable Peasant Agriculture and Food Sovereignty," *The Journal of Peasant Studies*, Vol. 38, No. 1 (January 2011) 168.

[128]Ibid., 171

[129]Ibid.

[130]Ibid.

that chooses to have one or more facilitator."[131] It is important to note that each cooperative has complete autonomy when it comes to deciding who to hire as a facilitator, with some even deciding to forego the position entirely.

This was the extent of the model for the first few years of the program, however, as it expanded throughout the country, spreading to all 15 provinces by 2003, the infrastructural and logistical challenges posed to individual facilitators became much too complex, necessitating the formation of a third role in the CAC system. This position is the "coordinator", filled by trained professionals in fields as far ranging as agricultural sciences, public relations, or administration. While the role of the coordinator is theoretically similar to that of the facilitator, they are charged with coordinating exchanges and training at "higher levels or on broader scales"[132] than the facilitator whose work is most often isolated to a single cooperative. In practical terms, this means that coordinators are responsible for managing a number of cooperatives at once, with positions filled at the municipal, provincial, and even national level. Unlike the facilitator, coordinators are hired and paid by ANAP itself and are an available resource for all cooperatives, regardless of whether they chose to hire their own facilitator.[133]

The following is a quote that I hope will help illuminate the intricacies of the individual roles explained above, as well as highlight the value of the CAC system in Cuba:

> If exchange visits are not well tailored to match needs, a lot of time and resources can be wasted. In the Banes method [Banes is the name of the municipality in which this method was first developed, however, due to its success, it is now used throughout the country], the members of a cooperative fill out a matrix form during the assembly of their co-op. The matrix is a self-inventory of both the effective agroecological practices that they carry out on their own farms and the still unsolved problems they are facing. These matrices are tabulated and cross-referenced by the municipal coordinator and the

[131]Ibid.
[132]Ibid., 173.
[133]Ibid.

> facilitator from each cooperative, and help rapidly identify potential new promoters, problem areas, and key exchanges that must be organized.[134]

By virtue of its decentralized nature, the CAC model described above is able to operate over relatively large areas and encompass a large number of farms and farmers without using up any significant quantity of time or money resources. Exchanges with a high likelihood of success are identified and made very easily, enabling the CAC education model to spread quickly throughout the country. In Cuba, this has enabled a rapid transition towards agroecological principles and practices, without demanding the huge volume of resources required to put every farmer in the country through fully formalized agroecological training.

During the 2000s, the CAC movement in Cuba grew extremely rapidly. The number of participating families went from 1,500 in 2000 to 110,000 in 2009, the number of promoters grew from 52 to nearly 12,000, the number of facilitators from 27 to 3,000, and the number of coordinators from 0 to 170.[135] This widespread growth of the program had demonstrable impacts on the production and livelihoods of peasant producers. By 2009, peasant agricultural production was up nearly 300% from pre-collapse levels,[136] all while using less than half the agrochemicals.[137] With regards to individuals actually partaking in the CAC education system, those who successfully implemented the agroecological practices they had been taught regularly saw their farm classification increase.[138] The jump from category one to two corresponds with a

---

[134]Ibid., 174.

[135]Braulio Machín Sosa et al., *Agroecological Revolution: The Farmer-to-Farmer Movement of the ANAP in Cuba*, ed. Meredith Palmer, trans. Ann Greenberg (ANAP, International Commission on Sustainable Peasant Agriculture of la Via Campesina, 2013), 105-6.

[136]Ibid., 108.

[137]Ibid., 110.

[138]A farm classification model has been implemented in Cuba to highlight the agroecological successes of individual farms, intended to promote the idea of learning from role-model farmers. The categories are defined as follows; "Category 1: Farms which have initiated the path towards agroecology… Category 2: Farms in agroecological transition… Category 3: Agroecological farms." From, Machín Sosa et al., *Agroecological Revolution*, 115-6. See Appendix A for a detailed list of the specific criteria associated with each category.

200 Cuban peso increase in profit per year, per hectare, and a 1,400 peso increase per year per unit of labor. The jump from two to three is even more impactful, with a 1,600 peso increase per year per hectare, and a 3,000 increase per year per unit of labor.[139] The use of the CAC system in Cuba has not only corresponded with a major increase in the adoption of agroecological practices and a subsequent boost in production, but it has also fundamentally altered the lives and livelihoods of campesinos throughout the country, granting them both food security and sovereignty.

[139]Ibid., 117.

Chapter 4: Land Reform and the Formation of Agricultural Cooperatives –

Land Reform and the Breakup of State Farms into UBPCs:

One of the earliest institutional responses to the Special Period and the damage it was doing to agriculture throughout Cuba took the form of a radical land reform. As discussed earlier, throughout the pre-collapse Castro period, land in Cuba was largely consolidated under state ownership, with state farms controlling roughly 75% of agricultural land in the years leading up to the reform.[140] As a result of the agricultural destitution brought about by the economic collapse, Cuban officials chose to privatize much of the state ownership structure, reducing its share of land to 40%.[141] This change was made with the intent to favor peasant and cooperative production and was accompanied by the formation of a new type of cooperative known as Basic Units for Cooperative Production (UBPCs). Literally built from old state farms, UBPC members were granted the land they had previously worked in permanent usufruct,[142] as well as financial and administrative autonomy, allowing members to choose their own means of agricultural production.[143] UBPCs were also integral in Cuba's economic recovery, as "in 1996 alone the expansion of UBPCs contributed to 73 percent of the newly created jobs in the country."[144] These cooperatives also played a major role in alleviating the worst of Cuba's chronic housing shortage through the creation of special funds dedicated to the creation and

[140]Efe Can Gürcan, "Cuban Agriculture and Food Sovereignty: Beyond Civil-Society-Centric and Globalist Paradigms," *Latin American Perspectives*, Vol. 41, No. 4 (July 2014), 131.

[141]Valdéz Paz, "The Cuban Agrarian Revolution," 75.

[142]Usufruct is a legal term meaning, "The right of temporary possession, use, or enjoyment of the advantages of property belonging to another, so far as may be had without causing damage or prejudice to this." From: "usufruct, n.". OED Online. March 2020. Oxford University Press. https://www.oed.com/view/Entry/220702. In the case of UBPCs, this meant rent free use of land still owned by the state, with the understanding that this land would be open for occupation and use permanently, as long as the cooperative did not damage or destroy the land.

[143] Funes, "The Organic Farming Movement in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 9.

[144]Gürcan, "Cuban Agriculture and Food Sovereignty," 132.

improvement of community housing.[145] By 1995, 2,643 sugarcane and 1,440 non-sugarcane UBPCs had been formed with 257,000 and 126,723 members respectively, with an average size of 1,125 hectares.[146]

The internal structure of the UBPCs is comprised of a general assembly made up of all the members of the cooperative and an elected nine-member board of managers who serve 5-year terms. The board typically consists of the general manager, senior engineer, and chiefs of economy, production, services, machinery, and land, as well as two other general-purpose positions.[147] Though members of the board are often distinguished and respected members of the cooperative, their power is "limited to the execution of development plans approved by the general assembly."[148] These plans are most often made during monthly assembly meetings in which all cooperative members are permitted to participate and vote. The assembly also holds weekly meeting to hear and discuss any complaints, benefits, and costs associated with any aspect of the cooperative.[149] Most UBPCs commit to sharing approximately 50% of surplus revenues with cooperative members, and use the remaining surplus to repay loans, purchase equipment, and cover any other costs associated with production. If these costs are covered by the surplus, remaining funds are dedicated to the development of services for cooperative members including healthcare, recreation, and technical trainings.[150] One key understanding within UBPCs in Cuba is that a cooperative will never be successful while its members are unhappy. For this reason, pathways for communication and dialogue between members have

[145]Ibid.
[146]Ibid., 133.
[147]Ibid.
[148]Ibid., 134.
[149]Ibid.
[150]Ibid.

intentionally been built into the structure of the cooperatives, which ultimately seems to be a critical facet of the successes UBPCs have seen since their inception.

Reorganization of Remaining State Farms into GENTs:

Not all state farms were immediately transformed into UBPCs, however. The 40% of land remaining under state control following the land reform was not seen as immediately ready for cooperative ownership and production. The remaining state farms were only slightly converted into the New-Type State Farms or GENTs (GENT is the acronym for: *Granjas Estatales de Nuevo Tipo* – meaning New-Type State Farm in Spanish) which now exist throughout the country. Though the GENTs are still under full state ownership, they are designed to offer much greater administrative autonomy than the traditional state farms.[151] This is achieved through the formation of workers cooperatives on the state farms, which over time take on financial and managerial responsibilities, with many on track to become a full-fledged UBPC.[152] In addition, cooperative members working in GENTs enter into profit sharing contracts which designate 50% of the GENT revenues to be shared between cooperative members,[153] on top of a guaranteed basic salary paid by the state.[154] This allows for both profits and risks to be shared between the state and workers cooperative, giving workers more flexibility and allowing for the creation of experimental projects and other work arrangements in the potential lead up to full cooperative ownership. Not all GENTs are destined for full cooperative

[151]Nieto, "Cuban Agriculture and Food Security," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 53.

[152]Lucy Martin, "Transforming the Cuban Countryside: Property, Markets, and Technological Change," in Fernando Funes et al., eds., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 60.

[153]Gürcan, "Cuban Agriculture and Food Sovereignty," 135.

[154]Martin, "Transforming the Cuban Countryside," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 60.

ownership, however, as the state maintains ownership of roughly 25% of the country's agricultural land, largely in the form of GENTs.[155]

Growth of the Peasant Sector and Rejuvenation of CCSs and CPAs:

Perhaps the most notable success following the collapse can be seen in Cuba's peasant sector. It was here that the original cooperatives were formed; first, the Credit and Service Cooperatives (CCSs), born of the First Agrarian Reform Law of 1959, though not fully formalized until the early 1970s, and the Agricultural Production Cooperatives (CPAs), formed at the Fifth Congress of the National Association of Small Farmers in 1977.[156] Though created at similar times, the two cooperative structures work very differently. CCSs take the form of an association of small farmers who own their individual land. Though they work and farm separately, they come together to create economies of scale for the purposes of marketing products, obtaining credit, and renting or purchasing farm machinery among other capital-intensive activities.[157] In contrast, CPAs much more closely follow the collective ownership model and internal structure of UBPCs, having been the inspiration for their design.[158] Unlike UBPCs, however, CPAs are composed entirely of small farmers who pooled their land and resources together to create a singular socialist economic entity.[159] CPA members share full ownership of their land as well as the means of production and other productive assets, without the potential for the state to reclaim that land under usufructuary law.[160] CCSs and CPAs

[155]Valdéz Paz, "The Cuban Agrarian Revolution," 75.
[156]Nova, "Cuban Agriculture Before 1990," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 30.
[157]Rosset et al., "The Campesino-to-Campesino agroecology movement of ANAP in Cuba," 166.
[158]Gürcan, "Cuban Agriculture and Food Sovereignty," 133.
[159]Machín Sosa et al., *Agroecological Revolution*, 47.
[160]Rosset et al., "The Campesino-to-Campesino agroecology movement of ANAP in Cuba," 166.

developed and spread across Cuba throughout the 70s and 80s, and on the eve of the Special Period, owned 12 and 10 percent of the country's land respectively.[161]

The successes of these cooperatives can be seen very clearly in the growth and resiliency of the peasant sector as a whole. Although its production levels fell by over 50% in the first five years of the special period, production levels have skyrocketed since 1994, reaching almost three times pre-collapse levels in 2009.[162] This success is further emphasized by looking at the growth in percent contribution of the peasant sector to total national production between 1988 and 2009. CPAs and CCSs now account for over half of Cuba's production of pork, milk, fruits, beans, maize, vegetables, roots and tubers, and a number of other less prominent crops, all on just over 25% of the country's farmland (see graph at Appendix B).[163] In fact, in 2009, the peasant sector reported unprecedented levels of growth, well beyond the levels expected within the National Planting Plan for the year.[164]

Much of this success can be attributed to the integration of the CAC movement into these private cooperatives, which occurred much more rapidly than in UBPCs and GENTs. As Rosset et al. write, "The CCSs proved to be very agile and rapidly adaptable to the changing conditions of the Special Period…Their members typically exhibit a strong sense of belonging to, and caring for, the land (called a sense of *pertenencia* in Spanish), making CCS families initially very open to ecological practices."[165] Things were not all perfect, however, as "the CCSs were administratively weak, and not particularly adept at marketing products, managing finances, navigating government programs, etc., and had little infrastructure."[166] On almost the exact other

---

[161]Machín Sosa et al., *Agroecological Revolution*, 47.
[162]Rosset et al., "The Campesino-to-Campesino agroecology movement of ANAP in Cuba," 180.
[163]Machín Sosa et al., *Agroecological Revolution*, 25.
[164]Machín Sosa et al., *Agroecological Revolution*, 109.
[165]Rosset et al., "The Campesino-to-Campesino agroecology movement of ANAP in Cuba," 167.
[166]Ibid.

side of things, the CPAs "tended to have a much stronger administration and good infrastructure, but the assigning of work teams to areas on a rotating basis meant there was little attachment to the land and no readily discernable link between hard work and remuneration, which led to lower labor productivity."[167] To remedy these issues, ANAP attempted to combine the best aspects of each with the other. CCSs were provided with management teams, tools, and trainings to enable widespread provision of services to their members and to aid in the acquisition and integration of new infrastructure. Within CPAs, a new division of labor was conceptualized built around the idea of "linking people to the land and to the final results."[168] An emphasis was placed upon building connections with a particular piece of land, and offering rewards for high quality work, inspiring much greater work ethic and productivity levels.[169] Both of these changes improved the output of the cooperatives, however, ultimately, CCSs were able to progress much more quickly by virtue of their rapid acceptance of agroecological principles.[170]

One notable change which was made specifically within CPAs, was the adoption of the *autoconsumo* system, the setting aside of land with the express purpose of subsistence production. This idea was very divergent from the previous norm within agricultural cooperatives of maintaining complete crop specialization and using all the land for cultivation of one or a few key crops.[171] The goal of this new system is to utilize areas not already under cultivation to grow food crops and raise livestock for self-provisioning, ensuring that all members of the cooperative are provided for, at least in part, in terms of food consumption

[167]Ibid.
[168]Machín Sosa et al., *Agroecological Revolution*, 63.
[169]Rosset et al., "The Campesino-to-Campesino agroecology movement of ANAP in Cuba," 167.
[170]Ibid.
[171]Laura J Enríquez, "Cuba's New Agricultural Revolution: The Transformation of Food Crop Production in Contemporary Cuba," *Food First/Institute for Food and Development Policy*, Development Report No. 14 (May 2000) 6.

demands.[172] Additional member needs were met through another new program named the *tiro directo*, literally the direct throw. These programs are composed of arrangements made between individual CPAs and nearby central markets, which allow the CPAs to deliver produce directly to market instead of operating through Acopio, the state marketing and distribution network. Through a decentralization and downsizing of the production and distribution process, local communities are served with fresher produce, and CPAs receive increased profits associated with the distribution of their crops, allowing for reinvestment into the cooperative.[173]

Put together, these changes have seen the peasant sector swell in size since the onset of the Special Period. Data on the number of peasant farmers and families before the Special Period is somewhat imprecise, unfortunately, and the earliest figures available are for 1997-8. At that time, after almost assuredly seeing some growth from pre-collapse levels, there were over 230,000 members of CPAs and CCSs.[174] Just over ten years later, in 2009, that number had grown to nearly 350,000.[175] On top of this, the desirability and success of peasant agriculture have made it a well-respected profession, with the state even giving away land in an attempt to expand the sector. As Machin Sosa et al. write, "the peasant sector in Cuba has experienced an increase in people who are involved in agricultural activities during the last twenty years. This is the result of a state policy to deliver vacant land in permanent usufruct, free to individuals and cooperatives who may have the interest and ability to work it."[176] Between 1993 and 1996, the number of these *usufructuarios* grew from zero to 43,000,[177] and have only continued to expand

[172]Ibid.
[173]Ibid., 12.
[174]Mavis D. Álvarez, "Social Organization and Sustainability of Small Farm Agriculture in Cuba," in Funes et al., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba*, (Oakland, CA: Food First Books, 2002) 75.
[175]Rosset et al., "The Campesino-to-Campesino agroecology movement of ANAP in Cuba," 175.
[176]Machín Sosa et al., *Agroecological Revolution*, 157.
[177]Martin, "Transforming the Cuban Countryside," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 64.

since then. ANAP has been attempting to incorporate these new individual farmers into existing CCSs, or create new cooperatives to accommodate them, however, many choose not to join, or are a part of one of the roughly 250 farmers associations in Cuba, more loosely organized entities than CCSs, serving a similar purpose.[178]

[178]Nova, "Cuban Agriculture Before 1990," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 30.

Chapter 5: Urban Agricultural Development –

Emergence of Urban Agriculture as Popular Resistance:

The last major change in Cuba's shift towards agroecology happened within the country's large cities. Although agriculture had been taking place in urban areas in Cuba since the early part of the 20th century, it wasn't until the onset of the Special Period that it took off in its expansion. Starting in the early 90s, in response to severe food shortages and a crumbling economy, urban residents, from construction workers to doctors, started growing whatever food they could on the unused land of their cities. Despite their lack of agricultural training and knowledge, through a process of trial and error, these newfound urban farmers were able to create the best cropping systems they could with the limited space and resources they had available. As Cederlöf writes in his paper "Low-Carbon Food Supply: The Ecological Geography of Cuban Urban Agriculture and Agroecological Theory," "After Cuba's loss of political and economic allies, people in the cities began cultivating back gardens, parking lots, roof tops, demolition sites, patios, garbage dumps, and unused urban land with vegetables to feed themselves. Cultivating the city became an act of resistance to the crisis where people engaged in a spatial politics to control food supply."[179] Their act of engaging in urban farming was a means of regaining agency during the time of crisis and shined a light on the importance of increasing agricultural output and supporting new agriculturalists.

The Cuban government, in response to this popular struggle and a part of a broader set of reforms intended to decentralize the agricultural sector and democratize decision making processes, in September of 1994, passed a law, Decree Law 191, which authorized the sale of

[179]Gustav Cederlöf, "Low-Carbon Food Supply: The Ecological Geography of Cuban Urban Agriculture and Agroecological Theory," *Agriculture and Human Values*, Vol. 33 (2016) 773.

agricultural surpluses at prices determined by supply and demand.[180] Their formation destroyed the black markets for food which had charged extortionate prices for the products available – as an example, rice, purchased through official channels was $0.20 pesos per pound, compared to roughly $40 pesos per pound on the black market[181] – and overnight, made urban farming a profitable enterprise. These new markets incentivized higher levels of production to meet the ballooning demand for food in Cuba, and rewarded producers with much higher prices than the state channels, though much more reasonable for consumers than the extortionate black-market prices which preceded them. Just three months after the law was passed, over 200 of these markets has been formed throughout the country, and within a year, free market sales represented 25 to 30 percent of the total production sold to Cuban consumers.[182]

Economic Growth of the Urban Agricultural Sector:

It did take some time, however, for production levels to catch up with demand. In the first few years after the opening of markets, individual producers were still struggling to determine how to best manage their urban gardens and yields were low. Despite their struggles, urban farmers could not simply stop producing food in the midst of the crisis, and over time they refined their practices and yields grew. In 1994, yields of vegetable production from intensive gardens was under 5 kg/m^2, and total production was just a few thousand tons. In 1995, yields grew to 7 kg/m^2, 1996 saw a jump to over 15 kg/m^2, and by 1999, yield per square meter was just short of 25 kgs, at which point, annual overall production had exceeded 850,000 tons (see graph at Appendix C).[183] Given the population of Cuba at the time, roughly 11 million, urban

[180]Enríquez, "Cuba's New Agricultural Revolution," 13.
[181]Ibid., 14.
[182]Gürcan, "Cuban Agriculture and Food Sovereignty," 139.
[183]Nelso Companioni et al., "The Growth of Urban Agriculture," in Fernando Funes et al., eds. *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 228.

agriculture was producing 215 grams of fresh vegetables per person, per day in 1999.[184] By 2000, the growth of the sector had created 160,000 new jobs in Cuba's densely populated and economically suffering urban centers,[185] doubling just three years later to over 320,000 jobs.[186] In 2010, the number of urban farmers had climbed to 350,000 and production had reached roughly 1.5 million tons of fresh vegetables each year,[187] amounting to 50% of the country's total production.[188]

Urban Demand and Self-Provisioning:

This rapid expansion of production, centered within Cuba's cities, had a profound impact on the way food was distributed throughout the country. What previously had to be brought in from rural areas through official state channels, was now being produced within city limits and sold at free markets. By the early 2000s, Havana, Cuba's capital and largest city, was producing roughly 90 percent of the fresh produce it was consuming, using just 12 percent of the city's land.[189] Not all of this was coming from city markets, however, as a significant emphasis has been placed on self-provisioning, similar to the *autoconsumo* program in CPAs, specifically within the workplace. Instead of feeding agricultural workers, these urban self-provisioning farms are owned and operated by factories, hospitals, schools, and other large entities, producing food for institutional cafeterias. By producing their own food, these facilities have been able to both lower food costs and increase food resources available to others in the area, while ensuring

[184]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 229.

[185]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 221.

[186]Gürcan, "Cuban Agriculture and Food Sovereignty," 138.

[187]Reardon and Pérez, "Agroecology and the Development of Indicators of Food Sovereignty in Cuban Food Systems," 916.

[188]Cederlöf, "Low-Carbon Food Supply," 772.

[189]Gürcan, "Cuban Agriculture and Food Sovereignty," 138.

that their constituents receive high quality and healthy food through subsidized lunch programs.[190]

Organizational Structure of Urban Agriculture:

Due in part to the successes discussed above, and by virtue of the significant urbanization of the Cuban population at large, there was a developed urban agriculture structure in every Cuban city and town by the early 2000s.[191] Each municipality has its own Municipal Urban Farm Enterprise responsible for coordinating all urban agricultural activities and providing services to farmers in the area. These services include extension services and technical assistance, help in linking urban farmers with one another, and creating links between farmers and research and educational centers.[192] Municipal Urban Farm Enterprises are also responsible for determining the best technologies for their subsidiaries dependent upon local resources, inputs, and land quality.[193] More narrowly, each Popular Council[194] has a representative dedicated to urban agricultural coordination for their given neighborhood. The Popular Councils, depending on local contexts, oversee specialist service units including veterinary clinics, nurseries, labs for the production of biological products, and many others.[195] These local and municipal level groups are overseen by The National Urban Agriculture Group (GNAU), a group within MINAG composed of agricultural specialists, government officials, and urban farmers, whose job it is to regulate and direct the spread of urban agriculture and provide technical support at all levels of

[190]Martin, "Transforming the Cuban Countryside," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 60.

[191]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 224.

[192]Ibid., 222.

[193]Ibid.

[194]Popular Councils are a local form of governance which exists at the neighborhood level throughout Cuba.

[195]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 224.

urban agricultural organization.[196] Within GNAU there are 26 sub-programs, each dedicated to a specific topic related to urban production (see full list at Appendix D).[197]

Important Agricultural Sub-Programs:

Though all of the sub-programs can be found throughout the country, some are much larger and more developed than others. The oldest, the vegetables and fresh herbs sub-program, is both the largest and most developed program, largely due to its age. It emerged as the first form of urban agriculture and has remained hugely important to the sector and to achieving Cuba's goals of producing 300 grams of fresh vegetables per capita daily.[198] Other noteworthy programs include small-scale "popular" rice production, medicinal plants and dried herbs, poultry, seeds, and science, technology, and training among a number of others.

In no particular order, the seeds sub-program is responsible for the cultivation of regional seed self-sufficiency through seed production and distribution. Provincial seed farms have been created across the country, ensuring a stable and timely supply of seeds to urban farmers. This is critical to guarantee a sufficient supply of seeds by appropriate sowing dates. This program also supports farmers in their endeavors to become seed self-sufficient for crops like cucumber and cowpea, which are relatively easy to produce with little training or expertise.[199]

The poultry sub-program, focusing on laying hens and ducks is by far the most advanced animal program within the urban sector. Producers are given ten females and one male from the local chicken breed, characterized by its resistance to environmental adversity and high production of meat and eggs. Laying hens with adequate feeding will lay year-round producing on average 200 eggs per bird. Ducks have been introduced to the program more recently, with

[196]Ibid.
[197]Ibid., 225.
[198]Ibid.
[199]Ibid., 232.

very promising signs. They grow very rapidly, reaching roughly three kilograms in just seven to eight weeks. Ducks are also very resilient and show greater resistance to environmental hazards and disease than chickens.[200]

The science, technology, and training sub-program is very different from the previous two. It focuses on designing practical trainings to take place in gardens and farms and has built a wide-reaching extension program for urban farming. Using extension agents, research centers, and experienced farmers, the extension services are tailored to local issues and contexts and provide urban farmers with the latest theoretical knowledge and practical training.[201]

The "popular" rice program, firmly under the aegis of ANAP, was formed with the intention of meeting domestic demand for rice, a staple crop in Cuba, without relying on large scale production. The program has encouraged a much greater number of small farmers to take up rice production and has also pushed large-scale production units like GENTs and UBPCs to grow small plots of rice in addition to their main crops.[202] These new small scale producers, through the support of ANAP and the program itself, have achieved yields above 5 tons/hectare, far outreaching the yield levels of state farms dedicated to rice production.[203]

The medicinal plants and dried herbs sub-program is one of the other most crucial programs to emerge from the urban sector. Starting during the years of the Special Period, along with just about all other goods, medicine imports to Cuba were halted. Almost concurrently with the economic collapse, the Cuban government opened up the Central Laboratory of Herbal Medicine, which began producing roughly 60 different medicinal extracts from plants which

---

[200]Ibid., 230-1.

[201]Ibid., 233.

[202]Miguel Socorro et al., "'Cultivo Popular': Small-Scale Rice Production," in Fernando Funes et al., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 238.

[203]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 229.

could be grown in Cuba (see full list at Appendix E).[204] As urban agriculture began to expand, the medicinal plants and dried herbs program was created to help meet local health needs. Typically, a portion of the production is sold to the Ministry of Public Health to be made into green medicines, with the rest being sold at local markets for domestic consumption.[205]

Production Systems of Urban Agriculture:

Through the growth of the urban agriculture sector in Cuba, a number of different cropping systems and farm structures were implemented. Probably the most distinct and innovative production system is the intensive *organopónoco* farm. This system makes use of land that is particularly unfertile and can even be built on artificial surfaces like concrete or other paved areas.[206] This is accomplished through the use of raised beds which are filled with high quality soil and organic material in which the crops are grown.[207] The system is characterized by its routine use of intercrops (see full list at Appendix F), which in most if not all cases leads to a much more efficient use of land. Using a method known as the land equivalent ratio (LER), it is possible to calculate the efficiency of an intercrop compared to the efficiency of each crop grown individually. This is done by comparing the relative land area in monoculture to give the same total production when crops are planted together (see full explanation of calculation at Appendix G). An LER of 1 means that intercropping and monocropping produce the same results, with lower numbers favoring monocropping and higher numbers favoring intercropping. Within *organopónocos*, three popular intercrops, cucumber-lettuce, cucumber-radish, and string bean-

[204]Mercedes Garcia, "Green Medicine: An Option of Richness," in Fernando Funes et al., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 213.

[205]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 229.

[206]Ibid., 226.

[207]Cederlöf, "Low-Carbon Food Supply," 773.

radish, have LERs of 1.44, 1.93, and 1.86 respectively.[208] This means, in the case of a cucumber-lettuce intercrop, the *organopónico* system produces on one hectare what a monocrop could produce on 1.93 hectares. This incredible land use efficiency has benefitted urban producers and bolstered the growth of the *organopónico* farming system. By 2007, over 3,800 had been formed, covering roughly 1,700 hectares of Cuba's urban areas.[209]

Employing similar intercropping systems, intensive gardens have also spread rapidly through Cuba. Unlike *organopónocos*, however, they do not rely on raised planter beds, mostly due to their placement on much higher quality soil. Despite this, organic material is regularly applied to the soil before planting, further improving the productive capacity of the gardens. In 2007, there were roughly 7,000 intensive gardens on just over 9,000 hectares.[210]

One somewhat unconventional cropping system widely employed throughout Cuba are known as popular gardens. They come in all sorts of shapes and sizes, mostly determined by what space is available. They exist on land between buildings, in public parks and other shared urban spaces, on patios, or even between sidewalks and streets. They are the embodiment of the need to grow food wherever land was available that pervaded the early years of the Special Period and have stuck around as significant contributors to both household and regional food supply. They have played a crucial role in the "development of an urban culture favorable to agriculture; have eliminated the abandoned spaces which in the past may have been breeding grounds for disease vectors and rodents; and have provided socially useful and productive

[208]Antonio Casanova et al., "Intercropping in Cuba," in Fernando Funes et al., *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba* (Oakland, CA: Food First Books, 2002) 148-9.
[209]Gürcan, "Cuban Agriculture and Food Sovereignty," 138.
[210]Ibid.

employment opportunities."[211] As of 2001, there were over 100,000 patios and parcels of land under production, covering roughly 3,600 hectares.[212]

At the outskirts of Cuba's cities, larger suburban farms have begun to emerge. They are much larger than most urban farms and gardens, though still relatively small in terms of farm size, ranging from two to 15 hectares on average. Due to their larger size, they are often much more rigorously agroecologically integrated than farms like *organopónocos* and regularly incorporate both crops and livestock. Mostly situated in larger cities, these suburban farms have played a crucial role in the development of nearly self-sufficient cities. In Havana alone, there are 2,000 private and 285 state owned suburban farms growing on over 7,500 hectares.[213]

[211]Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 227.
[212]Ibid.
[213]Ibid.

Part 3 – Analysis, Conclusion, and Moving Forward

Chapter 6: Analysis and Conclusion –

Centralization and Decentralization:

Throughout all of the most successful changes made in Cuban agriculture since the start of the Special Period, there has been one critical common factor. It might seem obvious to suggest that this factor is agroecology, or perhaps state action, however, I want to push a little further. This is not to suggest agroecology and state action and a whole host of other factors were not critically important, very much the opposite. But the real different maker, what has made Cuba a lasting success story and a role model for agroecology adoption the world over, has been their emphasis on the decentralization of agricultural technology and infrastructure, and with it, power.

The movement away from a failing and highly centralized agricultural sector required profound changes, not only in practices, but also in the way that farming was conceptualized. The industrialization, mechanization, and standardization so important to the pre-collapse Cuban agricultural model, and to large scale agriculture all over the world, simply cannot exist without a certain level of centralization. In Cuba's case, this centralization was very highly advanced. The state owned nearly 80 percent of the country's land, was responsible for the production, purchasing, and dissemination of nearly all agricultural inputs, and controlled all marketing and sales of agricultural products. The technologies involved in pre-collapse Cuban agriculture were highly centralized and facilitated an increase in efficiency and control of agricultural production.

Obviously, however, this system was far from stable, in large part due to its centralization. Cuban agriculture was built almost entirely upon heavy machinery and

agrochemicals imported from the Soviet Union and other COMECON countries used within large state-owned farms. This highly centralized power relation between Cuba, the Soviet Union, and a few of its allies had facilitated the rise and growth of Cuba's agricultural system, however, when the Soviet Union collapsed, so too did these trade relations, and with them, the entirety of Cuba's agricultural sector.

Largely by virtue of their isolation globally, but also due to realizations made within the Cuban government, immediately after the crisis, steps were taken to move to a decentralized model. First and foremost, the Cuban government redistributed a significant portion of land under its control, handing it out to individual farmers and agricultural collectives alike. Then a number of agricultural universities were formed across the country along with a tripling of agricultural high schools in rural areas, spreading agroecological education to every corner of the country. Beyond these institutional education centers, the spread of the CAC system, due in large part to the work of ANAP, facilitated an unprecedented growth in the implementation of agroecological practices and contributed massively to improving the lives and livelihoods of small farmers. Farming also spread to new areas of the country, namely urban centers, fueled by slackened regulations on the sale of fresh produce and further governmental land grants. The centralized and standardized industrial agricultural inputs so prevalent earlier were replaced by animal traction, improved practices, and locally specific seed varieties and biocontrol agents developed and produced within the regions in which they are used.

Here I would like to return to Luis Garcia's quote from his chapter in Funes et al.'s *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba*. He writes,

> While at first glance the essential differences between agroecological and conventional agricultural education are in the course content, the real contrasts and contradictions are in the basic philosophy of science. Conventional agronomy assumes you can break down any system to its basic production factors, separate

> and study them independently, and then reassemble your findings such that the total is equal to the sum of its components. Agroecology assumes that the interrelatedness of each production factor to the others is so profound that to study them you must take an interdisciplinary, holistic, and systemic approach.[214]

Though here he is discussing the nature of agroecological education, the key points can be applied elsewhere. Agroecology, in its understanding of the agrarian system as a complex and interrelated entity impossible to study without taking it all in as a whole, demands a more decentralized approach to its study, dissemination, and practice than the conventional industrial model. In the agrarian system, every minute factor influences the whole, and any changes in the components of the system have the potential to alter the best solution to any problems which might arise. Unlike in conventional teachings, there is no prescriptive solution or answer to the question of how best to farm agroecologically. One must, through collaboration, trial and error, and creativity adapt widely understood solutions to their local context, or simply find their own answers to the specific problems that they face. As Langdon Winner writes in his chapter of *The Whale and the Reactor* dedicated to the topic of decentralization, "One reason to prefer a large number and variety of centers for a given activity is that they may be more imaginative and creative than one or just a few centers."[215] It is this imagination and creativity which has been so important to the success of agroecology in Cuba, and the decentralization of Cuban agriculture can be held accountable for a great deal of that change.

Other Critical Factors to Cuba's Success:

Before wrapping things up, I want to highlight the importance of two more related facets of Cuba's successful agricultural transition; the collaboration between state and non-state actors,

---

[214]Garcia, "Agroecological Education and Training," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 104.

[215]Langdon Winner, *The Whale and the Reactor: A Search for Limits in an Age of High Technology* (Chicago: The University of Chicago Press, 1986) 87-8.

and the incorporation of traditional peasant knowledge. Though the incorporation of peasant knowledge and practices is a central pillar of agroecology as a whole, there is the real possibility that in the attempt to set up an agroecological system, this knowledge is forgotten or displaced by the conventional agricultural model, and attempts to reconstitute it are not prioritized, leaving traditional knowledge out of the new agroecological system. While this may not be a critical issue in many cases, simply resulting in the need for more experimentation and trial of practices, within the case of Cuba's crisis, their incorporation of traditional *campesino* knowledge was fundamental to their success. At such a time of crisis, when food and other necessities were startlingly scarce, the availability and integration of traditional practices and knowledge accelerated Cuba's recovery. It is *campesino* knowledge and practices which have formed the basis for Cuba's new models of crop rotation, polyculture, and soil management, with new and locally specific developments added on top of that historical foundation.[216]

Perhaps even more important to the lasting success of the agroecological revolution in Cuba has been the collaboration and support between the government and non-state actors, specifically ANAP.[217] It is clear that outside of direct governmental decisions like land redistribution and the opening of free markets, ANAP had their hand in just about every major agricultural change. More importantly, however, is the degree to which they worked alongside the Cuban government. Through their collaboration CPAs were formed in the 70s and their structure was improved alongside CCSs during the crisis, Cuban agricultural education and research was reformed and a rigorous and successful peer-to-peer education network was

[216]Funes, "The Organic Farming Movement in Cuba," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 17-8.

[217]The following is a list of other major NGOs in Cuba working in the field of agriculture and food security: the Cuban Animal Production Association, the Council of Churches of Cuba, the Federation of Cuban Women, the Cuban Association of Agricultural and Forestry Technicians, the Center of the Study of Inter-American Relations, and the Cuban Association of Sugarcane Technicians. From: Nieto, "Cuban Agriculture and Food Security," in Funes et al., eds., *Sustainable Agriculture and Resistance*, 52.

established throughout the country, and urban agriculture and self-provisioning emerged as major players in Cuban agriculture among a long list of other changes. It is really almost impossible to conceive of Cuba's agroecological revolution without the joint efforts of the Cuban state and ANAP and other NGOs, and this sort of collaboration seems like a very valuable tool to be applied elsewhere in the world.

Looking Critically at Cuba as a Whole:

Lastly, any case study of Cuba would be remiss without a critical look at the political structure of the country. Cuba operates under a single party model and self-defines as a people's democracy as described under Marxist-Leninist theory. Despite these claims of democracy, many other countries and international agencies, namely Human Rights Watch, have called into question the political freedom in Cuba, and the 2019 democracy index gave Cuba a score of 2.84 out of 10, in comparison China received a 2.26, Russia a 3.11, and the US a 7.96.[218] On top of this, the Committee to Protect Journalists ranked Cuba as the 10th most censored country in the world, citing state controlled media, prohibitively expensive internet access and mobile data, and the harassment, surveillance, and detention of journalists critical to the government.[219] The Human Rights Watch 2018 report on Cuba identified arbitrary detention and short-term imprisonment, restrictions on freedom of expression, detention of political prisoners, travel restrictions, overcrowded prisons and forced labor, international labor rights violations, and harassment of human rights defenders as ongoing human rights violations within the country.[220] These violations are clearly very troublesome, however, in recent years there have been some

[218]"Democracy Index 2019," The Economist Intelligence Unit, 2019, https://www.eiu.com/public/topical_report.aspx?campaignid=democracyindex2019.

[219]"10 Most Censored Countries," Committee to Protect Journalists, https://cpj.org/reports/2019/09/10-most-censored-eritrea-north-korea-turkmenistan-journalist.php#10.

[220]"World Report 2018: Rights Trends in Cuba," Human Rights Watch, January 18, 2018, https://www.hrw.org/world-report/2018/country-chapters/cuba.

signs of increased democracy and freedom within the country. Between the summer of 2018 and spring of 2019, a new constitution was proposed and enacted for the first time since 1976, which reshaped the structure of the Cuban government and changed the presidency of the country to an elected position.[221] On top of this, the constitution formally banned all discrimination based on gender identity and sexual orientation, though the legalization of same-sex marriages was not included in this.[222] Judicial law in the country now operates under a presumption of innocence along with the introduction of habeus corpus.[223]

Despite these positive changes, the country still operates as a single party state and many, both within Cuba and among the international community, have expressed concerns over the lack of real sweeping changes. Failure to ban discrimination for political views have left many opponents to the government worried about their safety and freedom moving forwards.[224] A maintenance of the ban on all independent media has also been raised as a key point of concern, extending the state monopoly over news and other means of information distribution. Lastly, though the new constitution grants the right to form independent organizations, many are concerned over the degree to which the government will respect this right, especially in the case of political organizations with differing stances to the Communist Party of Cuba.[225]

---

[221]Marc Frank, "Explainer: What Is Old and New in Cuba's Proposed Constitution," Reuters (Thomson Reuters, February 21, 2019), https://www.reuters.com/article/us-cuba-constitution-explainer/explainer-what-is-old-and-new-in-cubas-proposed-constitution-idUSKCN1QA273.

[222]"Cuba to Reshape Government with New Constitution," AP NEWS (Associated Press, July 14, 2018), https://apnews.com/83ba7c8abb9344a5b732417a3c0b0c1d/Cuba-to-reshape-government-with-new-constitution.

[223]Sarah Marsh, "Castro Says Cuba Will Not Abandon Venezuela despite U.S. 'Blackmail'," Reuters (Thomson Reuters, April 10, 2019), https://www.reuters.com/article/us-cuba-constitution/cuba-to-enact-new-constitution-launching-modest-state-revamp-idUSKCN1RM1VC.

[224]Antonio Recio, "Some Traps in Cuba's New Constitution," Havana Times, August 21, 2018, https://havanatimes.org/opinion/some-traps-in-cubas-new-constitution/.

[225]María Isabel Alfonso, "Cuba Expands Rights but Rejects Radical Change in Updated Constitution," UPI (UPI, February 27, 2019), https://www.upi.com/Top_News/Voices/2019/02/27/Cuba-expands-rights-but-rejects-radical-change-in-updated-constitution/1601551276671/?ur3=1.

I raise all of this to problematize the largely positive picture of Cuba that I have presented up to this point and to acknowledge the harm and oppression the Cuban government has perpetrated, while simultaneously making great strides forward in the agricultural realm. I want to emphasize the point that Cuba and the way it went about reaching the degree of agroecological development it now has is in no way an ideal. Much of what the country has done has been groundbreaking and revolutionary, paving a way forward for other countries and regions to follow, and much of the change has only been possible due to the oppression and control wielded by the Cuban state. This paper is in no way an attempt to identify the best strategy for transforming a national food system, rather an in depth look at the most successful case to date with the hopes that it can teach us some valuable lessons in our own attempts to transition food and farming systems around the world.

Afterword: Where We Go Moving Forward –

Now that the case study is more or less wrapped up, I would to take a few steps back and look at the bigger picture. The transition in Cuba, though rapid and wide reaching, was obviously spurred on by a nearly cataclysmic economic crisis and must be understood within that context. In any future attempts to make a transition towards agroecology, we cannot anticipate or rely upon such a crisis. To wait upon some similar situation as to what happened in Cuba is a horribly inadequate response to the problems we are faced with. Any economic or environmental crisis on the scale necessary to spur action would result in an untold amount of human damage and despair, and we should be looking to avoid such a situation at all costs. In an ideal world, the realities of the climate crisis and the failings of the industrial mode of agricultural production would be enough to elicit action from policymakers, farmers, and the agriculture industry as a whole, however, we do not live in that ideal world. Large corporations have invested so many resources into the industrial agricultural sector, and through lobbying and neoliberal policies these corporations have significant political clout when it comes to upholding the status quo.

It is also critical to understand contemporary industrial agriculture as a facet of the global industrial economy built on fossil fuels. Nearly every input to industrial farms is a byproduct of fossil fuels or requires a significant amount of energy to produce and or use. Though this paper has looked almost exclusively at agriculture, many of the issues discussed can be applied elsewhere to different parts of the global economy. This interrelatedness means that really changing agriculture on a global scale will require sweeping economic and political reform. I can think of no realistic way to make the switch to agroecology under a neoliberal capitalist global economy, outside of it being made necessary as a result of some economic or environmental crisis, which, as I have stated is an unacceptable response. Neoliberal capitalism has produced

and sustains the climate crisis, an unstable industrial model of agriculture, and the food insecurity and poverty that is creates. Any attempt to rectify these issues on a global scale, including making a shift towards agroecology, will require a dismantling of the unjust and unequal system that supports them.

As entrenched as these problems are, however, that does not mean we should simply sit down and wait for those in power to make change. This crisis requires action at every level. It is fair to say, that without policy change and institutional action, there is little to no hope for a sweeping agricultural change. However, it is just as true that without small-scale citizen actions and local grassroots change, there is little hope for success of an agroecological movement. No single person or political group or corporation has the strength and willpower to make such sweeping changes. I truly believe that to reach these lofty goals, everyone must do everything they can, whenever they can to push through change. Obviously, this is a lot to ask, however, if we are serious about fixing the problems we are faced with before things spiral out of control, we need to start acting, en mass very soon. This action can really take any number of forms, though popular examples like "voting with your fork" are probably quite a bit less groundbreaking than they seem. Instead, I would advocate for everyone to start growing food in some way. The way this will manifest for each individual will be constrained significantly by individual contexts and living circumstances, but one of the more obvious examples can be seen in American suburbia: the lawn. As of 2019, turf grass was the most irrigated crop in the US and covers roughly two percent of the total land in the country.[226] If everyone with a lawn in their front yard or their backyard, or both, chose to stop growing grass in favor of a diversified and agroecological

[226]"The Lawn Is the Largest Irrigated Crop in the USA," UCSB Geography, https://geog.ucsb.edu/the-lawn-is-the-largest-irrigated-crop-in-the-usa/.

garden or food forest, we could make a massive dent on agribusiness and boost food self-sufficiency.

In no way do I intend to suggest that this is all we need to do, of course. A global shift to agriculture governed by the principles of agroecology will take many, many years to enact and will require sustained and diverse action. I simply propose the idea of growing some of your own food as a good place to start. That's what's really important. The problems we face are so large, and the power structures so entrenched, that it can easily feel as though we are powerless to change anything. I hope that once we start to make that first step, and realize that it is just that, a single step in a long march of change, each subsequent step will be that much easier to make.

Appendix

A.

Category 1: Farms which have initiated the path towards agroecology have complied with the following:

1. *The Rapid Participatory Appraisal has been applied on the farm.*
2. *Alternative agroecological techniques have been applied to solve the diagnosed problems.*
3. *The farmer is developing 1-3 more agroecology practices.*
4. *The family has begun to be involved in the agroecology movement.*
5. *The family is aware of environmental issues and productive problems.*
6. *A family or an individual member has committed to participation in the agroecology movement at a General Assembly meeting.*
7. *The farm practices or is reviving peasant traditions.*
8. *There are prospects for diversifying plants and animals on the farm.*
9. *The practice or willingness to experiment (campesino experimentation.)*
10. *There is potential to produce and market with social objectives.*

Category 2: Farms in agroecological transition have complied with the following:

11. *Farms are well integrated in the processes of exchange, experimentation and advocacy of the agro-ecology movement and of the Farmer-to-Farmer method (as a receiver and actor within it).*
12. *Increasing biodiversity and integration of the productive components of the farm (integration of agriculture, animal husbandry, and forested areas.)*
13. *Substantial reduction in amount of agri-chemicals applied.*
14. *Increasing use of on-farm resources, and the proportional reduction of dependence on external resources.*
15. *Social commitment, integration of the family and cooperative group, with gender equity (equal participation of men and women, according to their capacities and conditions.)*
16. *Re-affirmation of the campesino identity, socially and culturally.*
17. *An economically efficient system of production.*
18. *The farm is orderly and functional.*

Category 3: Agroecological farms have complied with the following:

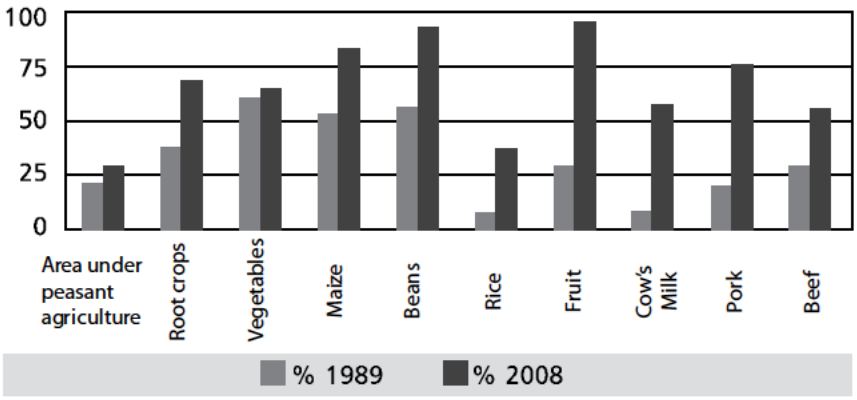
1. *Heightened awareness and conceptual mastery of agroecological sustainability and food security, with a focus on gender.*
2. *Commitment as a promoter in the Agroecological Movement, participating in workshops and skill shares.*
3. *Diversification, integration, and a high level of efficiency of the various components of the property (land, crops, trees, animals, water, seeds, and family culture).*
4. *High yields, sufficient for the family and local marketing (yield per area should be comparable or superior to conventional agriculture.)*
5. *No practices that are aggressive towards the environment exist on the farm (no use of chemicals, genetically modified seeds, hormones, over-mechanization, intensive monoculture, etc.)*
6. *Low (almost zero) external dependence for the production and maintenance of family life.*
7. *Assurance of a quality family life (family, education, health, and information.)*
8. *Participation in the activities of grassroots organizations.*
9. *Social commitment (providing local products in local markets, and involvement in social organizations.)*
10. *Conservation and practice of traditional campesino cultures.*
11. *The on-farm resources are highly valued through the conservation of soil and water, and self-generated field fertility, etc.)*
12. *Participation of the entire family (men, women, and youth) in the work and decisions of the farm.*

From, Machín Sosa et al., *Agroecological Revolution*, 115-6.

B.

FIGURE 5.3
Percentage of the contribution of peasant agriculture to total domestic production in various categories, and proportion of the national agricultural area under peasant agriculture in 1989 and 2008.

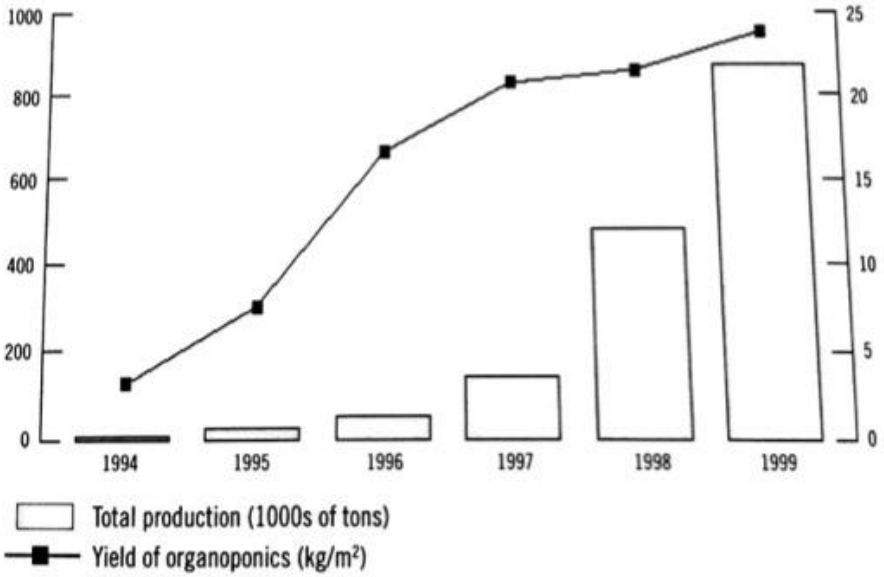
Source: Statistics of Departments of Organization and Agro-foods, ANAP



From, Machín Sosa et al., *Agroecological Revolution*, 25.

C.

Figure 1. Vegetable production from organoponics and intensive vegetable gardens



From, Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance*, 228.

D.

Table 2. Current sub-programs of Cuban urban agriculture

1. Soil management and conservation	14. Oilseed crops
2. Organic matter	15. Beans
3. Seeds	16. Animal feeds
4. Irrigation and drainage	17. Apiculture
5. Vegetables and fresh herbs	18. Poultry
6. Medicinal plants and dried herbs	19. Rabbit breeding
7. Ornamental plants and flowers	20. Sheep and goats
8. Fruit trees	21. Swine
9. Shade houses	22. Cows
10. Small-scale "popular" rice production	23. Aquaculture
11. Trees, coffee, and cocoa	24. Marketing
12. Small-scale "popular" plantain production	25. Small-scale agro-industry
13. Tropical roots and tubers	26. Science, technology, training, and environmental issues

From, Companioni et al., "The Growth of Urban Agriculture," in Funes et al., *Sustainable Agriculture and Resistance,* 225.

E.

Table 1. Medicinal plants commonly used in Cuba and the ailments they treat

COMMON NAME	SCIENTIFIC NAME	AILMENT
Chili pepper	*Capsicum annuum*	Rheumatism
Garlic	*Allium sativum*	Asthma, common cold, circulatory ailments, stomach ailments, fungal infections, parasites, high blood pressure, back pain
White basil	*Ocimum basilicum*	Stomach ailments, high blood pressure
Wild indigo	*Indigofera suffruticosa*	Lice
Anis	*Piper auritum*	Stomach and joint aches, rheumatism
Gourd squash	*Cucurbita moschata*	Parasites
Lemongrass	*Cymbopogon citratus*	Asthma, common cold, fungal infections, high blood pressure, throat ailments
Senna	*Cassia grandis*	Fungal infections
Dill	*Anethum graveolens*	Stomach ache
Eucalyptus	*Eucalyptus globulus*	Asthma, common cold, earache, cough
Lemon eucalyptus	*Eucalyptus citriodora*	Fever, cough
French senna	*Cassia alata*	Fungal infections
Guava	*Psidium guajava*	Diarrhea, fungal infections
Mint	*Mentha spicata*	Common cold, gastritis
Fennel	*Foeniculum vulgare*	Gastritis
Royal itamo	*Pedilanthus tithymaloides*	Stomach ailments, mouth sores
Five-leaf jasmine	*Jasminum grandifolium*	Nervous disorders
Ginger	*Zingiber officinale*	Gastritis, cough, vomiting
Lemon	*Citrus aurantifolia*	Circulatory ailments, stomach ailments
Plantago	*Plantago major*	Common cold, stomach ailments, mouth sores, burns, cough
Chamomile	*Matricaria chamomilla*	Diarrhea, stomach ache, fungal infections, gastritis, mouth sores
Japanese mint	*Mentha arvensis*	Stomach ache, gastritis
Muraya	*Murraya paniculata*	Headache
Sour orange	*Citrus aurantium*	Circulatory ailments, stomach ache
French oregano	*Coleus amboinicus*	Common cold, cough
Passion fruit	*Passiflora incarnata*	Nervous disorders
Licorice verbena	*Lippia alba*	Headache
Rue	*Ruta graveolens*	Nervous disorders
Aloe	*Aloe barbadensis*	Asthma, common cold, minor cuts and bruises, burns
Sago palm	*Maranta arundinacea*	Diarrhea
Sage	*Salvia officinalis*	Common cold, fungal infections, kidney ailments
Tamarind	*Tamarindus indica*	Constipation, kidney ailments
Kidney tea	*Orthosipon aristatus*	Kidney ailments
Linden	*Justicia pectoralis*	Common cold, nervous disorders
Orange mint	*Mentha citrata*	Diarrhea, fever
Periwinkle	*Lochnera rosea*	Conjunctivitis

From, Garcia, “Green Medicine,” in Funes et al., *Sustainable Agriculture and Resistance*, 217.

F.

Table 2. Common intercrops in urban organoponics (raised beds)

Lettuce–radish
Lettuce–chard
Lettuce–garlic or onions
Cabbage–lettuce
Cabbage–chard
Cabbage–garlic or onions
Pepper–radish
Pepper–garlic or onions
Pepper–lettuce
Pepper–chard
Pepper–string beans
Bush beans–lettuce
Bush beans–chard
Bush beans–garlic or onions

From, Casanova et al., "Intercropping in Cuba," in Funes et al., *Sustainable Agriculture and Resistance*, 148.

G.

$$LER = LER_1 + LER_2 + \ldots + LER_n$$

where:

LER = is the cumulative LER of the system, and

$LER_1, LER_2, \ldots, LER_n$ = the individual LERs of each crop in the association which are obtained from the equation:

$LER = A_x/M_x$, where:

A_x = yield of crop x in the association

M_x = yield of x in monoculture

If the overall LER >1, then intercropping is more efficient than monocropping, if LER = 1, intercropping and monocropping produce the same results, while if LER < 1 monocropping is more efficient than intercropping.

From, Casanova et al., "Intercropping in Cuba," in Funes et al., *Sustainable Agriculture and Resistance*, 149.

Bibliography

"10 Most Censored Countries." Committee to Protect Journalists. https://cpj.org/reports/2019/09/10-most-censored-eritrea-north-korea-turkmenistan-journalist.php#10.

"Ag and Food Sectors and the Economy." USDA Economic Research Service, September 20, 2019. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/ag-and-food-sectors-and-the-economy/.

Alfonso, María Isabel. "Cuba Expands Rights but Rejects Radical Change in Updated Constitution." UPI. UPI, February 27, 2019. https://www.upi.com/Top_News/Voices/2019/02/27/Cuba-expands-rights-but-rejects-radical-change-in-updated-constitution/1601551276671/?ur3=1.

Altieri, Miguel A., and Matt Liebman. "Polyculture Cropping Systems." In *Agroecology: The Science of Sustainable Agriculture*, 2nd ed., 205–18. CRC Press, 2018.

Arsenault, Chris. "Only 60 Years of Farming Left If Soil Degradation Continues." Scientific American, December 5, 2014. https://www.scientificamerican.com/article/only-60-years-of-farming-left-if-soil-degradation-continues/.

Arsenault, Chris. "Why Are Most of the World's Hungry People Farmers?" World Economic Forum, May 28, 2015. https://www.weforum.org/agenda/2015/05/why-are-most-of-the-worlds-hungry-people-farmers/.

Batte, Marvin T. and Mohammad Reza Ehsani, "Precision Profits: The Economics of a Precision Agricultural Sprayer System." Columbus, OH: OSU, 2005.

Behnassi, Mohamed. "Vulnerability of Food Systems and Food Security in Morocco." Class lecture, Climate Science and Policy from IHP Climate Change, Marrakech, Morocco, November 2, 2018.

Bryant, Lara. "Organic Matter Can Improve Your Soil's Water Holding Capacity." NRDC, December 15, 2016. https://www.nrdc.org/experts/lara-bryant/organic-matter-can-improve-your-soils-water-holding-capacity.

Carlsen, Laura. "What We've Learned from Nafta." The New York Times. The New York Times, November 24, 2013. https://www.nytimes.com/roomfordebate/2013/11/24/what-weve-learned-from-nafta/under-nafta-mexico-suffered-and-the-united-states-felt-its-pain.

Cederlöf, Gustav. "Low-Carbon Food Supply: The Ecological Geography of Cuban Urban Agriculture and Agroecological Theory." *Agriculture and Human Values* Vol. 33 (2016).

"Climate Change Adaptation and Mitigation." NASA. February 6, 2020. https://climate.nasa.gov/solutions/adaptation-mitigation/.

"Climate Change and Agriculture." Union of Concerned Scientists, March 20, 2019. https://www.ucsusa.org/resources/climate-change-and-agriculture.

"Cuba to Reshape Government with New Constitution." AP NEWS. Associated Press, July 14, 2018. https://apnews.com/83ba7c8abb9344a5b732417a3c0b0c1d/Cuba-to-reshape-government-with-new-constitution.

Daly, Patricia A. "Agricultural Employment: Had the Decline Ended?" *Monthly Labor Review*, November 1981, 11–17.

"Declaration of Nyéléni." Nyeleni, February 27, 2007. https://nyeleni.org/spip.php?article290.

"Democracy Index 2019." The Economist Intelligence Unit, 2019. https://www.eiu.com/public/topical_report.aspx?campaignid=democracyindex2019.

El Bilali, Hamid and Mohammad Sadegh Allahyari. "Transition towards Sustainability in Agriculture and Food Systems: Role of Information and Communication Technologies." *Information Processing in Agriculture* Vol. 5, No. 4 (2018).

Enríquez, Laura J. "Cuba's New Agricultural Revolution: The Transformation of Food Crop Production in Contemporary Cuba." *Food First/Institute for Food and Development Policy*. Development Report No. 14 (May 2000).

"Factory Farms Destroy Communities." Socially Responsible Agricultural Project. https://sraproject.org/factory-farms-destroy-communities/.

Fenton, Megan, Carl Albers, and Quirine Ketterings. "Soil Organic Matter." *Agronomy Fact Sheet Series* Vol. 41 (2008).

Frank, Marc. "Explainer: What Is Old and New in Cuba's Proposed Constitution." Reuters. Thomson Reuters, February 21, 2019. https://www.reuters.com/article/us-cuba-constitution-explainer/explainer-what-is-old-and-new-in-cubas-proposed-constitution-idUSKCN1QA273.

Fukuoka, Masanobu, *The One-Straw Revolution* (Rodale Press, 1978).

Funes, Fernando, Luis García, Martin Bourque, Nilda Pérez, and Peter Rosset, eds. *Sustainable Agriculture and Resistance: Transforming Food Production in Cuba*. Oakland, CA: Food First Books, 2002.

"Global Greenhouse Gas Emissions Data." EPA. Environmental Protection Agency, September 13, 2019. https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data.

"Growing at a Slower Pace, World Population Is Expected to Reach 9.7 Billion in 2050 and Could Peak at Nearly 11 Billion around 2100." United Nations Department of Economic and Social Affairs, June 17, 2019. https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html.

Gürcan, Efe Can. “Cuban Agriculture and Food Sovereignty.” *Latin American Perspectives* Vol. 41, No. 4 (July 2014): 129–46.

Hanson, Craig. “Biofuels Are Not a Green Alternative to Fossil Fuels.” World Resources Institute, September 26, 2018. https://www.wri.org/blog/2015/01/biofuels-are-not-green-alternative-fossil-fuels.

“Heat Island Effect.” EPA. Environmental Protection Agency, April 23, 2020. https://www.epa.gov/heat-islands.

Jared, George. “CDC: 'Farm Stress,' Suicides a Rising Rural Health Concern.” Talk Business & Politics, May 14, 2019. https://talkbusiness.net/2019/05/cdc-farm-stress-suicides-a-rising-rural-health-concern/.

Kukutai, Arama. “Can Digital Farming Deliver on Its Promise?” PrecisionAg, April 28, 2016. https://www.precisionag.com/digital-farming/can-digital-farming-deliver-on-its-promise/.

Lal, Ratan. “Soil Carbon Sequestration Impacts on Global Climate Change and Food Security.” *Science*. Vol 304, No. 5677 (June 11, 2004): 1623–27.

“Land Grabbing.” Global Agriculture. https://www.globalagriculture.org/report-topics/land-grabbing.html.

Lucci, Michael. “Illinois' Economic Growth Is Worse than during the Great Depression.” Illinois Policy, June 13, 2017. https://www.illinoispolicy.org/illinois-economic-growth-is-worse-than-during-the-great-depression/.

Lundin, Ola, Maj Rundlöf, Henrik G. Smith, Ingemar Fries, and Riccardo Bommarco. “Neonicotinoid Insecticides and Their Impacts on Bees: A Systematic Review of Research Approaches and Identification of Knowledge Gaps.” *Plos One* Vol. 10, No. 8 (August 27, 2015).

Mangalassery, Shamsudheen, Sofie Sjögersten, Debbie L. Sparkes, Craig J. Sturrock, Jim Craigon, and Sacha J. Mooney. “To What Extent Can Zero Tillage Lead to a Reduction in Greenhouse Gas Emissions from Temperate Soils?” *Scientific Reports* Vol. 4, No. 1 (April 4, 2014).

Marsh, Sarah. “Castro Says Cuba Will Not Abandon Venezuela despite U.S. 'Blackmail'.” Reuters. Thomson Reuters, April 10, 2019. https://www.reuters.com/article/us-cuba-constitution/cuba-to-enact-new-constitution-launching-modest-state-revamp-idUSKCN1RM1VC.

Miller, G. Tyler. *Sustaining the Earth*. 6th ed. Pacific Grove, CA: Thompson Learning, Inc., 2004.

“Monsanto Co: Total Contributions.” OpenSecrets.org. https://www.opensecrets.org/orgs/totals.php?id=D000000055&cycle=2014.

Mullen, Kimberly. “Information on Earth's Water.” National Groundwater Association. https://www.ngwa.org/what-is-groundwater/About-groundwater/information-on-earths-water.

National Research Council. *Precision Agriculture in the 21st Century: Geospatial and Information Technologies in Crop Management.* Washington, DC: The National Academies Press, 1997.

“Neonicotinoids.” Food Safety. European Comission, January 14, 2020. https://ec.europa.eu/food/plant/pesticides/approval_active_substances/approval_renewal/neonicotinoids_en.

Norman Borlaug: A Lifetime Fighting Hunger. *YouTube*. World Food Prize, 2009. https://www.youtube.com/watch?v=m2TmEdiXTvc.

Oliver, M.A., ed. *Geostatistical Applications for Precision Agriculture.* Springer, 2014.

Paz, Juan Valdéz. “The Cuban Agrarian Revolution: Achievements and Challenges.” *Estudos Avançados* Vol. 25, No. 72 (2011): 73–87.

Pearce, Fred. *The Land Grabbers: The New Fight Over Who Owns the Earth*. Boston: Beacon Press, 2013.

Perfecto, Ivette. “The Transformation of Cuban Agriculture After the Cold War.” *American Journal of Alternative Agriculture* Vol. 9, No. 3 (1994): 98–108.

“Pesticide Resistance.” Evolution: Library. Public Broadcasting Service. https://www.pbs.org/wgbh/evolution/library/10/1/l_101_02.html.

Ranganathan, Janet. “The Global Food Challenge Explained in 18 Graphics.” World Resources Institute, December 3, 2013. https://www.wri.org/blog/2013/12/global-food-challenge-explained-18-graphics.

Reardon, Juan Alberto Simón, and Reinaldo Alemán Pérez. “Agroecology and the Development of Indicators of Food Sovereignty in Cuban Food Systems.” *Journal of Sustainable Agriculture* Vol. 34, No. 8 (2010): 907–22.

Recio, Antonio. “Some Traps in Cuba's New Constitution.” Havana Times, August 21, 2018. https://havanatimes.org/opinion/some-traps-in-cubas-new-constitution/.

Rich, Robert. “The Great Recession.” Federal Reserve History, November 22, 2013. https://www.federalreservehistory.org/essays/great_recession_of_200709.

Ritchie, Hannah, and Max Roser. “Urbanization.” Our World in Data, June 13, 2018. https://ourworldindata.org/urbanization.

Rosset, Peter Michael, Braulio Machín Sosa, Adilén María Roque Jaime, and Dana Rocío Ávila Lozano. “The Campesino-to-Campesino Agroecology Movement of ANAP in Cuba: Social

Process Methodology in the Construction of Sustainable Peasant Agriculture and Food Sovereignty." *Journal of Peasant Studies* Vol. 38, No. 1 (January 2011): 161–91.

Rouse, Irving. *The Tainos: Rise & Decline of the People Who Greeted Columbus*. New Haven: Yale University Press, 1992.

Sainath, P. "Have India's Farm Suicides Really Declined?" BBC News. BBC, July 14, 2014. https://www.bbc.com/news/world-asia-india-28205741.

Shiva, Vandana. *Who Really Feeds the World? The Failures of Agribusiness and the Promise of Agroecology*. North Atlantic Books, 2016.

Sosa, Braulio Machín, Peter Michael Rosset,Adilén María Roque Jaime, and Dana Rocío Ávila Lozano. *Agroecological Revolution: The Farmer-to-Farmer Movement of the ANAP in Cuba.* Edited by Meredith Palmer. Translated by Ann Greenberg. ANAP, International Commission on Sustainable Peasant Agriculture of la Via Campesina, 2013.

Stuart, Tristram. "Food: How Much Does the World Need?" World Economic Forum, May 7, 2015. https://www.weforum.org/agenda/2015/05/food-how-much-does-the-world-need.

The Bill & Melinda Gates Foundation. "Agricultural Development: Strategy Overview." *Global Development Program,* August 2011.

"The Hidden Costs of Industrial Agriculture." Union of Concerned Scientists, July 11, 2008. https://www.ucsusa.org/resources/hidden-costs-industrial-agriculture.

"The Lawn Is the Largest Irrigated Crop in the USA." UCSB Geography. https://geog.ucsb.edu/the-lawn-is-the-largest-irrigated-crop-in-the-usa/.

The Power of Community: How Cuba Survived Peak Oil. AlchemyHouse Productions Inc., 2006. https://www.filmsforaction.org/watch/the-power-of-community-how-cuba-survived-peak-oil-2006/.

"The Quality of the Nation's Groundwater." United States Geological Survey, January 21, 2015. https://www.usgs.gov/news/quality-nation's-groundwater.

"Understanding Algal Blooms." St. John's River Water Management District. https://www.sjrwmd.com/education/algae/.

"Usufruct, n." Oxford English Dictionary. https://www.oed.com/view/Entry/220702.

"Via Campesina." Via Campesina: International Peasant's Movement. https://viacampesina.org/en/.

"Warming World: Impacts by Degree." *Warming World: Impacts by Degree*. The National Academy of Sciences, 2011.

"Water for a Sustainable World: Facts and Figures." *The United Nations World Water Development Report*, 2015.

Winner, Langdon. *The Whale and the Reactor: A Search for Limits in an Age of High Technology*. Chicago: University of Chicago Press, 1986.

"What Is a Dead Zone?" NOAA's National Ocean Service, March 14, 2019. https://oceanservice.noaa.gov/facts/deadzone.html.

"What Is Agroecology?" AgroEcology Fund. https://www.agroecologyfund.org/what-is-agroecology.

"World Report 2018: Rights Trends in Cuba." Human Rights Watch, January 18, 2018. https://www.hrw.org/world-report/2018/country-chapters/cuba.