Climate Change & Food Security: Furthering Inequalities and Harming Health

By Lauren Balotin

Introduction

While the effects of climate change's shifting weather patterns on food are clear to many, it is still uncommon for people to link this impact to disparate environmental justice for communities and the potential consequences for human health. However, as research concerning the effects of climate change are becoming increasingly clear, making this connection and finding appropriate methods of mitigation and adaptation is growing much more critical. Millions of individuals may face physical, emotional, and cognitive hardships due to undernutrition, or deficiency of energy, protein, or essential vitamins and minerals (IFPRI, 2016). These numbers will only continue to grow if climate change continues to advance according to its current trends.

The adverse effects of climate change on food security and malnutrition were acknowledged when the parties of the United Nations Framework Convention on Climate Change (UNFCCC) ratified the Paris Agreement in December of 2015. In the agreement, the parties state that they "*[recognize]* the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change" and aim to eradicate poverty by "increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production" (UNFCCC, 2015). This recognition marked one of the key steps towards taking tangible action against climate change. In 2015, the United Nations also adopted the 2030 Agenda for Sustainable Development with corresponding sustainable development goals. These goals include acknowledge the necessity of efforts towards zero hunger and elimination of poverty (UN, 2015).

At the 23rd Conference of the Parties (COP23) of the UNFCCC, which took place in November of 2017, nations reached a landmark decision regarding agriculture. This decision was the first time that the parties of the UNFCCC had agreed upon any action-oriented plans related to agriculture. Through the agreement, the Subsidiary Body for Science and Technological Advice and the Subsidiary Body for Implementation will review various issues related to agriculture in order to determine specific plans for action by COP26. COP23 also drew attention to small island developing states (SIDS), which are particularly vulnerable to deleterious effects of climate change on food. SIDS are especially susceptible to extreme weather events and natural disasters, and they lack the resources necessary to find other sources of food and income when agriculture is threatened. The UNFCCC's selection of the small island nation of Fiji to preside over COP23 has drawn appropriate attention to this vulnerability by increasing public and political attention towards the impacts of food insecurity in developing nations.

To address the growing prevalence of food security and malnutrition as issues posed by climate change, a larger focus on agroecology and the gradual elimination of food waste can aid in maintaining sufficient crop yields and promoting equal access to food and nutrients. National, international, and regional policies are necessary to ensure that these methods are implemented.

Background

Climate Change, Food Security, and Malnutrition

According to the Food and Agriculture Organization of the United Nations (FAO), food security requires equal physical, social, and economic access to food that is both nutritious and meets one's dietary needs (FAO, 2014). However, many countries still lack this equal access. Two billion individuals globally are deficient in one or more micronutrients, and 790 million individuals do not receive adequate energy from their dietary intakes (Myers et al., 2017). Roughly three million children die each year due to undernutrition or related causes, particularly in developing countries where food access is often scarce (Myers et al., 2017). Even in the United States, 12.3 percent of U.S. households were considered food insecure in 2016, most of which were predominantly households with children, single parents, minorities, and low-income families (USDA, 2017). According to the 2017 Global Hunger Index, which considers sufficiency of caloric intake, child undernutrition, and child mortality, levels of hunger are serious or alarming in 51 countries (IFPRI, 2017).

At COP23, government officials, researchers, and observers each recognized that climate change's adverse effects on agriculture are extreme. This shift is likely due to the interdisciplinary nature of food. Diets have clear implications for human health because of the nutrients food provides, yet it also has critical ramifications for socioeconomic status. Because communities with lower incomes are more likely to live in food deserts or experience food insecurity, their socioeconomic status is likely to be further exacerbated by agricultural adversities. Despite the fact that food is a necessary resource for survival, millions of individuals are currently food insecure. Just in the United States, 17.4 million households, equivalent to 14% of all U.S. households, were considered food insecure in 2014 (Lee et al., 2017). The number of malnourished individuals has declined by 216 million people since the 1990s, yet the number of malnourished or undernourished individuals still represents a significant proportion of the world's population (Moore, 2017). During his panel, Springmann called food insecurity one of the most important consequences of climate change because of the large number of people affected (2017).

Climate change's methods of impact on agriculture and food production vary widely. Most directly, heat stress exacerbated by climate change has severe effects. Climate change can result in average temperature increases between 2℃ and 4℃ by 2050 depending on how much emissions continue, according to the Intergovernmental Panel on Climate Change (Gianinni, 2017). Rising temperatures may also increase the mortality rate of livestock which may be unable to cope with heat stress, ultimately reducing food productivity from animal husbandry. Moreover, increasing temperatures limit the ability of farmers to safely perform manual labor while outdoors. Heavy outdoor labor will be limited to only 50 percent of the workday during the period of warmest temperatures in India, sub-Saharan Africa, and Australia by the end of the the twenty-first century if the RCP4.5 emissions scenario is met (Myers et al., 2017). Both physical labor and human productivity will decline as a result of this heat stress.

Climate change impacts agricultural production by altering the stability of the environment that crops are adapted to grow in. Rising carbon emissions increase the stock of greenhouse gases in

the atmosphere warming Earth; the average global land temperature for 2006-2015 was 1.0° warmer than that of the twentieth century and is expected to continue to rise under forecasting emissions scenarios (Myers et al., 2017). Global warming is also associated with altering precipitation patterns, particularly through decreased precipitation and a higher frequency and intensity of droughts arid regions of the world as well as increased precipitation and a higher frequency and intensity of flooding in polar latitudes (Myers et al., 2017). As a result, some regions of the world will experience soils overly saturated with water, while other regions will experience the opposite. These shifts in temperature and water availability will push the environment past the thresholds for optimal crop yields, resulting in a decrease in food availability and variety, and thus, a decline in overall food security and nutrition. Other extreme weather events, such as tornadoes and hurricanes may also increase in frequency and intensity due to climate change, with the potential to damage growing crops.

Rising temperatures also impact ecosystem services as well as the biological functions of various organisms. Global warming can increase the ability of insects and pests to survive during winters, providing them with more time to feed on crops (Myers et al., 2017). Increasing intensity of pests and diseases inflict our crops and lower our crop yields. Similarly, it may disrupt the timing of pollination; pollinators, which find the appropriate times to pollinate crops and flowers through environmental cues such as temperature, may attempt to pollinate crops too early in the year, thus limiting plant reproduction (Myers et al., 2017).

Fisheries, too, will suffer losses in production. Warm water streams affect the paths that fish follow to feed, and rising sea temperatures will make oceans more acidic and displace the habitats of many marine organisms that need cooler, more basic environments to survive (Myers et al., 2017). Plankton, which form the basis for most marine food webs, are particularly vulnerable, as well as organisms living in coral reefs, which are highly susceptible to degradation in acidic environments. Outputs of other animal-based foods, such as livestock, will also decline because lower water and crop availability will limit the quantity of food available to feed them.

Each of these effects will create an overall decrease in the abundance of food that can grow as well as the diversity of crops that is available. According to the IPCC, at low latitudes, crop productivity will decrease even with small local temperature increases of 1 to 2°C (IPCC, 2007). Climate change will result in a 14% decline in cereal production across the world by 2030, and regions in Africa and South Asia will experience 8% crop yield losses across all crop varieties by 2050 (Giannini, 2017). Monotonous diets due to decreased varieties of foods can lead to chronic diseases (Springmann, 2017). When an individual is undernourished, he or she has less resilience to chronic diseases, particularly cardiovascular diseases, hypertension, and type 2 diabetes (Friel, 2010). Food insecure households may be unable to afford the more expensive prices of food, forcing them to rely on cheaper, energy-dense foods such as those with refined grains and sugars and added fats (Seligmen et al., 2010). These foods are generally less healthy and more highly associated with chronic illnesses and conditions. Furthermore, as climate change lowers the availability of food, the world's population will simultaneously continue to grow, rising to reach an estimated 8 billion people by the year 2025 and 12.3 billion by 2100 (Faraco et al., 2016). The combination of an increasing population and a decline in food production may cause food insecurity to reach unprecedented rates.

In addition to decreasing the abundance of food, climate change also affects the nutritional quality within crops. At CO2 concentrations of 550 ppm, cereal grains and legumes will experience a 3 to 11% decrease in zinc and iron concentrations; an estimated 150 to 200 million people will suffer a new risk for zinc deficiency, while more than 1 billion people who are already deficient in zinc content will experience exacerbated deficiencies (Myers et al., 2017). For fisheries, climate change will result in reduced long-chain polyunsaturated fatty acid contents in phytoplankton, which will also affect the nutritional content of organisms higher in the food chain (Myers et al., 2017).

Strong economic effects will also be apparent; Brazil, for instance will lose up to $5 billion in potential income by 2070 because of a 30% loss in coffee-growing capabilities in the country's southeastern region (Gianinni, 2017). Other countries will experience similar downturns in their respective economies. Decreases in food availability will result in inflated prices for foods, leaving lower income families unable to purchase sufficient food resources to maintain a stable, healthy diet. Negative impacts for both health and income related to climate change's effects on agriculture and livestock production will inflict countries around the world until appropriate and sufficient mitigation and adaptation strategies are adopted.

Small Island Developing States (SIDS)

SIDS are especially sensitive to climate change because as islands, their geographical locations and landscapes put them at an increased risk for damaged infrastructure due to natural disasters, rising sea levels, and shifting precipitation patterns; they are also remote and unable to quickly and easily adapt to environmental changes (Scandurra, 2018). Because they so often rely on fisheries for food and income, they face a major threat to an industry that is immensely disturbed by temperature shifts. Levels of hunger in countries, such as Haiti, have already been classified as "alarming" in the 2016 Global Hunger Index (IFPRI, 2016).

The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) recognized that small islands face inundation, storm surges, and coastal hazards due to sea level rise, which will damage infrastructure and settlements that support agriculture and livelihoods (IPCC, 2007). Additionally, the deterioration of coastal conditions will affect local resources and water resources, which will ultimately become insufficient to meet the needs of communities during periods of low-rainfall.

In addition to the risks faced by them as islands, SIDS also face extreme risks because they are developing countries. Developing countries are especially susceptible to the deleterious effects of climate change because they lack the resources necessary to adapt to environmental shifts due to their poverty, weak governmental institutions, and fragile infrastructure (Hanna & Oliva, 2016). 75 percent of the world's poor relies on farming for their livelihoods in some way, and climate change will exacerbate their low incomes (Hanna & Oliva, 2016). Low nutrition can lead to health problems, but developing countries generally do not have healthcare systems strong enough to deal with this influx of issues (Hanna & Oliva, 2016).

As the presiding nation at the COP23 negotiations, Fiji held a distinct opportunity to draw attention to the vulnerability of SIDS. At COP23, Semi Koroilavesau, the Minister of Fisheries for Fiji, stated that Fiji has already begun to experience the impacts of climate change through the increased frequency and intensity of cyclones, droughts, and other extreme natural weather events which affect the livelihoods of Fijian farmers and fishers (2017). Similarly, in a personal interview, Inia Seruriatu, Fiji's Minister for Agriculture, Rural & Maritime Development, and National Disaster Management, addressed this inequality and his personal observations of localized effects within his community:

> For [Fiji], perhaps, malnutrition is not big [as an issue]. But it's nutrition security that is a bigger challenge… we have food, but it's not the right amount of food and that is affecting us in so many ways. In most of Fiji, because of climate change, there are great effects on the livelihoods of the people. They have to resort to low quality, inferior type foods, and this is a big problem. Climate change is affecting [Fiji] in terms of saltwater intrusion, changing weather patterns, unexpected pests and diseases, and, of course, the destruction caused by flooding and cyclones. So it is affecting our food security and the socio-economic livelihoods of our people in so many ways…. But [the people of Fiji] are thankful for this opportunity to be the voice of the affected and marginalized. By presiding over COP23, we are the voice of so many people all over the world, and we are the voice of the men, women, and children affected on islands. It is our hope that with our presidency and the key messages we bring, that people will most importantly work to implement the Paris Agreement and… act faster and more seriously (2017).

COP23 provided an outlet for similar testimonies from ministers in St. Lucia, Tuvalu, Samoa, and other SIDS. Despite the varying geographical locations of these countries in the Caribbean, South Pacific, and Polynesia, each faces exacerbated risks. For instance, Tuvalu, another small island developing nation in the South Pacific, is already paying the costs of the currently inadequate methods of adaptation.

"On Tuvalu, we are already feeling the impacts [of climate change]," Enele Sopoaga, the Prime Minister of Tuvalu, said at the High Level Roundtables on Climate Action for Zero Hunger on November 14, 2017. "Our freshwater tables are being contaminated by seawater… We can no longer use the water to plant trees or drink the water because it's now brackish. Corals are being bleached, which is affecting the stocks of fish which we eat and sell for our livelihoods."

The prior lack of recognition for the inequalities SIDS face and for appropriate methods of adaptation may be partially attributed to the scarcity of research regarding these countries. According to Thelma Krug, the Vice Chair of the Intergovernmental Panel on Climate Change (IPCC), it takes longer for developing countries to overcome climate change adversities because they generally have less peer-reviewed literature and research regarding them (2017). The IPCC must cope with the fact that these countries cannot provide as much data to show the potential impacts of climate change. In a personal interview, Krug stated:

> Some developing countries lack data and the ability to develop their own research models. The fact is that knowledge is currently lacking… But [the IPCC aims] to be more equitable in terms of the literature that it includes in assessments. This is why the IPCC,

> in its principles, acknowledges this difficulty for developing countries… When I look at the literature being assessed, obviously I would like to see it balanced. The IPCC has to cover all the regions globally because climate change is a global issue. If we don't see that match, we'll say 'Well, we are missing something.' Obviously it will be much richer and much more balanced if we bring in information from developing countries (2017).

Fiame Naomi Mata'afa, the Deputy Prime Minister and Minister of Natural Resources and Environment for Samoa addressed the idea that a lack of productivity in coastal communities forces SIDS to rely on food imports from other, more developed countries:

> Access to sufficient safe and nutritious food at all times has been recognized as a right for all people in our region by the Pacific Health ministers in endorsing the vision of healthy islands as an overarching framework for health protection and promotion in the Pacific. Pacific islanders have traditionally enjoyed comparatively good food security mainly because they have secured food in a variety of ways, such as subsistence farming, trading and selling products, fishing, and hunting. Now, this historic food security is being eroded... Changes in both the supply and demand of food pose an increasing threat to food security… Climate change seriously threatens the sustainability of the fishing industry and has the potential to undermine food security in a region strongly reliant on fish as a source of protein. Forests are often overlooked in the context of food security but are very important in the Pacific island countries. They provide important staple crops such as mangoes, citrus fruits, and the ubiquitous coconuts… So what does the global action program on food security and nutrition of small island developing states hold for us? The SAMOA Pathway calls for strengthened international cooperation and partnership with adequate investments and coordinated implementation to address and halt the persistent development challenges of SIDS (2017).

Developing countries are also usually major producers of food, so any climatic variations that disproportionately affect developing countries will have negative implications for the rest of the world as well (Faraco et al., 2016). As such, the extreme vulnerability of SIDS is not just a problem that the SIDS themselves will have to face; rather, it is one that parties to the UNFCCC must conquer together in order to ensure that the world meets its dietary and nutritional needs in spite of global warming.

Solutions

According to José Graziano de Silva, Director-General of the Food and Agriculture Organization of the United Nations (FAO), climate change, hunger, and poverty must be tackled together because we must not expect that poor communities and farmers will be able to cope with the effects of climate change without government support (2017). This issue is also difficult to solve because resilient agricultural development is difficult to sustain; it must answer current needs as well as be economically, environmentally, and politically sustainable in the long-term (De Pinto, 2017). With climate change, it must also address these needs in a potentially very different environment.

The ability of researchers to predict the intensity of decreases in crop yields and the results of these decreases upon malnutrition and food security is still difficult and uncertain, according to Richard Betts, the Head of Climate Impacts Research at the Office Hadley Centre (2017). There is still uncertainty about whether climate change will significantly affect the production of all crops or only certain varieties of crops, and there is also research that higher carbon concentrations in the atmosphere will positively impact crop production (Myers et al., 2017). Furthermore, there is currently little knowledge regarding how resilient crops, fisheries, and livestock are and how well they will be able to adapt to changing environments. However, despite these uncertainties, a risk management approach is necessary to ensure that humans do not continue to further the process of climate change and reach a threshold for crop yield decreases that they can no longer cope with. Sándor Fazekas, the Minister of Agriculture for Hungary, suggested that both communities and individuals should consider the "precautionary principle" when planning for food security in the future (2017). Outcomes are still uncertain, and as such, risk management plans should plan for worst case scenarios. Fazekas added that sustainably using resources is a "high priority for Hungary" (2017).

Finding appropriate solutions can yield economic and social benefits for many developed countries as well. During the panel "What You Eat Matters: Climate Change, Food Security, and Public Health," at COP23, Nicola Cantore, a researcher at Nagoya University and industrial development officer for the United Nations Industrial Development Organization, stated that redefining parameters for the agri-food industry could lead to positive externalities for many nations through beneficial economic outcomes (2017). The agri-food industry has the potential to facilitate international trade, while simultaneously supporting domestic incomes (Cantore, 2017).

Perhaps organizations such as the United Nations System Standing Committee on Nutrition should play a larger role in climate change negotiations, and health should receive a larger share of the adaptation funds for climate change. Public policies must be coherent across all sectors, from production to consumption, in order to ensure access to sustainable and healthy diets for all (Kristina, 2017). Given that the period from 2016 to 2025 is the United Nations (UN) Decade of Action on Nutrition, such methods would be particularly timely (Kristina, 2017).

Agroecology

Using practices derived from agroecology, the study of applying ecological practices to agricultural lands, is one method to help ensure that all individuals receive proper caloric and nutritional intakes. Agroecology and agroforestry can promote biodiversity as well as combat soil degradation through proper nutrient content, acidity, salinity, biomass, and moisture that will ensure that soil is fertile and optimally productive. (Scherr, 1999). Many countries have already created and implemented policies to promote agroecological practices and sustainable land management methods into their respective societies.

For instance, Stéphane Travert, the Minister of Agriculture for France, remarked on the ways in which implementing agroecological practices can create positive results to lift farmers out of poverty, improve food security and nutrition, and improve resilience in the face of climate change. In 2012, France announced that it would take action to train farmers to implement agroecological practices, research new practices, and incentivize agroecological practices by subsidizing the transition. France's ultimate goal for the program is to ensure that the majority of

French farms are committed to agroecological practices by the year 2025. In the panel "How Can Agroecology Help Countries Achieve Their Climate Commitments?," Travert described:

> We cannot continue to apply the same old recipes to work on biodiversity, economics, and food security separately. We need new approaches that aim for economic, environmental, health, and social performance and efficiency. These approaches will offer win-win solutions. The agroecological approach makes farmers more independent; they're less dependent on purchasing inputs and can reduce their operating expenses. Fertility is enhanced, promoting functional biodiversity. All of this helps to enhance a farm's resilience… Agroecology is not a one-size fits all silver bullet. It's about farmers working in their cultures with what they have. It puts back at the center of the system the farmers, who are the drivers of transitions (2017).

Similarly, Tunisia has begun to conduct research on proper water management and soil fertility for optimal crop yields and production. At the panel, Samir Taïeb, the Minister of Agriculture, Hydraulic Resources, and Fisheries for Tunisia also spoke about and emphasized this engagement with agroecology:

> Tunisia is one of the regions of the world that is hit the hardest by climate change—from agriculture to tourism, health, and infrastructure. Tunisia implemented a very strong-willed policy to adapt and become more resilient [to climate change] in 2015, which was submitted to the COP [COP21] in 2015. [Tunisia wants] to mobilize agroecological engineering knowledge to strengthen our country's ability to fight against the great decrease in production of our main crops, such as wheat and olives. We want to be able to produce more and produce better, but in this very difficult context, we must develop efficient systems combining water management and soil fertility… I would really like to underscore Tunisia's commitment to reduce climate change through agroecological practices (2017).

Movements towards the implementation of agroforestry methods have been further improved by the introduction of the United Nations Reducing Emissions from Deforestation and Forest Degradation in Developing Countries Programme (UN-REDD), which was initially launched at COP14 in 2008 and officially adopted at COP16 in 2010 (Farming First, 2017). UN-REDD focuses on four key cross-cutting themes of proper forest governance, tenure security, gender equality, and stakeholder engagement in order to ensure that its goals are met.

At COP23, the International Fund for Agricultural Development (IFAD) promoted the furthering of agroecological and agroforestry practices to create climate-resilient agriculture (IFAD, 2016). IFAD suggested methods such as crop diversification and intercropping, better water management, and integration of local and indigenous customs into land management. In 2014, the United Nations Climate Summit adopted the Global Alliance for Climate-Smart Agriculture in order to move towards these goals; however, further improvements must be made in order to sustainably continue the cultivation of crops and management of landscapes (Farming First, 2017).

Reduction of Food Waste

While agroecology primarily focuses on facilitating optimal environments for crop production, climate action strategies must not only ensure that agriculture can continue to be productive, but also find ways to make it more resilient. One method of doing so is through the reduction of food waste. 21,000 people, or roughly 15 people each minute, die each day due to hunger (Ghosh et al., 2015). Salvation of wasted food could feed 2 billion people each year (Ghosh et. al, 2015). However, research on improving food efficiency has been limited; only 5 percent of research in the past 30 years has focused on reducing crop losses in comparison to 95% focused on increasing crop productivity (Ghosh et al., 2015). Research has been geared towards producing more food rather than using it more efficiently.

However, reducing food waste can help to adapt to declining crop yields caused by global warming. Because roughly one-third, or 1.4 billion metric tons, of global food production is wasted each year, communities can implement programs to decrease waste in households and production to ensure that food is still available even when crop yields are decreased (Myers et al., 2017). Such practices already have been used in the past, but not on a widespread scale. The practice of gleaning, or collecting leftover crops from farmers to distribute, can provide resources for food banks. In 2010, New York collected 3.6 million pounds of fruits and vegetables through gleaning (Lee et al., 2017). To overcome the "food gap," we must increase food production by roughly 70 percent in the coming decades (Shepon, 2017). Since one-third of the food that we produce is lost, using resources more efficiently may be a more feasible option than increasing productivity of agricultural practices.

At the Closing Plenary of the High Level Roundtables on Climate Action for Zero Hunger, Ankit Kawatra, the founder of Feeding India, discussed his organization's commitment to a food redistribution program. Feeding India collects food before it is sent to landfills, especially to vulnerable individuals, such as children, disabled individuals, and the elderly (Kiwatra, 2017). By doing so, the programs assists in saving resources, cleaning India by displacing waste that would have otherwise been dumped in municipalities, improve nutrition, and prevent the food from producing methane gas while in the landfills. Kawatra noted that "unless the world agrees on what the basic human rights are, such as prevention of zero hunger, it will be extremely difficult for anyone to agree [upon international agricultural and food-related policies]."

High income countries, such as the United States, are particularly responsible for this high level of food waste; in the United States, 40% of all food grown, or 62 million tons of food, is wasted each year (Moore, 2017). In 1974, only 900 calories per person per day were wasted, but this number rose to 1,4000 calories per person per day in 2003. Just by reducing the amount of food that is wasted in the U.S. because it is considered "ugly produce," 266,000 tons of food could be saved and $277 million saved in a year (Moore, 2017).

While simultaneously helping to adapt to climate change, decreasing food waste can also have positive implications for mitigating climate change by reducing emissions. Each unit of food produced has an enormous impact on the environment; agricultural production emits more than 33 million tonnes of CO2 annually in addition to emissions from food production, packaging,

and transportation (Ghosh et al., 2015). In the United States, landfill costs up to $15 per tonne of waste and decomposing waste in landfills releases methane, a strong greenhouse gas (Ghosh et al., 2015). Alon Shepon, a researcher from the Weizmann Institute of Science in Israel, addressed this "two-way interaction between climate and food" at COP23 (2017). Each person's efforts can reduce his or her overall carbon footprint.

Reducing food waste is beneficial in terms of economics and social equity as well. Food waste occurs during agricultural production due to mechanical damage and attacks by insects, distribution due to inadequate storage and reaching expiration dates in supermarket shelves, processing due to trimming away of food by equipment, and consumption because they were not sold or eaten. Less food waste will allow producers and companies to spend less money on food that will be thrown away or never sold, and it can have positive implications for food security across communities of various incomes and ethnicities. Furthermore, it is a strategy that even individuals can take part in because so much food waste occurs at the consumer level within households. On an individual level, each person can plan the products they purchase for their meals more evenly and efficiently, compost leftover foods, be less stringent about expiration dates, and store their food correctly. Rather than rely on innovations of new technologies to mitigate or adapt to climate change, we can continue to use the resources that we already have solely by being more efficient in our utilization of them.

Policy Recommendations

The question of whether developed countries should be responsible for funding climate action efforts that assist developing countries or whether each country should be responsible for its own mitigation and adaptation efforts is one that has provoked much consideration and controversy, especially among UNFCCC negotiations. Some policymakers have argued that because developed countries have more economic, social, and political resources to make tangible changes occur, they should accept the bulk of the responsibility. Furthermore, developed countries are often more industrialized, so they contribute more carbon emissions to the atmosphere through their heavy industries. Others have argued that because climate change is a global issue, climate action efforts should be distributed equally among all nations. Regardless, new policies and implementation plans are necessary to ensure that climate change does not continue to persist in the future.

Though the Paris Agreement of 2015 recognized the need for a larger focus on food security and malnutrition as implications of climate change, subsequent negotiations have lacked specific policy recommendations for action. The Copenhagen Accord of 2009 and the Kyoto Protocol of 1997 similarly lacked these specifications. The absence of such consideration has thoroughly limited potential progression in this area. Each year that action-oriented plans are absent from international policies, the issue is worsening and growing more difficult to solve.

The UNFCCC should allocate a percentage of its Green Climate Fund (GCF) to support these efforts. These funds can be used to subsidize research by the IPCC and the subsidiary bodies of the UNFCCC for optimal agroecological practices, and subsequently, education for farmers. The funds may also assist in food waste reduction efforts through incentive funds. This portion of the GCF should be distributed to various nations based on their current contributions to food waste,

and each nation should provide monetary incentives to individuals for specified units of food waste that they redistribute to a community in need. International legislation should outline these policies, although national and regional legislation may add to it to make rules in those respective areas more strict. The legislation should be enforced by international organizations in order to ensure that each country is using the international funds properly, most effectively, and as dictated in the legislation. The Inter-Agency and Expert Group on Sustainable Development Goal Indicators has identified progress will be monitored for the United Nation's zero hunger initiative (IFRPI, 2016). These policies may be based on existing container deposit legislation that have some countries have enacted, which provide monetary deposit-refunds for the collection and return of recyclable containers. Although national and international bodies may be incentivized through other methods, financial motivation is critical to convince individuals to take climate action.

While a top-down approach towards policies and implementation is necessary, a grassroots approach towards community education and outreach is also necessary in order to ensure that individuals understand and support the overarching policies. As the International Food Policy Research Institute (IFRPI) recognized at COP23, inequalities in hunger and nutrition take place not only at national levels, but also at subnational and regional levels. The IFRPI advocated for more democratic governance of national food systems that more actively considers the needs of underrepresented groups, such as women and smallholders, when making policies that affect their long-term livelihoods. Local programs to teach farmers agroecological methods and to educate families and schools on how to plan to avoid food waste can help all individuals have an impact. A small, yet substantial portion of the GCF should be utilized for community-based outreach efforts, particularly for training, education, and capacity-building. Of this portion, 40 percent should support outreach efforts for farmers in the top agricultural producing countries, such as China and Brazil; 40 percent should support food waste reduction efforts in the countries that produce the most food waste per capita, which are typically highly developed countries such as the United States. The final 20 percent should be allocated to other nations in order to provide them with some opportunity to also contribute to food-based climate action efforts.

At the COP23 panel "Addressing Climate Change for a World Free of Hunger, Malnutrition, and Poverty," Allen Chastanet, the prime minister of Saint Lucia, addressed the necessity of taking local, community-based approaches as well as the needs of SIDS into consideration:

> I look at my region,… [and] clearly the consequences of repeated hurricanes and the ability to solve those issues [are affecting us]. This is a recurring theme… Speaking for the SIDS, I think that all too often the world has already made up its mind in terms of what policies there will be and imposes that policy on those small countries… The policy needs to instead start with individuals and the understanding of the capacity each individual, community, and country holds… When we're talking about the basics, such as being able to feed everybody in our society, I think we have to do a better job of understanding what the capacity of each individual countries is… and to agree on a minimum, living standard (2017).

The President of COP22 in Marrakech, Morocco, Salaheddine Mezouar, addressed the idea that hunger and climate change cannot be addressed without also addressing poverty. Climate change

affects food safety and security, which destabilizes communities, Mezouar said (2017). Hunger, in turn, will influence other international issues, such as migration of climate refugees who must move in order to escape poverty exacerbated by climate in their home regions. The issues of food production, healthy, poverty, and migration are so closely connected that they must all be considered in unison with each other. As such, a strong, decisive action that is agreed upon by the parties of the UNFCCC and entails specific policy implications is needed in order to show solidarity and concern for vulnerable populations. At the Closing Plenary of the High Level Roundtables on Climate Action for Zero Hunger, Mezouar stated:

> "A response [to this issue] can only be found in solidarity. I always insist on solidarity because this is a world in which we want to… build an environment that is more human so that we can care for human populations and individual human beings. This is a mission that will bring together all countries in the world. It is a very noble mission, and this is going to be a winning endeavor… When [people] sit around a negotiation table, they often do not feel like things are moving quickly enough. But as the president of COP22,... I know that thanks to this momentum [at the COP negotiations], we can face the challenges ahead of us" (2017).

Policies must also recognize long-term government commitment because the issue of nutrition security, like the broader issue of climate change, is one that must be solved over a large temporal scale across many generations. They must also be interdisciplinary; they require coordination across sectors such as agriculture, nutrition, health, social protection, education, sanitation, and hygiene (IFRPI, 2016).

Conclusions

Malnutrition and food insecurity are arguably two of the most significant rising issues caused by climate change. They will affect millions of individuals with the ability to affect even more as the severity of the issue continues to grow. They will both cause individuals to become more vulnerable to chronic diseases because of their ability to weaken immune systems, and they will exacerbate already unequal social and political hierarchies. Through its Sustainable Development Goals, the United Nations has recognized areas threatened by climate change's effects on food. The goals to end poverty and leave no individual behind, to end hunger and improve nutrition through sustainable agriculture, and to ensure healthy lives and promote well-being for individuals of all ages, are all directly correlated the world's ability to effectively combat global warming (United Nations, 2015).

Alessandro De Pinto, a senior research fellow at the International Food Policy Research Institute, echoed these thoughts at the COP23 panel entitled, "How Can Agroecology Help Countries Achieve Their Climate Commitments." De Pinto stated that, "climate change will only exacerbate already existing problems," adding that "if [the UNFCCC does not] help [those that are malnourished and food insecure] to produce the food with enough nutrients to support their health and if we do not help households in improving their agricultural practices and diversifying food production, then there is a catastrophic risk."

Given this risk, a larger emphasis must be placed on the importance of this issue in international policy created by the UNFCCC, and more substantial funding from the Green Climate Fund should be allocated to each of these causes. Maintaining current levels of agricultural production and nutrition security are not sustainable through the business-as-usual trend of greenhouse gas emissions. Moreover, if emissions continue through more severe representative concentration pathway (RCP) scenarios, agricultural production may decline more quickly than previously anticipated. Through the agricultural industry is only one sector negatively affected by the consequences of climate change, it is one that the UNFCCC and its parties should take action against quickly and efficiently.

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