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Climate Change, Food Security, and Agrobioversity: Toward a Just, Resilient, and Sustainable Food System

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ARTICLES

CLIMATE CHANGE, FOOD SECURITY, AND AGROBIODIVERSITY: TOWARD A JUST, RESILIENT, AND SUSTAINABLE FOOD SYSTEM

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The global food system is in a state of profound crisis. Decades of misguided aid, trade, and production policies have generated record levels of world hunger despite bountiful harvests and soaring profits for the transnational corporations that dominate the global food supply.[1] The rapid expansion of industrial agriculture has produced an unprecedented loss of plant genetic diversity,[2] making the world's food supply dangerously vulnerable to wide-spread crop failure akin to that of the Irish potato famine.[3] In addition, climate change threatens to wreak havoc on food production by increasing the frequency and severity of extreme weather events, depressing agricultural yields, reducing the productivity of the world's fisheries, and placing additional pressure on scarce water resources.[4]

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1. ERIC HOLT-GIMENEZ & RAJ PATEL WITH ANNIE SHATTUCK, FOOD REBELLIONS! CRISIS AND THE HUNGER FOR JUSTICE 1, 6, 20 (2009).

2. CARY FOWLER & PAT MOONEY, SHATTERING: FOOD, POLITICS, AND THE LOSS OF GENETIC DIVERSITY 63-76 (1990) (providing qualitative and quantitative information about the loss of crop genetic diversity and attributing this loss to the expansion of industrial agriculture); U.N. FOOD & AGRIC. ORG. (FAO), BUILDING ON GENDER, AGROBIODIVERSITY AND LOCAL KNOWLEDGE: A TRAINING MANUAL, 3-5 (2005), *available at* ftp://ftp.fao.org/docrep/fao/009/y5956e/y5956e00.pdf [hereinafter BUILDING ON GENDER](discussing the extent and the causes of declining agrobiodiversity).

3. *See* FOWLER & MOONEY, *supra* note 2, at 43-45, 82-83.

4. Anthony Nyong, *Climate Change Impacts in the Developing World: Implications for Sustainable Development, in* CLIMATE CHANGE AND GLOBAL

This Article examines the underlying causes of the global food crisis and recommends specific measures to address the distinct but related problems of food insecurity, loss of genetic resources, and climate change. Part I introduces the seldom-discussed crisis of agrobiodiversity, and explains the threats that genetic uniformity poses to the world's food supply. Part II explores the historic and current causes of widespread food insecurity, and analyzes the common roots of food insecurity and loss of agrobiodiversity. Part III examines the threat posed by climate change to global agricultural production and the role of agriculture in mitigating and adapting to climate change. Part IV argues that small-scale sustainable agriculture has the potential to address the interrelated climate, food and agrobiodiversity crises, and suggests specific measures that the international community might take through law and regulation to promote socially just and environmentally sustainable agricultural production.

The Article concludes that the root cause of the global food crisis is corporate domination of the food supply and the systemic destruction of local food systems that are healthy, ecologically sustainable, and socially just. As the devastating social and environmental consequences of industrial agriculture become increasingly apparent, social movements in the Global North and the Global South are calling for sustainable food systems that minimize greenhouse gas emissions, rely on local inputs, strengthen rural economies, and connect farmers and consumers.[5] By threatening widespread destruction of the natural resources necessary for food production, the climate crisis and the biodiversity crisis may spark a broad-based

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POVERTY: A BILLION LIVES IN THE BALANCE? 47-51 (Lael Brainard et al, eds., 2009).

5. *See* HOLT-GIMENEZ & PATEL, *supra* note 1, at 159-75 (describing movements in the United States and Europe to promote local, ecologically sustainable, and socially just food production and consumption); Marne Coit, *Jumping on the Next Bandwagon: An Overview of the Policy and Legal Aspects of the Local Food Movement,* 4 J. FOOD L. & POL'Y 45, 48-55 (2008) (examining the multiple objectives of the local food movement in the United States); Susan A. Schneider, *Reconnecting Consumers and Producers: On the Path Toward a Sustainable Food and Agriculture Policy,* 14 DRAKE J. AGRIC. L. 75, 83-85 (2009) (discussing growing interest in local and organic foods among U.S. consumers); Annie Shattuck & Eric Holt-Gimenez, Comment, *Moving from Food Crisis to Food Sovereignty,* YALE HUM. RTS. & DEV. L. J. 421-23, 431-33 (2010) (describing the food sovereignty and agroecology movements in the Global South).

political movement to redirect resources toward food production systems that sequester carbon, promote agrobiodiversity, and support the livelihoods of small farmers.

I. THE CRISIS OF AGROBIODIVERSITY

While the reality of climate change has finally penetrated the popular psyche, another environmental crisis – the dramatic loss of agrobiodiversity – silently threatens the world's food supply.[6] Agrobiodiversity consists of the biological resources that are important for food production, including the diverse varieties of animals, plants, and micro-organisms that sustain the functioning of agro-ecosystems.[7] This Article focuses on one aspect of agrobioversity – the planet's food crop diversity.

Over the last fifty years, much of the world's agriculture has transitioned into industrial agriculture, which requires greater inputs of water, synthetic pesticides and fertilizers, and fossil fuel-based energy than traditional peasant agriculture.[8] This model of agricultural production has triggered a wide range of environmental problems, including deforestation, increased reliance on dwindling stocks of fossil fuels, soil degradation, agrochemical contamination of water supplies, depletion of aquifers, and the release of greenhouse

6. *See* FOWLER & MOONEY, *supra* note 2, at ix.

7. BUILDING ON GENDER, *supra* note 2, at 1-2 (defining agrobiodiversity as: [t]he variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries. It comprises the diversity of genetic resources (varieties, breeds) and species used for food, fodder, fiber, fuel and pharmaceuticals. It also includes the diversity of non-harvested species that support production (soil micro-organisms, predators, pollinators), and those in the wider environment that support agro-ecosystems (agricultural, pastoral, forest, and aquatic) as well as the diversity of the agro-ecosystems.) *Id.* at 2 (Box 2).

8. *See* THOMAS PRUGH WITH ROBERT CONSTANZA ET AL., NATURAL CAPITAL AND HUMAN ECONOMIC SURVIVAL 80 (1995).

gases.[9] The impact on genetic diversity, however, has been particularly devastating.[10]

According to the United Nations Food and Agriculture Organization, 75% of the world's food crop diversity was lost in the twentieth century as farmers abandoned local varieties in favor of genetically uniform high-yielding crops.[11] Although thousands of crops have been cultivated since the dawn of agriculture,[12] twelve crops currently supply 80% of the world's plant-based dietary energy.[13] Just four crops – rice, wheat, potato, and maize – supply nearly 60% of plant-derived calories and protein.[14]

In addition to relying on a small number of crops, the world's food supply also relies on an alarmingly narrow genetic base.[15] Genetically uniform, high-yielding varieties have supplanted traditional varieties for 70% of the world's maize;[16] 50% of the wheat in Asia, Africa, and Latin America;[17] and 75% of Asian rice.[18] While Indian farmers cultivated 30,000 wild varieties of rice in 1950, only fifty varieties are projected to remain by 2015.[19]

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9. *See id.* at 79-84; JULES N. PRETTY, REGENERATING AGRICULTURE: POLICIES AND PRACTICES FOR SUSTAINABILITY AND SELF-RELIANCE 58-80 (1995) (describing the environmental consequences of industrial agriculture).

10. *See* FOWLER & MOONEY, *supra* note 2, at ix (describing the loss of genetic diversity in agriculture as a "devastating time bomb . . . . leading us to a rendezvous with extinction").

11. U.N. FOOD & AGRIC. ORG., *First Fruits of Plant Gene Pact*, (June 21, 2009), http://www.fao.org/news/story/0/item/20162/icode/en/. [hereinafter *First Fruits*].

12. FOWLER & MOONEY, *supra* note 2, at 86.

13. *First Fruits, supra* note 11.

14. *Id.*

15. Miguel A. Altieri & Paul Rogé, *The Ecological Role and Enhancement of Biodiversity in Agriculture, in* AGRICULTURE, BIODIVERSITY AND MARKETS: LIVELIHOODS AND AGROECOLOGY IN COMPARATIVE PERSPECTIVE 15, 17 (Stewart Lockie & David Carpenter, eds., 2010) (discussing the "genetic homogeneity that exists within some of the most commonly planted crops").

16. Christopher M. Picone & David Van Tassel, *Agriculture and Biodiversity Loss: Industrial Agriculture, in* LIFE ON EARTH: AN ENCYCLOPEDIA OF BIODIVERSITY, ECOLOGY, AND EVOLUTION 100 (Niles Eldredge ed., 2002).

17. *Id.*

18. *Id.*

19. *Id.*

The dangers posed by the genetic uniformity of the world's food crops can best be illustrated by the Irish potato famine of the 1840s.[20] Native to the Andes, the potato was introduced into Spain in 1570 and into England and Ireland in approximately 1590.[21] For over two centuries, all of the potatoes cultivated in Europe descended from these two introductions.[22] The Irish potato famine was caused by a fungus known as *phytophthora infestans*.[23] Due to the genetic uniformity of the Irish potato crop, a single infestation was sufficient to produce widespread devastation.[24] The Irish potato famine lasted for five years, and resulted in the death of as many as 2,000,000 people and the migration to the United States of a comparable number.[25] Eventually, potato varieties resistant to *phytophthora infestans* were discovered among the thousands of distinct potato varieties in the Andes and in Mexico, thus enabling potato cultivation to recover in Ireland.[26] If some of these resistant potato varieties had originally been planted in Ireland along with the more vulnerable varieties, then the Irish potato famine might have been averted.[27]

The Irish potato famine is a tragic example of the vulnerability of genetically uniform crops to pests and disease. Unable to rely on their own natural defenses, genetically uniform crops typically require significant agrochemical inputs to survive.[28] However, pesticides kill beneficial organisms as well as target pests, and typically lead to the resurgence of pests, outbreaks of new pests, and pesticide resistance.[29] In contrast, genetically diverse crops are more resilient

20. *See* FOWLER & MOONEY, *supra* note 2, at 43-45, 81-82.

21. *Id.* at 43.

22. *Id.*

23. *Id.*

24. *Id.* at 43-45.

25. *Id.* at 45.

26. *Id.*

27. Gerald Moore, *Multilateral and National Regulatory Regimes for Agrobiodiversity*, *in* AGRICULTURE, BIODIVERSITY AND MARKETS 48 (Stewart Lockie & David Carpenter eds., 2010).

28. FOWLER & MOONEY, *supra* note 2, at 46-47 (describing how certain crops would not have survived without pesticides or fertilizers).

29. *See* Jules N. Pretty, *Agroecology in Developing Countries: The Promise of a Sustainable Harvest*, 45 ENV'T SCI. & POL'Y SUSTAINABLE DEV. 9, 16 (2003). Pesticides often destroy the natural enemies of pests and thereby produce pest resurgences. They can also generate outbreaks of new pests by killing the natural enemies of species that were not previously pests. In addition, pests that survive the application of pesticides can transfer genetic pesticide resistance to their

than genetically uniform monocultures because some varieties are able to resist pests, disease, and adverse weather conditions to which other varieties might succumb.[30] Indeed, cultivating different crops and different crop varieties has historically served as an insurance policy for farmers — a means of protecting their livelihoods in the face of climate variations, pathogen infestations, price fluctuations, and socio-political disruptions.[31]

Regrettably, agrobiodiversity is under threat world wide – along with the local knowledge and skills required to cultivate and utilize different wild and harvested plant species and varieties.[32] The main reasons for this global crisis are the rapid expansion of industrial agriculture, the Green Revolution, the globalization of the food system and consequent marginalization of small-scale farmers, and the replacement of local crop varieties by "improved" non-native varities.[33] Local cultivation practices often disappear due to the intrusion of foreign technology that promises farmers short-term gains in the form of higher yields.[34] High-yielding crop varieties may thrive under favorable weather conditions, but they can also fail spectacularly under adverse conditions.[35] It is therefore vitally important to protect and preserve the skills, customs, traditions, and

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offspring, causing an entire insect population to develop resistance to pesticides. PRETTY, REGENERATING AGRICULTURE, *supra* note 9, at 64-65; FOWLER & MOONEY, *supra* note 2, at 47-50.

30. *See* FOWLER & MOONEY, *supra* note 2, at 47.

31. BUILDING ON GENDER, *supra* note 2, at 2.

32. *Id.* at 3.

33. *Id.* at 4-5. The Green Revolution was a public sector initiative designed to combat world hunger by breeding and distributing new varieties of staple crops (primarily cereals) that produced high yields in response to the application of fertilizer and irrigation. While the Green Revolution was extremely successful from the standpoint of food production, it accelerated the loss of traditional crops and crop varieties. *See* FOWLER & MOONEY, *supra* note 2, at 56-60. By the 1990s, Green Revolution crop varieties comprised approximately 70% of the world's maize, over half of the wheat produced in Asia and Latin America, and nearly 75% of the rice cultivated in Asia. FRANCES MOORE LAPPE ET AL., WORLD HUNGER: TWELVE MYTHS 58-59 (2d ed., 1998).

34. BUILDING ON GENDER, *supra* note 2, at 10 (describing how higher yielding sorghum varieties were introduced in Ethiopia to "increase food security and income" for rural farmers).

35. *See id.* (describing how the higher yielding sorghum varieties were successful when weather conditions were favorable, but failed in drought conditions).

technologies of small farmers as these skills form one component of an integrated system of agricultural knowledge.[36]

The diverse plant varieties under the stewardship of the world's small farmers are vital to global food security, not only for their ability to ward off catastrophic crop failure, but also as a source of the raw germplasm used by plant breeders to develop crops that can withstand environmental shocks, including those that may be associated with climate change.[37] Historically, plant breeders have used the diverse characteristics of traditional crops to select particular traits, such as drought resistance, tolerance for heat and cold, and resistance to specific pests and diseases.[38] Because traditional crops have survived in farmers' fields for thousands of years amidst pests and diseases without chemical inputs, they usually possess a wealth of valuable characteristics.[39] If traditional varieties cannot supply the needed traits, plant breeders typically turn to "wild relatives" – wild or weedy plants closely related to cultivated crops.[40] Plant breeders have used wild relatives to breed many cultivated crops, including sugarcane, strawberries, black pepper, peanuts, potatoes, tomatoes, tobacco, maize, wheat, and cacao.[41] Sadly, wild relatives are increasingly at risk as a consequence of the loss, degradation and fragmentation of natural habitats, and the continuing industrialization of agriculture.[42]

Genetic diversity also has value beyond the ability to fight pests and disease. As weather patterns become less predictable and agricultural yields decline, plants that currently have little or no economic value may become very important as sources of food and

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36. *See id.*; Stewart Lockie & David Carpenter, *Agriculture, Biodiversity and Markets, in* AGRICULTURE, BIODIVERSITY AND MARKETS: LIVELIHOODS AND AGROECOLOGY IN COMPARATIVE PERSPECTIVE, *supra* note 15, at 5.

37. *See* Carmen G. Gonzalez, Comment, *The Global Food Crisis: Law, Policy, and the Elusive Quest for Justice,* 13 YALE HUM. RTS. & DEV. L.J. 462, 468 (2010); *see also* FOWLER & MOONEY, *supra* note 2, at 42.

38. FOWLER & MOONEY, *supra* note 2, at 46; GORDON CONWAY, THE DOUBLY GREEN REVOLUTION: FOOD FOR ALL IN THE 21ST CENTURY 141 (1997).

39. *See* FOWLER & MOONEY, *supra* note 2, at 42-43, 60.

40. *Id.* at 50; UNITED NATIONS ENVIRONMENT PROGRAMME [UNEP], THE ENVIRONMENTAL FOOD CRISIS: THE ENVIRONMENT'S ROLE IN AVERTING FUTURE FOOD CRISES 74 (Christian Nellemann et al. eds., 2009) [hereinafter UNEP, THE ENVIRONMENTAL FOOD CRISIS].

41. FOWLER & MOONEY, *supra* note 2, at 51-52.

42. *See* UNEP, THE ENVIRONMENTAL FOOD CRISIS, *supra* note 40, at 74.

medicine.[43] Although the planet contains at least 75,000 edible plants, humans have historically consumed only 3,000 plant species, only 150 of which have been cultivated on a large scale.[44] Similarly, while one fourth of all medicines and pharmaceuticals are derived from plants, animals, and microorganisms (including analgesics, tranquilizers, contraceptives, diuretics, and cancer-fighting compounds),[45] only 3% of the world's flowering plant species have been tested for medicinal properties.[46] Regrettably, the dangerous decline in the genetic diversity of the world's cultivated crops is taking place at a time when the planet is losing wild plant and animal species at a rate 100 to 1,000 times the historical average – a rate of extinction unparalleled since the Cretaceous-Tertiary extinction sixty-five million years ago that resulted in the disappearance of dinosaurs.[47]

In sum, the expansion of industrial agriculture has narrowed the genetic base of the world's food supply, and has increased the likelihood of catastrophic crop failure in the event of drought, heavy rains, and outbreaks of pest and disease. In addition, the loss of genetic resources and the loss of local knowledge about traditional agricultural practices compromise the ability of farmers and plant breeders to develop plants that will resist future environmental shocks, including those associated with climate change. All of this is transpiring at a time of unprecedented extinction of wild plants and animals.[48] Because the agrobiodiversity crisis and global food insecurity have similar roots, the following section examines the common causes underlying these problems.

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43. *See generally* Climate Change Project, *The Use of Agrobiodiversity by Indigenous and Rural Communities* (Platform for Agrobiodiversity Research, Briefing Paper), *available at* http://www.agrobiodiversityplatform.org/blog/wp-content/uploads/2009/09/PAR_climate-change_briefing_web.pdf.

44. Norman Myers, *Biodiversity's Genetic Library*, *in* NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS 255, 259 (Gretchen C. Daily ed., 1997).

45. *Id.* at 263.

46. *See* PRUGH, *supra* note 8, at 65.

47. *Biodiversity Conference Starts in Japan,* N.Y. TIMES, Oct. 18, 2010, at A9; Ian Sample, *Human Activity is Driving Earth's "Sixth Great Extinction Event,"* GUARDIAN (July 28, 2009), http://www.guardian.co.uk/environment/2009/jul/28/species-extinction-hotspots-australia.

48. *See supra* notes 6-7.

II. GLOBAL FOOD INSECURITY AND LOSS OF AGROBIODIVERSITY: ROOT CAUSES

The United Nations Food and Agriculture Organization estimates that in 2009 1.02 billion people were chronically malnourished worldwide — a figure that represents one sixth of the world's population.[49] At least one billion of the world's malnourished people reside in the Global South.[50] The majority are peasants who produce at least seventy percent of the world's food and whose survival depends on marketing their agricultural output.[51] These small farmers are also the custodians of the genetically diverse crop varieties that may prove vital to the sustainability of the global food system.[52]

Food insecurity is a function of poverty rather than food scarcity.[53] Global food production has outstripped global population growth for several decades,[54] and there is currently more than enough food to eliminate world hunger.[55] People go hungry because they are too

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49. U.N FOOD & AGRIC. ORG. (FAO), THE STATE OF FOOD INSECURITY IN THE WORLD 4, 11 (2009), *available at* ftp://ftp.fao.org/docrep/fao/012/i0876e/i0876e.pdf.

50. *Id.* at 11 fig.4.

51. *See* ACTION GROUP ON EROSION, TECH. & CONCENTRATION (ETC GROUP), WHO WILL FEED US?: QUESTIONS FOR THE FOOD AND CLIMATE CRISES 1 (Nov. 2009), *available at* http://www.etcgroup.org/upload/publication/pdf_file/ETC_Who_Will_Feed_Us.pdf; *see generally* KEVIN WATKINS & JOACHIM VON BRAUN, TIME TO STOP DUMPING ON THE WORD'S POOR 2 (2003-2003), *available at* http://www.ifpri.org/pubs/books/ar2002/ar02e1.pdf (discussing inability of small farmers to successfully markets their agriculture output in global market due to developed countries' trade restrictions and subsidies).

52. *See* ALESSANDRA GIULANI, DEVELOPING MARKETS FOR AGROBIODIVERSITY: SECURING LIVELIHOODS IN DRYLAND AREAS 8 (2007).

53. WORLD BANK, POVERTY AND HUNGER: ISSUES AND OPTIONS FOR FOOD SECURITY IN DEVELOPING COUNTRIES v, 1 (1986). The food crisis of 2008, for example, coincided with record grain harvests in the world's major food producing nations and with record profits for the transnational corporations that dominate global food markets. ERIC HOLT-GIMENEZ, FOODFIRST: INST. FOR FOOD & DEV. POL'Y, THE WORLD FOOD CRISIS: WHAT'S BEHIND IT AND WHAT WE CAN DO ABOUT IT 1-6 (2008), *available at* http://www.foodfirst.org/sites/www.foodfirst.org/files/pdf/PB%2016%20World%20Food%20Crisis.pdf.

54. HOLT-GIMINEZ & PATEL, *supra* note 1, at 7; *see* LAPPE ET AL., *supra* note 33, at 9.

55. HOLT-GIMENEZ & PATEL, *supra* note 1, at 7; U.N. FOOD & AGRIC. ORG. (FAO), HUNGER IN THE FACE OF CRISIS (2009), ftp://ftp.fao.org/docrep/fao/012/ak541e/ak541e00.pdf; WORLD AGRICULTURE: TOWARDS 2015/2030: AN FAO

poor to grow or purchase food.[56] Nations are food insecure because they lack the ability to produce or purchase sufficient food to satisfy domestic nutritional needs.[57]

The root cause of food insecurity and loss of agrobiodiversity is a corporate-dominated food production and distribution system that marginalizes small farmers and places developing countries at a structural disadvantage in world agricultural trade. This food production and distribution system was imposed on the Global South in several successive stages outlined below.

A. The Colonial Legacy

Food insecurity in the Global South has its origins in colonialism.[58] As a consequence of the colonial division of labor, most developing countries entered the world economy as producers of raw materials and consumers of manufactured products.[59] Agricultural export specialization is economically disadvantageous due to the volatility of world market agricultural prices, to the declining terms of trade for agricultural commodities in relation to manufactured goods, and to the vulnerability of agricultural production to vicissitudes of weather and climate.[60] The genetic uniformity of export crops also makes them highly vulnerable to periodic crop failure due to pests and disease.[61]

PERSPECTIVE 136 (Jelle Bruinsma ed., 2003), http://www.fao.org/fileadmin/user_upload/esag/docs/y4252e.pdf.

56. *See* HOLT-GIMENEZ & PATEL, *supra* note 1, at 16-17; HUNGER IN THE FACE OF CRISIS, *supra* note 55; WORLD AGRICULTURE, *supra* note 55, at 136.

57. *See* Carmen G. Gonzalez, *Trade Liberalization, Food Security, and the Environment: The Neoliberal Threat to Sustainable Rural Development,* 14 TRANSNAT'L L. & CONTEMP. PROBS. 419, 430 (2004)

> The least food-secure states are those that combine inadequate domestic food production with heavy reliance upon one or two agricultural export commodities for a significant portion of foreign exchange earnings. Poor harvests or sudden declines in world market prices for exports can deprive these countries of the foreign exchange earnings necessary to purchase essential foodstuffs. Likewise, increases in the world market price of imports can make it difficult to obtain the food necessary to satisfy domestic nutritional needs. *Id.*

58. *See* LIZ YOUNG, WORLD HUNGER, 41-42 (1997).

59. *Id.*

60. *See* Gonzalez, *supra* note 57, at 422, 430.

61. *See id.* at 438.

Not surprisingly, food insecurity is concentrated in developing countries that dedicate high quality agricultural lands to export production, do not produce enough food for domestic consumption, and rely on a small number of agricultural exports to earn the foreign exchange with which to import food.[62] Adverse weather and market volatility depresses export earnings and creates chronic food shortages or famines.[63] To guarantee a reliable food supply, developing countries must invest in the domestic agricultural sector, protect the livelihoods of small farmers, and develop a more diversified economic base capable of generating stable and robust revenue streams to finance the importation of food and other goods not produced domestically.[64]

The trade and aid policies of industrialized countries in the aftermath of World War II undermined food security in the Global South by promoting dependence on imported food, devastating the livelihoods of small farmers, and depriving developing countries of the revenues with which to finance economic diversification. In the post-war period, agricultural producers in the United States and Western Europe, buttressed by state price supports and generous agricultural subsidies, disposed of surplus agricultural production in developing countries as food aid or dumped the food on the market at low prices.[65] This practice depressed agricultural commodity prices, discouraged food production in the Global South, impoverished small farmers, and generated dependence on cheap, imported food.[66] At the same time, the tariffs and other import barriers maintained by the United States and other industrialized countries diminished the export

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62. *Id.* at 423-35, 465-67. Among the most vulnerable are the forty-three developing countries in sub-Saharan Africa, Latin America, and the Caribbean that generate over half of their export revenues from agricultural exports and rely on one agricultural commodity for over twenty percent of these revenues. *See* THE STATE OF FOOD INSECURITY IN THE WORLD, *supra* note 49, at 17.

63. *See* U.N. FOOD & AGRIC. ORG. (FAO), THE STATE OF AGRICULTURAL COMMODITY MARKETS 32-34 (2009), ftp://ftp.fao.org/docrep/fao/012/i0854e/i0854e.pdf.

64. *See* Gonzalez, *The Global Food Crisis*, *supra* note 37, 474-75.

65. HOLT-GIMENEZ & PATEL, *supra* note 1, at 24; Gonzalez, *Trade Liberalization, supra* note 57, at 435-36.

66. Gonzalez, *Trade Liberalization, supra* note 57, at 436.

earnings available to developing countries to finance economic diversification and industrialization.[67]

The 1947 General Agreement on Tariffs and Trade ("GATT") did little to restrict agricultural subsidies and import barriers of the Global North.[68] Various GATT exemptions permitted industrialized countries to heavily subsidize domestic agricultural exporters and to restrict the importation of agricultural products from the Global South.[69] Although the GATT was amended several times in response to developing country demands for greater access to markets in the Global North,[70] these amendments were typically drafted in non-binding language and often excluded agricultural products, textiles, and clothing – the major export products of developing countries.[71] Thus, notwithstanding the GATT, trade barriers in the Global North continued to deprive developing countries of the export revenues needed to finance industrialization while Northern agricultural subsidies depressed world market agricultural commodity prices, harmed small farmers, and increased dependence food imports.[72]

B. The Green Revolution

The next major event in the history of the global food system was the Green Revolution, which sought to reduce world hunger by increasing agricultural yields.[73] With funding from the Ford and Rockefeller Foundations, international crop breeding institutions developed and disseminated new varieties of rice, wheat, and maize

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67. *See* Carmen G. Gonzalez, *Markets, Monocultures, and Malnutrition: Agricultural Trade Policy Through an Environmental Justice Lens*, 14 MICH. ST. J. INT'L L. 345, 361 (2006).

68. *See* Carmen G. Gonzalez, *Institutionalizing Inequality: The WTO Agreement on Agriculture, Food Security, and Developing Countries*, 27 COLUM. J. ENVTL. L. 433, 440-46 (2002).

69. YONG-SHIK LEE, RECLAIMING DEVELOPMENT IN THE WORLD TRADING SYSTEM 107-10 (2006); Gonzalez, *Institutionalizing Inequality, supra* note 68, at 440-46. For a description and analysis of the GATT negotiations prior to the Doha Round, *see generally* Faizel Ismail, *Rediscovering the Role of Developing Countries in GATT Before the Doha Round,* 1 L. & DEV. REV. 49 (2008).

70. Ismail, *supra* note 69, at 65-67.

71. *Id.* at 66, 71; Lee, *supra* note 69, at 37.

72. Gonzalez, *Trade Liberalization, supra* note 57, at 456-57.

73. CONWAY, *supra* note 38, at 44; KEITH GRIFFIN, ALTERNATIVE STRATEGIES FOR ECONOMIC DEVELOPMENT 144 (1989).

that produced higher yields than traditional varieties in response to synthetic fertilizers and controlled irrigation.[74]

While the Green Revolution dramatically increased global food production, it also perpetuated food insecurity in the Global South by increasing poverty and inequality.[75] The Green Revolution generally favored wealthy farmers because poor farmers lacked the resources to purchase the synthetic fertilizers, chemical pesticides, and irrigation equipment required to produce high yields.[76] Furthermore, by increasing global food production, the Green Revolution caused agricultural commodity prices to plummet, thereby impoverishing small farmers.[77] As one commentator observed, the Green Revolution "led in India, Thailand, Mexico and elsewhere to the concentration of land among those with the most capital, and to a veritable army of landless peasants."[78] A study reviewing over 300 published reports on the Green Revolution spanning a thirty-year period confirmed this assessment, concluding that the Green Revolution generally increased rural inequality.[79]

The Green Revolution's most significant environmental impact was a staggering worldwide loss of genetic diversity.[80] The Green Revolution displaced ecologically sustainable biodiverse agricultural practices, and promoted reliance on genetically uniform seeds, chemical fertilizers, and synthetic pesticides manufactured by transnational corporations based in the industrialized world.[81] The consequences of this dramatic shift to industrial agriculture included a loss of crop genetic diversity, heightened vulnerability to pests and

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74. CONWAY, *supra* note 38, at 51-55.

75. FOWLER & MOONEY, *supra* note 2, at 58-59; KEITH GRIFFIN, THE POLITICAL ECONOMY OF AGRARIAN CHANGE: AN ESSAY ON THE GREEN REVOLUTION 51 (1974) (describing how Green Revolution technologies favored landlords, strengthening the landlord class and increasing inequities); Young, *supra* note 58, at 72.

76. Gonzalez, *Trade Liberalization, supra* note 57, at 442-43.

77. *See id.*; *see also* GRIFFIN, *supra* note 73, at 158.

78. MARIA MIES & VERONIKA BENNHOLDT-THOMSEN, THE SUBSISTENCE PERSPECTIVE: BEYOND THE GLOBALISED ECONOMY 82 (Patrick Camiller et al., trans., 1999).

79. *See generally* Donald K. Freebairn, *Did the Green Revolution Concentrate Incomes? A Quantitative Study of Research Reports*, 23 WORLD DEV. 265 (1995).

80. *See* FOWLER & MOONEY, *supra* note 2, at 54-79 (describing the Green Revolution and its impact on agrobiodiversity).

81. *Id.* at 75-76.

disease, loss of soil fertility, pollution of water supplies by pesticides and fertilizers from agricultural runoff, depletion of aquifers for irrigation, loss of traditional food crops, loss of ecosystem biodiversity, and increased pesticide-related illness.[82]

In sum, the Green Revolution transformed peasant-based agricultural systems into large-scale commercial monocultures, and thereby accelerated the worldwide loss of genetic diversity. The Green Revolution also increased poverty and inequality – the underlying causes of food insecurity.[83]

C. Structural Adjustment and the WTO

The debt crisis of the 1980's initiated the final stage in the transformation of Southern agriculture. When the Organization of Petroleum Exporting Countries (OPEC) raised oil prices in the early 1970s, developing countries borrowed money from Northern commercial banks to pay for imported fuel and petroleum-based agricultural inputs.[84] When subsequent oil price shocks in 1979-80 coincided with soaring interest rates and declining prices for agricultural commodities, many debtor nations in the Global South were unable to repay their loans.[85] In exchange for new loans or for the restructuring of existing debt, the World Bank and the International Monetary Fund imposed a standard recipe of free market reforms (known as "structural adjustment") on these indebted nations that included elimination of subsidies to the agricultural sector, opening up their markets to foreign competition by reducing tariffs and other trade barriers, and promoting agricultural exports in order to service the foreign debt.[86] These policies bankrupted small farmers by depriving them of state support and by placing them in direct competition with highly subsidized U.S. and EU agricultural producers.[87] As domestic food production declined, much of the

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82. CONWAY, *supra* note 38, at 48, 88, 91; FOWLER & MOONEY, *supra* note 2, at 63-83; PRETTY, REGENERATING AGRICULTURE, *supra* note 9, at 69-72.

83. *See generally* Freebairn, *supra* note 79.

84. *See* SUSAN GEORGE, A FATE WORSE THAN DEBT 28-29 (1988); RICHARD PEET ET AL., UNHOLY TRINITY: THE IMF, WORLD BANK AND WTO 71 (2003).

85. Gonzalez, *The Global Food Crisis, supra* note 37, at 468-69.

86. *Id.*

87. Gonzalez, *Markets, Monocultures, and Malnutrition, supra* note 67, at 364-65.

Global South became dependent on food imports.[88] Africa, for example, was a net food exporter during the 1960s.[89] As a consequence of declining agricultural investment and the influx of cheap food imports, Africa currently imports twenty-five percent of its food and suffers from recurrent famines and food emergencies.[90] Ironically, the export-oriented policies favored by the World Bank and the IMF caused the foreign exchange earnings of many developing countries to decline as world markets were glutted with competing agricultural exports from a variety of countries in the Global South.[91] Because wealthy countries were not required to reduce subsidies or eliminate import barriers,[92] structural adjustment introduced a double standard in international agricultural trade that continues to the present day: open markets for the poor and protectionism for the wealthy.[93]

Structural adjustment exacerbated food insecurity in the Global South and accelerated the loss of agrobiodiversity. To increase the revenues available to service the foreign debt, developing countries were obligated to expand agricultural commodity exports – often at the expense of food production.[94] The emphasis on agricultural export production shifted land and other resources from food crops to cash crops, increased dependence on food imports, eroded crop genetic diversity, and produced a wide range of environmental harms associated with industrial agriculture, including excessive extraction of groundwater for irrigation, contamination of water resources, and higher levels of pesticide-related illnesses.[95]

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88. *See* HOLT-GIMENEZ & PATEL, *supra* note 1, at 44; Anuradha Mittal, United Nations Conference on Trade and Development, Geneva, Switz., Sept. 8-9, 2008, *The 2008 Food Price Crisis: Rethinking Food Security Policies, G-24 Discussion Paper Series* 14 (June 2009).

89. HOLT-GIMENEZ & PATEL, *supra* note 1, at 45.

90. *See id.* at 46.

91. *See* Gonzalez, *Markets, Monocultures, and Malnutrition, supra* note 67, at 365.

92. *See id.* at 364-65.

93. *See id.* 364.

94. *See* GEORGE, *supra* note 84, at 59-60; JOHN MADELEY, FOOD FOR ALL: THE NEED FOR A NEW AGRICULTURE 117 (2002); YOUNG, *supra* note 58, at 43.

95. *See* Gonzalez, *Trade Liberalization, Food Security, and the Environment, supra* note 57, at 469-70; STRUCTURAL ADJUSTMENT PARTICIPATORY REV. INITIATIVE, THE POLICY ROOTS OF ECONOMIC CRISIS AND POVERTY: A MULTI-

The WTO Agreement on Agriculture ("Agreement") purported to address the structural inequities in global agricultural trade and to create a "fair and market-oriented agricultural trading system."[96] However, the Agreement contained numerous ambiguities that enabled wealthy countries to subsidize and protect the domestic agricultural sector while constraining the ability of developing countries to utilize tariffs to protect their small farmers from economically devastating surges of cheap imported food.[97] In effect, the Agreement institutionalized the inequities that permit agricultural producers in the U.S. and the E.U. to destroy the livelihoods of millions of farmers in the developing world by dumping agricultural commodities on world markets at prices that are below the cost of production.[98]

In short, the policies imposed by the post-World War II trade, aid, and financial institutions increased hunger in the Global South by increasing poverty, eliminating social safety nets, depressing food production, and driving small farmers off the land.[99] These policies also produced an unprecedented decline in agrobiodiversity, as small-scale peasant-based agriculture was replaced by the large-scale commercial cultivation of genetically uniform crops.[100]

The primary beneficiaries of this dramatic and ongoing transformation of world agriculture are the large transnational corporations headquartered in the Global North that dominate an increasingly globalized food sector.[101] Supported by decades of government subsidies, overseas food aid programs, and public sector

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COUNTRY PARTICIPATORY ASSESSMENT OF STRUCTURAL ADJUSTMENT 124-26 (2002), *available at* http:www.saprin.org/SAPRI_Findings.pdf.

96. Uruguay Round Agreement, *Agreement on Agriculture*, ¶ 2 (April 15, 1994), *available at* http://www.wto.org/english/docs_e/legal_e/14-ag.pdf.

97. *See* Gonzalez, *Institutionalizing Inequality, supra* note 68, at 459-68, 478-80 (2002).

98. *See* SOPHIA MURPHY ET AL., INSTITUTE FOR AGRICULTURAL TRADE & POLICY, WTO AGREEMENT ON AGRICULTURE: A DECADE OF DUMPING 1 (2005), *available at* http://www.tradeobservatory.org/library.cfm?RefID=48532; ACTIONAID, THE IMPACT OF AGRO-EXPORT SURGES IN DEVELOPING COUNTRIES 8 (2008), *available at* http://www.actionaid.org/docs/cheap%20imports%20and%20protection%20of%20ag.pdf.

99. *See* Gonzalez, *Trade Liberalization, Food Security, and the Environment, supra* note 57, at 465-69.

100. *See id.* at 450, 465-69.

101. *See* HOLT-GIMENEZ & PATEL, *supra* note 1, at 20.

agricultural research, these multinational grain traders, agrochemical corporations, seed manufacturers, and supermarket chains wield unprecedented market power.[102] Two grain companies control 75% of the world's grain trade.[103] Six agrochemical corporations control 75% of global agrochemical sales and also dominate seed markets.[104] Ten corporations control 67% of proprietary seed sales, nearly 90% of the agrochemical market, and 40% of retail grocery sales.[105] This market power enables a handful of transnational corporations to pay farmers relatively low prices for crops even when prices spike on regional and international markets and to charge farmers high prices for inputs such as seeds and fertilizers.[106] In 2008, for example, soaring food prices yielded windfall profits for transnational food conglomerates while swelling the ranks of the world's malnourished people and sparking food riots throughout the Global South.[107]

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102. *See id.*; *see generally* BILL VORLEY, UNITED KINGDOM FOOD GROUP, FOOD, INC.: CORPORATE CONCENTRATION FROM FARM TO CONSUMER, *available at* http://www.ukfg.org.uk/docs/UKFG-Foodinc-Nov03.pdf; MOLLY ANDERSON, AGRIBUSINESS ACTION INITIATIVES, A QUESTION OF GOVERNANCE: TO PROTECT AGRIBUSINESS PROFITS OR THE RIGHT TO FOOD? (2009), *available at* http://www.agobservatory.org/library.cfm?refID=107086; MARY HENDRICKSON ET AL., THE GLOBAL FOOD SYSTEM AND NODES OF POWER (2008), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1337273.

103. VORLEY, *supra* note 102, at 39.

104. ETC GROUP, WHO OWNS NATURE? 15 (2008), *available at* http://www.etcgroup.org/upload/publication/707/01/etc_won_report_final_color.pdf.

105. *Id.* at 4.

106. *See generally,* Special Rapporteur on the Right to Food, *Agribusiness and the Right to Food*, 5, Human Rights Council, U.N. Doc. A/HRC/13/33 (Dec. 22, 2009); PETER M. ROSSET, FOOD IS DIFFERENT: WHY WE MUST GET THE WTO OUT OF AGRICULTURE 46-48 (2006); SOPHIA MURPHY, MANAGING THE INVISIBLE HAND: MARKETS, FARMERS AND INTERNATIONAL TRADE 21-29, 32 (2002), *available at* http://www.tradeobservatory.org/library.cfm?RefID=25497; RAJ PATEL & SANAZ MEMARSADEGHI, FOOD FIRST POLICY BRIEF NO. 6, AGRICULTURAL RESTRUCTURING AND CONCENTRATION IN THE UNITED STATES: WHO WINS? WHO LOSES? 34-36 (2003), *available at* http://www.foodfirst.org/sites/www.foodfirst.org/files/pdf/pb6.pdf; Timothy A. Wise, *The Paradox of Agricultural Subsidies: Measurement Issues, Agricultural Dumping, and Policy Reform* 8 (Global Dev. & Envtl. Inst., Working Paper No. 04-02, 2004), *available at* http://www.ase.tufts.edu/gdae/Pubs/wp/04-02AgSubsidies.pdf.

107. *See* HOLT-GIMENEZ & PATEL, *supra* note 1, at 6-7 (discussing the world-wide "food riots" in 2008 in response to skyrocketing food prices); THE STATE OF AGRICULTURAL COMMODITY MARKETS, *supra* note 63, at 6, 9 (describing the record increases in global food prices and in global food insecurity in 2006-2008);

However, small farmers did not benefit from these skyrocketing prices because agricultural input prices rose as well and because most small farmers sell their agricultural output to intermediaries rather than directly on world markets.[108] Even if the Global North's agricultural subsidies were eliminated, the quasi-monopoly power of transnational corporations over the global food chain would continue to distort agricultural markets to the disadvantage of small farmers and consumers.[109]

By disregarding the market distortions caused by the concentration in the food production and distribution chains while imposing free market reforms that constrain the ability of governments in the Global South governments to protect the livelihoods of small farmers, international trade and financial institutions reinforce the dominance transnational agribusiness at the expense of the poor in the developing world.[110] These agribusiness giants, in turn, use their considerable economic and political influence to perpetuate trade, aid and development policies that impoverish small farmers, hasten the demise of biodiverse, environmentally benign farming practices, and threaten the integrity of the world's food supply.[111] To make matters worse, the alarming decline in agrobiodiversity and the rising levels of food insecurity are occurring at a time when climate change threatens to wreak havoc on global food production.

III. CLIMATE CHANGE

After decades of denial, the risks posed by climate change can no longer be ignored. As the Intergovernmental Panel on Climate

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GRAIN, *Corporations are Still Making a Killing from Hunger,* 22-23 (April 2009), *available at* http://www.grain.org/seedling_files/seed-09-04-4.pdf (reporting the profits of the world's largest agri-food corporations during the 2008 global food price shocks).

108. *See* THE STATE OF AGRICULTURAL COMMODITY MARKETS, *supra* note 63, at 34-35 (explaining why small farmers did not benefit from the global food price increases of 2006-2008).

109. *See* Gonzalez, *Trade Liberalization, Food Security and the Environment, supra* note 57, at 490-91; Special Rapporteur on the Right to Food, *supra* note 106, at ¶ 9; MURPHY, *supra* note 106, at 21-29, 32.

110. *See* Gonzalez, *Markets, Monocultures, and Malnutrition, supra* note 67, at 369-70.

111. *See* ROSSET, *supra* note 106, at 41-51; HOLT-GIMENEZ & PATEL, *supra* note 1, at 81.

Change ("IPCC") observed in a recent report, "warming of the climate system is unequivocal, as is now evident from observation of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."[112] The average number of weather related-disasters has increased six-fold in recent decades — from 120 per year in the 1980s to 500 per year currently.[113] As the population increases, more people will experience catastrophic weather-related losses, and the poor will be disproportionately affected by climate-induced disasters.[114]

Climate change poses significant threats to food production.[115] Even if extremely aggressive mitigation measures are adopted, global temperatures are predicted to rise by at least two degrees Centigrade above pre-industrial levels during the 21st century.[116] Changes in temperature and rainfall, as well as increasing frequency and severity of droughts, floods, and pest infestations, threaten the livelihoods of poor farmers and jeopardize global food security.[117] According to the IPCC, yields for rain fed farming could decrease by as much as 50% in large areas of Africa by 2020 as the climate becomes hotter and drier.[118] By 2080, agricultural output could decline by as much as

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112. Intergovernmental Panel on Climate Change [IPCC], *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* 5 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf.

113. U.N. FOOD & AGRIC. ORG. (FAO), CLIMATE CHANGE AND FOOD SECURITY: A FRAMEWORK DOCUMENT 20 (2008), *available at* ftp://ftp.fao.org/docrep/fao/010/a1508e/a1508e00.pdf.

114. *See id.*

115. *See* JULIAN CRIBB, THE COMING FAMINE: THE GLOBAL FOOD CRISIS AND WHAT WE CAN DO TO AVOID IT 136-37 (2010).

116. Jodie Keane et al., *Climate Change and Developing Country Agriculture: An Overview of Expected Impacts, Adaptation and Mitigation Challenges, and Funding Requirements,* INT'L CTR. FOR TRADE AND SUSTAINABLE DEV. AND INT'L FOOD & AGRIC. TRADE POL'Y COUNCIL, Issue Brief No. 2, 1 (2009), *available at* http://ictsd.org/downloads/2009/12/j-keane-web_final.pdf.

117. INT'L CTR. FOR TRADE AND SUSTAINABLE DEV. AND INT'L FOOD & AGRIC. TRADE POL'Y COUNCIL, *ICTSD-IPC Platform on Climate Change, Agriculture and Trade: Considerations for Policymakers* 1 (Oct. 2009), *available at* http://www.agritrade.org/documents/IPC_PlatformForWeb_final.pdf.

118. IPCC, *Climate Change 2007: Synthesis Report* 50 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

28% in Africa, 24% in Latin America, and 19% in Asia.[119] Agricultural output in India could decline by as much as 38%,[120] and some African countries could experience declines in excess of 50%.[121] Climate change is also anticipated to severely impact biodiversity by causing the significant extinction of species and the loss of ecosystem services essential to food production.[122]

Ironically, agriculture is also one of the greatest contributors to global warming. Agriculture is responsible for approximately 13.5% of global greenhouse gas ("GHG") emissions, primarily methane and nitrous oxide.[123] Changes in land use (such as conversion of forests and other native vegetation to crop land) contribute an additional 17.4% of GHG emissions, mainly in the form of carbon dioxide.[124] In addition, agriculture contributes to global warming through indirect emissions arising from the manufacture of agricultural inputs (such as nitrogen fertilizer, synthetic pesticides, and fossil fuels used for agricultural machinery) and from the processing, packaging and transportation of food.[125] If all of these agriculture-related GHG emissions are taken into account, agriculture's total contribution to global warming may be as high as 32.2%,[126] making agriculture the single largest source of anthropogenic GHG emissions.[127]

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119. WILLIAM R. CLINE, GLOBAL WARMING AND AGRICULTURE: ESTIMATES BY COUNTRY 79 (2007).

120. *See id.*

121. *See id.* at 67-71, tbl.5.8.

122. *See* Nyong, *supra* note 4, at 50-51.

123. *See* IPCC, *Climate Change 2007: Synthesis Report* (2007), *supra* note 118, at 36, fig.2.1.

124. *See id.*

125. *See generally* INTERNATIONAL TRADE CENTRE (UNCTAD/WTO) & RESEARCH INSTITUTE OF ORGANIC AGRICULTURE (FiBL), ORGANIC FARMING AND CLIMATE CHANGE 2 (2007) [hereinafter, ORGANIC FARMING AND CLIMATE CHANGE], *available at* http://www.ifoam.org/growing_organic/1_arguments_for_oa/environmental_benefits/pdfs/FiBLStudyOrganic_Farming_and_Climate_Change.pdf; JESSICA BELLARBY ET AL., COOL FARMING: CLIMATE IMPACTS OF AGRICULTURE AND MITIGATION POTENTIAL at 15-16 (2008), *available at* http://marktcheck.greenpeace.at/uploads/media/Cool_Farming_Report_Final_web_01.pdf.

126. BELLARBY ET AL, *supra* note 125, at 16.

127. According to the IPCC, the next largest emitter is the energy supply sector, which is responsible for 25.9% of anthropogenic greenhouse gas emissions. *See* IPCC, *Climate Change 2007: Synthesis Report*, *supra* note 120, at 36, fig.2.1.

However, recent studies suggest that agriculture has significant potential to mitigate climate change, which could transform the role of agriculture from a major emitter to a much smaller emitter or even a net sink.[128] While industrial agriculture is one of the largest sources of greenhouse gases, small-scale sustainable agriculture can play a key role in climate change mitigation and adaptation while conserving agrobiodiversity and promoting food security.[129]

Sustainable agricultural production is a goal rather than a rigid set of practices. In general, sustainable agriculture seeks to integrate natural pest, nutrient, soil, and water management technologies into the production process while reducing the use of synthetic fertilizers and pesticides.[130] It combines the knowledge and skill of farmers with the latest scientific innovations to promote farmer self-reliance and to minimize dependence on costly external inputs.[131] Sustainable agriculture also strives to enhance and conserve agrobiodiversity, including plant genetic resources, livestock, insects and soil organisms.[132]

Sustainable agriculture can mitigate climate change by reducing GHG emissions and increasing carbon sequestration in soils.[133] Sustainable farming practices reduce fossil fuel-based carbon dioxide emissions because they consume less fossil fuel per hectare than industrial agriculture.[134] By relying on legumes, manure, and crop residues to fertilize the soil, sustainable agriculture minimizes the use of fossil-fuel based nitrogen fertilizers and also reduces nitrous oxide emissions.[135] Furthermore, sustainable farming usually involves practices such as the use of green and animal manure, crop rotation, intercropping, and composting that reduce soil erosion and enhance

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128. *See* ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 118, at 4.

129. *See* WORKING GROUP ON CLIMATE CHANGE AND DEVELOPMENT, OTHER WORLDS ARE POSSIBLE: HUMAN PROGRESS IN AN AGE OF CLIMATE CHANGE 40-42 (Nov. 2009), *available at* http://www.iied.org/pubs/pdfs/10022IIED.pdf; ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 21.

130. *See* PRETTY, REGENERATING AGRICULTURE, *supra* note 9, at 8-13.

131. JULES N. PRETTY, AGRI-CULTURE: RECONNECTING PEOPLE, LAND AND NATURE 56 (2002).

132. THRUPP, LINKING BIODIVERSITY AND AGRICULTURE, *supra* note 81, at 1-4, 10-12.

133. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 7-8.

134. *Id.* at 9, 23; BELLARBY ET AL., *supra* note 125, at 28.

135. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 10, 23; BELLARBY ET AL., *supra* note 127, at 29, 35-36.

the ability of soil to sequester carbon.[136] Agroforestry promotes the sequestration of carbon in above-ground vegetation as well as soil.[137] Finally, sustainable agriculture simultaneously enhances agricultural productivity and soil carbon sequestration by restoring soils that have been degraded by excessive disturbance, erosion, organic matter loss, salinization and other processes.[138]

The mitigation potential of agriculture is enormous. Sustainable agriculture could sequester nearly 40% of annual carbon dioxide emissions.[139] According to the IPCC, soil carbon sequestration alone is responsible for 89% of agriculture's mitigation potential.[140] The majority of this carbon sequestration potential (about 70%) is concentrated in developing countries.[141] Moreover, agricultural mitigation strategies can be implemented at an extremely low cost, as compared to mitigation options in non-agricultural sectors, such as energy, transportation and forestry.[142]

Sustainable agriculture can also play an important role in climate change adaptation. Sustainable farming practices reduce the vulnerability of crops to floods and drought by increasing the organic matter in soils, thereby enhancing the soils' water retention capacity.[143] Farmers practicing sustainable agriculture are better able to cope with hurricanes, droughts, and other extreme weather events than conventional farmers.[144] Surveys following Hurricane Mitch in Central America, for example, found that the lands of farmers practicing sustainable agriculture had 40% more topsoil, greater levels of moisture, more vegetation, and less erosion than the lands of

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136. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 13.

137. *Id.* at 15, 23; BELLARBY ET AL., *supra* note 125, at 32.

138. *See* ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 18, 23; BELLARBY ET AL., *supra* note 125, at 35.

139. TIM J. LASALLE & PAUL HEPPERLY, REGENERATIVE ORGANIC FARMING: A SOLUTION TO GLOBAL WARMING 1 (2008), http://www.rodaleinstitute.org/files/Rodale_Research_Paper-07_30_08.pdf.

140. IPCC, CLIMATE CHANGE 2007: MITIGATION, CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 499, 515 (2007), http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter8.pdf.

141. *Id.* at 499.

142. *See id.*

143. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 17.

144. *Id* at 17-18; PAR Climate Change Project, *supra* note 43, at 5.

conventional farmers.[145] Sustainable farming practices can also restore the productivity of degraded soils in the arid tropics, thus improving agricultural yields to a greater extent than synthetic fertilizers.[146]

Sustainable agriculture utilizes wild and cultivated landscapes and natural pest control strategies to enhance the resilience of agro-ecosystems to climate change-related disturbances.[147] Agrobiodiverse food production systems can resist climate-related changes in the geographic range of pests, disease vectors and invasive species through biological control of weeds, insects, and pathogens.[148] Sustainable agricultural systems rely on the diversity of crops, fields, landscapes and farm activities to buffer the effects of natural disasters and to provide alternative sources of food, fuel, and medicine.[149]

Finally, sustainable agriculture promotes food security by protecting the livelihoods of small farmers and indigenous communities.[150] Sustainable farming practices protect and enhance the traditional knowledge and skills that will play an essential role in adapting to climate change.[151] This knowledge will enable farmers to adapt to climate change by adjusting the timing and location of crop cultivation, breeding seeds suitable for changing thermal and hydrological conditions, changing the timing of irrigation, modifying the management of nutrients, and applying water-conserving technologies.[152]

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145. Eric Holt-Gimenez, *Measuring Farmers' Agroecological Resistance After Hurricane Mitch in Nicaragua: A Case Study in Participatory, Sustainable Land Management Impact Monitoring,* 93 AGRIC., ECOSYSTEMS AND ENV'T 87, 93 (2002).

146. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 18.

147. *Id.*

148. *Id.*; PAR Climate Change Project, *supra* note 43, at 16.

149. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 18; PAR Climate Change Project, *supra* note 43 at 9-11.

150. *See* PAR Climate Change Project, *supra* note 43, at 5.

151. ORGANIC FARMING AND CLIMATE CHANGE, *supra* note 125, at 17; PAR Climate Change Project, *supra* note 43, at 19.

152. INTERNATIONAL ASSESSMENT OF AGRICULTURAL KNOWLEDGE, SCIENCE AND TECHNOLOGY FOR DEVELOPMENT (IAASTD), AGRICULTURE AT A CROSSROADS: SYNTHESIS REPORT 51 (2009), http://www.agassessment.org/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Synthesis%20Report%20%28English%29.pdf.

IV. INTEGRATED SOLUTIONS TO THE CLIMATE, FOOD AND AGROBIODIVERSITY CRISES

The food, climate and agrobiodiversity crises described in the preceding sections highlight the urgent need for reform of global agricultural policies. Because agriculture both generates and sequesters GHGs, climate change may serve as a catalyst for agricultural policy reforms that promote sustainable agriculture as an integrated solution to the climate, food and agrobiodiversity crises. Sustainable agriculture produces fewer GHGs emissions than industrial agriculture, increases the ability of soils to sequester carbon, protects plant genetic resources, reduces the risks associated with climate change (such as floods and droughts), preserves traditional knowledge, and promotes food security by supporting the livelihoods of small farmers.[153]

In addition, sustainable agriculture is highly productive. Sustainable agriculture can produce enough food on a global per capita basis to sustain both current and projected future populations without increasing the amount of land devoted to agricultural production.[154] Indeed, sustainable agriculture in the Global South is at least eighty percent more productive than conventional agriculture.[155] Numerous studies have concluded that sustainable agriculture has significantly increased agricultural yields in Asia, Africa and Latin America, increased the incomes of small farmers, benefited the environment, reduced dependence on external inputs, and kept alive rural communities' deep reservoir of traditional knowledge.[156]

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153. *See supra* notes 128-52.

154. Catherine Badgley et al., *Organic Agriculture and The Global Food Supply,* 22 RENEWABLE AGRIC. & FOOD SYS. 86, 94 (2007).

155. *See id.* at 91; Jules N. Pretty et al., *Resource-Conserving Agriculture Increases Yields in Developing Countries,* 40 ENVTL. SCI. & TECH. 1114 (2006).

156. *See generally*, U.N. CONFERENCE ON TRADE AND DEV. (UNCTAD) & U.N. ENV'T PROGRAMME (UNEP), ORGANIC AGRICULTURE AND FOOD SECURITY IN AFRICA (2008), *available at* http://www.unep-unctad.org/cbtf/publications/UNCTAD_DITC_TED_2007_15.pdf; INT'L FUND FOR AGRIC. DEV., THE ADOPTION OF ORGANIC AGRICULTURE AMONG SMALL FARMERS IN LATIN AMERICA AND THE CARIBBEAN (2003), *available at* http://www.ifad.org/evaluation/public_html/eksyst/doc/thematic/pl/organic.pdf; NICHOLAS PARROTT & TERRY MARSDEN, THE NEW GREEN REVOLUTION: ORGANIC AND AGROECOLOGICAL FARMING IN THE SOUTH (2002), *available at*

There is an emerging consensus among policy-makers at the international level that promoting sustainable agriculture is necessary to address the environmental and food security challenges of the 21st century.[157] Reform of the global food system to promote sustainable agriculture is a daunting task, but there are a number of concrete measures that can be taken to address the most glaring inequities and move toward a more just and sustainable food production system.

First, phasing out agricultural protectionism in the Global North is an essential step toward protecting the livelihoods of small farmers, but it is by no means sufficient. An approach to international trade, aid, and finance that recognizes the primacy of human rights, including the fundamental right to food, is required. The right to food is recognized in the Universal Declaration of Human Rights, the International Covenant on Economic, Social, and Cultural Rights, and the United Nations Convention on the Rights of the Child.[158] Because a healthy environment is itself a human right in addition to being essential to the fulfillment of the right to food and other human rights,[159] trade and investment agreements should contain a provision

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http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/4526.pdf; Jules N. Pretty, *Reducing Food Poverty by Increasing Sustainability in Developing Countries,* 95 AGRIC. ECOSYSTEMS & ENV'T 217 (2003); Jules N. Pretty & Rachel Hine, *The Promising Spread of Sustainable Agriculture in Asia,* 24 NAT. RESOURCES F. 107 (2000); Jules N. Pretty, *Can Sustainable Agriculture Feed Africa? New Evidence on Progress, Processes and Impacts,* 1 ENV'T, DEV. & SUSTAINABILITY 253 (1999).

157. *See* IAASTD, AGRICULTURE AT A CROSSROADS: SYNTHESIS REPORT, *supra* note 152, at 5; UNEP, THE ENVIRONMENTAL FOOD CRISIS, *supra* note 40, at 8; UNCTAD & UNEP, ORGANIC AGRICULTURE AND FOOD SECURITY IN AFRICA, *supra* note 156.

158. Universal Declaration of Human Rights, G.A. Res. 217A, at 71, U.N. GAOR, 3d Sess., 1st plen. Mtg., U.N. Doc A/10, art. 25 (Dec. 12, 1948); United Nations Convention on the Rights of the Child, arts. 24 & 27, 1577 U.N.T.S. 3 (Nov. 20, 1989); International Covenant on Economic, Social and Cultural Rights, G.A. Res. 2200A, art. 11 (Dec. 16, 1966), *reprinted in* 6 I.L.M. 360 (1967).

159. *See e.g.,* SVITLANA KRAVCHENKO & JOHN E. BONINE, HUMAN RIGHTS AND THE ENVIRONMENT: CASES, LAW, AND POLICY xxi (2008) (discussing the increasing recognition by legislatures, courts, and experts that protection of the environment is an enforceable human right and not simply a policy choice); BERTA E. HERNANDEZ-TRUYOL & STEPHEN J. POWELL, JUST TRADE: A NEW COVENANT LINKING TRADE AND HUMAN RIGHTS 86-88 (2009) (explaining that the rights to life and health depend on a clean environment); United Nations Conference on Environment & Development, Rio de Janeiro, Braz., June 3-14, 1992, *Agenda 21,* art. 15.2, U.N. Doc. A/CONF. 151/26 (Vol. II) (June 13, 1992) (explaining that the

giving human rights and environmental norms hierarchical priority in the event of a conflict.

Second, trade and investment agreements should contain broad human rights and environmental exceptions designed to maximize the flexibility of governments to regulate in the public interest. Such provisions would give developing countries the "policy space" to utilize an appropriate combination of tariffs and subsidies to protect the livelihoods of small farmers, encourage domestic food production, support environmentally friendly cultivation techniques, promote rural development, and protect against devastating surges of under-priced food imports.

Third, trade and investment agreements must enable developing countries to use a wide range of protectionist measures to facilitate the transition from agro-export specialization to a more diverse economic base. The current rules governing international trade preclude the Global South from utilizing many of the development strategies that produced economic prosperity in the United States, France, Japan, the United Kingdom, Germany, and other wealthy countries, such as local content requirements, state financing of major industries, and protection of nascent industries through tariffs and other import restrictions.[160]

Fourth, international regulation is necessary to address the domination of agricultural markets by a handful of transnational corporations. In the United States, for example, the Justice Department is in the process of conducting an antitrust investigation of the seed industry and is also examining the lack of competition in agricultural markets more generally.[161] The European Parliament recently asked the European Commission to address the abuse of market power by major supermarket chains operating in the European

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loss of biodiversity threatens natural resources vital to the provision of flood, clothing, medicine, housing, and spiritual nourishment).

160. *See* LEE, *supra* note 69, at 9-13.; HA-JOON CHANG, BAD SAMARITANS: THE MYTH OF FREE TRADE AND THE SECRET HISTORY OF CAPITALISM 40-60 (2008); HA-JOON CHANG, KICKING AWAY THE LADDER: DEVELOPMENT STRATEGY IN HISTORICAL PERSPECTIVE 19-51, 59-66 (2002).

161. William Neuman, *Rapid Rise in Seed Prices Draws U.S. Scrutiny,* N.Y. Times, Mar. 11, 2010, at B1.

Union.[162] Given the global scope of the problem, it is essential that states collaborate to develop and enforce robust competition regimes.

Fifth, governments must re-orient resources toward small farmers and toward the protection of the natural resource base necessary for food production. The structural adjustment policies adopted in recent decades have deprived small farmers of social safety nets, education, marketing assistance, credit, technology, insurance, input subsidies, and price supports.[163] In recognition of the essential role of small-scale sustainable agriculture in responding to the food, climate, and biodiversity crises, a coalition of African governments, with the support of the U.N. Food and Agriculture Organization, and various non-governmental organizations, has proposed that the successor agreement to the Kyoto Protocol provide the financing, technology, and research and development necessary to promote climate change mitigation and adaptation through small-scale sustainable agriculture.[164] While an analysis of this proposal is beyond the scope of this Article, it is promising that agriculture and food security have

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162. *See* Olivier de Schutter, United Nations Special Rapporteur on the Right to Food, *Addressing Concentration in Food Supply Chains: The Role of Competition Law in Tackling the Abuse of Buyer Power,* Briefing Note 03 2-3 (Dec. 2010), *available at* http://www.srfood.org/images/stories/pdf/other documents/20101201_briefing-note-03_en.pdf.

163. Ha-Joon Chang, *Rethinking Public Policy in Agriculture: Lessons from History, Distant and Recent*, 36 J. PEASANT STUD. 477, 478, 480-81 (2009).

164. *See* COMMON MKT. FOR E. & S. AFR. (COMESA), *African Bio Carbon Initiative Background Document*, *available at* http://www.tnrf.org/files/E-INFO_BioCarbon_Background_Document.pdf; U.N. FOOD & AGRIC. ORG., *Carbon Finance Possibilities for Agriculture, Forestry and Other Land Use Projects in a Smallholder Context* (2010), http://www.fao.org/docrep/012/al060e/al060e00.pdf; WORLD AGROFORESTRY CTR., *Africa's Biocarbon Interests--Perspectives for a new climate change deal, Policy Brief No. 04* (2009), *available at* http://www.worldagroforestry.org/downloads/publications/PDFs/BR09047.PDF; WORLD AGROFORESTRY CTR., *The Case for Investing in Africa's Biocarbon Potentia, Policy Brief No. 05* (2009), *available at* http://www.asb.cgiar.org/PDFwebdocs/ICRAFPB04-InvestingInAfricasBiocarbonPotential.pdf; INT'L CTR. FOR TRADE AND SUSTAINABLE DEV. AND INT'L FOOD & AGRIC. TRADE POL'Y COUNCIL, *International Climate Change Negotiations and Agriculture* 12-14 (May 2009), *available at* http://ictsd.org/downloads/2009/11/international-climate-change-negotiations-and-agriculture.pdf; U.N. FOOD & AGRIC. ORG., Enabling Agriculture to Contribute to Climate Change Mitigation (2008), http://unfccc.int/resource/docs/2008/smsn/igo/036.pdf.

at long last been recognized as important issues in the global climate change negotiations.

Finally, the global food system must be protected against food commodity speculation and ill-advised biofuels policies that could result in food price increases, food price volatility, and "land grabs" in the Global South. It is now widely recognized that one of the key triggers of the food price crisis of 2008 was the shift of speculative investment into agricultural commodities in the wake of the collapse of the U.S. housing bubble.[165] Furthermore, the decision by the United States and the European Union to promote biofuels as the solution to the climate crisis has driven up food prices and diverted acreage from food production.[166] The biofuels boom and the spike in food prices, in turn, gave rise to efforts by domestic and foreign investors to purchase or lease large tracts of agricultural land in the Global South to guarantee food supplies and to capitalize on the demand for biofuels through offshore production.[167] These so-called "land grabs" pose a number of risks, including dispossession of small farmers, interference with domestic food production, and over-exploitation, degradation, and depletion of land and water resources needed by local communities.[168] Regulation of food commodity derivatives must be a central part of government strategies designed to protect the fundamental human right to food.[169] Biofuels policy must be pursued through an integrated approach that takes into account the impact on food production, biodiversity and human rights. Foreign acquisition of agricultural lands must be carefully regulated through domestic legislation and international agreements

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165. Peter Wahl, *The Role of Speculation in the 2008 Food Price Bubble, in* THE GLOBAL FOOD CHALLENGE: TOWARDS A HUMAN RIGHTS APPROACH TO TRADE AND INVESTMENT POLICIES 68, 70 (2009), http://www.fian.org/resources/documents/others/the-global-food-challenge/pdf.

166. STATE OF AGRICULTURE COMMODITY MARKETS, *supra* note 63, at 19-21.

167. Alexandra Spieldoch & Sophia Murphy, *Agricultural Land Acquisitions: Implications for Food Security and Poverty Alleviation, in* LAND GRAB? THE RACE FOR THE WORLD'S FARMLAND 39, 41-42 (Michael Kugelman & Susan L. Levenstein eds. 2009), *available at* http://www.wilsoncenter.org/topics/pubs/ASIA_090629_Land%20Grab_rpt.pdf.

168. *Id.* at 43-48.

169. Olivier de Schutter, U.N. Special Rapporteur on the Right to Food, *Food Commodities Speculation and Food Price Crises: Regulation to Reduce the Risks of Price Volatility*, Briefing Note 02 (Sept. 2010), *available at* http://www.iaahp.net/uploads/media/20102309_briefing_note_02_en.pdf.

to ensure that these transactions benefit local communities, uphold the right to food, and use natural resources in a sustainable manner.

In response to the global food crisis, social movements across the globe are challenging the export-oriented industrial agricultural model of food production in favor of food sovereignty.[170] Developed originally by the peasant organization La Via Campesina, the concept of food sovereignty refers to democratic national and local control over food production, distribution, and marketing in ways that are socially just and ecologically sustainable.[171] As Peter Rosset explains:

> Food sovereignty proponents argue that food and farming are about more than trade, and that production for local and national markets is more important than production for export from various perspectives: broad-based and inclusive local and national economic development, addressing poverty and hunger; preserving rural life, economies, and environments; and managing natural resources in a sustainable fashion. They argue that every country and people must have the right and the ability to define their own food, farming, and agricultural policies; to protect domestic markets; and to have public sector budgets for agriculture that may include subsidies provided these do not lead to greater production, exports, dumping and damage to other countries. . . . This alternative model also includes agrarian reform, with limits on maximum farm size, equitable local control over resources like seeds, land, water and forests, and firm opposition to patenting seeds.[172]

Food sovereignty has been embraced by social movements in the Global North and the Global South,[173] has been incorporated into the domestic legislation of several countries, including Venezuela,

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170. *See* ROSSET, *supra* note 106, at 102-25 (reproducing the statements and position papers of peasant and farmer organizations from the Global North and the Global South); SHATTUCK & HOLT-GIMENEZ, *supra* note 5, at 422, 431.

171. ROSSET, *supra* note 106, at 34-35; SHATTUCK & HOLT-GIMENEZ, *supra* note 5, at 422, 431-32.

172. ROSSET, *supra* note 106, at 34-35.

173. *See* SHATTUCK & HOLT-GIMENEZ, *supra* note 5, at 431.

Ecuador, Nicaragua, and Bolivia,[174] and has served as the basis for collaboration between the United Nations Food and Agriculture Organization and farmer and civil society organizations.[175] Food sovereignty is not a one-size-fits-all economic recipe.[176] Rather, it is a framework through which to critique the corporate-dominated food trade and production system so as to develop more democratic, localized, just, and sustainable alternatives.[177]

V. CONCLUSION

Scientists, development experts, farmer organizations, and civil society groups have long called for equitable and sustainable locally-controlled food production as an alternative to resource-extractive industrial agriculture.[178] Indeed, rural communities throughout the world have been struggling for decades to diversify their crops; conserve their seeds, soils, forests and water; protect traditional agroecological knowledge; and resist the takeover of their lands by local and transnational elites.[179] Most recently, the growing food justice movements in the Global North have sought to dismantle the inequities in the global food system that disproportionately affect low-income and historically marginalized communities and that produce widespread epidemics of obesity, type 2 diabetes, and other diet-related diseases.[180] As the common roots of the climate, food, and agrobiodiversity crises become increasingly apparent, popular mobilization may succeed in creating the political will necessary to overcome the power of transnational agribusiness and to create more just, resilient, and sustainable food production systems.

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174. *See* Saulo Araujo, Comment, *The Promise and Challenges of Food Sovereignty Policies in Latin America*, 13 YALE HUM. RTS. AND DEV. L.J. 493, 494 (2010).

175. *See* ROSSET, *supra* note 106, at 35.

176. Araujo, *supra* note 174, at 494-96.

177. *Id.* at 494-95.

178. *See* HOLT-GIMENEZ & PATEL, *supra* note 1, at 2-3; 181-217.

179. *See id.* at 2.

180. *See id.* at 159-77; SHATTUCK & HOLT-GIMENEZ, *supra* note 5, at 431-34.