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Food and agriculture

Jennifer Clapp and Sarah J. Martin

The ways in which food and agriculture are organized around the world have enormous implications for the global environment. The industrial organization of agriculture that feeds the dominant food system – including large-scale production methods and intensive livestock operations – is associated with soil degradation (Chapters 39 and 40), biodiversity loss (Chapter 37), pollution (Chapter 30), climate change (Chapter 28) and the depletion of water supplies (Chapter 34). At the same time, international economic forces in the food system – including the international trade in food and global financial activities that add to tensions between food, fuel and land – also contribute to environmental problems including greenhouse gas emissions (Chapter 28) and deforestation (Chapter 38). The environmental effects of industrial agricultural production and the integration of that production system into global food and agricultural commodity markets extend far beyond national borders. The issue, however, has not been dealt with effectively at the global scale. Food and agriculture have a grounded quality because of their intimate relationship with the soil, and because individuals consume food on a daily basis. Individual food choices of course have important implications for how agriculture relates to the environment and politics. But it is not just individual choice that matters on this issue. Political choices about how societies collectively organize agricultural systems are of overriding importance because these choices shape individual food choices in many ways. These issues thus require consideration not just at a local or national scale, but also at the international level.

The environmental dimensions of large-scale industrial agriculture and the rise of a globally organized food system are widely understood, but there is no clear agreement on the pathway forward toward a more sustainable way to feed the world – at least as organized on a global scale. There are vastly different interpretations of what exactly constitutes a more environmentally friendly international organization of agricultural and food systems, and how such a system should be structured and governed. Some argue that agroecological methods and more locally oriented food systems will reduce the environmental damage caused by agriculture and global food trade and finance. But others are skeptical that such methods will be sufficient to feed the world's growing population. Instead, they argue that the use of more sophisticated technologies, such as agricultural biotechnology, as well as the development of more globally integrated markets, are more promising methods to provide the required food at the least environmental cost. This debate has played out in global forums, from the World Bank to the International

Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) process.

In this chapter, we examine the linkages between agriculture, food and the environment on an international scale, and assess the state of the political debate over how best to make global food systems more sustainable. We begin by outlining the development and operation of industrial agriculture and livestock production. This organization of agriculture and food systems has serious environmental impacts. We then highlight some of the less visible impacts of global food and agriculture market dynamics, such as trade and finance. These global market dynamics have been linked to increasing biofuel production and pressure on land, which have important environmental implications. Next, we explore how the linkage between the organization of food and agriculture systems and the natural environment has recently begun to be debated at the international level. We review two recent reports from the World Bank and the IAASTD and their widely divergent visions for sustainable agriculture. Finally, we conclude the chapter with some reflections on how the polarized debate over how to vision sustainable agriculture has stalled progress on international cooperation in this arena of global environmental politics.

Industrial agriculture

The environmental impact of the intensification of agricultural production around the world is being increasingly studied and understood. The sustainability of agriculture has long been a concern, but the widespread adoption of industrial agricultural methods has produced new environmental issues. The adoption of a more "scientific" approach to agriculture in North America and Europe in the late 1800s and the first half of the 1900s was supported by laboratory research. The industrial agricultural model relied on a system of new specialty seeds, chemical fertilizers and pesticides, irrigation, and machinery for both planting and harvesting. Machines saved labor and chemicals saved land, which led to a model of maximum agricultural efficiency with large tracts of land with a single crop, known as "monocropping." The early postwar adoption of this kind of agriculture resulted in enormous production increases per acre for certain crops. The USA and Canada, for example, quickly produced massive surpluses of grain that began to be exported around the world, both commercially and as food aid in the 1950s (Barrett and Maxwell 2005). In Europe, price-supports and agricultural industrialization produced surpluses by the 1960s which resulted in "mountains of butter" and "lakes of milk."

The industrial agricultural production model was promoted not just in North America and Europe, but also globally. The USSR adopted a program of "chemicalization" of agriculture in the 1960s (McNeill 2000) and the developing world in particular was encouraged to adopt a technical and managerial model of industrial production as part of the broader push for a "green revolution" in the 1960s and 1970s (Clapp 2012a; on industry generally, see Chapter 13). In the late 1970s, China also adopted a model of industrial agriculture. International aid programs promoted research, development and adoption of new seeds designed for tropical climates, pesticides, fertilizers, machinery, irrigation and monocropping in many developing countries. While at first the green revolution was hailed as a success in the countries that embraced it fully, including large parts of South Asia, Southeast Asia and Latin America, its negative environmental effects soon became apparent. The industrial agricultural system as it has manifested around the world is considered to be deeply entrenched and difficult to change (UNEP 2012).

A major consequence of the expanding reach of the industrial agricultural model has been the loss of biodiversity. Widespread adoption of specialty varieties of hybrid seeds raised in monocultural fashion meant that fewer traditional crops and crop varieties were planted around the world. The Food and Agriculture Organization of the United Nations (FAO) has estimated that between 1900 and 2000 around three-quarters of the world crop diversity was lost, with the most rapid decline occurring between 1950 and 2000 (Commission on Genetic Resources for Food and Agriculture 2010). Since the 1960s, there has been a significant decline in the number of varieties planted. Just three crops – rice, wheat and maize – constitute over half of the world's food supply. Today around 90 percent of the world's wheat crop, 70 percent of the rice crop and 60 percent of the maize crop in developing countries are modern varieties (Imperial College of Science and Technology 2002). Looking ahead, the FAO expects that up to 22 percent of the wild relatives of peanut, potato and beans will disappear by 2055 (Commission on Genetic Resources for Food and Agriculture 2010). In addition, public investment in seed production has declined while investment in privately developed transgenic seeds has grown significantly from US$280 million in 1996 to US$7 billion in 2007 (Commission on Genetic Resources for Food and Agriculture 2010: 8). Diversity is necessary for maintaining species viability and if it is lost agricultural systems become more precarious and vulnerable to pests and diseases. If certain vulnerable varieties experience losses, other more robust varieties are often protected and can make up the loss. For this reason, crop diversity is vital for long-term resilience in agriculture and food systems.

The rise of an industrial agricultural model around the world has also contributed to a decline in nature's ecosystem services and functions (see Chapter 13). For example, industrial practices have contributed to a reduction in soil biodiversity (the living organisms in the soil that contribute to its fertility and other services) and some argue that the crucial functions of soil, such as water filtration, carbon fixing, climate regulation and nutrient cycling, are being compromised as a result. These problems are on top of the fact that declining soil fertility is a constraint on increasing food production.

Early in the development of scientific forms of farming, agricultural scientists encouraged the use of synthetic inputs – chemical fertilizers and pesticides – to make up for these lost soil and ecosystem functions caused by intensive agricultural practices. Synthetic chemical inputs can temporarily make up for the loss of soil fertility and can protect against pests. But over time as modern agriculture has become ever more reliant on these chemical inputs their effectiveness has come into question. The reliance on synthetic fertilizer use has increased by fivefold in the past 50 years (Foley et al. 2011: 338). More specifically, the application of nitrogen fertilizer increased sevenfold between 1960 and 1995. Although yields have increased with the rising use of synthetic fertilizers, the yield of grain as a ratio of fertilizer application has declined significantly and overall the responsiveness of crops to these chemicals has been highly uneven (Keating et al. 2010). The use of synthetic fertilizers has contributed to increased crop yields per acre for highly responsive crops, for instance maize, while for other crops the increases have not been nearly so dramatic.

Synthetic herbicides and pesticides often accompany the use of synthetic fertilizers in industrial farm operations. In fact, their use has increased even more sharply than that of synthetic fertilizers. In the USA, for example, the use of insecticides and herbicides increased by a factor of 40 between the mid-1940s and the mid-1970s. Globally, pesticide use increased in the 1970s and 1980s at a rate of around 5 percent per year (Pimentel et al. 1993; Ridgway et al. 1978). Because pests can build up resistance to chemicals designed to control them, there has been an increase in the use of those chemicals, or indeed the use of even more harmful chemicals, just to keep pests at a manageable level. The dramatic rise in chemical use intensified the ecological side-effects of industrial agriculture. Given that less than 1 percent of pesticides reach their target, it is not surprising that pollution of soils, water and air resulted (Lappé et al. 1998). Indeed, agriculture is the source of, for example, 60 percent of all pollution in US lakes and rivers (Mooney 2009). The spread of these chemicals into the environment has far-reaching human and ecosystem health impacts.

Agricultural intensification has also resulted in greater use of energy and water. Modern industrial agriculture is particularly reliant on fossil energy – especially petroleum products – not only to fuel farm machinery but also because they are key ingredients in fertilizers and pesticides. The rate of energy use has outstripped population growth and since the 1970s energy in agriculture use has doubled every 30 years. Pimentel et al. (2008) estimate that every year 2,000 liters of oil (or its equivalent) are required to produce the average US diet, totaling 19 percent of the country's energy use: the largest users included agricultural production, food processing and packaging at 14 percent, with transportation and preparation accounting for 5 percent. Foley et al. (2011: 338) cite the figures that irrigated cropland area has approximately doubled in the past 50 years. Some 70 percent of global freshwater withdrawals (80–90 percent of consumptive uses) are devoted to irrigation and intensive irrigation has led to significant drawdown on groundwater (see Chapter 34). For example, the Ogallala aquifer on the US High Plains which supplies most of US cattle and a significant portion of grain crops has been seriously drawn down (McNeill 2000: 154). Without irrigation it is estimated that cereal production, such as rice, wheat and maize, which draw on the largest amount of water, would decline by 20 percent (Siebert and Döll 2010).

In addition, agriculture not only uses resources such as petroleum and water, it is reported to contribute 30–35 percent of global greenhouse gas emissions, mainly with practices associated with industrial agriculture such as tropical deforestation, methane emissions from livestock (discussed below), emissions from the use of farm machinery and emissions from fertilized soils (Foley et al. 2011). The reliance on synthetic fertilizes, for example nitrogen, has produced a number of unintended consequences such as limiting plants' capacity to act as carbon sinks, which increasingly contributes to climate change (Smil 2001: 84; on climate change, see Chapter 28).

New technological developments since the 1980s and 1990s – especially the development of genetically modified (GM) seeds – have brought new concerns and controversy to studies on the environmental implications of industrial agriculture. The main kinds of GM crops are engineered either to produce their own pesticide, or to be resistant to herbicides. Increasingly, seeds are being engineered to do both. Since they were first commercialized in the mid-1990s, there has been a dramatic increase in the use of genetically modified crops globally. From the mid-1990s to 2012, the number of hectares planted with GM crops grew from practically zero to 170 million hectares (James and ISAAA 2012). Production is concentrated in just a handful of countries (the United States, Canada, Argentina, Brazil and India together account for nearly 90 percent of GM crop production), but the growing use of these crops has raised global concern. Critics argue that GM crops could further weaken genetic diversity, especially if they cross with wild relatives or traditional varieties that hold important genetic traits. Crops that are genetically modified to be herbicide tolerant could potentially cross with wild relatives to create "super weeds" and crops that are engineered to express their own pesticides could potentially be harmful to wildlife, including beneficial insects (Dale 2002).

While critics have expressed concerns about the ecological impact of genetically modified crops, proponents have argued that genetic modification can contribute to a more sustainable agriculture. By reducing the need for pesticide spraying, and making plants tolerant of relatively non-toxic herbicides, some of the environmental problems of industrial agriculture could be mitigated (Conway 2012; Paarlberg 2008). There is also the potential for agricultural biotechnology to develop crops that are resistant to drought and that can thrive in poor quality soils, although research on this front is thus far much less advanced than that for herbicide tolerance and pesticide expression.

The debate still rages over agricultural biotechnology. These crops have been in commercial production for some 15 years, and more in-depth studies of their impacts are now emerging.

The results have been mixed, giving the critics enough to worry about while the proponents continue to declare their safety. It will likely take another decade for a significant enough body of research to give more conclusive results on their ecological impacts.

Industrial meat production

A transformation in livestock production models paralleled the increasing use of industrial agricultural methods. The dramatic rise of surplus grains that accompanied industrial crop production in developed countries such as the USA in the 1950 and 1960s spurred an increase in grain-fed livestock. This surplus, along with new pharmaceuticals and new animal breeds, enabled the growth of large-scale animal operations known as intensive livestock operations (ILOs) or concentrated animal feeding operations (CAFOs). Through these developments, large-scale grain production and large-scale intensive livestock farming became closely linked. As the organization of meat production began to change, so too did consumption of meat. These developments have had enormous environmental impacts on a global scale.

The rise of industrial livestock production and processing brought new methods. Previously, livestock was seasonal, and constrained by weather and the availability of surplus crops and forage. At the turn of the last century, the spread of railways, refrigeration and centralized slaughterhouses and grain storage contributed to industrializing livestock processing in the USA (Cronon 1992). After the Second World War, seasonal limitations on livestock production were eased in the USA when poultry began to be raised indoors in CAFOs. In the 1980s, poultry CAFOs became a model for the expansion of US hog production (Drabenstott 1998; Rhodes 1995). Indoor confinement allowed animals to be raised faster with less feed and the rise of new veterinary pharmaceuticals suppressed diseases previously associated with large-scale animal confinement (Rhodes 1995). The FAO has reported that 50 percent of US antibiotics are used for livestock (FAO 2006b). More recently, the CAFO model has been increasingly established and replicated in countries around the world, especially where there is a surplus of cheap feedgrain such as in Brazil's Mato Grossa, or Canada's eastern prairie. The growth of China's hog industry has outstripped all other countries and now accounts for around half of the world's production (Schneider 2011). Genetically specialized breeds have been developed for CAFOs which, similar to industrial agriculture, has contributed to a narrowing of farm animal diversity. For example, a few commercial breeds provide more than one-third of global hog supply while a handful of commercial layer breeds provide some 85 percent of egg production (FAO 2006a).

The rise of CAFOs has increased the availability of inexpensive meat and poultry which is now globally produced, traded and increasingly available. Unlike the global car that is assembled from parts sourced globally, animals are disassembled and their parts are distributed to specialty markets around the world. Industrial production has led to industrial processing and today 8 out of the top 20 industrial polluters in the USA are slaughterhouses (UNEP 2012). In addition, an associated increase in per capita consumption of meat and poultry, or "meatification" of diets (Weis 2007), has accompanied industrial livestock production, although there are indications that meat consumption in some of the wealthier states is declining (Bittman 2012; on consumption generally, see Chapter 16). The FAO expects global livestock production to double by 2050 (FAO and Steinfeld 2006: 275). This increase, along with the fact that livestock production is a major contributor to increased greenhouse gas emissions, land degradation, water pollution and increased health problems, is worrisome (FAO and Steinfeld 2006).

Since livestock is the single largest anthropogenic user of land (FAO 2006b), ILOs have a significant "ecological hoofprint" (Weis 2007) with global effects. In particular, livestock production has huge climate implications. An indirect result of livestock production is that clearing

of land for cattle grazing has resulted in deforestation that contributes a significant amount of carbon dioxide (FAO and Steinfeld 2006: 91; see Chapter 38). More directly, livestock raising itself is credited with being responsible for 80 percent of total agricultural greenhouse gas emissions and these gases are considered more problematic than carbon dioxide (e.g., methane, nitrous oxide and ammonia which contributes to acid rain and acidification of ecosystems; on acid rain, see Chapter 30) (McMichael et al. 2007: 1253). Finally, livestock's "hoofprint" has a significant impact on energy consumption. Whereas agriculture is estimated to use energy at a 3:1 ratio, meat accounts for a 35:1 ratio (Pew Commission 2009: 9). Not only are there consequences to the production of feedgrains as chronicled above, livestock, especially ILOs, impose significant external costs in the form of manure and waste.

Manure from ILOs exceeds human waste by three times and contributes to a number of environmental problems, including excessive nutrient loads in waterways, which causes eutrophication. Fertilizer and manure are responsible for dead zones in both the Gulf of Mexico and the East China Sea. It is estimated that 15 percent of nutrient pollution in the Gulf of Mexico is directly tied to livestock production (Pew Commission 2009). Large lagoons are constructed to contain the waste. But in a number of cases the lagoons have failed and runoff has killed millions of fish (Union of Concerned Scientists and Gurian-Sherman 2008).

Intensive livestock operations have come under criticism by scholars examining environmental justice (see Chapter 24). In particular, the location of ILOs is in rural areas where the residents are predominantly poor (Stull and Broadway 2004) and/or are unable to gain political support to resist the establishment of ILOs in their communities (Novek 2003). This has meant that conflict often accompanies the establishment of ILOs. For workers, there are serious health concerns caused by the gas and dust produced in confined areas (Thu and Durrenberger 1998) and CAFOs are associated with high rates of respiratory disease (Pew Commission 2009).

Globalized food and agriculture market dynamics

As the world economy has become more globalized in recent decades (see Chapter 22), there has been an accompanying rise in the physical trade of food and agricultural products across borders as well as a sharp increase in the trade in financial derivatives linked to food and agriculture. The globalized food market, as well as its growing ties to financial markets, has sparked increased investment in a new complex nexus of finance, food, biofuel and land that has been associated with myriad ecological effects around the world.

The international trade in food has grown significantly over the past 20 years. In 2008 global food trade reached over US$1.1 trillion, up from just US$315 billion in 1990. The rise has been especially sharp in recent years, with an annual 13 percent increase in the value of food trade over the 2000–8 period. Global food trade has grown more rapidly than production, signaling the growing significance of global markets in the food system (WTO 2004, 2009). The global trade in food has been associated with significant greenhouse gas emissions. Recent studies have shown that in Europe and North America the average distance food travels from farm to plate is approximately 1,500 miles. A number of environmental groups have used the concept of "food miles" to raise awareness of the climate implications of long-distance food trade (Iles 2005; Pirog 2004).

There is some controversy around the notion of food miles, in that it tracks primarily the greenhouse gases associated with transportation of food, and not its production. Some have put forward the case that the production methods matter far more than travel itself (Weber and Matthews 2008). It should be noted, however, that the growing global food market is highly reliant on large-scale industrial agriculture, and as such a growing global food market and associated trade reinforces an energy intensive system. Moreover, the carbon emissions and pollution from trade are in addition to greenhouse gases from industrial agricultural production. It may be that in some cases more environmentally sound production methods reduce the climate impact of certain foods – for example, an imported organic tomato may be responsible for fewer carbon emissions than a local hot-house tomato. But, at the same time, locally traded foods do not necessarily produce high levels of greenhouse gases whereas internationally traded foods produce additional carbon emissions because of the fossil fuels used in long-distance transportation.

The rise of a globally integrated food market is also linked to the rise in the trade in complex financial derivatives based on agricultural and food commodities. According to a number of analysts, the food system has become increasingly "financialized," meaning that financial actors – investors and financial institutions in particular – have become a significant influence on the sector (see Chapter 13). Their behavior, although geared primarily to financial profit, has an important impact on food system outcomes – including the environment. Given the global nature of agriculture and food markets, this financialization has important implications for global environmental politics (Clapp 2012b).

The increasingly important role of financial actors was highlighted in the aftermath of the 2007–8 food price crisis, as many began to point to the role of financial speculators in driving up global food prices. This concern was sparked by a sharp increase in the speculative trade in agricultural commodity futures contracts and other agricultural commodity derivatives following financial deregulation that allowed them to gain more exposure to these markets. The total assets of financial speculators in agricultural commodity markets increased from US$65 billion in 2006 to some US$126 billion by early 2011 (Worthy 2011: 13). There is a heated debate over whether the growth in financial speculation on agricultural commodity futures markets has been a cause or a response to rising food prices. But whether cause or response, financialization has certainly facilitated further financial investment – both in biofuels and in land – both of which have profound ecological implications, as mapped out below.

Since the early 2000s there has been growing interest in crop-based biofuels as a renewable fuel source. A number of global forces have encouraged biofuel investments. The financialization of commodities more broadly, including not just food and agricultural products, but also petroleum, has facilitated this investment. Like food, oil price rises have also been associated with financialization, which has made biofuels a competitive product in energy markets. In turn, this has led to a further push to invest in land for their production. As food prices also rose, some say in part due to rising investment in biofuels, investment in biofuel operations became even more attractive because both food and oil prices were also rising, making investments in production facilities attractive as a hedge against further rising grain and fuel prices (Clapp 2012b). As a result, biofuel investment is used as a hedge against both agricultural commodity volatility and fuel price volatility. Although the complex nexus of these investments is understudied, it has enormous environmental implications at the global level.

Stoking the role of biofuel investment in this nexus has been the fact that the largest producers of biofuel, including the United States and the European Union, require a certain percentage of fuels to be from renewable sources. Along with subsidies, these policies have attracted an increased interest in biofuel investments. For example, the attractive subsidies and fuel mandates have increased the use of corn for biofuels in the USA steadily from 20 percent of the country's total corn output in 2006 to 31 percent in 2008–9 to 40 percent in 2010–11. Corn-based ethanol increased by a factor of six from 2000 to 2009 (US Department of Energy 2010) and global bio-ethanol production has increased by more than a factor of five between 2000 and 2011 (Balat and Balat 2009; see also OECD–FAO 2011).

Although requiring the use of renewable fuels is aimed at reducing a reliance on the very fossil fuels that create greenhouse gas emissions, biofuel production is far from evenly "green" in its environmental credentials (McMichael 2010). The energy return on investment for corn-based ethanol, for example, is very low when compared with that from sugar-based ethanol. A rise in greenhouse gas emissions results from the production of both types of biofuels, however, on account of industrial farming methods and refining operations (UNESCO–SCOPE–UNEP 2009). Palm oil, a common feedstock for biofuels in developing countries, is notoriously inefficient as a biofuel. A ton of palm oil produces some 33 tons of carbon emissions (primarily due to deforestation; see Chapter 38), 10 times more than a ton of petroleum (Rainforest Action Network n.d.). Critics generally agree that replacing food crops with biofuels will likely worsen climate change (see Chapter 28).

Rising food and fuel prices and the financialization of food have also encouraged and facilitated foreign land acquisition, a phenomenon that has increased sharply since 2006. According to World Bank estimates, at least 45 million hectares of large-scale agricultural land deals were made in the first 11 months of 2009 alone, some 70 percent of which were in sub-Saharan Africa. This compares with an average of only 4 million hectares per year of global farmland investment that took place prior to 2008 (Deininger and Byerlee 2011: xiv). A number of African governments have transferred enormous tracts of land to foreign investors with uncertain outcomes.

While increased investment in land in developing countries is often a goal for these governments, critics have raised warning bells about the possible negative effects of some of these land deals (Behrman et al. 2012; Makki 2012; Lavers 2012). To start, much of this investment is not actually for food production to serve developing countries' food needs, but rather it is to serve the needs of the investors. In some cases, the investment is from foreign governments that are seeking to ensure their own food security, and in these cases the investments often involve the import of large-scale industrial farming methods and the establishment of infrastructure to export the crops. In other cases, the investments serve the needs of financial speculators who have bought into land investment funds seeking profit. There are also cases of investments that are seeking to capitalize on higher global crop prices such as those for biofuel crops. The link between global capital and investment, agricultural land and biofuel development is occurring globally, from Brazil, to Ethiopia and areas in Southeast Asia such as Malaysia.

The ecological impacts of large-scale land investments can be significant, especially if they involve the import of large-scale industrial farming operations in both food and biofuels. In such circumstances, large-scale industrial agriculture can pose serious risks to the ecosystem as noted above. Tropical forests have already been cleared, for example, in many parts of Asia and Africa in order to establish palm oil plantations for the production of biofuel (see Chapter 38). These ecological risks associated with large-scale foreign land acquisition are a particular concern since these investors are seeking short turnaround on returns and longer term environmental impacts are often left off the balance sheet (Clapp 2012b).

The international politics of more sustainable food and agriculture

The environmental impact of food and agricultural systems has received less attention than it deserves within the field of global environmental politics. This is likely due to the fact that, unlike the issues of climate (Chapter 28), ozone (Chapter 29) or hazardous waste (Chapter 33), there is no one international "regime" or agreement that seeks to promote sustainable agriculture on a global scale (on regimes, see Chapter 9). A number of existing regimes do touch on some of the problems – such as biodiversity loss and genetically modified organisms (Chapter 37) and hazardous pesticides (Chapter 32). But these are not coordinated as "agriculture" agreements; agriculture is but one source of these particular problems. Part of the reason for the lack of a global agreement specifically focused on the environmental dimensions of food and agriculture is the lack of an international consensus on what exactly a more sustainable agriculture should or could look like in practice. There is much agreement that the current situation is not sustainable over the long run. Indeed, the United Nations Environment Program has stressed that a highly diverse agricultural system that is "eco-efficient" is considered more robust and better at ensuring food security (UNEP 2012: 425). While this is widely supported, there are differing views on how to move forward in a way that provides sufficient food for the world's population with the least damage to the environment.

Two views in particular have become prominent in the debate over the topic, and these have shaped the political discussion at the international level on sustainable agriculture. The first is characterized by the work of the World Bank, and is more mainstream in its approach. It takes as a starting point that some patterns in the global food and agriculture system are a given: for example, that meat consumption is likely to increase over time as the world population grows and as the size of the middle class in developing countries grows (see Chapter 16); an outgrowth of this assumption is a resolve that increased food production is essential. The key is to find a way to achieve this goal in the most environmentally sound way. Given this starting point, the World Bank articulates a vision for a more sustainable agriculture in its *World Development Report 2008, Agriculture for Development* (2007).

Written by a group of around 40 analysts, mostly economists, the World Bank report puts forward the case that the current organization of the food system is not the problem per se. Rather, there are areas where science and new technologies need to be applied and supported with proper management to improve efficiency and reduce environmental impacts (see Chapters 17 and 18). From this viewpoint, new technologies, including genetically modified organisms, need to be fully utilized in order for the world to meet the constant and rising demand for food. Newly developed GMOs, which are engineered for resistance to drought and pests, can meet food needs in a changing climate without the need for synthetic pesticides. The World Bank vision also relies on the promotion of more globally integrated food and agriculture markets with more private sector investment, including the development of more agricultural commodity exchanges and the facilitation of foreign direct investment in the sector. Indeed, the World Bank has played an important role in the development of new guidelines for the private sector for "responsible agricultural investment" (World Bank 2010).

Another major international report on the sustainability of agriculture was released on the heels of the World Bank's report. *Agriculture at a Crossroads* (IAASTD 2009) was the final product of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), an international assessment panel that was established in 2004. The IAASTD report aims to represent a far larger and more heterogeneous group of analysts, and included over 400 participants from a number of fields in academia as well as civil society and the private sector. In its own words, IAASTD describes itself as a multi-thematic, multi-spatial, multi-temporal intergovernmental process with a multi-stakeholder Bureau co-sponsored by a number of international organizations.

The IAASTD was an ambitious project to assess "the impacts of past, present and future era cultural knowledge, science and technology" in a wide variety of thematic areas. In contrast to the World Bank report, the IAASTD report's context was multifaceted. It explicitly aimed to examine urbanization, migration, dietary preferences, climate change, environmental degradation, among others, in the context of the future of agriculture. All of these global processes were tied to science, technology and knowledge but in a cultural context, which means that no single

model for agricultural development was presented (see Chapters 17 and 18). The report was careful to provide a balanced view on issues such as agricultural biotechnology and trade policies. But, at the same time, it demonstrated that agroecological methods could provide at least the same if not higher production results with less ecological damage than alternatives of the type espoused by the World Bank (see IAASTD 2009).

Other groups have also promoted an agroecological approach, including La Via Campesina and associated global food sovereignty movements. These social movements support agricultural governance that is decentralized and based on environmental stewardship (Patel and McMichael 2004; Cohn 2006), in contrast to the often large-scale and centralized management of industrial agriculture. The "pillars" of food sovereignty include local control in "environmentally sustainable ways which conserve diversity" and "work with nature" by rejecting energy intensive, monoculture and industrial models (Forum for Food Sovereignty 2007). Although originally seen as somewhat "radical," agroecological methods are gaining support from more mainstream scientific organizations such as the Royal Society, which supports agronomy and agroecological approaches (Royal Society 2009; on science, see Chapter 17). Indeed, much of the food consumed in the developing world is still produced with few, if any, external synthetic inputs and already relies on diverse crops and varieties, often genetically diverse local varieties (Commission on Genetic Resources for Food and Agriculture 2010).

Beyond the debate over the global organization of agriculture is the question of diets. A number of scholars and reports have called for a change in diet as a way to reduce the environmental impacts associated with meat consumption (e.g., McMichael et al. 2007; UNEP 2012). Reduced meat consumption could play a role in future climate change mitigation policies by reducing livestock's contribution to greenhouse gases. It has been estimated that eating 20 percent less meat is equivalent to switching from a standard American automobile to a Prius (Eshel and Martin 2006). Dr Pachauri, chair of the Intergovernmental Panel on Climate Change, has stated that lifestyle changes, including reducing meat consumption, are an important means for reducing emissions of greenhouse gases (Anon. 2010; see Chapter 28). Alternatively, some scholars have called for "de-intensification" – because pastoral systems and mixed crop–livestock systems have significant carbon sequestration potential and the fact that a majority of the global population are dependent on these systems for their livelihoods (Herrero et al. 2009, 2010). This view is somewhat supported by the FAO (2006b) which calls for payment for conservation services by pastoralists.

These various ideas on how to move toward a more sustainable food and agriculture future have only just begun to filter into global political bodies as they seek to respond to questions of food security. The views of the World Bank have been much more influential on bodies such as the G20 and the G8. The ideas of agroecology, while finding a more sympathetic hearing at the Committee on World Food Security, hosted by the Food and Agriculture Organization, and at the 2012 Rio+20 Conference, have less political weight on the global stage. The various global bodies are only just beginning to dialogue on the sustainable food and agriculture question, and it is important for scholars in the field of global environmental politics to keep a close eye on these developments.

Conclusion

The drive to improve agricultural production and efficiency has been met by industrial agriculture over the past century. But as outlined in this chapter, it has come with a significant environmental cost not just at a local level, but also on a global scale. The dominant food system is organized and shaped by industrial agriculture and international economic forces such as the international trade in food and global financial activities. These complicate and add to the already significant tensions between food, fuel and land. Importantly, these activities can intensify environmental impacts.

These complex and interrelated issues have been dealt with ineffectively at the global scale. Political choices about how societies collectively organize agricultural systems are of overriding importance because these choices shape individual food choices in many ways. But efforts to forge a global cooperative strategy to promote more sustainable food and agricultural systems have been stalled due to a lack of consensus on what constitutes "sustainable agriculture" (on sustainability generally, see Chapter 15). The two leading interpretations of how a more environmentally friendly international organization of agricultural and food systems could be implemented are widely divergent. Some argue that agroecological methods and more locally oriented food systems will reduce the environmental damage caused by agriculture. But others are skeptical that such methods will be sufficient to feed the world's growing population. These two views were exemplified in two reports – the IAASTD's *Agriculture at a Crossroads* (2009) and the World Bank's *Agriculture for Development* (2007).

The lack of agreement on a vision for a sustainable future for food and agricultural systems has meant that current agriculture, food and diet practices – many of which have negative environmental impacts – persist. This situation cannot last indefinitely, so long as the condition of the global environment worsens, and the demand for food from a growing global population increases. There is an urgent need for more explicit global dialogue on sustainability in agriculture. International institutions can promote more sustainable food systems in practice through the development of norms, rules and other incentives that shape collective societal choices on the organization of food and agriculture (see Chapters 8 and 9). To date, however, both scholars of global environmental politics and policy-makers have shown little interest in forwarding a specific vision for sustainable agriculture, much less putting up the financing needed to see it implemented. Although the 2012 Rio+20 document, *The Future We Want* (UNEP 2012), gives a nod to the need for sustainable agriculture, it remains vague on the details and sources of support. It is well past time that this issue be given serious attention, especially since agricultural issues intersect with key issues such as climate change, pollution and energy policy, and directly impact the wellbeing and livelihood of the globe's poorest people.

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