Institute for Agriculture and Trade Policy

The Changing Climate for Food and Agriculture: A Literature Review

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The Institute for Agriculture and Trade Policy works locally and globally at the intersection of policy and practice to ensure fair and sustainable food, farm and trade systems.

Introduction

Climate change and agriculture are inextricably linked. Agriculture still depends fundamentally on the weather. Climate change has already caused a negative impact on agriculture in many parts of the world because of increasingly severe weather patterns. Climate change is expected to continue to cause floods, worsen desertification and disrupt growing seasons. The Food and Agriculture Organization (FAO) warns that an increase in average global temperatures of just two to four degrees Celsius above pre-industrial levels could reduce crop yields by 15-35 percent in Africa and western Asia, and by 25-35 percent in the Middle East. An increase of two degrees alone could potentially cause the extinction of millions of species.

Agricultural practices also exacerbate climate change. The Intergovernmental Panel on Climate Change (IPCC) says that agriculture contributes 13.5 percent of global greenhouse gas emissions (2004). According to Greenpeace, if calculating both direct and indirect emissions from the food system, agriculture's contribution could be as high as 32 percent. (Greenpeace includes all related activities; in addition to agricultural production, they add land use, transportation, packaging and processing.) The future of agricultural production relies on both designing new ways to adapt to the likely consequences of climate change, as well as changing agricultural practices to mitigate the climate damage that current practices cause, all without undermining food security, rural development and livelihoods. This is a huge undertaking.

Climate change and food security are related because climate change can directly affect a country's ability to feed its people. However, research shows climate change will not equally affect all countries, and will likely have the biggest impact in equatorial regions such as sub-Saharan Africa. This means that countries already struggling with food security are likely to find they struggle still harder in the future. The IPCC projects that yields from rain-fed farming in some African countries could be reduced by up to 50 percent by 2020. Meanwhile, countries such as the United States are experiencing changing agricultural land use patterns due to climate change.

Despite the clear links between agriculture and climate change, agriculture is not currently on the agenda of global climate talks to strengthen the Kyoto Protocol (the international agreement that sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas emissions). Countries are meeting in Poznań Poland in December 2008; the talks are scheduled to conclude in Copenhagen, Denmark in December 2009.

The following literature review does not reflect the position of the Institute for Agriculture and Trade Policy on climate change, agriculture and trade. Rather, it summarizes the existing literature to provide a tool for policymakers and civil society groups. The literature comes from a range of sources, including international and civil society organizations, universities, and international press.

How to produce more climate-friendly food

There is considerable support for organic farming as the best way to mitigate greenhouse gas emissions. Organic agriculture's emissions are generally lower than those of industrial agricultural methods. Although some modes of organic agriculture do not produce yields as high as industrial or chemical agriculture, it is a more sustainable means of cultivating the land. It builds soil quality and uses more diverse cropping systems, which in turn reduces the number of greenhouse gases emitted. And it is better at sequestering (absorbing) carbon and nitrogen than industrial agriculture.

There are nonetheless mixed views regarding which model of agriculture most effectively minimizes climate change. Under some scenarios, industrial agriculture produces fewer greenhouse gas emissions. There is almost universal agreement among researchers, however, that the overall impact of chemical fertilizers is negative.

Opinions vary greatly regarding the amounts of energy used in different production processes and regarding which methods most effectively minimize greenhouse gas emissions. Organic standards have not typically developed climate-related criteria (e.g., controlling how much oil is used on-farm in production and harvesting of crops). Further comparative research needs to be conducted on industrial versus organic and small-scale versus large-scale farming. Of the pieces reviewed, the Greenpeace paper makes the most ambitious attempt to answer these needs. The analysis needs to deepen.

There is also a growing body of research showing how organic farming can feed the world, and that switching from chemical to organic farming would not reduce the world's food supply.

Reviewed: IAASTD (2008); Greenpeace (2008); ITC (2007); OECD (2002); IPCC (2007); IFAD (2008); Pretty (2007), Cline (2007), University of Michigan (2007).

A. International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) (2008). Synthesis Report.

The IAASTD examines how agricultural knowledge, science and technology can be used to reduce hunger and poverty, and facilitate environmentally, socially and economically sustainable development. Climate change will require a new look at water storage. To mitigate climate change, a number of approaches are proposed, such as lower rates of agricultural expansion in natural habitats, agroforestry, restoration of underused or degraded lands, reduction and more efficient use of nitrogenous inputs, better management of manure, and use of feed that increases livestock digestive efficiency.

B. Greenpeace (2008). Cool Farming: Climate Impacts of Agriculture and Mitigation Potential.

The Greenpeace report finds the total global greenhouse gas contribution of agriculture from both direct and indirect sources is between 17 and 32 percent; the most prominent sources include: land conversion to agriculture, nitrous oxide released from soils, methane from cattle and enteric fermentation (flatulence-produced methane emissions), biomass burning, rice production, manure, fertilizer production, irrigation, farm machinery and pesticide production. Although greenhouse gasses come from several sources, there is enormous potential for reducing greenhouse gas emissions through agriculture. According to Greenpeace, up to 100 percent of the direct emissions could be eliminated, mainly through carbon sequestration, but it would also require significant methane and nitrous oxide reductions.

The results were mixed when Greenpeace researchers compared organic with conventional products for their contribution to climate change. For products such as wheat bread, canola and potatoes, the organic versions were more climate friendly than the conventional. For products such as poultry, eggs and milk, however, the conventional versions did better than their organic counterparts. Products clearly need to be examined on an individual level in order to determine which method is best for minimizing climate change, Greenpeace concluded.

C. International Trade Center (ITC) (2007). Organic Farming and Climate Change.

Agriculture is both a cause and a victim of climate change, but organic farming is a useful tool to mitigate the impacts of the industry. Organic farming is able to accomplish this because it generally requires less fossil fuel use per hectare of land and kilogram of produce than crops that use chemical fertilizers. According to ITC, organic farming also increases soil fertility, which leads to increases in water retention. Furthermore, organically managed soils are better equipped to deal with extreme changes in weather because organic soil is much more productive than conventional soil, which relies on chemical fertilizers. For example, organic plants and soils have been shown to perform better under extremely dry conditions than conventional plants and soils. This is good news for those regions of the world experiencing water constraints as a result of climate change.

On the downside, organic farming can still be a major contributor of greenhouse gas emissions in that it frequently depends on the use of nutrients derived from livestock manure (the livestock sector is a major contributor to greenhouse gas emissions), according to ITC.

D. Organization for Economic Cooperation and Development (OECD) Joint Working Party of the Environment Policy Committee and the Committee for Agriculture (2002). Agricultural Practices that Reduce Greenhouse Gas Emissions.

There are several links between agriculture and greenhouse gas emissions. This paper explores ways to mitigate greenhouse gas emissions in OECD countries specifically. These mitigation practices include carbon dioxide and nitrogen sequestration through the use of manure, bio-fertilizers and crop rotation, as well as decreased land tillage and improved methods of irrigation. The impact of ruminant (cattle, sheep, deer) livestock production is significant. OECD countries account for 42-99 percent of total global livestock-related methane emissions. Mitigation efforts suggested by this paper include increasing feed digestibility/feed conversion efficiency through the use of diet manipulation and feed additives, increasing animal size or improving productivity, and reducing livestock numbers. There are also more adaptive measures that can be taken, such as the use of genetically altered animals that would produce less methane, or the use of an anti-methane vaccine. Additionally, OECD suggests that some genetically modified crop varieties may be engineered to reduce the need for inputs that add to greenhouse gas emissions.

E. Intergovernmental Panel on Climate Change (IPCC) (2007). From Climate Change 2007; Chapter 8: Agriculture.

Agriculture is one of the world's largest industries. Agricultural land alone covers 40-50 percent of the world's land surface. Greenhouse gas emissions from global agricultural production increased by 17 percent between 1990 and 2005. Livestock account for about one third of global anthropogenic emissions of methane. Agriculture is responsible for only 4 percent of global gross domestic product (GDP) but directly employs roughly 1.3 billion people and feeds the world. In developing countries, agriculture uses 87 percent of total extracted water.

Greenhouse gas emissions are expected to increase in all regions of the world except Europe. The IPCC calls for better cropland, fertilizer and livestock management, as well as enhanced crop diversification, a reduction/elimination of fossil fuel-based fertilizers, a reduction in livestock and the use of better livestock feeds. The IPCC also proposes an increase in agricultural research and development of modes of agriculture, and increased knowledge and technology transfers.

F. International Fund for Agricultural Development (IFAD) (2008), Policy Reference Group on Climate Change. Climate Change and the Future of Smallholder Agriculture.

IFAD advocates planned adaptation measures such as the use of more heat or drought-resistant seeds, changing fertilizers or methods of fertilization, more effective use of water, and altering the timing or location of agricultural production. In terms of mitigation, the paper suggests reducing emissions, enhancing carbon dioxide removals and avoiding emissions. In conclusion, the major barrier to adaptation and mitigation is diffusion of knowledge. Major international development organizations are called upon to use their collective expertise and resources to support smallholder agriculture.

G. Pretty, Jules (2008). Background for World Development Report: Agroecological Approaches to Agricultural Development.

This is a vision piece for what a sustainable food system might look like, and approaches the issue from a development perspective. The paper argues that improved management of agricultural ecosystems with a focus on sustainability can be hugely beneficial to developing countries. Pretty describes a number of technologies that have been developed to decrease fossil fuel-intensive practices, including integrated pest management, integrated nutrient management, conservation tillage, agro-forestry, aquaculture, water harvesting and livestock integration.

A study conducted over the course of four years on 286 agricultural projects found that the use of more sustainable agricultural systems such as those mentioned above resulted in a mean relative yield increase of 79 percent. In addition to increased yields, farmers experienced improvements to natural, social and human capital.

To maximize poverty alleviation through improved management of ecological systems, corresponding policy measures are necessary, including better linkages between small farmers and domestic markets, agribusiness development, investment in agro-processing and value-added activities, support for urban agriculture, livestock development, encouraging consumer demand for more ethical and organic foods, and regulation of supermarkets and other retailers to connect consumers with local and domestic producers.

H. Cline, William. The Peterson Institute for International Economics (2007). Global Warming and Agriculture: Impact Estimates by Country

Cline calls into question the argument that global warming of a few degrees could potentially increase global agricultural productivity. He suggests that although some countries may experience temporary yield increases, developing countries will be the hardest hit by global warming and will have the least capability to adapt. The effects of global warming will be further exacerbated in developing economies where agriculture constitutes a larger percentage of GDP compared with developed countries.

This study concludes that within this century, global warming will have a modest negative impact on global agriculture. However, developing countries will be more affected by global warming than will more developed countries—the hardest hit being Africa, Latin America and India. This study provides a breakdown on a country-by-country basis of the current versus projected average temperature and precipitation. If agricultural production continues without the use of better carbon fertilization, expected losses in agricultural output capacity could be 28 percent for Africa, 24 percent for Latin America and up to 40 percent for India.

I. University of Michigan (2007). Organic Agriculture Can Feed the World

A group of scientists from the University of Michigan found that a switch to organic farming would not reduce the world's food supply and could even increase food security in developing countries. The researchers point out that the materials needed for organic farming are more accessible and affordable to farmers in poor countries. The researchers also found that small farms tend to produce more per hectare of land.

Reconciling agricultural trade with climate change

A review of the literature reveals a range of significant tensions. On the one hand, a larger role for trade is advocated to ensure adequate food supplies for countries that are likely to suffer from climate change. In addition, a number of developing countries account for a significant and growing share of agricultural trade and some authors argue that this is vital for economic development, income growth and employment. On the other hand, trade is associated with significant environmental costs that are undermining food security, and therefore other authors argue for a smaller role for trade in order to reduce emissions and mitigate climate change.

Developing countries, particularly in Africa, are predicted to be the hardest hit by climate change. The World Bank, WTO and other organizations argue that these countries will have to increasingly rely on international trade to secure enough food as their own production levels fall. They ignore the contribution of trading agricultural commodities to increased greenhouse gas emissions. Both trade and industrialized agricultural production are heavily dependent on fossil fuels and therefore increase greenhouse gas emissions and exacerbate climate change. There is need for further research on emissions from export-oriented agriculture, including processing, packaging, storage and transportation.

The existing literature says little definitive about which economic models are best for the climate. Although there has been a recent movement in developed countries to consume locally produced foods to reduce transport-related greenhouse gas emissions, the trend has been criticized by organizations such as the Overseas Development Institute (ODI) because local, small-scale farming practices can often be more greenhouse gas intensive if they are produced in an unsuitable region or climate.

Other researchers suggest that greenhouse gas emissions produced by transportation and packaging are so minimal (compared to the greenhouse gas emissions from agricultural production itself) that efforts to reduce emissions should focus on modes of production rather than other factors in the food chain. Meanwhile, still other researchers argue that greenhouse gas emissions from these indirect sources comprise a higher percentage of total emissions than those resulting from agricultural production, and therefore require the most attention.

The increase in biofuel production, in conjunction with policies that set minimum targets for biofuel use, has also intensified the debate about the impact of trade on climate change.

Reviewed: ECOSOC (2000); Shrybman (2000); World Bank (2008); ICTSD (2008); ICTSD (2008); Earth Policy Institute (2005); Pretty, Ball, Lang & Morisson (2005); ODI (2007); Lincoln University (2007); Shah (2008); Rubin & Tal (2008)

A. United Nations Economic and Social Council (ECOSOC) (2000). The Realization of Economic, Social and Cultural Rights: Globalization and its Impact on the Full Enjoyment of Human Rights.

This report addresses the various ways in which globalization and trade liberalization have affected human rights throughout the world. Of particular concern are the policy prescriptions given by institutions such as the International Monetary Fund and the World Bank, and their impacts on rural livelihoods. Women and rural farmers have been particularly affected. Emphasis on export crops has threatened food security, and industrial agriculture has caused job loss, an increase in pollution and overall environmental degradation.

B. Shrybman, Steven (2000). Trade, Agriculture and Climate Change: How Agricultural Trade Policies Fuel Climate Change.

Shrybman argues that the ways in which we assess the impacts of agricultural production on climate change need to be changed. Current climate change literature overlooks the combined impacts of trade and agriculture. There is a lack of emphasis on the energy demands that an industrialized food and agriculture system depends upon, such as packaging, processing and distribution. Governments both nationally and at the WTO fail to consider the true energy demands of agriculture. According to Shrybman, agricultural trade policies dictate the way that agricultural production and distribution systems operate. Therefore, trade policymakers must take into account rising greenhouse gas emissions and the energy that their policies demand.

C. World Bank (2008). Climate Change and Agriculture: A Review of Impacts and Adaptations.

Climate change is affecting agricultural regions throughout the world. It has been estimated that the overall economic impact on agriculture could be up to 10 percent of GDP. The countries that are most affected by climate change will have to increase their involvement in international trade as their environment worsens (and they become unable to adequately provide for themselves). Economic reforms that would help countries negatively affected by climate change could include the introduction of flexible land-use policies and the elimination of subsidies. Increased access to financial services such as credit, marketing systems, training and irrigation would also mitigate the impacts.

D. International Centre for Trade and Sustainable Development (ICTSD) (2008). Climate Change, Agriculture and Trade: Implications for Sustainable Development.

According to ICTSD, globalization tends to heighten agricultural vulnerability. ICTSD defines globalization as liberalization of international trade. Proponents of a liberal model suggest that it has the potential to benefit developing countries by improving their access to other developing markets, as well as increasing agricultural commodity prices in rural areas where poverty is concentrated.

According to this report, these potential benefits have not been realized. Trade liberalization has instead become a threat to agricultural development in developing countries. IMF statistics even suggest that the more liberal the trade policy, the less economic growth countries achieve. The liberal model is therefore flawed in that it assumes that risk is reduced through a reallocation of world food supplies corresponding with comparative advantage. What this does not take into account is the recent instability of comparative advantage due to increasing climate change. Because environments most conducive to the production of specific crops are moving, it is difficult for countries to maintain a comparative advantage in one agricultural commodity versus another. Significant mitigation and adaptation of agricultural practices will need to occur, particularly in developing countries, to stabilize prices and realize comparative advantage.

E. International Centre for Trade and Sustainable Development (2008). Climate Change and Trade on the Road to Copenhagen

One of the major shortcomings of the international trade system is that the transportation of goods is a largely unregulated sector. Consequently, the reduction of transportation-related greenhouse gasses does not fall under the jurisdiction of any particular country. Transport emissions have historically been "out of sight, out of mind." As more research is done, however, it is becoming evident that air freight is not the only carbon intensive mode of transportation (as is commonly thought). Shipping is also being recognized as carbon intensive. As countries push for an increase in regulations and standards to improve greenhouse gas emissions standards, they will likely see it necessary to introduce higher prices for transportation, both for goods and public transit. This report points out that remote, small countries will be particularly affected by an increase in transport regulations and costs.

F. Earth Policy Institute (2005). Oil and Food: A Rising Security Challenge

Growing food accounts for only one-fifth of the totally energy used by the U.S. food system. This means that the other four-fifths result from off-farm sources such as transport, processing, packaging, food retailing, restaurants and caterers, and home refrigeration and preparation.

Consumption patterns are becoming increasingly unsustainable, with food traveling farther and farther before it is consumed. Processed foods are also growing as a percentage of the average diet, comprising three quarters of overall world food sales. As large-scale grocery stores replace neighborhood ones, the number of food suppliers is also reduced in an effort to achieve homogeneity of inventory in all branches of a particular supermarket, which in turn increases transportation, refrigeration and packaging-related energy consumption.

G. Pretty J.N., Ball A.S., Lang T. and Morisson J.I.L (2005). Farm Costs and Food Miles: An Assessment of the Full Cost of the Weekly UK food basket.

This study analyzes the full costs of the weekly UK food basket from farms to the consumer's plate. The authors study 12 commodities and assess the real cost of food production, including externalities such as farm externalities, domestic road transport, government subsidies and shopping transport. The authors advocate for organic farming, localized food systems and sustainable transport to reduce the environmental costs of the UK food system.

H. Overseas Development Institute (2007). Climate Change and Agriculture: Agricultural Trade, Markets and Investments.

This paper challenges the assumption that taxing food that is transported long distances (because of the implications for greenhouse gas emissions) is a good policy. The paper points out such fines would inevitably hurt developing countries that have developed export sectors to service demand in richer countries. Because much of the fresh produce consumed by the developed world comes from the developing world (and usually has to be transported via air), higher transportation costs would unfairly penalize developing countries. Furthermore, the environmental impact of internationally traded goods is frequently less than those produced domestically. For example, there is less energy consumption involved in flying cut flowers from sub-Saharan Africa to Europe than for the flowers to be produced in hothouses domestically. Similarly, there is less energy consumption involved in the transportation of New Zealand lamb to Europe than there is for continentally produced lamb that must be transported overland.

I. Saunders, Caroline and Andrew Barber. Comparative Energy and Greenhouse Gas Emissions of New Zealand's and the UK's Dairy Industry. Agribusiness and Economics Research Unit of Lincoln University. Research Report No. 297. Lincoln, New Zealand (2007).

This study calculates the greenhouse gas impact of milk produced in New Zealand and shipped to the UK versus milk produced and sold domestically. The study concludes that UK domestic milk is about 30 percent more greenhouse gas-intensive (inclusive of CO_2, N_2O and methane), despite the travel savings. The largest differences result from the energy intensity of UK animal feeds compared to New Zealand's grazing system, the fuel requirements of on-farm machinery in the UK and the greater use of nitrogen fertilizers in the UK. Data sources for farming practices in the two countries were different, and there may be some discrepancies in data collection or assumptions that haven't been accounted for.

J. Shah, Hasit (2008). The Carbon Footprint in Agricultural Trade [A Background Paper for the International Centre for Trade and Sustainable Development]

Hasit Shah argues that the drive to eat locally produced and seasonal fruits and vegetables is neither practical nor realistic. The paper looks at the experience and debate in the UK around food miles, and uses Kenya as an example of a developing country that relies on agricultural exports to the UK and Europe. The author argues that agricultural exports are a crucial social and economic sector for the developing world that generates income and employment. The author advocates for maintaining the system of global trade in agriculture while trying to reduce carbon emissions at different stages in the life cycle, from production to consumption. He says agriculture should be grown in the most suitable climates, without subsidies and as efficiently as possible.

K. Rubin, Jeff, and Benjamin Tal (2008). Will Soaring Transport Costs Reverse Globalization?

The authors of this study suggest that globalization is reversible and that reversal has already begun. Due to the oil crisis and rising fuel prices, the transportation of goods has begun to slow. In a global economy heavily focused on trade liberalization, transportation costs may be creating larger barriers to trade than tariffs. According to Rubin and Tal, in tariff-equivalent terms, transport costs have offset all trade liberalization efforts made over the past 30 years. The U.S. and Canada are already beginning to re-domesticate industries formerly outsourced to Asia and South America. For example, for low-labor, high-transportation cost industries such as steel, U.S. production increased by 10 percent in 2007 while China's steel exports fell by more than 20 percent.

Is our global appetite sustainable?

There is a proliferation of literature available on changing patterns of consumption, particularly in relation to the developing world. In general, the bigger a country's Gross Domestic Product (GDP, commonly used as a proxy for development), the more dependent its population becomes on energy-intensive consumption. For example, as people get richer, they buy more meat, dairy and eggs, all of which require more energy to produce, store and distribute than cereals or legumes. Along with this change in consumption choices comes an increase in the use of commodities as inputs, such as oil (used in fertilizers, farm machinery and transportation) and water (for cultivation).

It is difficult to quantify food security or to determine how much energy must be spent on a population in order to provide it with adequate, healthy and culturally appropriate food. There is little information available on what a sustainable diet would optimally consist of or what would constitute an energy-excessive diet.

Waste is also an important issue. In the United States and other countries, many people are not only consuming more than their nutritional needs, but are also wasting a lot of their food. This has significant consequences not only for market economies, climate change and natural resource scarcity, but public health as well.

Although in some developed countries there is an increasing trend toward vegetarianism, organic food consumption, and local foods, the trend is not sufficient to change the larger global consumption trends. There is widespread agreement that the world is becoming increasingly more dependent on energy-intensive foods and will continue to be for some time.

Reviewed: Food Navigator (2004); Stockholm International Water Institute (2008); FAO (2006); Food Ethics Council (2007)

A. Food Navigator (2004). U.S. Wastes Half its Food

Agricultural and household food waste is a major problem in the United States. Forty to fifty percent of food ready for harvest in the U.S. is never consumed. This results in several environmental and economic impacts. The U.S. government and consumers could potentially save tens of billions of dollars every year if waste were even partially reduced.

B. Stockholm International Water Institute (2008). Saving Water From Field to Fork: Curbing Water and Wastage in the Food Chain.

This report walks the reader through the food chain—from the field to pre-processing, transport, storage, processing, marketing and finally, the kitchen—and estimates that up to half of all food produced is lost. These losses within the food chain are not the same for rich and poor countries. Broadly speaking, in poor countries most food losses occur at the beginning of the food chain, often in the field due to poor harvesting, or as a result of poor storage and transport facilities (made worse in hot and humid weather). In industrialized countries, the losses occur toward the end of the food chain, where food is wasted in wholesaling, retailing and among consumers who tend to throw away a significant amount of food. The authors point to the role of globalization in food loss and in turn make the case for stronger local food systems.

C. Steinfeld, H., P. Gerber, T. Wassenaar, V. Castel, M. Rosales, and C. de Haan. Livestock's Long Shadow: Environmental Issues and Options. Livestock, Environment, and Development Initiative. Published by the UN Food and Agriculture Organization (2006).

This piece analyzes the impact of the livestock sector on the environment, and quantifies the full global impact of livestock on the climate. The livestock sector emerges as one of the most significant contributors to the most serious environmental problems from local to global, including climate change, land degradation, pollution, water shortage and loss of biodiversity. The authors find that extensive and intensive livestock production is responsible for an estimated 18 percent of anthropogenic emissions worldwide, largely from deforestation, methane emissions and atmospheric N_2O uptake from the use of nitrogen-based feedstock fertilizers.

The livestock sector is also socially and politically significant. It accounts for 40 percent of agricultural GDP, employs 1.3 billion people and creates livelihoods for one billion of the world's poor. Livestock products provide one-third of humanity's protein intake, and are contributing causes of obesity.

Growing populations and incomes are rapidly increasing demand for livestock products, and globalization is boosting trade in livestock. Global production of meat is projected to more than double between 2000 and 2050. The environmental impact of livestock production must be cut by half to avoid increasing the level of damage beyond its present level, the paper concluded.

D. Food Ethics Council (2007). Meat Consumption: Trends and Environmental Implications.

Livestock account for 18 percent of global greenhouse gas emissions and contribute to biodiversity loss and water scarcity. Although it has been advocated by some that a reduction in meat consumption is necessary to reduce these impacts, some fear a decrease in demand for meat in developed countries could lower world meat prices, causing an increase in global meat consumption. A change in production followed by an increase in the price of meat (as opposed to a decrease in consumption) as a means of mitigating the problem of livestock-related greenhouse gas emissions would be preferred. A decrease in livestock production would not necessarily lead to a surplus of productive land or of grain for human consumption, and many of the foods such as fresh fruits, vegetables and nuts that would replace meat can also be extremely energy intensive.

The corporate agenda for climate change

In the midst of a global hunger crisis, the biggest beneficiaries have been transnational commodity traders and investors. Record profits and growth have been achieved at the expense of food security throughout the world and the loss of rural livelihoods.

Food and agricultural corporations are also positioning themselves to become the main beneficiaries of climate change. Agricultural corporations have been developing new seeds to resist drier climates, use less fertilizer and provide greater nutritional value.

There is a lack of inter-governmental discussion on the role of corporations in contributing to climate change and about what actions could be taken to minimize the harmful effects. Instead, market-based approaches to mitigating global warming have been proposed, such as international cap and trade initiatives, and tax credits on carbon sequestration. In Europe, farmers are already able to sell the amount of carbon they sequester by the ton. Many critics argue that these initiatives will benefit corporations and fail to address the causes of climate change.

Many agribusiness corporations and philanthropic organizations are touting the need for genetically modified seeds as a means of adapting to climate change.

Reviewed: GRAIN (2008); McKibben (2003); ETC Group (2008); Shand (2008)

A. GRAIN (2008). Making a Killing from Hunger.

The world is in the midst of a global food crisis, yet agribusiness companies are turning record profits. Profits at Cargill's Mosaic Corporation, which controls much of the world's potash and phosphate supply, more than doubled in 2007. The world's largest potash producer, Canada's Potash Corp, made more than US$1 billion in profit, up 70 percent from 2006. On April 14, 2008, Cargill announced that its profits from commodity trading for the first quarter of 2008 were 86% higher than the same period in 2007. Bunge, another big food trader, saw its profits of the last fiscal quarter of 2007 increase by 77 percent compared with the same period of the previous year. The 2007 profits registered by Archer Daniels Midland (ADM), the second largest grain trader in the world, rose by 65 percent to a record US$2.2 billion. Thailand's Charoen Pokphand Foods, a major player in Asia, is forecasting revenue growth of 237% in 2008. The recent increases in the price of grains have benefited the corporations who have considerable market power both within the supply chain and on commodity trading floors.

B. McKibben, Bill (2003). Food Fight: Local Farming vs. Agribusiness.

Bill McKibben addresses some of the impacts in the United States and globally from the loss of independent, small-scale agriculture. For example, the U.S. has lost over 50 percent of its farms since 1977. The average North American meal must travel 1,500 miles from production to plate. In the U.S., efficiency and productivity have become the main focus of agriculture, an industry that employs less than 2 percent of the population. Because this food can be produced inexpensively, it can be transported to other regions of the world still reliant on small-scale farming, which depresses local markets and undermines local food production.

C. ETC Group (2008). Patenting the "Climate Genes" . . . And Capturing the Climate Agenda.

Many of the world's largest agricultural corporations are currently in the process of stockpiling hundreds of patents on seeds that could withstand such effects of climate change as drought, heat, cold, floods and saline soils. In reaction, multilateral organizations have launched a global appeal for governments to stop granting patents to companies seeking to patent climate change-resistant seeds. BASF currently holds the largest number of patents followed by Syngenta and Monsanto. Together, BASF and Monsanto hold patents for 49 percent of the patent families identified by the ETC Group. There is concern that due to heavy marketing measures, the countries most affected by climate change will turn to these seeds, which have, according to many, undergone insufficient impact analysis and will sidestep bio-safety rules.

D. Shand, Hope (2008). Foreign Policy In Focus, Corporations Grab Climate Genes.

The Bill and Melinda Gates Foundation is currently supporting (with a $47 million grant) a study being conducted by BASF and Monsanto to develop drought-resistant corn crops. In turn, BASF and Monsanto will "donate" (royalty free) drought-tolerant transgenes to African researchers. This sort of market-based philanthropy is misguided. The newly developed seeds will not likely directly benefit African farmers because they will likely be accompanied by intellectual property laws, seed regulations and other products and practices that are all geared to support agricultural corporations rather than farmers, especially small farmers.

Governments should respond to the climate challenge by promoting and strengthening farmer-based breeding and conservation programs; keeping genetic diversity a top priority; conducting research on the "climate-ready" genes and suspending their patents; and, by facilitating an exchange of information between farmers and eliminating current restrictions on access to germplasm.

Conclusion

The available literature on agriculture, trade and climate change lacks clear long-term solutions. Increasing demand for energy-intensive foods is also increasing the volume of agricultural commodities in global trade. A continued emphasis must be placed on the ways in which trade-related greenhouse gas emissions from processes such as transportation and packaging can be reduced. Ultimately, governments and policymakers should pay more attention to the direct and indirect emissions produced by export-oriented agriculture such as production methods, packaging, storage and transportation.

Resources

Agriculture

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