Chapter 7

Environmental Issues

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In the United States, legislation requiring formal environmental assessments of certain physical projects dates back 30 years. Within the last decade, nongovernmental organizations (NGOs) and other stakeholders have been calling for an extension of these environmental assessments to trade agreements (WWF, 2001). The goal of this chapter is to discuss the economics of trade and environment links, discuss environmental issues in the Free Trade Area of the Americas, provide a review of existing literature on the environmental effects of agricultural trade liberalization, and quantify the possible environmental effects of an FTAA on U.S. agricultural areas. This chapter does not represent an official environmental review under U.S. Executive Order 13141, which mandates that the environmental impacts of trade agreements be evaluated.

The first relatively in-depth environmental assessment of a free trade agreement, was the U.S.-Chile Free Trade Agreement (FTA) (USTR, undated). However, that assessment of U.S. environmental effects of agricultural trade liberalization was conducted in a qualitative manner. The assessment's judgment that these environmental impacts in the U.S. will be small is primarily based on the fact that U.S. agricultural exports to Chile are, and will continue to be, a small fraction of total U.S. exports. While a qualitative analysis was sufficient in the U.S.-Chile FTA case, many interest groups may desire a more rigorous analysis for trade agreements that may alter trade flows significantly.

Although the discussion in this chapter focuses on effects in the United States, the environmental impact of trade liberalization, and the assessments thereof, are of global interest. For instance, paragraphs 6 and 31-33 of the ministerial declaration of the Fourth World Trade Organization Ministerial Conference held in Doha, Qatar in November 2001 address trade and environment issues. These include "the efforts by members to conduct national environmental assessments of trade policies on a voluntary basis."[1]

The Environmental Impact of Trade Liberalization

What are the short- and long-run environmental outcomes of liberalization? Such outcomes may be positive (decreased environmental damage) or negative (increased environmental damage). Both Anderson (1992) and Lopez (1994) find that if countries do not have effective environmental policies in place, the environmental effects of freer trade can be negative. On the other hand, if such policies are in place, freer trade will generally increase total benefits to society (Anderson, 1992). As an aid to understanding the possible outcomes and their causes, it can be useful to sort the environmental impact of trade liberalization into three general categories of effects—scale, technique, and composition effects (Cole, Rayner, and Bates, 1998):

- *Scale Effect*. Empirical evidence has long linked open economies to economic growth (Edwards, 1992; Harrison, 1996). Increased output and scale of production due to trade liberalization, however, may generate additional pollution emissions and accelerate the depletion of natural resources (outcome: likely to be negative).

[1] See http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_e.htm for text of the declaration.

- *Technique Effect*. All else being equal, increasing per capita income due to liberalization tends to result in calls for increased regulation mandating cleaner technologies. Trade liberalization thus may have a technique effect as producers alter production methods to adopt cleaner production technologies (outcome: positive). In addition to this wealth-driven effect, market-driven technological change reduces the ratio of inputs to outputs, and re-engineers production processes so as to minimize waste (outcome: likely to be positive).

- *Composition Effect*. Trade liberalization may also affect the composition of output produced in an economy, as resources formerly devoted to inefficient protected industries, which are frequently pollution-intensive, will be utilized elsewhere according to the notion of comparative advantage (outcome: uncertain).

These three effects may interact to create an inverted-U relationship between income and pollution, although it is not at all clear how robust this relationship is (Dasgupta et al., 2002). Named in honor of Simon Kuznets, who proposed a similarly shaped relationship between income and income inequality, this hypothetical relationship is known as the environmental Kuznets curve (EKC) (Dasgupta et al., 2002; World Bank, 1999). The argument is that when a country develops from an initially low level of income, the scale effect dominates, as there is increased demand for all inputs, including the use of the environment as a sink (disposal site) for waste. Rising incomes, however, increase the willingness to pay for environmental amenities. Regulations are enacted, forcing a shift to cleaner production processes, as the technique effect reduces harmful emissions and environmental damage. As resources are shifted out of protected polluting industries and rising incomes shift preferences to cleaner goods, the composition and technique effects eventually dominate the scale effect. See Nimon, Cooper, and Smith (2002) for a more detailed discussion of these concepts.

Agricultural production can both enhance and degrade the environment. Agriculture provides rural landscape amenities and wildlife habitat, but also has resulted in soil erosion, nutrient and pesticide runoff, and the loss of wetlands. Agriculture is likely the leading source of water quality impairment of rivers and lakes in the United States (U.S. EPA, 1998). If agricultural trade liberalization increases total production in the United States then in parallel, environmental degradation could increase. However, at the same time, the loss in rural amenities in some regions (through conversion of agricultural land to other uses) could slow down. Mitigating the increasing degradation associated with scale effects could be the increasing adoption of environmentally benign farm management practices in less developed regions as their incomes increase. Certainly there will be regional shifts in levels, as well as types, of environmental externalities as comparative advantage produces geographic redistribution of agricultural production.

The relative importance of types of agricultural production methods may differ according to a country's level of per capita income. For example, the prevalence of *extensive* methods of agricultural production, in which output is increased by expanding the area planted, possibly to marginal lands, may be greater in poorer countries. In contrast, higher-income countries tend to be more likely to employ *intensive* methods, in which output is increased by expanding the use of inputs other than land.

Extensive and intensive methods are associated with different types of externalities. For example, soil erosion and deforestation may be relatively more prevalent externalities for extensive agriculture while nutrient and pesticide runoff may be relatively more prevalent under intensive agricultural practices (Wood et al., 2000). Agricultural trade liberalization may affect the overall level of environmental degradation, but it may also cause shifts between types of effects.

Only a few empirical studies specifically examine the environmental effects of agricultural trade liberalization, and even fewer studies focus on the FTAA countries. Some research has been conducted on Organization for Economic Cooperation and Development (OECD) countries and a few studies have been done on NAFTA countries (United States, Mexico, and Canada). As these three countries will account for a large portion of the amount traded with in the FTAA, this research does provide some insights. However, taken as a whole, the results of these studies are inconclusive. See Nimon, Cooper, and Smith (2002) for a discussion of these studies.

Environmental Impact on U.S. Agricultural Areas

Regarding the change in U.S. agricultural output as a result of trade liberalization under an FTAA, the production changes are quite small, so it would be reasonable to expect that the environmental effects will be small as well. However, there are still several justifications for conducting an empirical analysis of the environmental effects. One is to confirm that these effects will indeed be small. Secondly, even though the overall effects may be small, they may hide some notable regional effects. Finally, it can serve as a model for analysis of the environmental impacts of future trade agreements.

In this section, we empirically analyze the environmental effects on the United States of estimated agricultural production changes associated with the trade liberalization scenario.[2] The empirical framework used is the U.S. Regional Agricultural Model (USMP, see appendix 7-1 for further discussion). USMP simulates how changes in various farm policies (e.g., those related to commodity production, resource use, the environment, and trade), commodity market conditions, and agricultural sector technologies will affect regional commodity supplies, commodity prices, commodity demands, farm input use, farm income, government expenditures, participation in farm programs, and various indicators of environmental quality.[3] The USMP model, in addition to scale effects, allows for some composition effects such as changing crop mix and technology effects such as changing fertilizer application rates and tillage practices, in response to trade shocks, although these are expected to be small given the small predicted changes in production associated with the FTAA.[4]

Among the primary environmental impacts that traditionally tend to be of interest in agriculture are measures of soil erosion and nitrogen and phosphorus contamination (see appendix 7-1). As the current version of USMP has 24 environmental indicators relating primarily to these impacts,

[2] U.S. agricultural production impacts of the FTAA are reported in the chapter on trade and welfare effects of the FTAA, in this report.

[3] USMP and the MTED model use somewhat different aggregations for the output categories. Appendix 7-2 maps the MTED output categories to the closest related USMP output categories. MTED's fruit and vegetable and sugar categories have no counterpart in USMP, and hence are not considered here.

[4] The state-of-the-art approach for quantitative national level analysis across multiple commodities of the environmental impacts of a trade agreement would be through multiple commodity partial equilibrium (PE) models (a simplified model of the economy that presumes no income effects due to price changes), such as USMP, or through multisector computable general equilibrium models (a model which simultaneously represent all the industries in a national economy, or even in all of the world's economies), such as ERS' Future Agricultural Resources Model (FARM) model (USTR, 2000). To the best of the authors' knowledge, the analysis presented in this chapter is the only quantitative national level analysis across a reasonably comprehensive set of agricultural commodities of several environmental impacts of an agricultural trade agreement. Other comprehensive analyses appear to have been performed for several countries utilizing ad hoc approaches (e.g., UNEP, 2001). In the American hemisphere, Agriculture Canada's Canadian Regional Agricultural Model, a PE model similar in scope to USMP, could in principle be used for an environmental assessment of a trade agreement. OECD (2000) provides an overview of methodologies for assessing the environmental effects of trade liberalization agreements.

only a small subset can be presented here; the focus in this presentation is on the indicators in USMP that may be the most direct measure of environmental implications beyond the edge of the field. These indicators are nitrogen loss to water and to the atmosphere, phosphorous loss to water, and sheet-, rill-, and wind-related soil erosion.

As is evident from table 7-1, the total national level impacts (last column) are minimal, as would be expected given the small changes in production. Nationwide in the United States, the FTAA is predicted to lead to small environmental benefits in terms of soil erosion and water pollution from nitrogen and phosphorus, with reductions of less than 0.2 percent of baseline values, and small environmental costs in terms of air pollution from nitrogen, with increases of less than 0.1 percent of baseline values. However, the totals do mask some larger, but still relatively small changes at the regional level. For instance, while soil erosion decreases nationwide, it does increase slightly in some regions, and while air pollution from nitrogen increases nationwide, it does decrease in some regions. It is important to consider the change in the actual levels in conjunction with the percentage changes as some of the larger percentage changes (e.g., the 3.9 percent and 2.9 percent increase nitrogen loss to surface and ground water and to atmosphere, respectively, in the Pacific region) represent changes from relatively small baselines. The higher percentage changes in the Pacific region relative to the other regions may be due to USMP predicting that most of the increase in U.S. rice production will occur there. Given the spatial reallocations in production of a given crop as well as the shifts from one crop to another as predicted by USMP, both decreases and increases in environmental indicators are evident in the tables. The production changes are too small for changes in environmental indicators to be ascribed to changes in input application rates. At any rate, an in-depth analysis of the specific model results is not a productive exercise as the changes in the indicators are likely smaller than the range of inaccuracy in the results.

Placing monetary values on these environmental impacts (see appendix 7-1) is useful for assessing the costs and benefits of agri-environmental policies. However, not only are researchers still in the early stages of assessing the environmental impacts of agricultural activities beyond the edge of the field, relatively few attempts have yet been made to assign monetary values to these impacts. As is evident from table 7-2, the total national level effects (last column) are minimal, as would be expected given the small changes in production. Offsite damages due to nitrogen loss to surface water (table 7-2) increase by $500,000 (with most of that increase being attributable to changes in the Pacific region), while offsite damages due to sheet and rill erosion decrease by $2.4 million. However, the totals do mask some larger, but still relatively small changes at the regional level. The net increase in the cost of loss of soil productivity due to erosion (i.e., soil depreciation) is minimal.

Additional Trade and Environmental Concerns

This section provides brief overviews of trade and environment issues that cannot be addressed by our empirical analysis, but that may be of some concern within the FTAA region. These issues include the creation of “pollution havens,” the introduction of harmful nonindigenous species, the environmental impacts of sugar and horticultural production, and transboundary environmental issues.

One concern regarding trade liberalization frequently expressed by governments is that this process creates an incentive for countries to lure capital by lowering environmental standards, which in turn may cause other countries to respond in kind. This process is commonly referred to as the “race to the bottom” hypothesis. Little evidence has been found for this effect in practice (e.g., Fredriksson and Millimet, 2000; Xu, 1999), and the concept appears to apply more to manufacturing than to agriculture. A related concept is that of the "pollution haven" hypothesis, which says that some countries with low demand for environmental quality will adopt lax environmental standards that attract investment and export pollution-intensive goods. Countries with a high demand for environmental quality will adopt high standards and import pollution-intensive goods.

Another concern is that increased agricultural trade among FTAA countries may increase the risk of introducing invasive agricultural pest species and diseases to new countries and new geographic areas. The costs of invasive pests can be significant, in terms of increased production costs, lost output, reduced access to foreign markets, and ecosystem damage. However, the difficulty in

Table 7-1—Change in physical environmental indicators resulting from agricultural trade changes under FTAA (from USMP)

Indicator		North East	Lake States	Corn Belt	North Plains	Appa-lachia	South East	Delta States	South Plains	Moun-tain	Paci-fic	U.S. Total[1]
Nitrogen						*Million tons*						
Loss to atmosphere	Base	0.020	0.103	0.600	0.283	0.058	0.018	0.077	0.281	0.060	0.060	1.559
	FTAA Scenario	0.020	0.103	0.600	0.283	0.058	0.018	0.077	0.279	0.060	0.061	1.559
	Change	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.002	0.000
	% Change[2]	-0.195	0.021	0.024	0.136	-0.122	-0.245	-0.350	-0.541	0.340	2.889	0.034
Loss to water	Base	0.237	0.460	1.670	1.039	0.455	0.164	0.472	0.631	0.165	0.096	5.388
	FTAA Scenario	0.237	0.460	1.670	1.040	0.455	0.164	0.470	0.628	0.165	0.099	5.386
	Change	0.000	0.000	0.000	0.000	0.000	0.000	-0.002	-0.003	0.000	0.004	-0.003
	% Change	-0.309	0.018	-0.032	0.047	-0.176	-0.154	-0.327	-0.484	-0.066	3.933	-0.050
Phosphorous						*Million tons*						
Loss to water	Base	0.038	0.038	0.180	0.124	0.053	0.023	0.046	0.060	0.020	0.003	0.585
	FTAA Scenario	0.038	0.038	0.180	0.124	0.053	0.023	0.046	0.060	0.020	0.003	0.584
	Change	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	% Change	-0.337	-0.135	-0.053	0.053	-0.179	-0.193	-0.416	-0.771	0.362	0.113	-0.159
Soil erosion						*Million tons*						
Sheet & rill erosion	Base	47.542	97.992	419.721	169.302	68.660	46.252	83.480	82.284	62.300	41.033	1118.566
	FTAA Scenari	47.504	98.114	419.713	169.276	68.633	46.174	83.140	82.062	62.445	40.552	1117.614
	Change	-0.038	0.122	-0.008	-0.025	-0.027	-0.078	-0.340	-0.222	0.145	-0.481	-0.952
	% Change	-0.081	0.125	-0.002	-0.015	-0.039	-0.168	-0.407	-0.270	0.232	-1.172	-0.085
Wind erosion	Base	0.948	119.919	41.466	136.953	0.498	0.000	0.000	199.336	162.493	28.570	690.184
	FTAA Scenario	0.950	120.216	41.431	138.085	0.498	0.000	0.000	196.491	163.215	27.957	688.843
	Change	0.002	0.297	-0.035	1.132	0.000	0.000	0.000	-2.846	0.722	-0.613	-1.340
	% Change	0.235	0.248	-0.084	0.827	0.108	0.000	0.000	-1.428	0.444	-2.147	-0.194
Total soil erosion	Base	48.490	217.911	461.187	306.255	69.157	46.252	83.480	281.620	224.794	69.604	1808.750
	FTAA Scenario	48.454	218.330	461.144	307.361	69.131	46.174	83.140	278.553	225.660	68.509	1806.457
	Change	-0.036	0.419	-0.043	1.107	-0.026	-0.078	-0.340	-3.068	0.866	-1.095	-2.292
	% Change	-0.074	0.192	-0.009	0.361	-0.038	-0.168	-0.407	-1.089	0.385	-1.573	-0.127

[1]Due to rounding of the numbers necessary for presentation in the tables, the regional subtotals may not add up to the values in the U.S. total column. Negative numbers denote reduced environmental damage relative to baseline; positive numbers denote on increase in damage.
[2]Due to rounding of the numbers necessary for presentation in the tables, the '% Change' numbers may be nonzero even though the 'change' values may be zero.
Source: USMP.

measuring these costs makes it extremely challenging to determine what standards should be set for import screening. A standard of "zero entry" would be prohibitively expensive, while standards that are too lax could expose agricultural producers, consumers, and the natural environment to unacceptable risks. To safeguard against invasive pests, USDA's Animal and Plant Health Inspection Service (APHIS) operates a variety of point-of-entry, quarantine, and foreign pest control programs and activities. The important policy question then is whether current standards and resources devoted to these programs and activities are appropriate given the increasing level of trade expected among the FTAA countries, and hence, expected risks from trade.

Thirdly, among the products whose environmental impacts cannot be modeled by USMP is sugar, either from sugarcane or sugar beets, given that these commodities are not included in the model. One significant agri-environmental issue in the United States involves the Florida Everglades Agricultural Area (EAA), where sugarcane production has contributed to loss of water retention capacity of the land base, a loss which has negative environmental consequences for the broader Florida Everglades watershed. The lowering of natural water tables on drained cropland has accelerated oxidation and decomposition of organic peat soils in the EAA, resulting in wide scale land-elevation declines due to soil subsidence. Soil subsidence and related loss in water retention capacity in soil are a serious concerns in the EAA (Aillery, Shoemaker, and Caswell, 2001). Such losses increase excessive floodwater discharges to the Everglades marsh, decrease dry-season water flows to the marsh and to Florida Bay, and increase reliance on lake management for water storage purposes. Hence, a decrease in crop production in the EAA could potentially increase water retention capacity. Aillery, Shoemaker, and Caswell (2001) found that a 10 percent (20 percent) reduction in the domestic price of raw sugar could increase EAA water retention capacity by 10,000 (80,000) acre-feet annually over baselines levels of 46,000 acre-feet annually, attributable primarily to an acceleration of cropland retirement. The magnitude of this change cannot be directly compared to the environmental effects estimated for other commodities by USMP as

Table 7-2—Monetized value of selected environmental indicators resulting from agricultural trade changes under FTAA (million $)

Indicator		North East	Lake States	Corn Belt	North Plains	Appalachia	South East	Delta States	South Plains	Mountain	Pacific	U.S. Total[1]
Nitrogen loss to surface water damage												
Offsite $ damages	Base	29.0	0.7	5.4	0.6	39.4	34.5	16.2	23.8	2.1	16.0	167.7
	FTAA scenario	29.0	0.7	5.4	0.6	39.4	34.5	16.1	23.8	2.1	16.6	168.1
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.5
	% Change[2]	-0.1	-0.1	-0.1	0.0	0.0	-0.1	-0.3	0.1	-0.4	3.7	0.3
Sheet and rill soil erosion damages and soil depreciation												
Offsite $ Sheet & rill damages	Base	642.8	576.3	1029.0	234.2	222.6	176.3	297.4	307.7	96.5	127.5	3710.3
	FTAA scenario	642.5	577.5	1028.9	234.1	222.5	176.0	296.3	307.0	96.7	126.4	3707.8
	Change	-0.3	1.2	-0.1	-0.1	-0.1	-0.3	-1.2	-0.6	0.2	-1.1	-2.4
	% Change	0.0	0.2	0.0	0.0	0.0	-0.2	-0.4	-0.2	0.2	-0.9	-0.1
Soil $ depreciation	Base	14.4	12.9	77.7	123.8	40.5	1.3	51.5	1.9	9.0	36.8	369.9
	FTAA scenario	14.5	13.2	77.9	123.9	40.6	1.4	51.0	2.0	9.0	36.4	369.9
	Change	0.1	0.2	0.3	0.1	0.1	0.0	-0.4	0.0	0.0	-0.4	0.1
	% Change	0.5	1.9	0.3	0.1	0.3	1.2	-0.9	2.4	0.3	-1.0	0.0

[1]Due to rounding of the numbers necessary for presentation in the tables, the regional subtotals may not add up to the values in the U.S. total column. Negative numbers denote reduced environmental damage relative to baseline; positive numbers denote on increase in damage.
[2]Due to rounding of the numbers necessary for presentation in the tables, the '% Change' numbers may be nonzero even though the 'change' values may be zero.
Source: USMP.

implications of water retention capacities for the environmental indicators in USMP (the level of decrease in erosion, for instance) are unclear. Of course, the long-term environmental consequences of the movement of land out of sugar production depend on the alternative land uses. For instance, if the land is developed into urban uses, the negative environmental consequences could be greater than under sugarcane production.

In addition to sugar, the USMP model does not contain horticultural products, and hence, it cannot assess the environmental impacts of changes in their production. Horticultural production tends to be associated with high levels of pesticide and herbicide applications. However, with a predicted production increase of 0.1 percent due to the FTAA, the environmental consequences are likely to be small.

Fourthly, in terms of the transboundary environmental implications of agriculture under FTAA, the risk of introducing harmful nonindigenous species (HNIS) is likely to be the main area of direct concern to the United States, since additional transboundary implications for air and water pollution associated with the FTAA over those associated with NAFTA are probably small. One would expect that increased trade with countries not on the U.S. border will have minimal transboundary effects on air and water quality in the United States. Of course, this assumption presumes that trade between NAFTA countries will not greatly increase with an increase in the free trade area. On the other hand, due to the FTAA, trade between NAFTA countries in some commodities could decrease, potentially leading to decreasing transboundary effects on air and water quality between those countries. Finally, the expansion of trade within North America will likely be associated with increased traffic, congestion, and air pollution along certain transportation corridors.

Conclusion

Agricultural trade liberalization under the FTAA is likely to affect the environment in a variety of ways, some positive and others negative. However, our modeling results show the effects on selected U.S. agri-environmental indicators to be small, which should be expected given the small predicted changes in U.S. production associated with the FTAA. Longer run effects are ambiguous, especially given the scale, technique, and composition effects that can occur outside the static time reference of the model used here. The FTAA likely will produce composition effects associated with the process of liberalization, as price incentives concentrate industries in areas possessing a comparative advantage. Crop substitution, technological modernization, importation of invasive agricultural pest species, increased use of transportation, and the development of environmentally friendly products are other examples in which the expanded agricultural trade associated with the FTAA could have positive or negative effects on the environment.

In principle, assuming that increased trade contributes to rising future incomes in the hemisphere, then the increasing willingness to pay for environmental amenities could translate in the long run into increasingly stringent domestic environmental regulations and enforcement. This, at least, is the case made by the environmental Kuznets curve (EKC) which suggests that beyond a certain income level at least, increasing income is associated with decreasing negative environmental consequences, given that increasing income results in the increasing demands for environmental services. Growth in GDP in the Caribbean region and several South American countries attributable to the trade liberalization under the FTAA could be significant. Income increases in these regions or countries may result in their increasing willingness to pay in those regions for environmental amenities. Nonetheless, it is unknown whether or not such an increase in incomes will be sufficient to induce increasingly stringent domestic environmental regulations and enforcement related to their agriculture sectors.

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