Expanding Agricultural Trade and the Environment: Complementary or Conflicting?

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As global economic integration proceeds, and as domestic and international environmental priorities broaden, increasing concern has focused on how trade might affect the environment—and how environmental programs might affect trade. Whether the expanding trade and environmental forces can work together, or whether they necessarily conflict, has been a matter of prolonged debate (10,18). In fact, in the space of 20 years, the scope of the debate has widened from economic and environmental issues under U.S. jurisdiction to include international commerce and global environmental questions. The simple label "trade and environment" consequently covers a large, complicated, and ever-growing web of topics that are crucially important to legal, economic, and environmental interests alike (23,64).

Chief among the most striking developments has been a steady rise in world trade. The nominal value of world agricultural trade, for example, has risen fivefold since 1970, from about $40 billion to more than $200 billion (86). The North American Free Trade Agreement (NAFTA) and the Uruguay Round Agreements (URA) of the General Agreement on Tariffs and Trade (GATT) will further fuel that trade. Other regional agreements designed to lower trade barriers, such as the Mercado Comundel Sur (MERCURSOR) pact among Argentina, Brazil, Uruguay, and Paraguay, will likely do the same.

Coupled with rising production for domestic consumers, increases in agricultural trade placed new pressures on the U.S. environment in the 1970s and early 1980s. As they produced more, farmers used more machinery, pesticides, and fertilizers, and irrigated more acres. Technological advances made it less costly to convert prairies, wetlands, and other areas to farmland. As a re-

sult, all levels of government introduced more environmental management initiatives affecting agriculture. (See chapter 4 and also chapter 6, which documents similar trends in national agroenvironmental programs among selected trading partners and competitors.) While the pressures on input use abated slightly in the late 1980s and early 1990s, the potential exists for a recurrence with trade expansion.

Multilateral and global environmental initiatives have multiplied as well. Since the early 1970s, both developed and developing nations have been increasingly active, and have sought cooperation on transboundary environmental problems such as ozone depletion, endangered wildlife, and greenhouse gases. Several major international conferences have marked the expanding multilateral environmental interests—U.N. Stockholm Conference (1972) leading to the United Nations Environment Program (UNEP), the 1987 World Commission on Environment and Development addressing sustainable development, and the 1992 U.N. Conference on Environment and Development held in Rio de Janeiro, Brazil, producing climate change and biodiversity conventions.

Such conferences and other fora have devoted considerable attention to trade and environment issues, but definitive answers to fundamental questions remain elusive. How and how much will expanded trade ultimately affect national and international environments? Will domestic and multilateral environmental protection measures conflict with liberalized trade? Or are the two forces basically complementary?

It is difficult to answer these questions definitively because research on them is immature (78). Imperfect knowledge of how new global trade regimes, new environmental management agreements, and the markets for traded goods operate—and, ultimately, of how the environment is related to agriculture—have made the agricultural trade/environment debate to this point primarily a conceptual exercise. Most analyses have focused on defining terms and potential complementarities and conflicts, instead of providing direct, quantifiable links between agricultural trade and environmental conditions, or between environmental management and trade flows. A growing number of quantitative studies are analyzing the size and nature of the domestic and international linkages (for example, 39,83), but much more effort is required.

This chapter examines what is currently known about how agricultural trade and the environment affect each other in the United States—and advances hypotheses about their future relationship. International developments that complement or work against national interests are also covered. For the purposes of this chapter, the term "environment" refers to natural resources such as water, soil, wildlife, and so forth. (See chapter 4.) Food safety questions are, for the most part, not addressed.

Pearson lucidly defines four trade and environment policy issues that are the collective focus of this chapter. First is the effect of environmental regulation on trade. According to some schools of thought, costly environmental regulations can force domestic producers to lose export markets or move overseas. As this chapter will demonstrate, however, studies of nonagricultural industries indicate that exports have been little affected and that overseas migration has not been significant overall. Because the U.S. agricultural sector is subject, for the most part, to voluntary conservation and environmental programs implemented with subsidies, the overall effects of these programs on trade flows and firm location should be negligible as well. Moreover, many competitors abroad must comply with similar agroenvironmental programs. (See chapter 6.)

On the other hand, some agricultural sectors may suffer from environmental regulations in the short term. A case in point is the fruit and vegetable sector, which relies on the pesticide methyl bromide for crop production, but also to treat food exports and imports. Methyl bromide depletes the ozone layer, however, and its use is to be phased out by 2001 under the Montreal Protocol on Substances that Deplete the Ozone Layer and the U.S. Clean Air Act. Clearly then, the effects of a broadening environmental agenda on trade will depend on the specific types of environmental programs

implemented. Complementary research and technology developments targeted to achieve environmental and trade objectives simultaneously are a sensible option to reduce conflicts. (See chapter 4.)

Second to be considered is the role of product standards. National product standards, such as tolerance levels for pesticide residues, serve as nontariff measures to screen certain imports. The URA established new health and safety, as well as "technical barriers to trade," codes that address this issue. Among other things, the codes specify that product standards should be based on science and restrict trade no more than necessary to achieve a nation's desired level of protection. However, certain agricultural product standards are crucial to addressing environmental ills. For example, keeping harmful nonindigenous species (HNIS) out of the United States (now a major environmental concern) depends primarily on enforcing measures covered by the codes, such as quarantines. It is not clear whether these kinds of standards will come under fire as unjustifiable barriers to trade. If they do, only future rulings by the World Trade Organization (WTO), the trade community's successor to GATT, will determine their status.

The third major topic to be addressed in this chapter is the effect of trade liberalization and expansion on the environment. NAFTA and the URA do not require the United States to reduce current commodity program payments affecting production, or to "decouple" (i.e., separate) the payments from levels of production. Thus, potential environmental changes from commodity program reform should not be expected. Shifts in agricultural production that result from the new trade agreements will likely cause little overall change in U.S. environmental conditions. Indeed, environmental conditions may improve in some areas, as imports displace environmentally damaging domestic production. Certain other areas—such as border zones, where trading could flourish—may come under increased environmental stress, and HNIS, such as invasive weeds on rangelands, could pose new commercial and environmental risks as they enter through trade pathways. Controlling domestic environmental quality hinges principally on how U.S. agroenvironmental programs are run. These programs are not, at this writing, wholly effective: they do not offer comprehensive and enduring environmental coverage, or incentives for complementary technology research and development.

Expanding agricultural trade may pose special risks for developing countries that have inadequate environmental programs and would respond to higher world prices by producing more products for export. Pressures on transboundary and global environmental resources of interest to the United States, such as border water resources and habitats for migratory wildlife, may result in significant costs. The present patchwork of multilateral environmental agreements does not appear able to systematically address this kind of dilemma.

Fourth, and finally, this chapter looks at how trade measures are used to meet international environmental objectives. NAFTA and the URA were the first trade agreements to incorporate significant environmental provisions, but the ultimate efficacy of those provisions depends on future political dynamics. In contrast, the use of trade measures in a limited number of international environmental agreements has been demonstrably effective. Current WTO rules do not specifically address the use of international environmental trade measures, and therefore clear guidelines are not at hand. Further, critical questions about the conditions justifying unilateral or multilateral actions and extraterritorial objectives remain unanswered. Such "offensive" environmental trade measures have not been widely applied to agriculture, although they may be in the future. Clear rules promulgated by the WTO would assist environmental and trade efficiency. An international organization responsible for global environmental management could work with the WTO to ensure that both global trade and environment needs receive appropriate consideration.

Based on careful examination of the issues, it is OTA's conclusion that efforts to expand agricultural trade and upgrade environmental quality can complement each other, if appropriate envi-

For the first time in history the signing of a trade pact-the North American Free Trade Agreement-was accompanied by an environmental side-agreement to pursue regional environmental protection.

ronmental management programs are in place and are properly run. Unfortunately, current programs at domestic and international levels do not ensure that this will happen. Reconstitution and retargeting of environmental programs; more funding for technology research and development that aids both trade and environmental quality; introduction of new institutions; and greater levels of multilateral cooperation are essential.

EFFECTS OF ENVIRONMENTAL PROGRAMS ON TRADE COMPETITIVENESS

As environmental concerns escalated in the early 1970s, the trade community began to worry that a country's efforts to promulgate environmental legislation might impose high compliance costs on its industries-and so damage their ability to compete in international markets (58). Further, some argued that if the compliance costs were subsidized by governments, environmental resources would continue to be undervalued and squandered. The Organization for Economic Cooperation and Development (OECD) addressed the issue back in 1972, when it published its ***Guiding Principles Concerning the International Economic Aspects of Environmental Policies.*** This document marked the international debut of the "polluter-pays principle" (PPP), which, simply stated, requires polluters in the private sector, and not governments, to pay for the environmental degradation they cause.

The PPP reflects a sound trade and environmental policy principle: unless private parties pay the full amount it costs them to produce goods (and eventually pass those costs onto consumers through higher prices), environmental and other resources will be misused and trade will be ineffi-

cient (3,56). The actual costs of environmental degradation are usually not included in the prices producers pay or in the prices they charge to consumers because, in economic terms, property rights for many environmental resources are undefined or work poorly (57). Essentially, the full costs of using environmental resources in agricultural production—or of inadvertently degrading them through agricultural practices—are left out of the market prices for agricultural goods. A classic example of this dilemma is field runoff carrying sediment, fertilizer, or pesticides, which pollutes water downstream. The cost of the pollution is not paid by the polluter, and so he or she does not incorporate that cost into the price of his or her products. A related principle implies that there will be insufficient positive environmental services unless the parties that generate those services are subsidized. An agricultural example might be compensating farmers for environmental benefits that also accrue to other parties, such as providing habitat for migratory wildlife.

If significant environmental problems stemming from freer trade are ignored by markets, then freer trade does not necessarily guarantee that a society's welfare will improve—that is, that a society will be on the whole better off than it was before it liberalized trade (3). Prices that do not take all costs into account also convey incomplete signals to private and public environmental technology research and development. (See chapter 4.) Theoretically, appropriately targeted policies that do take external environmental costs (and benefits) into account could lead to gains in both trade and environmental quality (3). Unfortunately, accurate and comprehensive "environmental" or "natural resource accounting," which would assess those costs and benefits, is not yet possible (9).

For governments not to levy an environmental charge under the PPP means that parties other than the polluter lose income or otherwise have to pay a "significant" cost for what the polluter has done. In some cases, the environmental consequences of agricultural production may not result in "significant" external costs. In others, farmers may have economic incentives to address the environmental problems they have caused, because the damages directly affect their assets and/or profits. Losses of soil productivity due to erosion fall into this category. Clearly, a first step in remedying environmental problems, whether they are generated by trade or domestic sources, is to determine what kinds of activities result in significant external effects, whether negative or positive.

Governments use regulatory standards, taxes, subsidies, and other policy instruments to "pay" for negative or positive environmental effects. But public subsidies of pollution abatement costs, for example, violate the PPP and have been discouraged by the Organization for Economic Cooperation and Development (OECD) and GATT accords.[1] Despite such arguments against subsidies, they remain the dominant approach in U.S. agroenvironmental management programs. (See chapter 4.) Other industrial countries have been similarly disinclined to factor the PPP into their agroenvironmental policies (76). However, the use of environmental subsidies in agriculture is expanding, and could pose future problems.

Impacts on Agriculture

Like producers in other industries, farmers fear that the costs of complying with environmental programs will significantly constrain their ability to compete with foreign firms. For agriculture, such diminished competitiveness has not been a major issue until now, because most conservation and environmental programs have been voluntary and implemented with subsidies, or have been a side requirement of commodity program subsidies. (See chapter 4.) There are currently regulations pertaining to pesticide registration, water runoff from confined animal operations, and land use controls to protect endangered species. Also,

[1] Because not all environmental effects are counted in the market, it is argued, polluters, in effect, receive an implicit subsidy (54,71).

potential regulations may be used to improve the water quality of coastal zones. But the prospect of more, and more extensive, regulations has generated worries about their impacts on competitiveness. At this writing, the net costs of environmental programs affecting U.S. agriculture, including subsidies, regulatory expense, and private benefits, are unknown. Some studies have attempted estimates, but their data are incomplete (29).

Because there is little compliance cost information available for agriculture, it is useful to look at how trade in other U.S. industries has been affected by the environmental regulations that they have been forced to follow for more than 20 years. The evidence indicates that pollution abatement costs (PACs) do not have a large influence on overall trade patterns, nor do they, on the whole, induce industries to migrate overseas (19,74,80). Some sectors with relatively high PACs, such as chemical manufacturers, may be disadvantaged because of the kinds of pollution they produce and/or the kinds of regulations they face. Still, such cost differences should be compared with the environmental benefits they create to determine their benefit-cost consequences for the nation.

Whether agriculture is or will become a sector with high PACs is, as suggested above, not clear. Data are incomplete, and the provisions of future environmental programs are unknown. Current environmental regulations, as discussed in chapter 4, do not engender large overall costs for agriculture that negatively affect trade. More likely, if trade is adversely affected, it is because current agroenvironmental programs predominantly use subsidy approaches that do not conform to the PPP. For the United States, the magnitude of subsidies have been small to date, about 4 percent of total product value, suggesting small overall effects on trade (76). However, those subsidies are not restricted in total by NAFTA or the URA, and are growing. The largest subsidy programs—acreage set-asides such as the Conservation Reserve Program (CRP), which restrict production—are those most likely to interfere with agricultural trade.

Although the overall effects may be negligible, specific sectors may suffer as the result of particular pollution problems and regulations. The methyl bromide controversy is an example that is often cited. Methyl bromide is a chemical used as a soil fumigant pesticide in the production of crops, and in the treatment of agricultural imports and exports. Methyl bromide also depletes ozone in the atmosphere, and its use will be phased out in the United States by 2001 under the Montreal Protocol and U.S. Clean Air Act. In the South, the production and/or export of cotton, tobacco, citrus fruits, and peanuts may be reduced if the use of methyl bromide is restricted (43). Forsythe and Evangelou (27) estimate that without methyl bromide, fresh fruits and vegetables imports would cost the United States $1.1 billion more over five years. This estimate is based on the short- and medium-term costs of substituting irradiation treatment for methyl bromide, and does not take into account any possible environmental benefits. Ferguson and Padula (26) estimate the economic costs of banning methyl bromide as a soil fumigant at $1 billion per year for producers and consumers. Their estimate does not incorporate the development of substitute technologies before the ban that might lower costs. The regional distribution of costs are uneven, concentrating in the southeastern states and California. Yarkin, et al. (92) estimate that California walnut growers would lose $9.9 million (or about 3 percent) of their gross returns in the short term from the phase-out. Long-run impacts again depend on the development of substitute treatments, and whether other countries follow the ban. The impacts of such bans generally tend to moderate in the longer run, as new technologies emerge to substitute for the restricted product.

Gauging impacts on future competitiveness requires details on the nature of new conservation and environmental programs. The discussion of agriculture's broadening environmental agenda in chapter 4 suggests that environmental management costs could rise appreciably, in particular for sectors that generate large amounts of very damaging wastes. Depending on the extent and nature of the management programs, U.S. agricultural competitiveness in world markets could be reduced—a hazard for all sectors subject to increas-

ing environmental compliance costs (80). Any loss in trade profits, however, should be weighed against environmental gains that accrue from the program requirements. Although the results pertain to an export competitor rather than to the United States, analyses by Lueck and by Halley empirically estimate that under some potential European Union (EU) agricultural nitrate reduction and water quality programs, EU food production and trade could decline. (See chapter 6 for a more detailed discussion of this topic.) In such an instance, the United States could gain some of that market—but it would have to consider all of the significant environmental effects stemming from expanded production to ensure a net benefit.

TRADE AND ENVIRONMENTAL EFFECTS OF PRODUCT STANDARDS

National product standards relating to human, animal, or plant health, and to the conservation of natural resources, can affect the ability of traded goods to enter foreign markets. Permissible pesticide residue levels, auto emissions technology requirements, and other standards are intended to treat the effects of using a product, whether of domestic or foreign origin. Such standards may be used legally under WTO rules[2] by the United States to regulate imported goods, or by foreign countries to control U.S. exports—but they must be applied uniformly to the product in question, whether imported or domestically produced, to avoid discrimination against foreign products. Thus, the WTO rules for product standards simultaneously protect U.S. agricultural exporters from unfair requirements in foreign markets and protect U.S. citizens against food, environmental, or other risks caused by imported goods.

During the early 1970s, concern centered on the potential for product standards to serve as nontariff barriers. Pearson notes that some individuals in the trade community have historically responded by advocating harmonization of standards whenever possible, to avoid barriers and reduce the high costs of selling in markets that each have different standards for exporters to meet. Devices such as the Codex Alimentarius Commission (which aims to harmonize global food and agricultural standards); GATT rules on health, safety, and other technical measures; and regional trade groups like the EU have facilitated harmonization. The potential benefits of harmonization include minimizing the use of product standards as trade barriers, as well as reducing the high costs of design, production, inventory, and information required to sell in a variety of markets with different standards (58). The potential costs of harmonization include less accommodation of countries' individual preferences and abilities across countries to achieve the standards and the transaction costs of negotiation (43). The balance between benefits and costs will determine the incentives to harmonize any particular set of standards.

Harmonizing natural-environment-related product standards may be more complicated than it is for health and safety standards, because of countries' diverse natural resource and social conditions. Some environmental groups have in fact challenged harmonization efforts, arguing they could lead the world's trading nations (all of which have different incomes, environmental concerns, natural resource endowments, abilities to assimilate pollution, and desired levels of protection) to adopt the lowest standards possible for the sake of uniformity. Little systematic evidence is available to analyze the potential for so-called downward harmonization. Esty, citing the Montreal Protocol's effective upward harmonization for phasing out CFCs, argues that just the op-

[2] Specifically, article XX provides for two categories of general exceptions related to the environment. Article XX(b) allows exceptions for measures "necessary to protect human, animal or plant life and health," and article XX(g) permits exceptions for measures "relating to the conservation of exhaustible natural resources." Any measures implemented under the exceptions must not be "applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade" (48).

posite may occur (23). But the strength of upward harmonization forces will likely vary according to each specific environmental problem, and its potential benefits and costs.

New Product Standards Codes

The URA approved new codes for health and safety (called sanitary and phytosanitary, or S&P), and for technical barriers to trade (TBT), both of which address the question of product standards. The S&P code permits a country to impose trade measures to protect human, animal, or plant life or health from risks arising from the spread of pests and disease, and from additives or contaminants found in human food, beverages, or feedstuffs.[3] Key provisions of the new agreement base measures on scientific principles; use international standards as minimums where they exist (thus achieving partial harmonization); preserve federal, state, and local governments' rights to set their preferred level of risk protection and standards; state a preference for least-trade-restrictive measures; avoid disguised restrictions on trade; and provide opportunities for governments to demonstrate equivalency of protection from different measures (e.g., chemical versus nonchemical treatments) (48).

In negotiating the S&P agreement, the United States focused primarily on two food safety issues: preventing foreign governments from using false criteria to limit U.S. food exports, and ensuring that high U.S. food safety standards could be maintained (48). However, the new S&P code offers the opportunity for the 123 signatory countries to use product standards to protect their natural environments as well. Although the S&P code does not require signatories to adopt existing international standards as minimums, it improves matters by integrating more science, requiring risk assessments, and permitting higher national standards to avoid downward harmonization (67).

The TBT agreement essentially defines the process for distinguishing legitimate uses of product standards, technical regulations, and conformity assessment procedures from efforts to use them as disguised barriers to trade. "The TBT agreement addresses the development and application of mandatory and voluntary product standards which affect trade, and the procedures used to determine whether a particular product meets a standard" (48). For example, a measure requiring that foreign automobiles be equipped with air pollution emissions equipment falls under the TBT code. Possible agriculture-related issues falling under the TBT code include food-packaging requirements for waste disposal purposes, food product labeling, and definitions of the ingredients and processes used in certain food products, such as "fresh" milk.

The TBT agreement ensures a URA signatory country's rights to protect human health or safety, animal or plant life or health, and the environment as legitimate objectives. Only environmental measures related to product standards, however, are covered. The TBT agreement does not, therefore, cover most measures under the Clean Water Act, Clean Air Act, or similar legislation. Key provisions of the agreement include nondiscrimination against imports, measures that do not restrict trade more than necessary, and measures that are established in a more transparent way (48). The agreement also promotes the use of international standards where they exist, but preserves the right of countries to enforce more stringent standards at the federal, state, or local levels if they choose. The latter provision also addresses fears that use of international standards could cause downward harmonization of U.S. standards. (NAFTA also ensures that countries have the right to set higher standards and encourages upward harmonization.)

[3] "S&P measures include a wide range of health protection and food safety measures, such as: quarantine procedures; food processes and production methods; meat slaughter and inspection rules; and procedures for the approval of food additives or for the establishment of pesticide residue tolerances" (48).

The principal thrust of the new S&P and TBT codes to be administered under the WTO is to reduce unjustified restriction of trade by product standards. In that respect, they are directly applicable to agricultural trade, but concern food safety more than natural environment issues. A well-known case is the EU's action to ban imports of beef raised with the aid of growth hormones. The prospects for more disputes of this kind are considerable, given the URA provisions that reduce other forms of border protection. Data detailing such actions related to agriculture have not been assembled systematically for the nation or for its trading partners. The sole recourse for judging the extent and degree of potential trade restriction affecting agriculture—whether for food safety or for natural environment reasons—is extrapolation from isolated cases. A recent survey of agricultural crops from the southern United States found that existing product standards (and environmental regulations) do not significantly hinder the region's competitiveness in international markets, with the exception of the forthcoming methyl bromide ban discussed above (43).

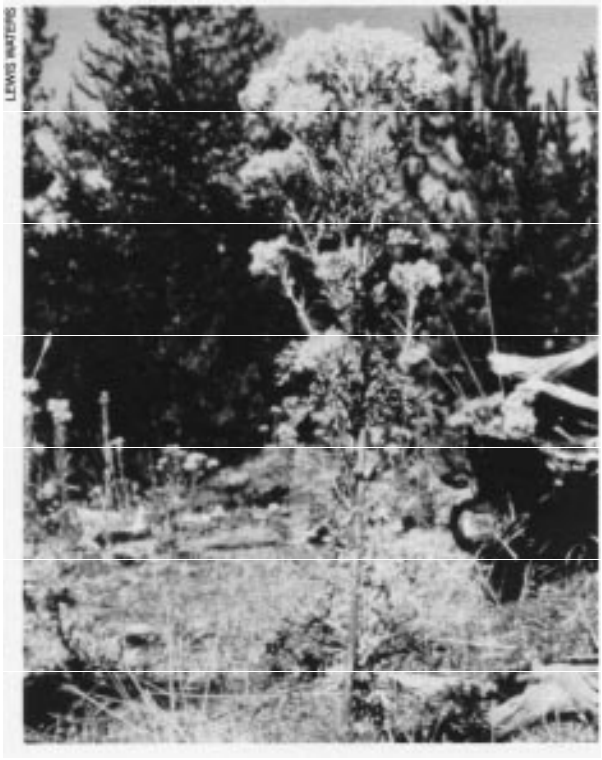
The new codes also provide a mechanism and rules to address environmental protection through product standards. The rules place the burden of proof on the country imposing trade measures for environmental purposes, thus forcing the country to defend its action as an article XX exception (23). The crucial test for environmental issues comes in whether WTO panels will approve product standards for environmental purposes, and under what conditions. Most cases relating to environmental matters that were brought before GATT panels in the past were either deemed not applicable to the exceptions code, or were not eligible for treatment as exceptions (78). There is consequently little evidence that the GATT processes have been an important venue for addressing trade-related environmental risks. Moreover, the panels that rule on such disputes have not included environmental scientists in the past, and have operated in closed sessions.

A review of key environment-related cases does not reveal a consistent set of principles for countries to use when planning to institute environmentally related product standards (23). As an illustration, an initial GATT dispute panel ruled that U.S. import restrictions against tuna caught by Mexican fishermen were illegal, because the environmental problem extended beyond U.S. borders. (See appendix II.) However, a subsequent dispute panel requested by the EU did not find such extraterritoriality a violation of the GATT rules (48). Perhaps the diversity of findings and lack of central principles should not be surprising, given the changing makeup of the panels and the different specifics of each case. Nonetheless, the United States plans to raise the scope of article XX exceptions related to the environment as a WTO agenda item (48). Clarifying the scope will help countries to makes decisions on domestic and international environmental issues. Also, the United States has urged the WTO to consider broader representation on environmental dispute panels, and to make the hearings and decisions more accessible to the public.

Harmful Nonindigenous Species

The role of nonindigenous species in U.S. agriculture has varied over time. Some introduced species, including soybeans, wheat, and cattle, have helped to create new agricultural industries, jobs, and wealth in the United States. But others have caused widespread and continuing damage. An estimated 50 to 75 percent of major U.S. weeds are nonindigenous and cause extensive damage to public and private lands; and 40 percent of the insect pests afflicting agriculture and forestry (including Russian wheat aphids, European and Asian Gypsy moths, and imported fire ants) are nonindigeous as well (28,66).

Also referred to as "exotic," "alien," "introduced," or "non-native" species, such harmful nonindigenous species (HNIS) have, in the past, been accidently or deliberately introduced into the United States, sometimes through trade. The invasions of knapweeds and cheatgrass/medusahead to western native rangelands and the introduction of melaleuca, a fast- growing tree to dry out south Florida wetlands, are examples. Future expansion



A number obnoxious weeds have been spread through trade causing commercial and environmental damages.

of agricultural trade will likely provide HNIS with new avenues into the United States (79). Controlling them at the border illustrates the product standard approach to dealing with possible environmental damages related to agriculture.

The costs of HNIS can be significant. From 1906 to 1991, the cumulative economic damage caused by 79 NIS organisms or species cases, less than 14 percent of the total invasions, was estimated at $97 billion (in 1991 dollars). HNIS agricultural weeds were not included. Estimates of future damages from 15 very harmful animal and plant diseases range between $66 billion and $134 billion (in 1991 dollars) (16). These estimates are, unfortunately, based on incomplete data, and almost certainly underestimate the actual costs because 1) in many cases, damage estimates were unavailable; 2) some commercial costs, such as private control expenses, were infrequently incorporated; and 3) the costs of certain losses to the environment, such as declines in recreational fishing, were not always quantified. According to the OTA assessment, much of the commercial damage is done to the agriculture and forestry industries. The environmental costs included declines in indigenous species and transformations of ecological communities and ecosystems. These environmental damages are significant, and extend beyond agriculture and forestry to national parks and other areas.

When the private parties or public agencies responsible for introducing HNIS are not responsible for paying such commercial and environmental damages, they will not be inclined to evaluate new introductions for the potential harm they might cause.[4] In those cases, the government may play a role in regulating trade, to prevent the introduction of HNIS. The S&P code is used for HNIS cases. The code sanctions the use of quarantines, for example, to minimize the chances that HNIS will enter a country. The United States has invoked this provision on a number of occasions: for example, to place restrictions on cut flowers from the Netherlands, and to ban seed potatoes from Canada and avocados from Mexico. Future actions, however, may be viewed as nothing more than protectionism, and open to challenge under WTO rules. GATT has rarely been used for such challenges in the past, though, because, as stipulated in article XX and elsewhere, it upholds a nation's right to establish its own rules and regulations regarding health and safety (which cover HNIS).

Preventing the introduction and spread of HNIS is an endeavor full of uncertainty and risk. Governments must not only establish criteria and procedures for controlling introductions, but also choose control strategies once HNIS have been introduced. Further, governments must determine acceptable levels of environmental and human risk, set risk thresholds above which formal decisionmaking approaches are invoked, and identify

[4]Some states require the deposit of funds to pay expenses in case nonindigenous species cause damage or require public action.

tradeoffs that may have undiscernible outcomes (79). Despite the considerable uncertainty, a review of selected economic studies shows that the benefits of controlling HNIS exceed the costs, usually by a large margin, with one exception (16). Early detection and eradication of HNIS can prevent much greater eradication or control costs after the pest has become widespread.

The key policy question relating to agricultural trade is whether to upgrade standards for screening imports. The OTA study cited above concludes that "perfect screening, detection, and control are technically impossible and will remain so for the foreseeable future" (79). Aiming for a "zero entry" standard would not only be prohibitively expensive, but unrealistic. Setting standards that are too high may unduly restrict trade, shut out helpful NIS, and lead other countries to retaliate by upgrading their own standards. However, setting product standards that are too lax exposes agriculture, other industries, and natural areas to the possibility of severe damage. A strategy of targeting agricultural crops and environmental systems at greatest risk from HNIS might, in this context, be the most effective way to deal with the problem.

As previously mentioned, the new URA product standard provisions stipulate that member countries must base their S&P measures on international standards (if they exist), and harmonization of standards is encouraged. The OTA assessment concludes that "complete harmonization of pest risk standards is probably not achievable, although agreeing on analytical processes may be" (79). Resolving scientifically complex issues of this sort through WTO panels will require expert environmental science input.

As the United States embarks on expanded trade relations with Mexico and Canada through NAFTA, new HNIS cases in North America will likely grow. For example, Mexico has recently changed its regulations affecting imported Canadian and U.S. Christmas trees-ostensibly to screen for gypsy moth infestations. However, it does not apparently have a clear scientific basis for doing so. Previous bilateral agreements have

Imports of containerized freight allow the introduction of harmful nonindigenous species to affect agriculture and the environment throughout the country instead of just U.S. porfs of entry

attempted to halt the transmission of foot and mouth disease between Mexico and the United States, as well as the invasion of the zebra mussel in the Great Lakes between Canada and the United States. Considerable resources have been devoted to coordinating pest prevention approaches with each country. NAFTA, in a vein similar to that of the URA, affirms members' rights to maintain "the level of protection of human, animal or plant life or health in the territory of a party that the party considers appropriate"; it requires that such measures be based on both scientific principles and risk assessment; it notes that in establishing their levels of protection, members "should take into account the objective of minimizing negative trade effects"; and it encourages harmonization of standards where appropriate, but discourages downward harmonization. It also made criteria for defending challenges to product standards more deferential to environmental measures and gave more access to environmental expertise for dispute panels than previous GATT or new WTO rules (21). The agreement does not directly address the problem of HNIS, but it does establish a Committee on Sanitary and Phytosanitary Measures that is charged with improving health and safety conditions throughout North America. A subcommittee devoted exclusively to HNIS

might help to improve those conditions yet further.

DOMESTIC ENVIRONMENTAL EFFECTS OF AGRICULTURAL TRADE LIBERALIZATION AND EXPANSION

The potential environmental effects of changes in trade or trade policy have been described and categorized in myriad ways. Grossman and Krueger sort them into scale, product composition, and technique (i.e., production technology) categories. Runge (65) expands that set to include effects from general improvements in resource use causing less waste and from improved (environmental) policy. Building on these concepts, the OECD recommends national governments conduct a comprehensive review of the effects that trade measures or agreements might have on the environment. The review covers five categories (52):

1. *Structural effects*, which are associated with changes in the patterns of (micro or firm-level) economic activity (e.g., includes improved farm resource use);
2. *Technology effects*, which are associated with changes in physical, biological, or other processes or production methods;
3. *Scale effects*, which are associated with the overall level of economic activity induced by changes in trade flows and the implications for environmental pollution and cleanup;
4. *Regulatory effects*, which are associated with legal or policy effects of a trade measure or agreement on environmental regulations, standards, subsidies, or other programs; and
5. *Product effects*, which are associated with the export or import (but not production) of specific products that can harm or improve environmental quality.

The following analysis uses the OECD terms to examine the effects that expanded and liberalized agricultural trade might have on the U.S. environment. The structural and technology categories are combined to capture the shifts in crops and livestock enterprises with their closely tied production technologies. Major product effects are not expected to be significant (save for the effect of HNIS, which has already been detailed), and are not discussed.

Structural and Technology Effects

Farmers' decisions about what kinds of crops to grow; where to grow them; and how to combine land, water, and other resources to produce their products all have environmental consequences. For example, in response to larger markets overseas, a farmer may use more land to grow certain crops, or use land more intensively—that is, by tilling more pasture or prairie, or applying more fertilizers or pesticides. Conversely, farmers who have been protected from foreign competition by tariffs, quotas, or other trade barriers may change the kinds of crops they plant and the way they grow them if, as a result of trade liberalization, they are faced with more foreign competition. Depending on how the land is used after the trade restrictions are removed, stress on the environment could increase or decrease.

The environmental effects of a farmer's decisions will depend on what combination of choices he or she makes with regard to particular resources. For instance, the amount of water runoff or chemical leaching that results from producing corn depends on whether the corn is planted on steep uplands or on sandy, permeable lowland soils that overlie shallow groundwater susceptible to chemical leaching. Some environmental consequences, such as erosion runoff and muddy streams, are obvious locally, but cannot be easily traced further downstream. Others, such as groundwater contamination or wildlife effects from habitat changes, may not be completely revealed for some time.

The shifts in agricultural trade caused by NAFTA and the URA will determine the size, location, and nature of such new strains on the environment. The U.S. Department of Agriculture (USDA) estimates that expected increases in production related to the agreements are relatively small, ranging from a low of about 1.5 percent of acres planted in major crops in the year 2000 to a high of approximately 3 percent in 2005 (85).

Crop-specific estimates indicate that wheat acreage increases by 5 to 8 percent, coarse grain acreage by 1 to 2 percent, soybean acreage by 3 to 4 percent, and cotton acreage by 2 to 5 percent (compared with what the situation would be without the agreements). Land that currently remains "idle" under government supply control programs would likely meet the additional export demands in 2000 and probably up to 2005, although it would mean some increase in erosion and other environmental damage. Another set of estimates by the International Trade Commission (ITC) shows smaller net production increases. (90) (See chapter 3.).

Looking at these overall changes is, however, merely a starting point. To project the possible environmental effects of expanding agricultural trade, it is necessary to examine specific changes in production and in the means of production (i.e., production technologies). OTA contracted with researchers at Texas A&M University to analyze what regional shifts in agricultural production would occur, and what possible environmental stresses would result, from projections of expanded agricultural trade under NAFTA and the URA (44). The analysis assumed that the current commodity programs continued with Acreage Reduction Program (ARP) levels at 1990 levels of about 27 million acres; that commodity program base flexibility remained at 15 percent of enrolled commodity program acres; and that 10 million acres of the most highly erodible land in the Conservation Reserve Program (CRP) were kept out of production.

Estimates show that overall cropland use rises less than 1 percent by the year 2000 under the higher USDA export projections with the URA and NAFTA. The enlarged cropland base from CRP lands returning to production, coupled with average technology improvements, nearly offset the rise in net export demand. None of the major environmental measures showed changes of more than 1 percent and some even declined (for instance, water use and phosphorus). Overall, the combination of changes in crops and technology, when spread across all farmland, was not estimated to cause significant damage to, or for that matter improvement in, the environment. The low projected erosion rates result from a combination of cropland returning to production under conservation tillage techniques; the retention of the most erosive lands in the CRP; wheat production technology, which causes less erosion than the production technologies used for some of the crops it is projected to replace (59); and other changes. The larger agricultural export estimates for 2005 would, it is assumed, have larger effects on the nation and various regions, but would probably not increase any environmental measures by more than 3 percent. These findings are consistent with general assessments of the environmental effects of trade and trade liberalization (51) and for other countries (e.g., 61).

Commodity Program Influences

For the OTA analysis conducted by Texas A&M researchers, it was assumed that agricultural commodity programs would operate as they do now because the URA did not mandate change for the most part. The URA establishes a ceiling and reduction schedule for total domestic agricultural support (which the United States has already met), exempts deficiency payments from the ceiling and reduction calculations, and preserves the United States' authority to make commodity specific payments and acreage set-asides.

Even though the URA did not effectively reform commodity programs, budget pressures and other forces will likely lead to further changes in them. Assuming that there will be additional reform, what type of environmental effects might follow? Basically, how the crops, livestock, and their production technologies spread across the natural resource base determine what happens to the environment (5). Much depends on the precise nature of any reform—for example, whether income and price supports are eliminated or just "decoupled" from particular crops and production levels, and whether land set-asides continue. Also pertinent are assumptions about how competing exporters may reform their programs, and how those reforms might affect world markets and price levels. For example, if all WTO countries simultaneously removed subsidies that encourage

domestic overproduction, world prices would rise significantly in the short term as global supplies fell. In the longer term, other sources of supply (e.g., developing countries) could appear and make markets stable again—at prices that would be higher than what they are now, but lower than what they would be during the initial short-run surge.

Investigations of the environmental effects of reforming agricultural support programs have taken place on the international, national, and regional levels. It is important to consider that the science and data to describe the production-environment relationships at ecosystem levels simply do not exist, and so precise calculations are impossible to make.[5] Nonetheless, results from all levels provide largely consistent and corroborative results. (See appendix I.) Generally, multilateral reform of commodity programs—by lowering or decoupling price subsidies and by reducing land set-asides—would likely decrease chemical pollution and many other stresses on domestic environmental resources, such as water withdrawals for irrigation. Although the analyses focus on reforms in prior years, the findings are still relevant because the basic structure of U.S. commodity programs has remained unchanged. Kuch and Reichelderfer (37) note that the potential environmental effects of reform will likely be limited in industrialized countries. Moreover, agricultural program payment levels in industrialized countries have been decreasing, which implies that less environmental change will occur if support is withdrawn because the programs are exerting less effect on production. (See chapter 6.) Kuch and Reichelderfer stress that the extent of environmental impacts depends largely on the kinds of environmental programs in place after agricultural programs are reformed. A separate assessment arrives at the same conclusion (50).

Because current studies of program reform do not fully describe long-term adjustments, overall estimates of environmental improvement are probably lower than they need be. (Flexible, cost-effective environmental programs might, for instance, induce farmers to change their production methods, and so further reduce impacts on the environment.) (See chapter 4.) Some analyses have indeed indicated that pollution could be reduced more over the longer term (1). The overall implications for global environmental conditions are not clear, but are likely to be positive, because there will probably be less chemical use in developed countries, and some livestock production will move to developing countries (thus reducing higher concentrations of livestock in the developed countries).[6] However, that positive outcome depends on the developing countries' abilities to translate increased income from trade gains into more effective environmental protection.[7] At least one negative domestic environmental effect is forecast: erosion rises as land that had been idle under the ARP or CRP is planted.

Import Liberalization

NAFTA and the URA also reduce some U.S. trade barriers against foreign agricultural products, thus

[5] Fairly complete data on the production of crops and livestock and the use of fertilizers, energy, and other inputs by major U.S. regions are recorded each year by USDA, which separately collects data describing the condition of natural resources used in agriculture (82, 87). However, data that describe existing agricultural production technologies and crops and how they relate to the environment are not collected on a comprehensive basis, perhaps owing to the size and cost of the task. Without that information, unfortunately, precise estimates of the environmental effects of expanding agricultural trade across ecosystems are not possible.

[6] Anderson (2) explains that production patterns and technologies in developing countries rely relatively more on extensive land use for growing crops and livestock, and less on increased fertilizers and pesticides, than in developed countries. As a result, production shifts under policy reform would be expected to put relatively more pressure on the land resources in developing countries and less on chemical use in developed countries.

[7] There is doubt that developing countries can design and implement effective environmental programs to ameliorate significant problems in the event of full agricultural trade liberalization, especially in the short term (42).

increasing market access for imports. Currently, several kinds of U.S. agricultural products are still protected from foreign competition, including sugar, dairy products, and peanuts. Generally, in such cases, domestic production (and land use) expands to fill domestic demand, and producers receive more for their products than they could if they faced unsubsidized foreign competition. If protected sectors are not subject to effective environmental programs, they may use more "unpriced" environmental resources than unprotected sectors do, simply because they are larger. But protected sectors earn high "pure" profits (profits in excess of all production costs) and can invest in developing technologies to retain their profit position.[8] That is, if they are required to meet certain environmental standards, they may do it at a lower cost than they could when faced with more competition.

Box 5-1 explains how the south Florida sugar cane industry, which has benefited for decades from protectionist policies, may be able to devel-

BOX 5-1: Agricultural Production and Environmental Linkages in South Florida—Sugar's Connection to the Everglades*

The environmental problems facing the Florida's Kissimmee-Okeechobee-Everglades watershed (69) center on three major issues:

1. *Water Quantity, Distribution, and Timing* —How much water goes where, when, and how is it distributed?
2. *Water Quality* —How "clean" should the water be, and what is the best way to make it clean?
3. *Cost* —Who pays the bill?

As a result of the current water management system, the remaining Everglades natural areas receive about half as much water, and about 200 tons more phosphorus, than they originally did (69) The drainage and flood control system constructed to aid urban, agricultural, and other developments has not only heavily contributed to present environmental conditions, but has also defined how land will be used. Agriculture has taken over a large amount of the drained land (about a half million acres of former custard apple swamp and marsh) As a result, agriculture will figure prominently in any solution to the area's environmental problems

Since 1988, Florida, working with federal agencies, has developed an environmental Improvement plan for the Everglades Passed in 1994, the Everglades Forever Act (EFA) defines a plan to

> begin restoring a significant portion of the remaining two-million-acre Everglades ecosystem by reducing the amount of phosphorus-enriched agricultural stormwater entering the system, improving the quantity and distribution of freshwater, and setting deadlines to achieve these objectives (70).

EFA also creates funding mechanisms that address all three of the issues raised above In addition, it establishes mechanisms to control harmful nonindigenous species (HNIS), even though problems with HNIS are not linked directly to Everglades agriculture.

For agriculture specifically, EFA has several important implications More than 40,000 acres of man-made filtering wetlands, called stormwater treatment areas (STAs), will be created in the Everglades Agricultural Area (EAA). The STAs are designed to reduce the amount of phosphorus in stormwater runoff before the stormwater enters Everglades and Water Conservation Areas, and to improve the Everglades hydroperiod. Specifically, the interim water quality target is 50 parts of phosphorus per billion,

(continued)

[8] Whether allowing a sector to earn pure profits (and essentially granting it associated research and development advantages) reflects the most appropriate use of those funds remains an open public policy question.

BOX 5-1 (Cont'd.): Agricultural Production and Environmental Linkages in South Florida—Sugar's Connection to the Everglades*

and the amount of water flow IS estimated to increase by 28 percent and lengthen the duration of flow. After the interim measures have been implemented, a scientific process will be used to determine the final targets for water quality

The question of who pays how much IS also addressed Sugar and vegetable growers must pay about $25 per acre per year in the form of an "agricultural privilege tax" over the next 20 years to construct the STAs If further pollution control measures are required to reach the final targets, the cost could rise to $35 per acre from 2006 to 2113 under assumed conditions (60) Vegetable growers are not subject to the potential Increase. When the STAs are completed, EAA growers will pay $10 per acre for operation and maintenance costs, while farmers operating outside the EAA but in the area wiII pay about $2 per acre Supplemental funding will be collected from public sources such as highway tolls

EFA also requires all farmers in the area to develop and implement innovative best management practices (BMPs) to reduce all pollutants flowing into runoff waters Since these BMPs are not in place, the true costs are not known. Current estimates are $1 per acre to achieve the minimum 25-percent reduction in phosphorus emissions (which wiII obviate the need for the $10 tax Increase) The estimates rise to about $25 per acre for a 45-percent reduction (91) Florida sugar growers were estimated to have received an average of about $230 of pure economic profit or rent per acre from 1986 to 1990 (69) Future profits are projected to decline slightly from the $230 level The total tax and BMP charge would reduce pure profits to about $200 per year for the 20-year construction period Converting the taxes and BMP costs to a per- pound of sugar basis (based on 1986-90 yields) implies that the charges constitute a O 5 cent increase per pound, or just over 2 percent of average price of sugar over the same period.

These figures reveal that, on the whole, sugar growers have ample capacity to absorb the environmental charges, Gwen their large pure profits, sugar growers have resources to develop innovative technology to reduce the BMP costs even further, assuming that flexible environmental policies prevail Sugar production appears to be an economic fact of life under current market conditions and given the relatively low-cost south Florida production technology---despite the fact that large federal subsidies were used to develop that efficient technology Trade liberalization will not likely displace Florida's sugar industry, although it may reduce its size.

Environmental restoration of the Everglades must proceed with these realities in mind What should be the sugar industry's role in that restoration process? Under the EFA environmental targets, the average costs imposed on sugar producers take only a small portion of their pure economic profit Achieving environmental restoration beyond the current EFA targets—by reducing the area of sugar production—would be expensive in two respects. First, taking land out of production wiII be costly as evidenced by the large pure profits and land values. However, removing the sugar program protection will lower the land values and therefore lower land acquisition costs Second, unless some mechanism can be found to allow the lands to revert to natural conditions, alternative land uses may do more environmental damage. Data often reveal that using land for urban and industrial purposes generates much greater pollution per unit area, Assuming that the elimination of domestic sugar subsidies releases some land from sugar production, it does not follow that environmental conditions wiII Improve automatically, That determination depends on how the land IS ultimately used and the environmental rules under which it will be used,

* Material in this section was drawn from a contractor report prepared for OTA by Rand Snell and William Boggess "Water,Agricultural, and Environmental Policy Issues in South Florida, " June 1994

op cost-effective technologies to meet high environmental standards (69).[9] Also explained is the notion that the ultimate environmental effects of any land leaving sugar production depends on the applicable environmental policies. In south Florida, either vegetable farms or residential developments may do more harm than existing sugar production (69). It is crucial to note that these findings do not support the use of protectionism to improve the environment. Indeed, open competition between domestic and foreign producers is conducive to achieving long-run economic and environmental benefits. However, the case study indicates how difficult it can be to devise effective environmental policies when dealing with an historically and economically anomalous situation. If Florida's sugar growers had always faced competition, then effective environmental programs, and public research targeted to complementary technologies, would likely have benefited society more than the growers' current efforts at environmental cleanup do. The messages from chapter 4 and from this case are the same: the nature of agroenvironmental management programs is the most critical element to determining environmental quality.

Overall, import liberalization resulting from the URA will probably exert a limited effect in the near-term due to ambiguous rules governing the process (67). Some measures were included to guard against foot-dragging by importing countries reluctant to open their markets, however, there are no guarantees of improved market access (73). Certain areas where protected crops dominate and significantly affect the environment may undergo considerable change over the longer-term as pressure for further liberalization grows. Again, it is obvious that emphasis must be placed on identifying regional pockets where the environment will be greatly stressed, and on targeting these areas with appropriate agroenvironmental programs.

Regulatory Effects

The nature of the environmental effects that result from expanded and liberalized agricultural trade depends not only on the magnitude and types of changes in production, but also on domestic environmental policy—more specifically, on the way governments manage or change their environmental programs due to the trade measure or agreement.

The possible return of idled acres to production demonstrates once more that domestic environmental programs ultimately dictate the consequences of trade expansion. The basic problem is that comprehensive, effective policies do not cover areas facing significant risks of environmental damage. Can current domestic environmental programs effectively treat any pockets of stress or other large problems, such as invasive HNIS, without significantly interfering with trade flows? Cost-effective management programs can induce technological changes over time, such as improved conservation tillage practices, better soil

[9] Popular belief dictates that protected (and less than fully competitive) industries are likely to be less vigorous in reducing cost than other industries. The Florida sugar industry's declining production and processing cost structure do not support that notion. The incentive to continue earning, and even to enlarge, their pure economic profits, coupled with the large capital base afforded by price protection, has evidently led to technological innovation and production cost decreases through economies of size (69). In this "trustified capitalism" formulation, the pure economic profits are necessary to allow the firms to invest in research and development that will lead to innovation. Industries comprising many competitive firms do not enjoy the necessary capital base or profit-making opportunities to permit such dynamic technological innovations, although they have strong incentives to adopt existing technological improvements. If accurate, this view of technological innovation has two implications for the issues at hand. First, profit-producing trade restrictions that protect certain industries (such as sugar) may allow them to conduct kinds of research and development that may not be considered a priority in other industries. Second, if the industries remain protected and retain their customary profit levels, they will be able to meet environmental requirements at lower costs through their technological innovations. A related observation is that more-competitive industries will not be as likely to generate technological innovation in meeting environmental standards, because they cannot earn pure profits. In the latter case, if competitive markets remain an overriding public goal, the rationale for public research and development assistance directly follows (22).

testing that can reduce fertilizer application rates, and increased use of biological pest controls to reduce applications of chemical pesticide applications. These changes can simultaneously lessen environmental damage and reduce the estimated cost of environmental compliance, thus helping trade to remain competitive.

How do existing programs measure up when all the environmental benefits and costs are considered? Two criteria may be used. First, are the standards or levels for environmental quality too high or too low? On this matter, analysts can provide information about the likely environmental, economic, and social benefits and costs of various standards—but the public, through Congress, must ultimately decide what the appropriate standards are. Second, are existing mechanisms adequate to ensure that farmers and consumers fully pay environmental costs and receive compensation for providing environmental benefits? Environmental programs come in a variety of forms: production or emissions controls, technology requirements, purchase of land or water rights, and subsidies and taxes. The basic question is, which mechanism achieves the environmental objective, in the short term and long run, at the lowest possible cost?

The United States has nearly 60 years of experience in applying conservation and environmental programs to agriculture. Chapter 4 reviewed programs that deal with soil conservation, water quality, wetlands protection, pesticide registration, and other issues. The principal conclusions of the review were:

- traditional voluntary education and technical assistance efforts have not produced widespread and enduring change;
- subsidy-based programs have produced benefits, but for the most part have not been targeted for maximum opportunity to yield benefits;
- compliance programs do not match environmental priorities and are vulnerable to budget cuts;
- regulatory efforts have been spotty and have not stimulated timely technology innovation; and
- research and development efforts to understand agroenvironmental priorities, and to develop technologies that produce complementary production and environmental effects, have been insufficiently funded.

The recurrent themes of insufficient targeting and incomplete coverage suggest that the agroenvironmental programs currently in place will not cope well with any trade-induced pockets of environmental stress or invasions of HNIS. Moreover, those shortcomings, when considered along with insufficient science and technology R&D, do not promise a long-run complementary path for agricultural trade and the environment.

Scale Effects

As mentioned previously, increases in agricultural production resulting from NAFTA and the URA are not expected to exert significant stress on the environment. Indeed, as increased agricultural trade raises incomes, the environment could benefit. A growing body of evidence indicates that as per-capita income levels increase, environmental pollution decreases, although the relationship is not fully understood (32,40,41).

One of the key determinants of this relationship is the rising demand for environmental quality as income levels increase. However, recent reviews of evidence on this relationship suggest that the rise in demand may not be as large as thought previously (36). Changes in the composition and technology of production also play important roles. If this relationship applies to agriculture, increased income from trade growth could improve agroenvironmental conditions.

The hypothesized effects pertain to expanding trade under NAFTA and GATT. As liberalized trade places more pressure on environmental resources and raises incomes, stronger environmental management programs will emerge. The resulting effects on the environment will, accordingly, depend on the balance between the two forces and the timing of problems and management programs. Given that expanded trade will not change either U.S. production patterns or income dramatically (estimated at less than 0.2

percent of GDP) over the next five years, the near-term effect is likely to be small (67). In the long run, income growth from general development, including expanded trade, will spur improvement in the national environment, but only gradually. The nature of that improvement will be defined by incentives for technology development and behavior change encouraged by environmental programs. Whether the improvement extends to global environmental resources, such as plant and animal biodiversity, is unclear because of the difficulty of cooperatively managing those resources.

TRADE MEASURES TO ACHIEVE INTERNATIONAL ENVIRONMENTAL OBJECTIVES

Some of the transboundary or global environmental problems stemming from increased agricultural trade affect U.S. interests. Pesticides may contaminate air and rivers that cross into U.S. territory; losses of plant and animal species may reduce the gene pool available for domestic production and ecological functions. In such cases, national environmental programs will not be enough to ensure that the problems are addressed (68). Regional or international mechanisms, such as multilateral environmental measures tied to trade, stand a better chance of success. So far, two trade-related approaches have been used. The first approach has been to work through trade agreements to accomplish environmental goals; the second, to use trade measures within international environmental agreements.

Environmental Provisions Related to Trade Agreements

NAFTA presented the first opportunity to use a trade liberalization agreement for advancing regional environmental objectives. Mexico suffers from severe environmental problems—especially along its border with the United States, where most of the country's foreign-owned "maquiladora" plants are located. NAFTA opponents argued that if the agreement were implemented, Mexico could become a "pollution haven" for industries that did not wish to pay the costs of complying with U.S. or Canadian environmental laws. Such arguments proved persuasive, even though the Mexican and U.S. governments had earlier concluded an integrated border environmental plan to clean up the region.

Ultimately, the NAFTA negotiators were compelled to include several unprecedented "environmental" provisions in the body of the agreement, making it the world's first "green" trade pact (21). The NAFTA text states, for example, that the provisions of certain international environmental agreements (e.g., the Basel Convention on the Control of Transboundary Movements of Hazardous Waste, and the Montreal Protocol on Substances that Deplete the Ozone Layer) generally take precedence over NAFTA provisions. NAFTA members are allowed to set their own levels of environmental protection, within certain parameters. NAFTA further exhorts members to enforce their own environmental laws, and to refrain from attempting to attract foreign investment by lowering, or failing to enforce, environmental standards. It also allows members to impose some environment-related performance requirements on foreign investors, and to refrain from granting patents for inventions that might harm the environment.

Public pressure also led to the addition, in August 1993, of a NAFTA environmental side agreement, which deals more specifically with transboundary environmental concerns. The North American Agreement on Environmental Cooperation (NAAEC) lays the groundwork for addressing regional environmental issues through a tripartite Commission for Environmental Cooperation (CEC), funded by the three NAFTA members. The CEC's mission is to monitor how NAFTA's environmental provisions are implemented, work toward harmonizing and raising North American environmental standards, develop ways to enhance the North American environment, function as a clearinghouse for NAFTA-related environmental issues, and review cases of members' alleged nonenforcement. Cases may go to an arbitral panel under the CEC if a NAFTA party allegedly engages in a "persistent pattern of failure"

to enforce a particular environmental law or laws. Thus, the CEC is geared not only to regional environmental improvement, but also to leveling the trade playing field by punishing lax enforcement of domestic environmental laws—which, theoretically, might affect industries' location and investment decisions. Finally, NAAEC commits countries to provide for public participation in domestic environmental policymaking and enforcement (21).

An agreement such as NAAEC is unprecedented in the history of trade negotiation and represents a landmark achievement in linking regional environmental and trade issues. Nonetheless, it is difficult to determine whether NAAEC will be a particularly useful institution for addressing transboundary environmental issues, for three key reasons:

- First, the NAAEC provisions significantly restrict the kinds of nonenforcement actions that may be challenged. Under NAAEC, only a "persistent pattern" of nonenforcement (which is defined in the text only as "a sustained or recurring course of action or inaction") may be challenged, and a member "has not failed to effectively enforce its environmental law" if its action "results from bone fide decisions to allocate resources to enforcement in respect of other environmental matters determined to have higher priorities." The agreement also stipulates that sanctions against a NAFTA member that does not enforce its own environmental laws must take into account "the level of enforcement that could reasonably be expected of a party given its resource constraints," and that NAFTA members may withhold information on a case from the CEC under certain circumstances.
- Second, as critics such as Charnovitz (15) argue, the CEC has no enforcement power beyond allowing one member to institute trade sanctions against another. Such action would be taken only after a significant amount of time had elapsed and significant sums had been spent on litigation. However, the CEC can conduct fact finding and publish the results in attempts to use adverse publicity to instigate pollution cleanup.
- Third, and crucially, the NAAEC agenda conceptually treats transboundary and domestic environmental problems as equal concerns. As a consequence of casting their environmental net so widely, it is possible that the NAAEC member states may not be able to focus the attention they otherwise could on pressing transboundary problems. As the Environmental Protection Agency (EPA), other agencies, and countless experts have confirmed, the border region between the United States and Mexico suffers from serious pollution problems (89), which may be exacerbated to some extent by NAFTA. Such problems as the highly polluted New River, which flows from the industrialized and overcrowded Mexican city of Mexicali through California's agricultural Imperial Valley, may be one of the most polluted rivers in the world, with problems yet to be fully addressed (38). However, in one of the first cooperative efforts under NAFTA, the U.S. Environmental Protection Agency (EPA) and the Mexican Secretariat for Social Development have cooperatively made the reduction of New River pollution a high priority on both sides of the border (84). Several other initial activities between the United States and Mexico suggest a principal focus on border-related problems, so for the moment the potential for spreading efforts too broadly appears small (84). The countries are also cooperating on studying similar agroenvironmental problems (e.g., rangeland erosion), and possible transfer of technologies (81).

A more direct approach to the problem of the border region, and by extension to transboundary environmental problems related to trade, has been through bilateral agreements between the United States and Mexico, and through the recent creation, in NAFTA's implementing legislation, of the North American Development Bank (NAD Bank) and the Border Environment Cooperation Commission (BECC). As mentioned above, the United States and Mexico released an Integrated

Environmental Plan for the Mexican-U.S. Border Region in February, 1992, which aims to attack border pollution problems through joint efforts to promote training, education, and planning programs, and to better enforce the nations' environmental laws. The border plan has been criticized as vague, without commitments to specific projects (34), and its allocation of $200 million for 1994 from the United States falls strikingly short of the billions of dollars that some experts deem necessary to improve sewage systems, water pollution, and air pollution in the area. For example, Hufbauer and Schott (34) recommend that $5 billion be dedicated to the border region over five years.

NAD Bank's initial purpose is to make loans for infrastructure projects that will ensure cleaner water, adequate wastewater treatment, and adequate solid waste disposal in the border region.[10] Located in San Antonio, Texas, and capitalized by the governments of the United States and Mexico, NAD Bank will make some $2 billion to $3 billion in guarantees and loans available for these projects. For 1995, $56 million was appropriated by Congress. The bank will work cooperatively with BECC, which will help locate, design, assess the environmental impacts of, and approve the projects in communities on both sides of the border. As these institutions are so new, it is not possible to gauge their efficacy, although the U.S. House Committee on Banking, Finance, and Urban Affairs found that the NAD Bank proposal was "seriously defective" because the bank's financial mechanisms were potentially unworkable (77).

One area that might test the efficieny of NAAEC and NAD Bank lies along the southwest Texas and Mexican borders, where trade liberalization will expand industrial growth. Box 5-2 explains some of the cross-border problems of the Lower Rio Grande Valley and the current difficulties in addressing the issues. Interestingly, there is little chance that gradual reduction of trade barriers here will induce substantial agroenvironmental problems. Rather, concerns center on the negative effects that nonagricultural growth could have on agriculture, especially with regard to transboundary flows of polluted water.

Increased trade and manufacturing activity along the U. S.-Mexican border causes increased pressure on transboundary environmental resources,' here an effluent from a Mexican cottage industry drains into the Rio Grande River which U.S. agriculture draws on for irrigation.

Although it in no way rivals NAFTA as a "green" trade pact, the URA has new "environmental" provisions as well. The text sets the environmental stage for the World Trade Organization (WTO). Explicit mention of the need to address environmental issues and pursue sustainable development appears in the WTO preamble (49). Specific environmental provisions include the

10 An obvious question is why subsidized loans may be acceptable tO use for transboundary pollution but not for national environmental problems under the OECD principles. The answer maybe one of necessity: subsidies are necessary to induce transboundary cooperation because multilateral regulations requiring cooperation do not exist and collaboration is costly.

BOX 5-2: Transboundary Environmental Linkages: The Lower Rio Grande Valley*

Adjoining the Mexican border and its maquiladora plants, the Lower Rio Grande Valley (LRGV) of Texas lies at the heart of expanding trade between Mexico and the United States The LRGV is replete with valuable environmental resources, such as several rare and endangered wildlife species The Rio Grande River is an integral resource for the region, but its quality deteriorates as it approaches populated areas downstream. Air quality is also a concern, as urban sprawl, Industry, and transportation expand in response to the region's growth, Many of the LRGV's environmental resources are shared across the border and so require multinational approaches for effective management.

Surface and groundwater quality are two transboundary challenges Because the river and its reservoirs provide and receive U.S. and Mexican municipal, industrial, and agricultural waters, it is a critical resource Above the cities of McAllen and Reynosa, Rio Grande River water quality is primarily influenced by releases from the Falcon Reservoir (on the western edge of the LRGV) and is excellent (72) But as the river continues southeast, it becomes increasingly degraded Below the two cities, for example, the river does not meet quality standards for swimming due to elevated fecal conform bacteria levels, primarily the result of Inadequate treatment of Mexican municipal sewage. Five Mexican cities—Juarez, Cludad Acuna, Piedras Negras, Nuevo Laredo, and Reynosa---dump 60 million gallons of raw or partially treated sewage into the Rio Grande each day (20), Untreated sewage IS dumped into the river by colonias (unincorporated rural subdivisions) on both sides of the Rio Grande. Fecal conform levels below Nuevo Laredo are 33 times greater than the allowable safe Iimits. Further, phosphorus and chlorophyll a levels in sediment are concerns as is DDE (a derivative of DDT during degradation) toward the river's mouth

These river water quality problems are Iinked to agriculture in two ways. First, irrigation water for fresh vegetables and other crops is taken from the degraded portion, and may cause problems for food safety Second, agricultural nutrient and pesticide effluents can move to the river from Mexican farms Pesticide and fertilizer use have generally Increased over the past two decades, with potential for runoff to surface waters and leaching to groundwaters (88). Some researchers believe that agricultural pesticides may be a source of birth defects along the U S -Mexico border (1 1). However, a recent U.S. Environmental Protection Agency (EPA) study did not find sufficient pesticide exposures near Brownsville to warrant health concerns. Within Texas, there are also surface water quality problems in the Arroyo Colorado, which flows from Hildago county to the Laguna Madre on the Gulf Coast: principally elevated levels of phosphorus, ammonia, nitrate, chlorophyll a, and fecal coliform, plus concerns about manganese, selenium, DDE, and PCBs. The Texas Natural Resource Conservation Commission attributes most of the problems to municipal effluents.

Groundwater in the LRGV ranges in depth from 180 feet in the west to 20 feet or less near the coast Generally, groundwater quality problems stem from excess sodium chloride, bicarbonate, and sulfate, most of which occur naturally and are not directly attributable to agricultural activities, The Texas Water Commission reports that some groundwaters are vulnerable to pesticide leaching, but they are generally too salty for Irrigation or human consumption, For a 17-county area of southern Texas, where there are high-growth centers (for instance, McAllen, Eagle Pass, and Laredo), the groundwater levels are declining due to pumping with little systematic planning and intervention from either or both countries, In this larger region, there are some aquifers at risk, At present, Texas and Mexico have no history of cooperation to manage transboundary aquifers, With Increased economic growth, the potential for further groundwater mining for municipal and Industrial purposes will increase, and allocation problems will likely grow.

There are other Important transborder environmental issues, Growth in fresh fruit and vegetable imports from Mexico, along with an Increasingly diverse product mix, will place additional demands on

BOX 5-2 (Cont'd.): Transboundary Environmental Linkages: The Lower Rio Grande Valley*

U.S. Food and Drug Administration resources to monitor fresh produce as it crosses the border (47) Available Information reveals a significant gap between U.S. and Mexican pesticide standards regarding their impacts on human health (63). Newman notes that Mexican regulations on pesticide use are Increasingly similar to those in the United States, but questions about relative enforcement are unanswered Another effect stems from Increased air pollution accompanying greater motor vehicle transport of commerce (and toxic spill potential), which can negatively affect crop yields, human health, and aesthetics Mexico's current vehicle smog emission standards are less restrictive than those of the United States (63) Finally, managing wildlife habitat, some for endangered species, in the face of expanding populations poses a considerable multilateral challenge

Environmental Program Responses

Existing institutions in both countries do not adequately address environmental losses or exploit potential environmental gains (e g , wildlife habitat). Most of the region's environmental problems stem from the absence of effective mechanisms, markets, public policies, or lack of enforcement of policies, to balance benefits and costs or risks An assessment of the existing environmental institutions shows a mixed picture of policy effectiveness In some cases, the policies may unnecessarily constrain competitiveness. In short, the LRGV region appears to suffer from incomplete environmental policy coverage on both sides of the border, as well as for managing critical transnational resources

Effluents coming from Mexican sources are subject to Mexico's General Ecology Law (1988) and Implementing institutions. Mexico has taken several steps forward in environmental management during the past decade. Mexico's poor economic state has, however, hampered the implementation and enforcement of more stringent environmental standards Additional resources for monitoring, technical assistance, and enforcement wiII be necessary to control water pollution effluent from Mexican cities as they grow. A similar prognosis applies to air quality and wildlife habitat protection

Effectively addressing these issues wiII require cooperation between agriculture and other sectors, between domestic government agencies, and most important, between Mexico and the United States Three courses of action warrant consideration (62) First, public officials could evaluate the harmonization of environmental standards between the United States and Mexico, including those pertaining to agricultural production and lands. Following NAFTA provisions, the harmonization process should not lower the level of protection in either country, and preferably harmonize to the higher level in either country Second, environmental problems stemming from public entities such as wastewater treatment facilities could be attacked by creating innovative funding mechanisms. Most of the border communities are not high-income areas and wiII require financial assistance to eventually meet existing water and air quality standards. Third, programs could be developed to assist public agencies in both countries on environmental monitoring and enforcement activities. Technical training on instrumentation, inspection protocols, and data monitoring and interpretation should be high-priority activities. Coordination across the border is key The translational Institutions created as part of the NAFTA process, such as the North American Development Bank and the Border Environment Cooperation Commission, have the potential to help in this regard, but are only skeletons at this point Their potential effectiveness wiII depend largely on the vigor with which private and public parties infuse them with energy, resources, and wise policy choices (7)

*Material in this section was drawn from a contractor report, "Agricultural Trade and the Environment Potential Impacts on the Lower Rio Grande Valley of Texas," by C.P. Rosson Ill, A. Pagano, E.B. Summerour II, L.L. Jones, R D Lacewell, T. Ozuna, A. Wise, M J Taylor, and S.M. Masud of the Department of Agricultural Economics, Texas A&M University, July 1994

new S&P and TBT agreements already discussed in this chapter, permission for selected environmental subsidies, and a dispute settlement procedure that is more open to public scrutiny (48). In addition, and like NAFTA, the URA text allows panels that are convened to settle trade disputes to seek expert scientific and technical advice regarding environmental matters. Finally, the WTO established a permanent committee on trade and the environment with broad terms of reference and a two-year period for reporting recommendations.

The inconsistency of the URA subsidy provisions with the polluter-pays principle (PPP) merits further comment. Governments are generally permitted to subsidize efforts that "promote adaptation of existing facilities to new environmental requirements imposed by law." Such subsidies must be one-time measures and are limited to 20 percent of the cost of adaptation. But agriculture is treated differently: the agreement permits the use of agricultural environmental subsidies, as long as those subsidies have no or minimal "trade-distorting" and production effects, are part of an clearly defined government program, and cover only added cost or lost income (48). Such payments are not subject to treaty subsidy reduction commitments, and are not subject to countervailing duties or to multilateral subsidy dispute challenges during a nine-year "peace clause." After that, they can be challenged if they are thought to have been abused (e.g., used as disguised production subsidies). Obviously, this provision for agricultural environmental subsidies conflicts with the PPP and previous GATT policy, unless the subsidies are used to enhance environmental quality levels beyond those considered social norms, i.e., provide positive environmental services.

U.S. officials estimate that the URA will subject the nation's environment to a small amount of direct pressure from agricultural production growth that, diffused over an extended period, will lead to environmental losses and gains. They also believe that the URA will indirectly improve environmental quality by encouraging specialization and larger farms that are better able to adopt and employ environmental technologies; through larger consumer incomes and demands for safe food and less pollution; and by leading to less marginal land in production (48). Specific evidence on the nature and magnitude of these effects is not provided.

The NAFTA provisions are generally considered to be substantially "greener" than those of the new GATT accord. But whether all of the NAFTA provisions are entirely workable is not clear. Hufbauer and Schott, for example, observe that complaining NAFTA parties may find it difficult to prove that another member has intentionally lowered environmental barriers to encourage investment. The efficacy of the NAFTA environmental provisions and institutions hinge on the strength of public agency and private interest group commitments to carrying out the skeleton arrangements in the agreements (6). Taken together, however, the new GATT and NAFTA "environmental" provisions constitute a novel attempt to incorporate some environmental concerns into international trade agendas, although they do not, as written, deal in any detail with transboundary or global environmental effects of expanded trade.

Environmental Trade Measures

Clearly, not all trade-related environmental problems will fall under NAFTA and URA provisions. Tropical forest destruction, greenhouse gas buildup, ozone depletion, and species extinction, for example, are among the "global commons" issues that potentially affect or are affected by policies and practices related to trade. For example, Malaysia's cutting of tropical forests has affected the environment beyond its borders, but forest production and trade policy choices understandably remain a national prerogative (31). As noted previously, methyl bromide, which is used extensively in production and to kill HNIS on imports, damages the ozone layer.

Trade measures such as embargoes, sanctions and quarantines, offer possible instruments for addressing environmental problems outside trade pacts. With varying degrees of success, trade measures are used in international environmental agreements, such as the Montreal Protocol on Substances that Deplete the Ozone Layer and the

Convention on International Trade in Endangered Species of Wild Fauna and Flora. Several hundred "legal instruments" are in place to deal with international environmental issues (12). These instruments come in a wide variety of guises, and have differing degrees of potential efficacy and effects on trade (14). For example, Barrett (8) reasons that the Montreal Protocol will sustain itself with the help of the threat of credible and substantial trade restrictions because the potential benefits from collective cooperation in ozone reduction outweigh the compliance costs. As of 1992, only 17 international environmental agreements employed trade measures (30). Esty had counted 20 by 1994, including a few that directly or indirectly relate to U.S. agriculture, such as the International Plant Protection Agreement (which relates to HNIS) and a code of conduct on pesticide distribution and use (23). Understandably, many of these environmental trade measures (ETMs) pertain to resources such as marine fisheries and wildlife, which cross borders, or to global environmental phenomena such as air pollution.

Many types of ETMs exist, including domestic standards, domestic taxes, import/export restrictions, and sanctions. Charnovitz (14) discusses the wide variation in degrees of unilateralism, scope of discrimination, degrees of intrusiveness, and beneficiaries of restrictions, and concludes that ETMs have existed since the 1800s and are not just the invention of "green" activists. Also, based on a review of actual ETMs, clean distinctions between product and process standards, between unilateral versus multilateral actions, and between trade and environment instruments are easier in theory than practice.

Combining many dimensions of ETMs, Esty sorts potential "offensive" uses of trade measures for the environment into four types of approaches:

- "trade restrictions or sanctions expressly authorized by international agreement and imposed multilaterally;
- unilaterally imposed trade measures employed in support of internationally agreed standards (and thus at least tacitly internationally condoned);
- unilaterally imposed trade measures invoked without the benefit of any multilateral agreement but aimed at global or transboundary harms affecting the country imposing the measures;
- unilaterally imposed trade measures invoked without any multilateral agreement and aimed at extraterritorial harms with no direct physical impact on the country imposing the measures (23)."

Category 1 is the option preferred by the WTO and the most common type of agreement. This kind of ETM may have the greatest potential to remedy global environmental problems that extend over large areas. The second category covers "multilateral unilateralism" and can be "legitimate" even in the absence of multilateral action. U.S. trade measures against Norway for violating the International Whaling Commission's rules are an example. Dispute panels have traditionally ruled against a country acting alone—that is, "unilaterally"—and using trade provisions to achieve environmental responses outside a country's borders—that is, "extraterritorially." However, the U.S.-EU tuna-dolphin dispute panel did not find either type of action illegal (48). Although unilateral-extraterritorial measures may be legal under GATT, their efficacy and efficiency in resolving transboundary and global environmental problems requires careful review. If the offending country has access to other markets for its environmentally damaging exports, then unilateral action may be insufficient. Also, the possibilities of transshipment may negate the direct export sanctions. In such cases, other types of actions—such as technical or financial assistance, or institutional reform—may be more effective and have fewer negative repercussions for international trade.

Understandably, the preference for multilateral actions and restrictions over national actions stems from WTO's focus on permitting traded goods to move freely, and on avoiding discrimination against foreign products through nontariff barriers. Not surprisingly, the WTO preferences may not be in line with environmental reality. Many of today's transboundary and global envi-

ronmental problems may not be remedied through product approaches and multilateral agreements. Increasing attention is being given to the application of process and production method (PPM) measures, because environmental damage stems from those processes, rather than from products. (See appendix II.) However, because it is difficult to monitor and judge their legitimacy, PPMs can potentially be used as disguised nontariff trade barriers for a number of sectors, including agriculture.

When only one country incurs physical environmental injury, unilateral action may be the only recourse. The key issues, according to Esty, are whether a bona fide environmental injury exists, and who applies the standard (23). Such multilateral conflicts highlight GATT's past inattention to environmental matters and the absence of an effective international environmental body to handle such issues. The new WTO Trade and Environment Committee may help clarify some issues. Until an acceptable consensus test for the legitimacy of environmental measures affecting trade emerges, the offensive use of such measures will remain controversial and risky. "The response to international environmental problems remains uncoordinated, unfocused, insufficient, and susceptible to competitively driven disregard" (24). As a result, global commons problems—including those affecting and affected by agricultural production—may be unlikely to improve consistently and significantly overall.

In the end, it appears that existing trade-related institutions do not, and other proposed institutions may not, have the funding, efficacy, or flexibility to deal effectively with transboundary and/or global environmental issues (including agricultural linkages) related to trade. Strikingly, however, there are numerous institutions and agreements whose functions may be complementary, and whose overall focuses and objectives may be similar. In the short run, it may behoove the parties to these institutions and agreements to better coordinate their efforts in the interests of efficacy and economy, particularly given the straitened governmental budgets of the 1990s. In the long run, institutions that address various agendas and efforts may be needed. Suggestions for both short-run and long-term solutions are considered in the last chapter of this report.

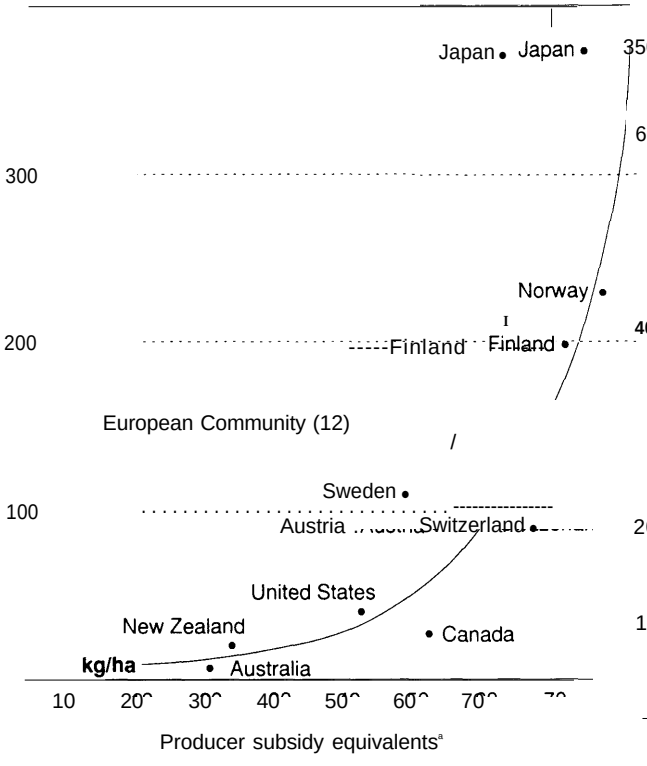
APPENDIX I: POTENTIAL ENVIRONMENTAL EFFECTS OF COMMODITY PROGRAM REFORM AND TRADE LIBERALIZATION

This appendix examines the three types of analyses that have been performed on the potential environmental effects of commodity program reform and international trade liberalization. The first type takes a global perspective; the second considers the U.S. situation; and a third looks at the regional effects of liberalization and program reform within the United States.

Examples of global studies include those by Anderson and by Lutz. In scenarios for world trade liberalization in 1990, Anderson (2) found that world food production changes very little, but shifts away from the highly protected agricultural sectors of the industrialized countries to the agricultural sectors of developing countries—especially when developing countries stop taxing their own farmers. World food prices rise mainly because farmers in countries where subsidies are reduced stop overproducing. The total long-run economic gains, which accrue principally to producers and taxpayers, are about $60 billion to $100 billion. If it is assumed that only developed countries will implement the reforms, and that developing countries still produce less (because they continue to tax their farmers), food prices rise more.

The environmental effects of world trade liberalization have been inferred from the regional nature of changes in agricultural production. Such estimates do not, however, include any detailed analysis of natural resource conditions. It is clear, however, that the global use of agricultural chemicals and intensive livestock feeding decline as crop and livestock production move to developing countries, where farmers tend to use fewer chemicals and more land than in developed countries. Moreover, farmers in developed countries will likely use fewer chemicals as their subsidies

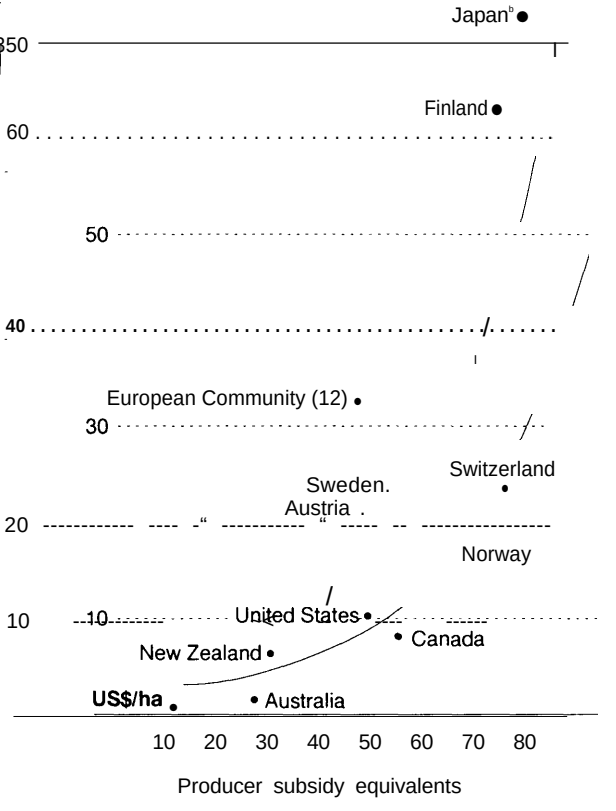
FIGURE 5-1: Average Rate of Fertilizer Use and Producer Assistance in OECD Countries, 1986-89



[a]The producer subsidy equivalent is a measure of the value of monetary transfers from domestic consumers and taxpayers to producers, expressed as percentage share of the total value of farm production

SOURCE: K Parris and J. Melanie, "Japan's Agriculture and Environmental Policies. Time to Change, "*Agricultural and Resources Quarterly* 5(3):386-399,1993.

FIGURE 5-2: Average Rate of Pesticide Use and Producer Assistance in OECD Countries, 1986-89[a]



[a]Expenditures have been converted to U S dollars by the OECD's Purchasing Power Parities

[b]Japan's pesticide use is US$378/ha with a PSE value Of 74 percent

[c]The producer subsidy equivalent is a measure of the value of monetary transfers from domestic consumers and taxpayers to producers, expressed as a percentage share of the total value of farm production

SOURCE: K. Parris and J Melanie, "Japan's Agriculture and Environmental Policies: Time to Change,'' *Agricultural and Resources Quarterly* 5(3):386-399, 1993.

decrease. Figure 5-1 displays the general association between fertilizer use and the degree of producer subsidization in OECD countries, a positive and increasing relationship between application rates and subsidy level, known as the producer subsidy equivalent (PSE). A similar relationship exists for pesticides (figure 5-2). The portrayed relationships do not account for variations in soils, climate, or other production factors, but the associations are striking. In Anderson's view, reductions in chemical use and the globalization of livestock production would likely reduce the pressure that agricultural production brings to bear on the environment. Some environmental damage would inevitably occur in developing countries that produce more, but Anderson argues that their increased incomes will eventually provide the means for better environmental control. Fears of widespread deforestation are not well-founded, because the evidence indicates that farmlands in developing countries will not expand much even if prices go up (13). Some reforestation will likely occur in developed countries when programs for land set-asides are discontinued.

In a similar study, Lutz also projects positive environmental outcomes for the industrialized countries. He is less optimistic about stemming environmental damage from increased agricultural production in developing countries, however, and concludes that the net effects of liberalization and reform on the environment are unclear. Lutz acknowledges that removing subsidies for fertilizer and other inputs and introducing effective environmental programs in developing countries, could lead to a positive outcome for the global environment. As explained in the chapter, environmental standards generally rise as a country's income increases.

The Anderson and Lutz studies of necessity have little detail on environmental changes because of their aggregate focus. However, their findings illustrate a fundamental point: agricultural program reform (liberalization) is not likely to reduce the overall scale of world production a great deal, but the regional composition of agricultural production, and technology, will shift significantly, from developed to developing economies, thus raising concern about the efficacy of environmental management in developing countries affecting transboundary and global resources.

Reliable estimates of the environmental impacts engendered by such trade and production shifts continue to elude current science. As an example, Antle and Crissman (4) illustrate the difficulties of forecasting precise environmental outcomes of trade and production shifts among Ecuadorian farmers under simple reforms. Therefore, while some analyses of the effects of aggregate shifts suggest that stress on the global environment may be alleviated, they hinge on the supposition that effective environmental programs are in place.

A second type of study focuses on the overall effects of U.S. commodity policy reform, without considering reform efforts by other countries. Such a scenario is unlikely because the United States alone would suffer production and trade losses if other countries continued to subsidize agriculture, but it offers some insight into possible national adjustments. One group estimated how crop production and resource use would change in the late 1980s, if direct income payments to farmers were substituted for commodity-specific incentives, and if annually diverted land under the Acreage Reduction Program (ARP) were allowed to return to production (46). (Land held out under the Conservation Reserve Program (CRP) would remain fallow.) In other words, given this scenario, incentives for farmers to produce more crops fall, and more land becomes available. Conceptually, production could increase or decrease, depending on the balance between the reduced incentives and the availability of more land for production. Empirically, the authors estimate that overall U.S. farm output would decline—in essence, that the impact of the reduced incentives outweighed the attractions of increased land. Total erosion increased because more land was being tilled, but chemical use declined. Table 5A-1 presents estimates of changes in environmental stress from a base case in which commodity programs continued. Generally, the shifts were small in relation to total figures, varied significantly over regions due to changes in crop mixes and technology, and amounted to substituting more land and erosion for fewer chemicals. The increases in erosion came from more land being planted. The chemical decreases came from shifts in the mix of crops, as well as lower crop prices. The authors point out that the magnitude of short-run effects depends on the strength of commodity program incentives when reform is undertaken. It is worth noting that if all CRP land were allowed to return to production, erosion and chemical use would increase.

Tobey and Reinert (75) also analyzed reductions in U.S. price and income supports as measured by PSE decreases, and in ARP set-aside reductions. The CRP was retained, as in the previous study. Their estimates for combinations of 20 and 40 percent PSE and ARP reductions show environmental damages decline from 3 to 11 percent. Lower fertilizer use is judged to outweigh the effects of increased erosion from reduced ARP set-asides causing higher offsite sedimentation damage. In general, the greater the substitutability between ARP lands and fertilizer, the greater the environmental improvement. In the longer term,

TABLE 5A-1: U.S. Intermediate-Run Resource Effects of Simulated Agricultural Policy Reform in 1990*

	Changes				
	Corn	Cotton	Soybeans	Wheat	4-Crop total
Erosion (10,000 tons)	+ 164	-44	-1,284	4,874	3,709
N (1 ,000 tons)	-420	-15	-4	10	-429
P_2O_5 (I ,000 tons)	-75	-3	-19	16	-81
Herbicides (10,000 **LB)**	**-1,075**	-12	-663	-45	-1,795
Insecticides (10,000 LB)	13	-20	-85	-45	-135

'Conservation Reserve Program retained

SOURCE: J. Miranowski, J. Hrubovcak, and J Sutton, "The Effects of Commodity Programs on Resource Use, " *Commodity and Resource Policies in Agricultural Systems,* R Just and N. Bockstael (eds.) (New York, NY Springer-Verlag,1 991).

which neither the Miranowski, et al., nor the Tobey and Reinert studies could fully explore, greater substitution is likely as operators exhaust all management techniques, and as new technologies emerge to use the less expensive land and conserve relatively more expensive inputs such as pesticides and fertilizers. The increased erosion and runoff clearly indicate that management programs are a key factor in determining the eventual environmental outcome of any commodity policy reform.

The third type of analysis examines the consequences of policy reform for specific U.S. regions. A study performed by the World Resources Institute looked at what might happen if there were a multilateral move to reform commodity payments into income supports, and if export subsidies and import restrictions were simultaneously eliminated by major trading countries (25). Global food supplies were estimated to decrease and world food prices to rise. Economic and environmental effects were estimated for case farms in Pennsylvania and Nebraska, compared to 1985 base levels. A special feature of the analysis was its incorporation of "natural resource accounting" methods, under which the environmental costs of farming, such as soil degradation and offsite water pollution, were charged against crop profits-an illustration of the polluter-pays principle (PPP) detailed in the chapter 5 text. Table 5A-2 displays the estimated effect on net farm income for various crop rotations on the Nebraska farm, without and with natural resource accounting and a soil depreciation charge.[11] The estimates suggest that if trade is liberalized and the PPP applies, farmers would make as much money by growing some rotations that put less stress on the environment. Increased profits would stem primarily from a combination of higher prices and lower production costs.

Another regional study estimated that increases in target prices and other supports make the adoption of irrigation technology more profitable and thereby increase groundwater depletion in Nebraska's northern Ogallala aquifer (35). The combination of price supports and set-asides was estimated to substantially increase depletion within five years of implementation. Table 5A-3 shows the estimated effects. A third regional study estimated that a 50-percent reduction in commodity program price support would decrease irrigated water use by one-third in the Plains and Pacific states (33). In essence, the reduced program incentives make it less profitable to grow program crops that need large amounts of water. The figure was smaller for the Mountain states, where

[11] The rationale for deducting soil depreciation charges through an external environmental policy is unclear. Several studies have shown that soil depreciation through erosion and other processes are reflected to a considerable degree in expected net returns and cropland prices (45). If such internal accounting is accurate, external charges are redundant.

TABLE 5A–2: Estimated Change in Net Economic Value[a] Under Agricultural Program Reform (Nebraska Case Farm) Net Economic Value and Change in Net Economic Value ($/acre/4 years)

	CC	HFCB	FOCB	ORGCB	HFROT	FOROT	ORGROT
Baseline NEV	72	480	483	474	348	344	340
MLDC NEV	250	561	561	553	458	449	445
Increase	(233) [b]	78	78	70	(25)	(34)	(38)
	(483-250)	(561-483)	(561 -483)	(553-483)	(458-483)	(449-483)	(445-483)

NEV - Net economic value
c c - Conventional continuous corn
HFCB - Conventional corn-beans, w/herbicides and fertilizer
FOCB - Corn-beans w/fertilizer but no herbicides
ORGCB - Organic corn-beans
HFROT - Corn- beans-corn-oats/clover w/herbicides and fertilizer
FOROT - Corn- beans-corn-oats/clover w/fertilizer but no herbicides
ORGROT - Organic corn-beans-corn-oats/clover
MLDC - Multilateral Decoupling

[a]Increases (or decreases) in Net Economic Value for each rotation are based on the most profitable conventional rotation--the fertilizer-only corn-beans rotation (FOCB)--under baseline policy The table shows the result of a movement from FOCB under baseline policy to the given rotation under multilateral decoupling

($MLDC\ NEV_{ROTATION}$ - Baseline NEV_{FOCB} = $Increase_{RoTATIoN}$)

These calculations assume output prices as in table 4 of Faeth et al. (1991 for Multilateral Decoupling)
[b]Figures in parenthesis are negative.

SOURCE: P. Faeth et al., "Paying the Farm BiIl: U.S. Agricultural Policy and the Transition to Sustainable Agriculture" (Washington, DC World Resources Institute, March 1991), p 15

TABLE 5A–3: Results of Simulations of Agricultural Program Effects on Irrigation Water Use

	Effective price of wheat (dollars per bushel)			Effective price of corn (dollars per bushel)			Irrigated acreage		Average pumping lift (feet)	
Scenario	**1984**	**1985**	**2004**	**1984**	**1985**	**2004**	**1985**	**2004**	**1985**	**2004**
Base	3.8354	37949	37700	3.1600	2.8719	2,8527	710,066	701,561	123.59	125.82
1	3,8341	3.7932	37569	3.0737	2,8714	2,8527	711,209	711,208	126,25	125,75
2	3.8366	4.0125	48647	3.2495	3.0950	4,0869	723,757	796,816	126,85	130,27
3	3.5961	3.4882	3.4168	3.0542	2.5992	2.0187	690,377	632,134	125,23	122,28
4	4,1304	4.1022	5,6325	3.2652	3.1449	4.5065	730,475	818,173	127,17	131,20
5	4.0164	39877	4.7115	3.1323	3.0290	3.6735	722,443	757,055	126,79	128,46
6	4,0964	*40431*	*4.0313*	*3.1600*	*2.9946*	*3.6475*	*712,554*	*772,019*	*126,31*	*129,16*

*Scenarios are defined as: 1. A 10% reduction in price supports for wheat and corn (with corresponding changes in price controls for the farmer-owned reserve). 2. A 10% increase in price supports for wheat and corn. 3. A 10% reduction in both price supports and target prices for wheat and corn. 4. A 10% increase in both price supports and target prices for wheat and corn. 5. A 10% reduction in the diversion requirement. 6. Maintain - ing the high diversion and support of 1983

SOURCE: R. Just, E Lichtenberg, and D Zilberman, "Effects of Feed Grain and Wheat Programs on Irrigation and Groundwater Depletion in Nebraska, " *Commodityand Resource Policies in Agricultural Systems,* R E Just and N Bockstael (eds.) (New York, NY Springer-Verlag, 1991), pp. 215-232

profitable alternative crops that also need large amounts of water can be grown.

APPENDIX II: PROCESSES AND PRODUCTION METHODS

An increasingly frequent proposal is to impose trade measures for environmental purposes based on the nature of production processes (termed processes and production methods, or PPMs) (23,93). Process standards may resemble product standards, but the issues and problems are quite different. Product standards deal with the effects of using a product by domestic parties; PPMs are meant to control negative environmental byproducts of the production process in foreign countries. For product standards, the problem is observable and easily monitored, and the actions can be legally exercised under WTO rules by the importing country. For PPMs, the production process occurs outside country borders, is not easily monitored, and cannot be legally used to screen imports under WTO rules. But the rising emphasis on PPMs is critical, because environmental problems generally arise from the production process, not the product.

Sovereignty is an issue central to the notion of PPMs. Can one country demand that the goods it imports from another be produced in what it deems an "environmentally correct" manner? This question has achieved notoriety in the 1990s with the tuna-dolphin dispute first between the United States and Mexico, then between the United States and the EU (48). The dispute began when the United States boycotted tuna imports from Mexico on the grounds that Mexican fishing practices violated the U.S. Marine Mammal Protection Act (MMPA), which restricts certain seafood imports from nations whose fishing practices kill marine mammals such as whales and dolphins. Claiming that such an action violated international trade rules, the Mexican government registered a complaint with GATT.

An initial GATT dispute panel ruling in 1992 found that the U.S. action indeed violated GATT disciplines. GATT, the panel maintained, prohibits a member from taking trade measures to enforce its own laws regarding animals or exhaustible natural resources outside its jurisdiction, and from taking such measures because a foreign country's production methods do not satisfy domestic regulations. At the behest of Mexico, the report ultimately was not presented to or adopted by the GATT Council, which would have had the power to impose actual sanctions. The EU launched a similar case against the United States. In May 1994, a second GATT dispute panel ruled that article XX exceptions could be applied to protect resources outside a country's jurisdiction, but that the embargo was still illegal under GATT, because the action would not effectively achieve U.S. conservation objectives (48). The Office of the U.S. Trade Representative requested a public review of the second GATT decision.

Current WTO rules do not generally permit the use of PPMs to address environmental problems, although the issue was not definitively addressed by the URA. Article III requires that imported goods receive treatment no less favorable with respect to internal laws and regulations than the treatment accorded "like" products of national origin (48). A central issue with respect to PPMs is whether those laws can differentiate between different goods based on the processes or methods used in their production, if those processes or methods are not reflected in the observable and measurable physical characteristics of the product itself .

WTO article III rules potentially conflict with international environmental agreements incorporating trade measures based on PPMs. For example, the Montreal Protocol has established a schedule for the phase-out of ozone-depleting substances by restricting trade in the substances—and restricting trade in products produced with the substances. Because production processes and not products cause much environmental damage, the conflict between WTO's emphasis on avoiding trade barriers and efforts to pursue legitimate environmental objectives is genuine.

What constitutes legitimate environmental activities is another unanswered question. Can a country act unilaterally to restrict the entry of a

product made by using inputs that cause environmental damage to the acting country? For example, could the United States restrict the entry of certain agricultural commodities produced in Mexico that use a banned U.S. pesticide which, eventually, migrates into U.S. territory and threatens endangered species? Under current WTO rules, the answer appears to be no. When can several countries act multilaterally to diminish transboundary or global environmental problems and avoid WTO sanctions? These questions capture the extraterritoriality and unilateral/multilateral dimensions of trade-environmental conflicts that are unsettled by WTO or any other organization. As mentioned in the chapter, problems in identifying goods because of transshipment and the advisability of using instruments other than trade measures require consideration in these cases.

A growing number of potential PPM cases, some agricultural in content, are necessitating further discussion and review by international bodies. The OECD has issued a note outlining the conditions under which PPM-based trade measures might be used; their effectiveness, feasibility, and efficiency considerations; and alternatives to such measures (53). Young has also proposed a set of disciplines to guide the use of PPMs that preserve maximum benefits from freer trade while allowing countries to pursue environmental objectives beyond their borders. As noted above, the major PPM issues turn on the feasibility of monitoring processes and production methods in foreign countries—and the potential for abusing them, by using them as nontariff barriers to trade. Using effective low-cost alternatives (e.g., sharing technical assistance and technology) may help to avoid the problems that may accompany PPMs. Consensus positions or principles on PPM use have not been issued. However, as mentioned above, several agricultural cases of product-related PPMs may emerge in the near future, including genetically engineered plants and organic farm products that require clarification of international rules. This topic will likely be one of the key issues for the WTO's new Trade and Environment Committee.

CHAPTER 5 REFERENCES

1. Abler, David G., and Shortle, James S., "Environmental and Farm Commodity Policy Linkages in the US and EC," *European Review of Agricultural Economics*, vol. 19, 1992, pp. 197-217.
2. Anderson, Kym, "Agricultural Trade Liberalization and the Environment: A Global Perspective," *World Economy*, vol. 14, No. 4, December 1991.
3. Anderson, Kym, "The Standard Welfare Economics of Policies Affecting Trade and the Environment," *The Greening of World Trade Issues*, Anderson and Blackhurst (eds.) (Ann Arbor, MI: University of Michigan Press, 1992), pp. 25-48.
4. Antle, John A., and Crissman, Charles C., "Empirical Foundations for Environment-Trade Linkages: Implications of an Andean Case Study," *Agricultural Trade and the Environment: Discovering and Measuring the Critical Linkages*, M. Bredahl, N. Ballenger, and T. Roe (eds.) (Denver, CO: Westview Press) (forthcoming).
5. Antle, J., and Just, R., "Effects of Commodity Program Structure on Resources and the Environment," *Commodity Policy and Resource Use in Agricultural Systems*, N. Bockstael and R. Just (eds.) (New York, NY: Springer-Verlag, 1991).
6. Ballenger, Nicole, and Krissoff, Barry, "Environmental Side Agreements: Will They Take Center Stage?" *Agricultural Trade and the Environment: Discovering and Measuring the Critical Linkages*, M. Bredahl, N. Ballenger, and T. Roe (eds.) (Denver, CO: Westview Press) (forthcoming).
7. Ballenger, Nicole, Beattie, Rachael, and Krissoff, Barry, "Coordination of Agricultural Trade and Environmental Policy: A Western Hemisphere Example," *Environmental Policies: Implications for Trade*, J. Sullivan (ed.), U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Economic Report 252, June 1994, pp. 75-81.

8. Barrett, Scott, "Trade Restrictions in International Environmental Agreements," University College, London: Centre for Social and Economic Research on the Global Environment, working paper GEC 94-13, 1994.
9. Beattie, Rachael, "Environmewntal Accounting: Including the Environmental Measures of Well-Being," *Environmental Policies: Implications for Trade*, J. Sullivan (ed.), U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Economic Report 252, June 1994, pp. 6-12.
10. Bhagwati, Jagdish, "The Case for Free Trade," *Scientific American*, November 1993, pp. 42-49.
11. Bowman, Jean A., *The Rio Grande—A Confluence of Waters, Nations, and Cultures* (College Station, TX: Texas Water Resources Institute, 1993).
12. Brown-Weiss, Edith, Magraw, Daniel Barstow, and Szasz, Paul C., *International Environmental Law: Basic Instruments and References* (New York, NY: Transnational Publishers, 1992).
13. Cavallo, D., "Agriculture and Economic Growth: The Experience of Argentina, 1913-84," *Agriculture and Governments in an Interdependent World*, A. Maunder and A. Valdes (eds.) (London: Dartmouth for International Association of Agricultural Economists, 1989).
14. Charnovitz, Steve, "A Taxonomy of Environmental Trade Measures," *Georgetown International Environmental Law Review* VI(1):1-46, winter 1993.
15. Charnovitz, Steve, "NAFTA's Environmental Significance," in Magraw, Daniel, "NAFTA's Repercussions: Is Green Trade Possible?" *Environment*, vol. 36, No. 2, March 1994.
16. Cochran, M.J., "Non-Indigenous Species in the United States: Economic Consequences," contractor report prepared for the Office of Technology Assessment, March 1992.
17. Cochrane, W., and Runge, C.F., *Reforming Farm Policy: Toward a National Agenda* (Ames, IA: Iowa State University Press, 1992).
18. Daly, Herman E., "The Perils of Free Trade," *Scientific American*, November 1993, pp. 50-57.
19. Dean, J., "Trade and the Environment: A Survey of the Literature," *International Trade and the Environment*, P. Low (ed.), World Bank Discussion Papers 159, Washington, DC, 1992.
20. Eaton, David J., and Hurlburt, David, "Challenges in the Binational Management of Water Resources in the Rio Grande/Rio Bravo," LBJ School of Public Affairs, Austin, Texas, 1992.
21. Emerson, Peter M., and Nessman, Alan C., "Integrating Environmental Protection and North American Free Trade," paper presented to the *Australian Agricultural Economics Society Annual Conference*, Wellington, New Zealand (Austin, TX: Environmental Defense Fund, 1994).
22. Ervin, D., "Soil and Water Conservation Down on the Farm: A Changing Economic Landscape," *Journal of Soil and Water Conservation*, May 1994.
23. Esty, Daniel C., *Greening the GATT: Trade, Environment, and the Future*, Washington, DC: Institute for International Economics, 1994.
24. Esty, Daniel, Director, Yale Center for Environmenter Law and Policy, New Haven, CT, personal communication, 1994.
25. Faeth, Paul, et al., "Paying the Farm Bill: U.S. Agricultural Policy and the Transition to Sustainable Agriculture" (Washington, DC: World Resources Institute, March 1991).
26. Ferguson, Walter, and Padula, Armand, "Economic Effects of Banning Methyl Bromide for Soil Fumigation," U.S. Department of Agriculture, Economic Research Service, Resources and Technology Division, AER No 677 (Washington, DC: March 1994).
27. Forsythe, Kenneth, and Evangelou, Phylo, "Costs and Benefits of Irradiation Quarantine Treatments for U.S. Fruit and Vegetable Imports," *Environmental Policies: Implications for Trade*, J. Sullivan (ed.), U.S. Department

of Agriculture, Economic Research Service, Foreign Agricultural Economic Report 252, June 1994, pp. 82-90.
28. Foy, C.L., et al., "History of Weed Introductions," *Exotic Plant Pests in North American Agriculture*, C.L. Wilson and C.I. Graham (eds.) (New York, NY: Academic Press, 1983), pp. 65-92.
29. Gardner, B., The Impacts of Environmental Protection and Food Safety Regulation on U.S. Agriculture (Washington, DC: Agricultural Policy Working Group, 1993).
30. General Agreement on Tariffs and Trade, Secretariat, "Trade and Environment," *International Trade, 1990-91*, Geneva, March 1992.
31. Giordano, Mark, "Tropical Forest Policy and Trade: A Case Study of Malaysia," *Environmental Policies: Implications for Trade,* J. Sullivan (ed.), U.S. Department of Agriculture, Economic Research Service, Foreign Agricultural Economic Report 252, June 1994, pp. 113-121.
32. Grossman, G., and Krueger, A., "Environmental Impacts of a North American Free Trade Agreement," discussion paper, John M. Olin Program for the Study of Economic Organization and Public Policy, Princeton University, February 1992.
33. Howitt, R., "Water Policy Effects on Crop Production and Vice Versa: An Empirical Approach," *Commodity and Resource Policies in Agricultural Systems*, Just and Bockstael (eds.) (New York, NY: Springer-Verlag, 1991), pp. 234-253.
34. Hufbauer, G.C., and Schott, J., *NAFTA: An Assessment* (Washington, DC: Institute for International Economics, 1993).
35. Just, R., Lichtenberg, E., and Zilberman, D., "Effects of Feed Grain and Wheat Programs on Irrigation and Groundwater Depletion in Nebraska," *Commodity and Resource Policies in Agricultural Systems*, Just and Bockstael (eds.) (New York, NY: Springer-Verlag, 1991), pp. 215-232.
36. Kristöm, Bengt, "Is the Income Elasticity of Environmental Improvements Less than One? Evidence from Europe and Other Countries," *Environmental and Resource Economics* (forthcoming).
37. Kuch, P., and Reichelderfer, K., "The Environmental Implications of Agricultural Support Programs: A United States Perspective," *Improving Agricultural Trade Performance Under the GATT,* T. Becker, R. Gray, and A. Schmitz (eds.) (Kiel, Germany: Wissenschaftsverlag Vauk Kiel KG, 1992), pp. 215-231.
38. Lavelle, Marianne, "Poisoned Waters Provide Early Test for NAFTA," *National Law Journal*, Mar. 21, 1994.
39. Lee, Hiro, and Roland-Holst, David, "International Trade and the Transfer of Environmental Costs and Benefits," Paris: OECD Development Centre Technical Paper No. 91, December 1993.
40. Lucas, Robert E.B., " International Environmental Indicators: Trade, Income and Endowments," *Agricultural Trade and the Environment: Discovering and Measuring the Critical Linkages*, M. Bredahl, N. Ballenger, and T. Roe (eds.) (Denver, CO: Westview Press) (forthcoming).
41. Lucas, R., Wheeler, D., and Hettige, H., "Economic Development, Environmental Regulation, and the International Migration of Toxic Industrial Pollution: 1960-1988," *International Trade and the Environment*, P. Low (ed.) (Washington, DC: The World Bank, 1992).
42. Lutz, E., "Agricultural Trade Liberalization, Price Changes, and Environmental Effects," *Environmental and Resource Economics,* 1992.
43. Marchant, Mary A., and Ballenger, Nicole, "The Trade and Environment Debate: Relevant for Southern Agriculture," *Journal of Agr. and Applied Econ.,* vol. 26, No. 1, July 1994, pp. 108-128.
44. McCarl, B.A., William, N., and Houshmand, Z., "Environmental and Economic Effects of Trade and Agricultural Policy Alterations," contractor report prepared for the Office of Technology Assessment, August 1994.

45. Miranowski, John A., and Hammes, Brian D., "Implicit Prices for Soil Characteristics in Iowa," *American Journal of Agricultural Economics*, vol. 66, 1984, pp. 379-383.
46. Miranowski, J.A., Hrubovcak, J., and Sutton, J., "The Effects of Commodity Programs on Resource Use," *Commodity and Resource Policies in Agricultural Systems*, R. Just and N. Bockstael (eds.) (New York, NY: Springer-Verlag, 1991).
47. Newman, Mark, *NAFTA: Effects on Agriculture—Environmental Concerns* (Chicago, IL: American Farm Bureau Research Foundation, 1991).
48. Office of the U. S. Trade Representative, *The GATT Uruguay Round Agreements: Report on Environmental Issue* (Washington, DC: U.S. Government Printing Office, 1994).
49. Office of the U.S. Trade Representative, *Uruguay Round of Multilateral Trade Negotiations General Agreement on Tariffs and Trade* (Washington, DC: U.S. Government Printing Office, 1994).
50. Organization for Economic Cooperation and Development, *Agricultural and Environmental Policy Integration: Recent Progress and New Directions* (Paris, France: 1993).
51. Organization for Economic Cooperation and Development, *The Environmental Effects of Trade* (Paris, France: 1994).
52. Organization for Economic Cooperation and Development, *Methodologies for Environmental and Trade Reviews*, OCDE/GD(94)103 (Paris, France: 1994).
53. Organization for Economic Cooperation and Development, *Further Analysis on PPMS: Trade Measures and Alternatives* (Paris, France: October 1994).
54. Paden, R., "Free Trade and Environmental Economics," *Agriculture and Human Values*, winter, 1994, pp. 47-54.
55. Parris, K., and Melanie J., "Japan's Agriculture and Environmental Policies: Time to Change," *Agricultural and Resources Quarterly*, vol. 5, No. 3, 1993, pp. 386-399.
56. Pearce, D., "Should GATT Be Reformed for Environmental Reasons?" lecture to Oregon State University Seminar Series on Trade, Development, and the Environment, Department of Agriculture and Resource Economics, Corvallis, Oregon, 1993.
57. Pearce, D.W., and Turner, R. K., *Economics of Natural Resources and the Environment* (Baltimore, MD: Johns Hopkins University Press, 1990).
58. Pearson, C.S., "The Trade and Environment Nexus: What is New Since '72?" *Trade and the Environment* (Washington, DC: Island Press, 1993), pp. 23-32.
59. Reichelderfer, K., "Environmental Protection and Agricultural Support: Are Tradeoffs Necessary?" *Agricultural Policies in a New Decade*, K. Allen (ed.) (Washington, DC: Resources for the Future, 1990).
60. Rhoads, P., Director, Ecosytem Restoration Office, South Florida Water Management District, West Palm Beach, FL, personal communication, 1994.
61. Rodriguez, Adrian G., Abler, David. G., and Shortle, James S., "Trade Policy, Natural Resources, and the Environment: The Case of Costa Rica," paper presented to Resource Policy Consortium symposium *International Environmental Management and National Policy* (proceedings), The World Bank, May 16-17, 1994.
62. Rosson, C.P., III, et al., "Agricultural Trade and the Environment: Potential Impacts on the Lower Rio Grande Valley of Texas," contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, July 1994.
63. Runge, C. Ford, "The North American Free Trade Agreement: Issues and Impacts for Minnesota," Center for International Food and Agricultural Policy, WP93-2 (St. Paul, MN: University of Minnesota, May 1993).
64. Runge, C. Ford, *Freer Trade, Protected Environment: Balancing Trade Liberalization and*

Environmental Interests (New York, NY: Council on Foreign Relations Press, 1994).
65. Runge, C.F., "Trade, Pollution and Environmental Protection," *Handbook of Environmental Economics,* D. Bromley (ed.), forthcoming, 1994.
66. Sailer, R.I., "History of Insect Introductions," *Exotic Plant Pests and North American Agriculture,* C.L. Wilson and C.L. Graham (eds.) (New York, NY: Academy Free Press, 1983), pp. 15-38
67. Schott, Jeffrey J., *The Uruguay Round: An Assessment* (Washington, DC: Institute for International Economics, 1994).
68. Segerson, K., "Natural Resource Concepts in Trade Analysis," *Agricultural Trade and Natural Resources: Discovering the Critical Linkages*, J. Sutton (ed.) (Boulder, CO: Lynne Reiner, 1988).
69. Snell, R., and Boggess, B., "Everglades Case Study: Water, Agricultural and Environmental Issues," contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, July 1994.
70. South Florida Water Management District, "Surface Water Improvement and Management Plan for the Everglades (SWIM-PLAN)," West Palm Beach, FL, March 1992.
71. Sutton, J., "Resource Policy Subsidies and the GATT Negotiations," U.S. Department of Agriculture, Economic Research Service, AER No. 616 (Washington, DC: 1989).
72. Texas Water Commission, *The State of Texas Water Quality Inventory,* 11th ed., Austin, TX, 1992.
73. The International Agricultural Trade Research Consortium, "The Uruguay Round Agreements on Agriculture: An Evaluation," Commissioned Paper No. 9 (St. Paul, MN: University of Minnesota, Dept. of Agriculture and Applied Economics, 1994).
74. Tobey, James A., "The Effects of Domestic Environmental Policies on Patterns of World Trade: An Empirical Test," *Kyklos*, vol. 43, No. 2, 1990, pp. 191-209.
75. Tobey, James A., and Reinert, Kenneth A., "The Effects of Domestic Agricultural Policy Reform on Environmental Quality," *The Journal of Agricultural Economics Research*, vol. 43, 1991, pp. 20-28.
76. Tobey, James A., and Henri, Smets, "The Polluter-Pays Principle in the Context of Agriculture and the Environment," *The World Economy* (forthcoming).
77. U.S. Congress, House of Representatives, *North American Free Trade Implementation Act,* 103d Congress, 1st sess., H. Rept. 103-361, part 2, 2.
78. U.S. Congress, Office of Technology Assessment, *Trade and the Environment: Conflicts and Opportunities*, OTA-BP-ITE-94 (Washington, DC: U.S. Government Printing Office, May 1992).
79. U.S. Congress, Office of Technology Assessment, *Harmful Nonindigenous Species in the United States*, OTA-F-566 (Washington, DC: U.S. Government Printing Office, September 1993).
80. U.S. Congress, Office of Technology Assessment, *Industry, Technology, and the Environment: Competitive Challenges and Opportunities*, OTA-ITE-586 (Washington, DC: U.S. Government Printing Office, January 1994).
81. U.S. Department of Agriculture, Agricultural Research Service, "Erosion Study Crosses Border," *Agricultural Research*, September-October 1994, pp. 10-13.
82. U.S. Department of Agriculture, Economic Research Service, *Crop and Livestock Production and Input Use, 1993* (Washington, DC: 1993).
83. U.S. Department of Agriculture, Economic Research Service, *Environmental Policies: Implications for Agricultural Trade*, Foreign Agricultural Economic Report No. 252, June 1994.
84. U.S. Department of Agriculture, Economic Research Service, "NAFTA: An Early Assessment," Washington, DC, December 1994.

85. U.S. Department of Agriculture, Office of Economics and Economic Research Service, "Effects of the Uruguay Round Agreements on U.S. Agricultural Commodities," March 1994.
86. U.S. Department of Agriculture, Foreign Agricultural Service, *Desk Reference Guide to U.S. Agricultural Trade*, Agricultural Handbook No. 683, revised January 1993.
87. U.S. Department of Agriculture, Soil Conservation Services, "National Resources Inventory, Summary Report and Backgrounder," Washington, DC, July 1994.
88. U.S. Department of Commerce, Bureau of the Census, *Census of Agriculture*, Washington, DC, 1969-1987, 1988.
89. U.S. Environmental Protection Agency/Secretaria de Desarrollo Urbano y Ecologia (SEDUE), *Integrated Environmental Plan for the Mexican-U.S. Border Area (First Stage, 1992-1994*) (Washington, DC: 1992).
90. U.S. International Trade Commisssion, "Potential Impacts on the U.S. Economy and Industries of the GATT Uruguay Round Agreements," Publication 2790 (Washington, DC: June 1994).
91. Willis, L.M., et al., "Analysis of On-Farm Best Management Practices in the Everglades Agricultural Area," *Proceedings of the Second Conference on Environmentally Sound Agriculture*, Orlando, FL, 1994.
92. Yarkin, Cherisa, et al., "Canceling Methyl Bromide for Postharvest Use to Trigger Mixed Economic Results," *California Agriculture*, vol. 48, No. 3, 1994, pp. 16-21.
93. Young, Michael D., "Ecologically-Accelerated Trade Liberalization: A Set of Disciplines for Environment and Trade Agreements," *Ecological Economics*, vol. 9, No.1, January 1994, pp. 43-52.