Exploring Linkages Among Agriculture, Trade, and the Environment: Issues for the Next Century. By Barry Krissoff, Nicole Ballenger, John Dunmore, and Denice Gray. Natural Resources and Environment Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 738.

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Abstract

Many trade and environment issues will confront agriculture over the next several years. This report provides an economic framework to better understand these issues and discusses prior empirical inquiries and findings. Four primary issues are addressed: (1) how will environmental policies affect agricultural trade?; (2) how will agricultural trade liberalization affect environmental quality?; (3) to what extent should there be international harmonization of environmental policies and product standards?; and (4) is there economic justification for using trade measures to protect the environment? This report demonstrates that basic economic paradigms can provide a basis for understanding how trade and the environment interact. The few empirical studies based on these concepts have found many of the linkages between trade and the environment to be weak or the effects small. Trade and environment issues remain important to monitor, however, because economic and environmental relationships and domestic and international policies are continually evolving, and decisionmakers need good information to confirm or disprove the numerous hypotheses that have surfaced in international discussions.

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Keywords: Environmental policy, agricultural policy, trade policy, trade, environment, harmonization

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Summary

Agricultural trade barriers are coming down at the same time that environmental awareness is increasing in many parts of the world. Trade and environmental interests sometimes clash, as governments, industries, businesses, environmentalists, and consumers push their competing agendas. This report examines the trade and environment issues likely to confront world agriculture over the next several years.

The four main issues are:

1. How will environmental policies affect agricultural trade? Governments can choose a variety of regulations or taxes to reduce the level of pollution (soil erosion and loss of wildlife habitat, for example) that may occur in the production of agriculture and food products.

Studies, mostly in manufacturing, have found that environmental regulations designed to reduce pollution have not led to significant changes in trade. The main reason for this may be that the costs of environmental compliance have tended to be small in relation to overall costs on an aggregated sectoral basis. However, these regulations may have significantly affected some localities or commodities or may be more significant in the future.

2. How will agricultural trade liberalization affect environmental quality? The GATT (General Agreement on Tariffs and Trade) Uruguay Round agreement and NAFTA (the North American Free Trade Agreement) aim to liberalize trade by reducing trade barriers. These agreements, particularly NAFTA, also addressed environmental issues, such as those related to food, health, and safety standards, the role of international environmental agreements, and relaxation of environmental measures for attracting foreign investment.

The effect of freer agricultural trade on environmental quality depends on what happens to the level of economic activity and associated pollution, the intersectoral changes in economic activity, and changes in production methods. Well-designed and enforced environmental policies are more likely to ensure that trade liberalization will bring economic growth and gains in environmental quality. Economic growth and higher incomes engendered by free trade may also lead to a greater social preference for the resources available to achieve environmental improvement.

3. To what extent should there be international harmonization of environmental policies and product standards? Variation of environmental policies makes economic sense because countries differ in their demand for and supply of environmental amenities. However, harmonization of environmental policies including product standards designed to protect health, safety, and the environment may improve market performance by lowering costs and improving the quality of consumer information. International environmental problems can also be alleviated by harmonization of environmental performance standards.

4. Is there economic justification for using trade measures to protect the environment? There is a spectrum of issues for which there has been interest in using trade measures for environmental purposes, including efforts to control pollution generated by a trading partner, measures to protect the global commons, actions taken against imported products not meeting domestic standards, and efforts to level the playing field. Economic concepts justify the use of trade measures in some cases. However, global environmental problems are often better addressed by voluntary negotiations and by consensus policies that do not interfere with international trading rules. Again, the message is that sound environmental policy directed at the problem is preferred to restricting trade.

Glossary

BECC—Border Environmental Cooperation Commission

CODEX—Codex Alimentarius Commission

CTE—Committee on Trade and Environment

EU—European Union

GATT—General Agreement on Tariffs and Trade

IEA—International Environmental Agreements

IPM—Integrated Pest Management

MMPA—Marine Mammal Protection Act

NAAEC—North American Agreement on Environmental Cooperation

NADB—North American Development Bank

NAFTA—North American Free Trade Agreement

NAPIAP—National Agricultural Pesticide Impact Assessment Program

NTB—Non-tariff Trade Barrier

OECD—Organization for Economic Cooperation and Development

PPM—Production and Processing Methods

S&P—Sanitary and Phytosanitary

WTO—World Trade Organization

Exploring Linkages Among Agriculture, Trade, and the Environment

Issues for the Next Century

Barry Krissoff
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John Dunmore
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Introduction

The linkages between international trade and the environment frequently are the focus of domestic and international discussions. International policy forums such as the United Nations Conference on Environment and Development, the Committee on Trade and Environment (CTE) under the auspices of the new World Trade Organization (WTO), and the Organization for Economic Cooperation and Development (OECD) all discuss trade and environment issues.[1] For approximately 2 years, WTO and OECD discussions have focused on such topics as: (1) how environmental policies affect trade and competitiveness, (2) how agricultural trade liberalization affects environmental quality, (3) to what extent international harmonization of environmental policies and product standards should exist, and (4) what economic justifications exist for using trade measures for environmental quality.

Part of the discussion stems from concerns of environmental and consumer groups (Greenpeace, Sierra Club, National Wildlife Federation, and Public Citizen, for example), which generally support a closer scrutiny of the environmental effects of multilateral and regional trade policies and an international consensus with their recommendations on conservation, sustainable development, and safer and healthier products. Some environmental and consumer organizations complain about the allegedly negative environmental effects of shifts in production and trade due to trade liberalization. Also, some environmental groups worry that international trade agreements will encourage harmonization of environmental policies at lower national standards than those currently in force in industrialized nations. Finally, some of these groups favor the use of trade instruments to achieve their environmental policy goals.

Another aspect of the discussion originates from industry groups, including farm and food organizations. These groups often are concerned that domestic environmental regulations will impair their international competitiveness. If environmental regulations increase domestic costs of production, they argue, competing exporters should face similar constraints. A related issue of concern to food processors is the myriad of labeling and packaging standards among countries. Industry groups wonder if different foreign standards are legitimate or whether they are covert trade barriers. Harmonization of labeling and packaging standards, including "ecolabeling" (labels that reflect environmental harm associated with production, consumption, or disposal of the products), has been raised at international forums as a means of addressing perceived unfair competition.

Trade and environment issues also generate apprehension among developing countries. Developing country groups are concerned that their environmental standards and enforcement, if less strict than those of developed nations, may invoke trade restrictions from developed countries. While less environmental protection may be the result of lower economic development levels and fewer resources, lower standards also make a convenient

[1] In April 1994, more than 100 nations including the United States agreed to reduce trade barriers and create a new World Trade Organization (WTO). The Committee on Trade and Environment also was established at this time. The multilateral agreement, negotiated under the auspices of the General Agreement on Tariffs and Trade (GATT), was ratified by the United States in December 1994. The WTO will supersede the GATT as the international organization governing global trade. Trade and the environment is one of the main agenda items of the new WTO.

and popular justification for trade complaints from environmental and producer groups in developed countries.

Economists and policy analysts have begun to explore the linkages between trade and environmental quality. Some economic tenets are clear in the debate. It is widely accepted that freer trade leads to increased economic efficiency and economic growth, but these gains neither guarantee improvements in environmental quality—such as reductions in erosion, improved surface and groundwater quality or increased wildlife habitat—nor necessarily create environmental problems. At the same time, environmental policy may significantly improve environmental quality, but its effects on production, trade, and competitiveness are not well understood.

Environmental Policies, Trade, and Competitiveness

Economists use the term "externality" to describe a harmful or beneficial side effect that occurs in the production, consumption, or distribution of a particular good. Production of an agricultural good may generate an environmental externality, for instance. To produce the good, a farmer, rancher, or forester chooses a technology and input mix (land, labor, machinery, and chemicals) to maximize profits. In the production process, wastes or amenities may be produced as a byproduct. These are environmental externalities if they affect the well-being of others and the farmer does not pay the costs of the waste cleanup or receive compensation for the benefits of the amenity provided.

An externality often occurs when there are ill-defined or poorly enforced property rights, for example, when resources such as ground and surface water or air over a city are owned by the community or by no one. Externalities also tend to occur when those affected are widely dispersed and difficult to identify (Pearce and Turner, 1990). Markets may fail to reflect the cost to the community of the externality.[2]

Agricultural practices can cause both negative and positive externalities. Farmers do not bear all the costs associated with agricultural production, such as soil erosion, water depletion, surface and groundwater pollution, deforestation, loss of wildlife habitat, and chemical misuse and contamination. On the other hand, they do not reap the benefits of recreational amenities that may be produced. Environmental effects can also occur or be exacerbated by government when public policies raise or lower input and output prices above or below market levels that would exist in the absence of such policies. Some examples of support programs are export restitutions, deficiency payments, and import quotas.

Market failure occurs in a competitive environment when market prices differ from social costs (private costs of production plus environmental or "external" costs or benefits). Producers or consumers may have little incentive to alter activities that contribute to pollution or to adopt environmentally beneficial technologies because these external costs do not enter their private costs of production. Often, policies in the form of regulations (such as standards, bans, and restrictions on input use) and incentive-based mechanisms (such as taxes, subsidies, and marketable permits) are implemented as corrective measures. While these policies may meet their environmental goals, they also affect production, trade, investment, technological change, and consumption. Such effects may be particularly important to agricultural producers and food processors.

Selection of Environmental Policies and Policy Instruments

To provide private market incentives for pollution abatement, policymakers must address two interrelated issues: how much pollution should be reduced and what type of policy is most effective in achieving that goal? To answer the first question, we need to know the value society places on the damage from pollution, such as that associated with contaminated water or carcinogens in the air, and the net benefits from production at different levels of economic activity (fig. 1).

Society could opt to eliminate most, if not all, pollution, but the costs of doing so may well exceed the benefits. For example, while all pesticides could be banned from agricultural use, this could drastically reduce the food supply or make it very expensive. In this case, the output and pollution levels would be less than Q^* and P^*. A more economically rational approach is to compel the producer to pay an amount equal to the costs of the pollution, for example, a tax on production (*t* in figure 1). The producer's marginal net benefit curve shifts downward with a tax of rate t on each unit of production, and production is Q^*, the point at which the marginal net benefits from production equal zero. The optimal tax is that tax rate leading to economic activity and pollution at the social optimum (Q^* and P^*), eliminating the gap between private and social costs.

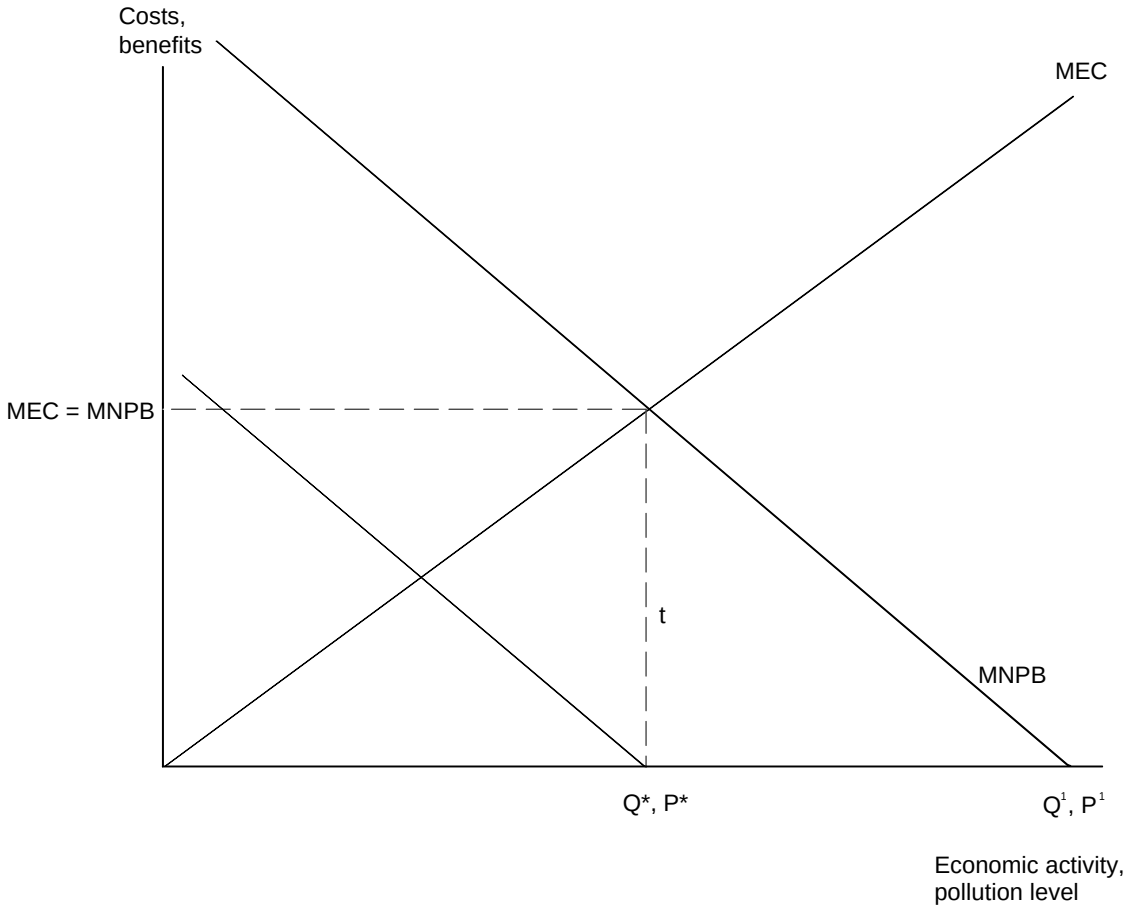
[2]Market failure would not exist if the negative externality generated in the production process affected only a next-door neighbor with clearly defined property rights. The producer and the neighbor could privately negotiate a payoff to reduce the level of the bad externality and an efficient solution could be attained. Whether the producer pays the neighbor or the neighbor pays the producer depends on who owns the property rights associated with the offending pollutant.

Environmental policy instruments include regulations, often called "command and control" approaches, as well as incentive-based mechanisms such as taxes, subsidies, and marketable permits. Regulations can take the form of standards or quotas for allowable discharge levels; restrictions on economic activity in certain environmentally vulnerable areas; bans on the use of products with potentially adverse environmental effects; or the setting of standards for products or for production and processing methods.

Industrialized countries use a variety of environmental regulations in food and agriculture including regulations on packaging, labeling, and the recycling of waste; restrictions on land use; restrictions and bans on the use of certain agricultural chemicals; quotas on the production and application of manure; restrictions on the number of animals per hectare or the size of livestock operations; and restrictions on dumping pollutants into ground- or surface-water supplies.

Taxes can be levied to reduce polluting activities or the use of polluting inputs. Taxes can also be used to raise revenue in support of research into environmentally preferred technologies or the undertaking of a new investment. Taxes on chemical use in agriculture are

Figure 1
Optimal pollution level and tax



Source: Economic Research Service, USDA, adapted from Pearce and Turner, 1990.

Figure 1*—This figure describes the value society places on the damage from pollution, such as that associated with contaminated water or carcinogens in the air, and the net benefits from production at different levels of economic activity. Following Pearce and Turner, these damages and benefits can be represented by marginal external costs (MEC) and marginal net private benefits (MNPB). The MEC curve measures the additional costs of pollution to society from changes in production levels. We draw the MEC as upward sloping to reflect the greater per unit cost from environmental damage at higher levels of economic activity. The MNPB schedule shows the benefits, minus private costs, flowing to the producer from different levels of production. Ignoring the social costs of production, the producer would choose to produce at level Q^1, with an associated level of pollution P^1, at levels higher than the societal optimum. When social costs are considered, society's optimal level of economic activity, and the associated level of pollution, occur at that level of production where the marginal benefits to producers equal the marginal costs of pollution to society (Q*, P*).*

gaining in popularity, although some studies suggest rates must be set very high to significantly reduce pollution in vulnerable areas (Haley, 1993). When taxes are employed, the country is said to be following a "polluter-pays" approach.[3] Although taxes can be imposed at different points in the production cycle, economic theory suggests that targeted taxes are more efficient than more general ones. For instance, effluent taxes are superior to producer taxes or levies on trade because they can be specific to firms or industries that pollute in regions where the environment is slow to recover. Effluent taxes could spark technological change that reduces emissions per unit of output (Beghin, Roland-Holst, and van der Mensbrugghe, 1994). A practical difficulty of targeting taxes in agriculture is that many of the environmental issues associated with agricultural production are nonpoint problems. How to determine who is polluting and, therefore, whom to tax becomes a critical obstacle.

Subsidies are another environmental policy instrument. Subsidies provide compensation to produce less pollution or to employ environmentally "friendly" technologies, which may also be higher cost technologies. Payments to farmers willing to engage in soil conservation and water-quality improving practices represent a "pay to conserve" approach used in some developed regions, such as the United States and the European Union (EU).

Taxes and subsidies can have different effects on sector-wide output and total pollution. A tax raises the costs of doing business for a firm (or reduces the price received by the firm) and discourages the polluting activity. A subsidy encourages environmentally sensitive inputs and, therefore, discourages the polluting activities of the firm. However, subsidies do have possible downsides. Unlike a tax, a subsidy approach may encourage new firms to enter (or discourage firms from exiting) the industry by lowering private average costs of production. While the incentive for each firm is still to pollute less, an increase in the number of firms may lead to expanding total industry output and possibly an increase in pollution (Pearce and Turner, 1990).

A marketable permit is another policy instrument that provides more flexibility among firms in meeting government-established environmental regulations. In contrast to producer taxes, marketable permits allow for a nonuniform distribution of costs of compliance to government standards. For example, when a tax policy targets a group of producers identified with a particular source of pollution, each producer pays a fixed marginal tax rate based on the level of inputs used or output produced, even though some producers may be polluting at higher rates than others. If, instead of being hit with a production tax, all firms were issued equal permits to pollute, those with a higher rate of pollution could purchase permits from the "cleaner" producers (or reduce their pollution levels). The result: heavier polluters pay higher costs to produce. For example, marketable permits might be used in livestock operations; farmers who produce intensively or have soils that are more susceptible to nitrate overloading may need to purchase permits from less polluting operations or may need to reduce the intensity of their operation. Similarly, marketable permits could allow trade-offs across types of polluters—those who emit pollutions from the end of a pipe and those who are nonpoint source or diffuse polluters, such as agricultural producers (Letson, Crutchfield and Malik, 1993). Provided that the barriers to marketable permits are not too high (regulations and administrative costs, for example), marketable permits theoretically can achieve the same end as taxes, with lower costs to producers and consumers.

Environmental Policies, International Trade, and National Welfare—Effects on Production

How does environmental policy affect production, consumption, trade, and prices? To answer this question, we need to consider several factors: (1) does the externality occur in the production or consumption process? (2) is the externality local to the country, transboundary, or global? (3) does the externality occur in the exporting country, importing country, or both? (4) what type of environmental policy is adopted? (5) is the environmental policy enacted in the exporting country, the importing country, or both? and (6) is the exporting or importing country a large enough trader of the good to influence world market prices?

In our first illustration, we consider the small-country case, where the polluting country is unable to influence world prices. Pollution occurs in the production of a traded good, but the pollution's effects are strictly local. We assume that an environmental tax is imposed on the output of the good, such as an output tax placed on the livestock industry to reduce the effects of excess manure production on water (fig. 2).[4] Imposition of an environmental tax will reduce domestic production, pollution, and exports. However, domestic consumption levels will remain unchanged, since consumers face

[3]The Polluter Pays Principle was approved by member countries of the OECD in 1972. Under this principle, the public owns environmental resources and those who pollute these resources must pay compensation to the public (Baumol and Oates, 1988).

[4]The reader can bypass figures 2-9 without losing the main content discussed in the text. The figures provide additional technical detail.

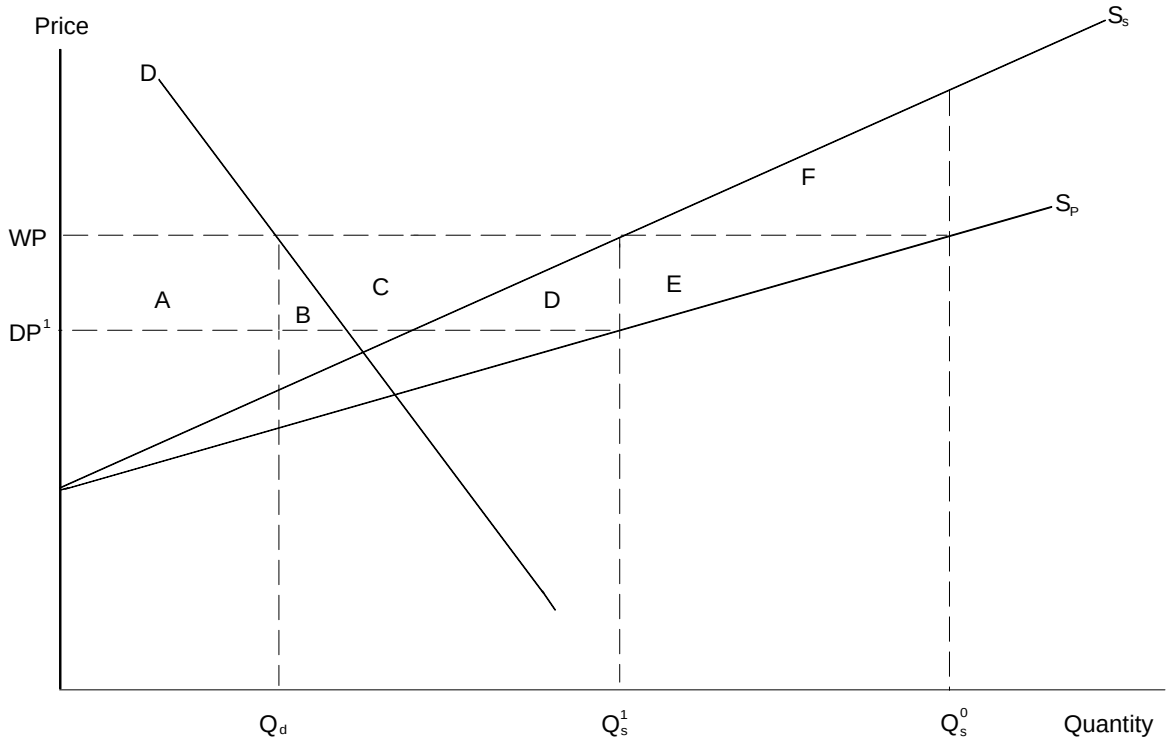
an unchanged world price. While domestic producers are hurt, society overall is better off.

In our second illustration, we consider a similar externality; now, however, the country is a large trader of the good and capable of influencing world prices. The importing country also produces the good but does not require environmental protection, possibly due to a larger capacity to absorb contaminants or different societal priorities in regard to this type of pollution. The imposition of an environmental policy in an exporting country is likely to have a trade-reducing effect, at least in the short term, and to shift competitiveness away from the exporter (fig. 3).[5]

[5]Although conventional economic logic underlies this and subsequent illustrations, there are several simplifications from the complex real world. The illustrations assume that the world consists of two countries (or two groups of countries), that markets are perfectly competitive, and that there are no costs related to international transactions. Also, it is assumed that the good is homogeneous and implementation of the environmental policy does not change other prices, income, population, technology, or consumer tastes.

Figure 2

Trade and welfare effects of an optimal output tax for environmental purposes in a small country exporter



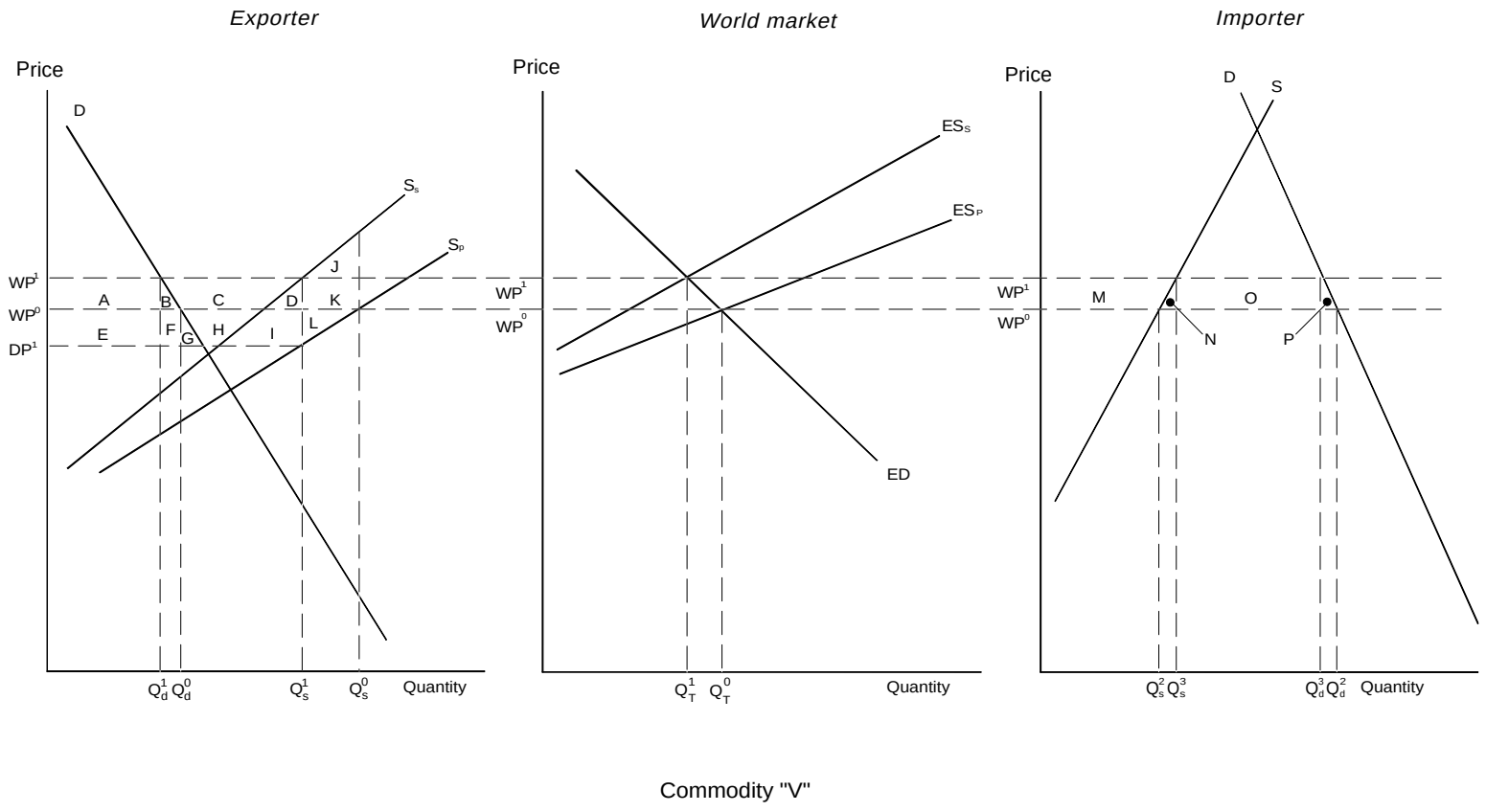
Source: Economic Research Service, USDA.

Figure 2—*This figure describes market conditions in a small exporting country before and after the imposition of an environmental tax. The before-tax supply schedule S_p reflects only the private (or internal) costs of producing, for example, livestock products; the after-tax supply schedule S_s reflects the full societal costs of production, which include the private production costs and the costs to society of the effects on water quality. Thus, the tax internalizes to the industry the external costs of its operations, which raises industry costs and reduces the supply of livestock products to the market. The tax is "optimal" because it eliminates the gap between private and social costs at each potential unit of production.*

The country is small in terms of supplying the world market, so it is unable to affect the world price. Before the tax, the country produces at Q_s^0, consumes Q_d, and exports $Q_s^0 - Q_d$, in response to world price level WP. After the tax, producers, in response to a domestic price of DP^1, reduce production to Q_s^1. Domestic consumption remains unchanged, so exports fall to $Q_s^1 - Q_d$. Producers lose welfare represented by areas ABCDE, and consumer welfare is unchanged. Government tax revenue increases to ABCD, while environmental damage falls by EF. On net, the exporting country is better off by area F. The optimal environmental tax has thus made the country better off.

Figure 3

Trade and welfare effects of an optimal output tax for environmental purposes in a large country exporter



Source: Economic Research Service, USDA.

Figure 3—*Panel one describes the market conditions in the exporting country before and after the environmental tax. As in figure 2, the before-tax supply schedule S_p reflects the private costs of production and the after-tax supply schedule S_s reflects the full societal costs of production. The middle panel shows that the effect of dampening production incentives in the exporting country is to reduce its supply to the world market, as shown by a shift in the position of the excess supply schedule to ES_s from ES_p. The effect of the shift is to reduce trade from the pretax level of Q_T^0 to the after-tax level Q_T^1 and to shift global production toward the importer.*

Some of the burden of the tax on producers also falls on domestic and foreign consumers. This happens because the exporting country's sector is large enough to cause prices to rise when it reduces supply in response to a tax or regulation. A small country, in contrast, would be unable to turn the "terms of trade" in its favor when implementing a supply-reducing environmental policy (fig. 2).

An environmental policy implemented in a large exporting country affects the welfare of market participants in both nations. In the exporting country, producers and consumers incur welfare losses equal to areas labeled EFGHIL and AB, respectively. Government tax revenue increases, however, as represented by area ABCDEFGHI, and social damage costs generated by the production of the good fall by area JKL. Therefore, the exporting country is, on net, better off by areas CD (terms-of-trade effect) and areas JK (externality effect). As for the importing nation, producers benefit from the increased world price (area M), but consumers incur welfare losses (area MNOP).

This occurs because the environmental tax increases the cost of production for the exporter thereby reducing its incentive to produce and trade. Because it is a large supplier, some of the increased cost of production is shifted to foreign and domestic consumers, implying that domestic producers and consumers and foreign consumers pay the costs of reducing domestic pollution.[6] The size of the tax relative to other costs of production is a critical element in determining how strong the output and trade effects of the tax might be. The exporting country as a whole—taking into account society's valuation of environmental benefits—is still better off. The imposition of an optimal tax assures that the benefits of reduced pollution outweigh the tax-induced costs to producers and consumers.

Environmental policies can also influence the composition of agricultural production and trade. As the cost structure of a regulated industry or activity rises relative to that of other less-regulated industries or activities, productive resources will shift toward the less-regulated sectors. Resources may be encouraged to move out of agriculture should environmental controls in agriculture become more restrictive than in other industries. These output composition effects also influence the relative mix of agricultural output and trade. For example, production and export of less fertilizer-intensive crops, such as soybeans, might be encouraged should a fertilizer tax be implemented. The composition effect may also influence the relationship between primary production and processing of agricultural products. Pesticide restrictions or livestock density limitations could reduce production of raw sugar, fruits, vegetables, and livestock. A country may then import more primary products for processing or may import the processed products and shift resources out of agribusiness.

Theoretically, environmental policies influence the level and composition of trade through their effects on production costs. The direction and magnitude of the effects of environmental regulation vary due to several factors, including stringency and type of environmental measure. All else equal, stringency is likely to be proportional to the level of environmental degradation, since societies tend to target resources at their most urgent problems. The EU's high livestock density and subsequent manure pollution problems led to the enactment of their Nitrate Directive, one of the strictest nitrate pollution measures in the world. Countries in the EU have flexibility in the type of measure implemented; a headage tax on livestock producers or density restrictions would have different effects on the composition and level of trade. The United States, with fewer nitrate problems, does not have such a strict national nitrate regulation.

Another factor may be the breadth of application of an environmental measure. An environmental regulation targeted at a particular geographic site or environmental problem may result in geographically diverse costs. However, price and trade competitiveness at the national border may not be affected. One other factor is the availability of alternative low-cost or cost-reducing production techniques. If alternative low-cost techniques are not available, the cost of complying with an environmental policy in the short term could be high.

Empirical Examples: Environmental Policy Effects on Trade

Empirical studies of nonagricultural industries generally find that environmental policies do not significantly affect trade. The studies, which vary markedly in methodology, time period of study, and industry of focus, are summarized by Dean (1992); Pearce (1993); Beghin, Roland-Holst, and van der Mensbrugghe (1994); and Jaffe, Peterson, and Portney (1995). Examples include:

- Walter (1973) found average annual overall environmental-control costs for U.S. exports at 1.75 percent of their total value and for U.S. imports 1.5 percent of their total value. In a more recent study, Tobey (1990) found U.S. environmental regulation costs to be no more than 1.85 percent of total costs for 40 industries and between 1.85 and 2.89 percent of total costs for 24 industries.
- Reductions in output caused by environmental control costs are insignificant on average, although significant for some individual sectors. A study by Yezer and Philipson (1974) found that the percentage decrease in output attributable to environmental control costs for 14 industrial sectors averaged less than 1 percent.
- There is little evidence of any significant effect of environmental control costs on patterns of trade. Robison (1988) suggested that marginal changes in environmental control costs will affect the U.S. trade balance, but that the effect would be small overall.

[6] In the small-country case, domestic producers absorb the entire cost increase.

- Differences in environmental regulatory costs between industrialized and developing countries have been an industry concern. Industrialized-country producers fear that stricter domestic environmental regulation will give developing-country producers a competitive edge. Developing-country producers worry that they will have to comply with stricter industrialized-country standards. Slade (1991) found that production and trade effects of developing-country producers adopting industrialized-country standards and industrialized-country producers adopting stricter standards are very small for the two sectors examined—nonferrous metals and energy. Low (1991) estimated that Mexico's exports would be reduced by less than 2 percent if it adopted an environmental tax equivalent to U.S. policies.

Little empirical work exists on the trade effects of environmental policy in the agricultural sector. Some studies lend support to the above generalizations. Tobey (1991) showed that environmental regulations in industrial countries are unlikely to change agricultural trade significantly. Tobey determined the relative pollution intensity of 10 crops based on nitrogen and pesticide use and average soil erosion. Assuming that industrial countries were more likely to regulate pollution-intensive commodities (tobacco, peanuts, corn, and sorghum) and that developing countries' export market shares of these commodities constituted a modest proportion of world trade, Tobey found that the change in agricultural export patterns from industrial countries to developing countries was likely to be small as a result of developed-country agro-environmental policies.

Ballenger, Krissoff, and Beattie (1995) examine specific agricultural commodities and particular environmental concerns. Ballenger and others looked at orange and apple juice trade in Western Hemisphere countries and the health risk to farmworkers from exposure to pesticides. They estimated that the cost of regulations to protect U.S. workers was no more than 0.5 percent of total production costs and could be as low as 0.08 percent of total costs beyond the first year. Assuming that juice-exporting nations in Latin America implement similar worker protection regulations, Ballenger and others found that such harmonization only marginally affected the value of exports.

In contrast to the estimates reported above, current and proposed agro-environmental regulations in some nations could significantly alter production costs, output, and trade, at least in the short run, in selected product markets. The National Agricultural Pesticide Impact Assessment Program (NAPIAP) of the U.S. Department of Agriculture (USDA) examined the short-term economic implications of banning methyl bromide (MB) for soil and product fumigation (USDA, 1992).[7] The NAPIAP assessment found that effects on the United States would be costly because currently available alternative control practices are less effective or more expensive than MB. The study estimated annual economic losses of approximately $1.3-$1.5 billion, with much of the loss borne by U.S. consumers in the form of higher prices for fruits and vegetables, particularly tomatoes and strawberries. The study measured economic losses under both "closed" (no imports) and "open" economy scenarios, concluding there were few differences between scenarios. In a closed economy, producer revenues actually increased as the price rose (particularly for tomatoes), more than offsetting the production decline, with the burden of the loss falling totally on consumers. In an open economy, the price rise associated with the production decrease was offset by imports from competing products (such as Mexican tomatoes). Domestic producer revenues fell, with the economic loss more equally shared by producers and consumers.

The NAPIAP study also indicated that some 35 fruits, vegetables, and nuts from over 130 countries required MB or an alternative treatment as a condition of entry into the United States. The loss of MB as a quarantine fumigant might restrict imports of many of these commodities. Additionally, U.S. exports of several fruits, nuts, cotton, and oak wood to particular countries require fumigation with MB to meet their quarantine regulations. Exports of these commodities, valued at nearly $250 million in 1991/92, would be affected by the ban.

An American Farm Bureau-sponsored study concluded large-scale changes in supply and production costs for many fresh and processed fruit and vegetable crops would occur if pesticide use were cut by 50 percent or simply ended. The study, directed by Knutson (1993), examined 9 fruits and vegetables in 12 U.S. States and concluded that average yields across the commodities and States could decline by 70 percent with pesticide elimination. While this estimate is very high, the scenario is extreme, extending far beyond most environmentalists' recommendations. More realistic is a policy to eliminate some pesticides rather than all pesticides, allowing producers to substitute other agrochemicals and limiting declines in yields.

EU legislation that will become effective in the late 1990's may significantly affect the environment. High

[7]The Montreal Protocol seeks to regulate the use of methyl bromide due to its effect on the ozone layer. Under the U.S. Clean Air Act, production and importation of methyl bromide were frozen in 1994 at 1991 levels. Production and imports are also to be phased out by the year 2001.

levels of nitrates in ground and surface water, common throughout the EU, can adversely affect the health of humans and livestock and promote eutrophication of water bodies. (Eutrophication reduces the amount of oxygen levels due to an increase in nutrient levels, making a body of water more supportive of plant life over animal life). In response to rising regional nitrate levels, regulations directed at farming practices in the EU have been enacted at both the national and EU level. The 1991 EC Nitrate Directive attempts to restrict the application of livestock manure and chemical fertilizers in areas with high nitrate levels. USDA's Economic Research Service (ERS) has indicated that the Directive, due to take effect in 1999, may reduce livestock production in Belgium by 29 percent, the Netherlands by 65 percent, Denmark by 9 percent, and would translate into EU-wide reductions in livestock production of roughly 8-10 percent (Leuck and others, 1995). Results imply that EU beef exports could be reduced by as much as a third and change the EU from a net exporter of pork and poultry to a net importer (Haley, 1993).

East Asian governments have also begun to regulate livestock waste to improve the environment. For instance, Taiwan has enacted legislation to reduce animal waste pollution, although enforcement has been limited (Taha, 1992). In Japan, the hog industry has become more concentrated as the number of producers has fallen. The number of hog producers fell by over 30 percent during 1990-92, while swine inventories fell just under 8 percent (Taha, 1992). Part of this change in the industry is attributed to environmental regulation that created high investment costs in handling livestock wastes. These findings suggest that Japanese environmental controls could significantly affect production costs and output, with potential implications for trade in both feedstuffs and livestock products.[8]

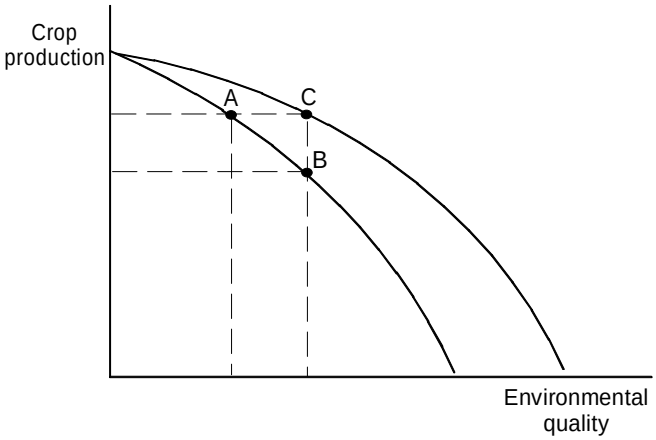
Environmental Policies and Technological Change

Environmental regulations often raise production costs and reduce competitiveness in the short term, but long-term effects are less certain as firms adjust and innovate. A 1992 study by the Office of Technology Assessment indicated that some firms adapted to regulations in ways that offset any early cost disadvantage and, over the long run, those firms have even benefited from the regulations. Deteriorating quality of ground water associated with the overuse of water through central-pivot irrigation technologies in the U.S. Plains States has propelled institutional changes (taxes, subsidies, and regulations) directed at improving the quality of ground water. Runge, Houck, and Halbach (1988) found that the regulations, in turn, altered input values and imposed costs on producers, inducing a change in input use and the subsequent choice of alternative technologies.

Thus, changes in relative factor prices stimulate innovative activities. Both private producers and public research institutions innovate to remedy the constraint imposed by the policy-induced factor scarcity. Runge and others (1988) argue that environmental regulation can act as a signaling mechanism that stimulates research into environment-conserving technologies. In their irrigation and groundwater example, the regulations limiting water use increased its scarcity value and stimulated research into more efficient "drip-irrigation" technologies.

Environment-saving technological change allows more goods to be produced with less damage to the environment (fig. 4). Such technological change can allow a country to improve environmental quality without constricting crop production.

Figure 4
Effects of environment-saving technological change



Source: Economic Research Service, USDA.

Figure 4—*The downward-sloped production-possibility frontier indicates that crop production must decline to improve water quality. Initially that trade-off is relatively steep, as indicated by the move from point A to point B. Environment-saving technological change, such as pest-resistant crop varieties, can expand the production-possibility frontier and allow the country to improve water quality without a corresponding loss in crop production, as indicated by the movement from point A to point C along a new production-possibility curve. The adopting country's competitive advantage in world markets for agricultural crops may also be enhanced, although the new crop varieties may quickly transfer to other countries as well.*

[8] An important theoretical point is illustrated here. The livestock/manure production structure has a Leontief relationship; that is, there is a fixed input-output association. When technology is Leontief, regulating output is as efficient as regulating the effluent. Other environmental problems, however, have different production relationships.

Environmental Policies and Foreign Direct Investment

National environmental policies may exert longrun effects on international investment flows and firm location. Just as labor-intensive industries may concentrate where labor is abundant (everything else equal) polluting industries may concentrate in countries with less stringent environmental policies (everything else equal). One concern is that developing countries, in particular, may use their lower environmental standards to attract foreign investment and stimulate economic growth.[9] Another is that countries that are moving toward stricter environmental regulations will encourage industrial and capital flight toward countries offering "pollution havens."

Little evidence supports the pollution-haven hypothesis, particularly concerning the importance of differing environmental standards for foreign direct investment in the food and agriculture sectors. Pearson's survey (1987) finds little evidence of industrial flight to developing countries as a result of differing environmental standards. In another study, Pearson (1976) estimates that developing countries may have increased their export revenues by 2.1-4.6 percent by lowering their environmental standards. Duerkson and Leonard (1980) conclude that there is no evidence of widespread relocation of U.S. industries to pollution havens. However, Molina (1994), investigating pollution abatement costs and U.S.-Mexico trade in food-related products, finds some evidence to support the pollution-haven hypothesis. He finds that in U.S. industries that incur higher water and solid waste abatement costs relative to Mexico, the United States is more likely to import from that industry and, consequently, firms are more likely to migrate.

The decision to relocate is a complicated decision involving, among other factors, total variable costs (not just costs of meeting environmental regulations), relocation costs, and transportation costs associated with shipping goods back to domestic markets. In the production of crops, the quality and availability of land and water resources are also likely to play an important role in the decision to relocate production. In general, stronger economic criteria drive investment location decisions, such as access to foreign markets, lower production costs, or investment credits. Cost reductions associated with less strict environmental regulations are likely to be small compared with other cost factors such as wages (OTA, 1992). For example, in recent years, U.S. poultry processing and fruit processing firms have relocated or expanded to Mexico to take advantage of lower labor costs as well as to produce for the Mexican market.[10] An added benefit to these firms may be in the lower water-quality standards in Mexico (resulting in less management of effluents), but it is unlikely to be the most important factor in the decision to produce in Mexico.

Firms cannot always gain from lower foreign environmental regulations if traded products must meet quality or environmental standards in the importing country, a requirement particularly relevant for agricultural commodities. For example, some pesticides that cannot be legally used in U.S. crop production can be used in Mexico. While these pesticides may be legal and cheap in Mexico, commodities that contain residues of these pesticides cannot enter the United States.

While there appears to be limited evidence from formal studies of changes in investment and firm location due to environmental regulation in agriculture, the adoption of more stringent policies in industrialized countries could introduce costs that, at the margin, lead businesses to relocate. As new environmental regulations are introduced across the globe, there is a greater need for empirical studies to examine the role of environmental policy and its effects on foreign investment in agriculture and agribusiness.

Product Standards, International Trade, and National Welfare—Effects on Consumption

The interface between consumption policies relating to product standards and international trade requires a different analysis than that for production-based environmental standards. Product standards can pertain to the product itself (for example, the food item), the packaging materials, or the information contained on the package. They can be imposed for environmental purposes (which are referred to as environment-related product standards). Product standards can relate to animal and plant health or environmental issues in a number of ways, particularly through food health and safety risks of consuming the product or disposing of its packaging. Product standards may affect costs of production and, therefore, the product's competitiveness in international markets. Failing to meet product standards can also directly inhibit the acceptability of a nation's products in export markets. Because of this trade-restricting effect, product standards may cause trade frictions.

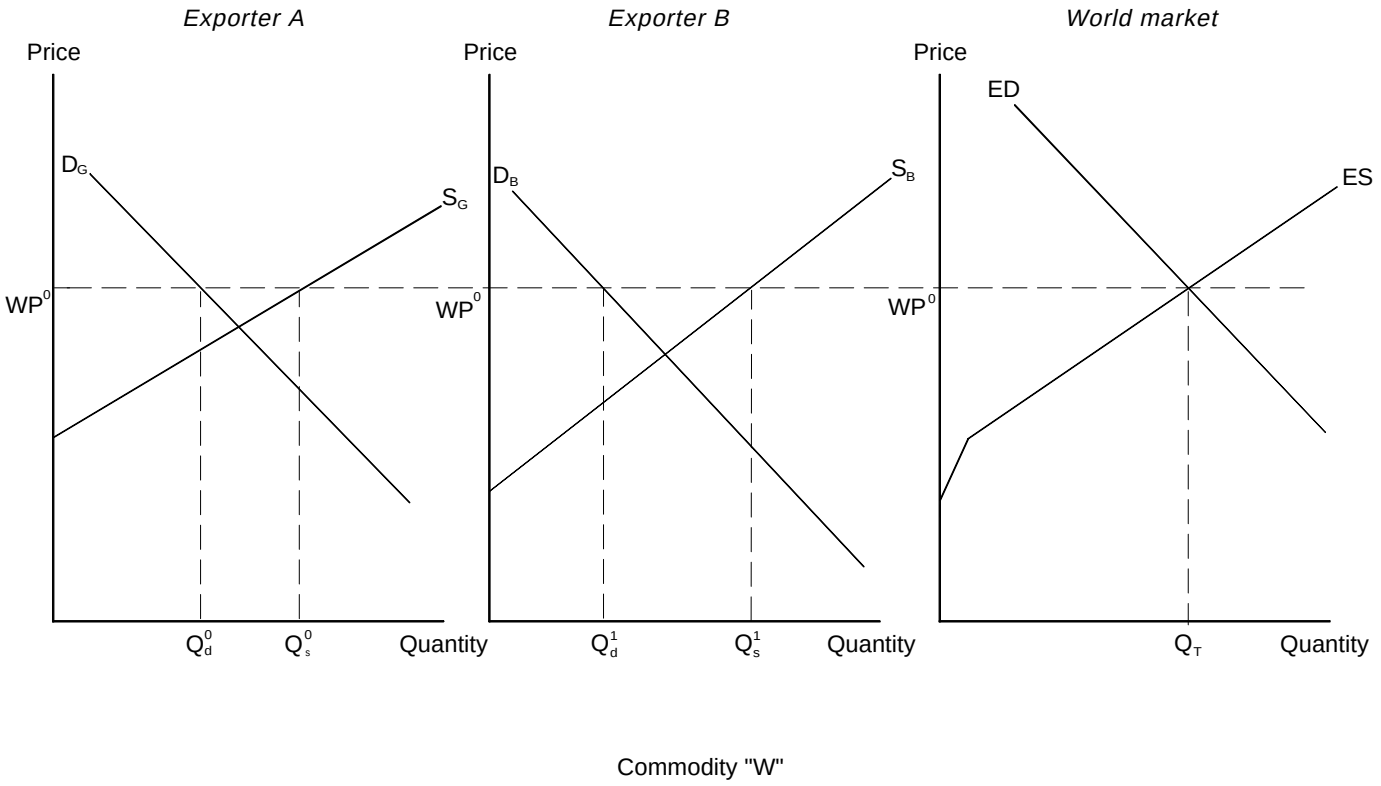
There are several examples of product standards for food and agricultural products that may be justified on eco-

[9]There are various reasons why a developing country's environmental standards differ from an industrialized country. See "Harmonization of Product and Environmental Standards and Production and Processing Methods" on page 21.

[10]The United States does not import poultry from Mexico because their processing facilities do not meet USDA regulations and because Newcastle's disease and avian influenza are present in some areas.

nomic grounds but also could be designed to operate as implicit trade barriers. For example, governments use food safety standards to assure that consumers are not exposed to unsafe levels of pesticide residues in foods. Government involvement is widely accepted, since consumers would be unlikely to be able to make the safety determination themselves. Governments serve to reduce consumer uncertainty of food safety (one aspect of product quality) by increasing the amount of accurate product-quality information. Without government intervention, sellers may market poor-quality food as high-quality food and reap undeserved returns. Were that to happen, the average quality of food would then fall, reducing the size of the market (fig. 5). The legitimacy of using product standards at country borders to restrict imports continues to be based on "scientific principles," although the level of the standards adopted may reflect society's values. Numerous trade disputes

Figure 5
Asymmetric information and product standards



Source: Economic Research Service, USDA.

Figure 5—*There are two exporters in this figure who sell commodity "W" to the world market. Exporter A produces a high-quality commodity, while exporter B produces a low-quality commodity; both sell their excess supply to world markets. (In theory, both A and B could produce and sell both qualities of the good, but we simplified the story here for graphical purposes.) At a world price of* WP^0, *Exporter A sells* $Q_s^0 - Q_d^0$ *and exporter B sells larger quantities* $Q_s^1 - Q_d^1$. *This is because Exporter A faces higher production costs than does Exporter B and is less willing to sell the commodity at comparable prices. Thus, there is a greater supply of the low-quality commodity in the world market.*

Without accurate information, the world market demand by importers for commodity "W" is the average of good and bad quality in the short run. Over time, purchasers of the low-quality commodity become less likely to demand it. Thus, world demand declines and eventually only low-quality commodity is sold. Exporter A has effectively been driven out of the world market by a lower quality product.

Governments can reduce consumer uncertainty in product quality by establishing product standards. Consumers could then make informed purchasing decisions, allowing higher quality products to become available.

arise because importers and exporters disagree on the level of food safety standards.

One distinguishing feature of environment-related product standards is that "societal preference" (a cleaner environment, for example) often overrides "available scientific and technological information" as a justification for a standard. For example, the disposal of food-product packaging can be an environmental issue. Societal costs to dispose of packaging waste are not captured in the market price of food products. Consumers may purchase a product that is initially inexpensive but costs more to society in the long run because of the added cost of disposing of its packaging waste. This added cost of disposing of packaging waste disposal is called a "consumption externality." Consumption externalities may lead to regulations mandating that packaging materials be recyclable or imposing consumption taxes on the offending products. These regulations or taxes may restrict product trade (fig. 6). Even an optimal consumption tax can restrict trade, although it may improve overall social welfare in the country that addresses the externality.

Other examples of trade restrictions stemming from societal preferences for a product or production-process standard include:

- European restrictions on beef imports from countries using chemical growth stimulants;
- U.S. restrictions on imports of shrimp caught in a way that harms sea turtles, and a similar attempt to ban imports of tuna caught in a way that harms dolphins;
- European restrictions on furs from countries that use leg-hold traps for capture.

A country that develops an environment-related product standard for domestic products will likely apply the same standard to imported products. The standard can affect both exporters and domestic and foreign producers. If exporters cannot meet the standard, trade may be restricted; if higher production costs affect domestic and foreign producers differently, their market positions in the importing country will be affected. Foreign exporters may also incur a loss in economies of scale because these different packaging standards affect only a portion of total product sales.

Environmental labeling is another policy instrument. Ecolabeling provides consumers with information so that their preferences for environmental protection can be better expressed in the marketplace. Labeling of tuna fish cans to indicate the fishing methods employed—"dolphin-friendly tuna"—is an example of ecolabeling. Labeling standards, while possibly affecting trade, would not necessarily be considered a nontariff trade barrier (NTB), since consumers, rather than the government, discriminate among suppliers (domestic and foreign) in the marketplace. In fact, a 1991 GATT panel ruled in favor of the U.S. "dolphin-friendly tuna" label over Mexican objections that the label is an NTB (see box—"Tuna-Dolphin Cases").

Packaging costs comprise a significant share of final food product value— over 10 percent in 1992 (Dunham, 1994). Food and beverage industries use many types of containers, including metal cans, glass containers, plastic bottles, folding cartons, and corrugated containers. Packaging standards, such as recycling, and labeling requirements may affect international trade and competitiveness of processed food products.

Although there are efforts within OECD and WTO to formulate international rules regulating packaging and labeling standards, one basic principle of the WTO must be adhered to: that imported and domestic products be treated equally. In other words, the imposition of a product standard aimed at affecting only the imported product would constitute an unfair trade barrier.[11]

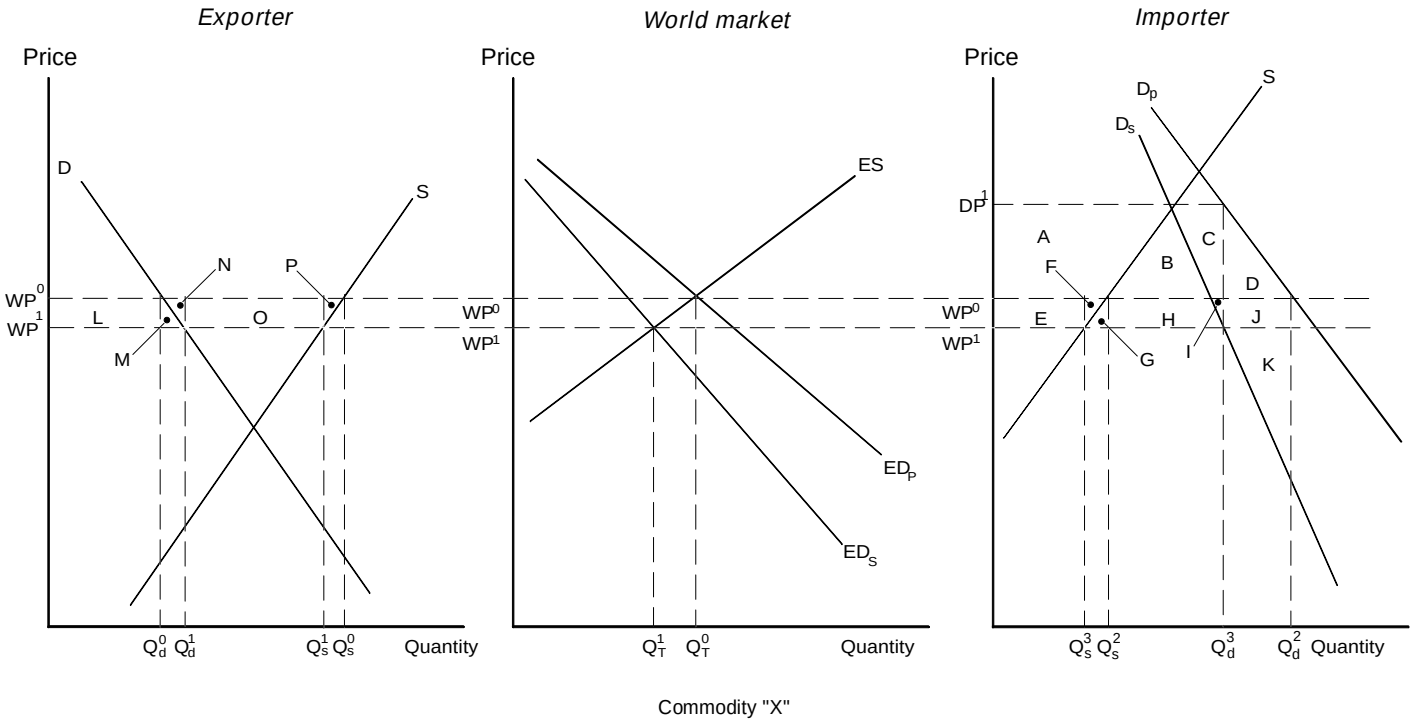
Trade Liberalization and Environmental Quality

The effect of freer agricultural trade on environmental quality depends on several factors, such as the level of production, mix of post-reform goods, variable input use, land use, technical change, and the assimilative capacity of the natural resource base. Three separate mechanisms are at work:

(1) the scale effect, which describes what happens when trade liberalization changes the level of economic activity (for example, both economic activity and pollution levels may increase under freer trade);

[11]In a recent case ruled on by a GATT panel, U.S. environmental rules that affected imports more than domestic goods were challenged by the European Community (EC). In 1993, the EC protested U.S. car fuel-efficiency rules, the "gas guzzler" tax, and the luxury tax, claiming that these policies discriminated against European imports. The United States made the case that these policies were in place to reflect preferences for natural resource conservation and environmental protection and that they were not designed to be discriminatory. The GATT panel sided with the United States, upholding all provisions except one aspect of the car fuel-efficiency rules that established separate domestic and import fleets for the calculation of corporate average fuel efficiency rates.

Figure 6
Trade and welfare effects of an optimal tax on consumption



Source: Economic Research Service, USDA.

Figure 6—*The curves D_p and D_s for the importing country represent national demands before and after an optimal consumption tax, which eliminates the external costs of consumption. D_p and D_s reflect the private and social benefits of consumption; the area under D_s encompasses the consumer gain in purchasing commodity "X" and the loss from the externality associated with the consumption of "X". The change in the quantity demanded due to the tax, Q_d^2 to Q_d^3 , triggers a reduction in demand for the imported product as well, indicated by the fall in exports from Q_T^0 to Q_T^1. In addition to curtailing consumption, the tax generates funds that could be used for waste management or recycling activities.*

As in the case of a production externality, the welfare of market participants in both countries is affected by the environmental policy. By imposing the optimal consumption tax, the importing country realizes a net welfare gain of areas GHI (terms-of-trade effect) and JK (externality effect). Consumer welfare falls due to higher after-tax prices (DP^1), producer welfare falls due to lower world prices (WP^1), but the tax revenue gain (areas ABCEFGHI) and the reduction of the externality (areas DJK) more than offset these losses. The tax revenues could be used to finance the costs of recycling. In the exporting country producers lose areas LMNOP and consumers gain areas LM, so there is a net welfare loss because of the deterioration of the terms-of-trade.

Tuna-Dolphin Cases

In September 1990, the United States banned imports of tuna from Mexico, Panama, and Ecuador. This embargo was the result of the U.S. Marine Mammal Protection Act (MMPA), which sets dolphin protection standards for the domestic fishing fleet and for international fishing boats that harvest yellowfin tuna in the eastern tropical Pacific Ocean. The eastern tropical Pacific is singled out because this is where schools of tuna swim together with schools of dolphins. Traditionally, fishermen would watch for dolphins coming up for air. When spotted, they would cast their nets out, assuming that there were tuna below, and drag the nets until they were full.

The 1972 MMPA was amended by Congress in 1984 and 1988. It now requires all nations exporting tuna to the United States to document that they have adopted a dolphin conservation program comparable to that of the United States It also requires the incidental dolphin take rate of foreign ships to be no greater than 125 percent of the U.S. take rate. The MMPA further imposes an intermediary embargo banning tuna imports from countries that import tuna from those subject to a primary embargo by the United States Thus, if the EU is importing tuna from Mexico and there is a U.S. embargo on Mexican tuna, the United States will not import tuna from the EU. Also, it allows tuna products to bear the label "dolphin safe" if MMPA practices are followed.

The tuna embargo had the largest effect on Mexico, because it is the largest fisher in the eastern tropical Pacific. In January 1991, Mexico filed a protest with the GATT to evaluate whether MMPA's embargo and labeling requirements violate GATT rules. The United States argued that GATT's national treatment provision permitted the enforcement of dolphin-protection standards under the MMPA and that the import embargo could be justified because the GATT allows for the protection of animal health or exhaustible natural resources. However, the GATT ruled on the side of Mexico, finding that the GATT required a comparison of product standards, not harvesting or processing methods, and that a contracting party (the United States) cannot use trade measures to enforce its own laws outside of its jurisdiction. Therefore, the United States could not embargo Mexican tuna imports. Mexico did not press the GATT council for a final decision, so the panel decision was not formally adopted.

However, in May 1994 the same issue was raised by the EU (an intermediary in tuna trade) and heard in front of a GATT panel. Again the panel ruled that the U.S. boycott was illegal because the GATT does not allow trade bans based on production methods. This second ruling was considered to be more "environmentally friendly" because the ruling recognized the legitimacy of extraterritorial measures. Daniel Esty (a former NAFTA negotiator for EPA) claims that the ruling implicitly recognizes the right of the United States to take action in defense of wildlife (Charnovitz, 1994; *Wall Street Journal*, May 23, 1994).

(2) the composition effect, which characterizes intersectoral changes reflecting a country's comparative advantage (for example, agricultural production expands while chemical output declines); and

(3) the technique effect, which portrays changes in production methods due to trade liberalization.

Freer trade generally increases the rate of economic growth, which can harm the environment if polluting activity increases with growth but can improve the environment if resources are reallocated to less polluting activity or if growth leads to the adoption of environmentally friendly technology. Economic growth is also recognized as a crucial factor in increasing the demand for environmental quality. Consequently, just as the implementation of agricultural and trade policy creates a complicated set of environmental distortions, reforming agricultural and trade policies generates an equally complicated set of environmental responses. As Dean (1992) states, "...trade liberalization...will undoubtedly have some impact on the use of natural resources and the extent of environmental degradation. However, the type of impact is not predictable *a priori*" (p. 25).

Trade Reform—GATT and NAFTA

The GATT agreement and the North American Free Trade Agreement (NAFTA) illustrate the themes common to the debate on the linkages between free trade and environmental quality. The Uruguay Round GATT agreement aims to reduce trade barriers multilaterally across a broad range of products. NAFTA's objective is to liberalize trade in goods and services and reformulate foreign investment policies in the United States, Mexico, and Canada. Both trade agreements raise several environmental issues: GATT establishes rules on issues relating to food, health, and safety standards, while NAFTA establishes the importance of international environmental agreements; renounces the relaxation of health, safety, and environmental measures for attracting foreign investment; addresses food safety, animal and plant health concerns, and other product-standard issues; and is sensitive to environmental issues in dispute settlement provisions. Both sets of contracting parties involved

in the GATT and NAFTA processes have also agreed to examine or monitor the environmental impact associated with post-reform changes in crop mix, regional production patterns, and land and variable input use.

While NAFTA may be more sensitive to environmental concerns than the GATT agreement, it does not address the broad-based domestic and transboundary environmental issues that are not related to trade among the three signatories. Rather, the signatories established three other mechanisms for addressing transboundary issues: the North American Agreement on Environmental Cooperation (NAAEC), the establishment of a Border Environmental Cooperation Commission (BECC), and a North American Development Bank (NADB). NAAEC may be the most far-reaching mechanism, as it establishes new institutional structures and rules for promoting environmental cooperation, multilateral discussion, and public participation. It has the potential to generate a continuing evolution of environmental policy change. In NAAEC, the contracting parties also reaffirm their commitment to improve national enforcement of each country's laws relating to environmental protection and natural resource issues. Nevertheless, each country maintains its sovereignty over domestic environmental policies (Ballenger and Krissoff, 1996). The purpose of the BECC is to approve environmental improvement projects in the U.S.-Mexico border region. These projects will be funded through the NADB.

Trade Policies, Agricultural Policies, and Environmental Quality

Within the context of agricultural trade policy reform, the most important characteristic of a policy is the degree to which it distorts trade. In agriculture, trade distortions arise from both domestic and trade policies. A common problem in agriculture is the use of a variety of trade and domestic policies to intervene in agricultural markets while tariffs are used less frequently (Schwartz, Magiera, and Mervenne, 1988). Consequently, it is often difficult to separate trade policy from domestic policy, as trade goals are often achieved through domestic policy instruments or domestic goals are achieved through trade instruments. Economists must understand how distorting policies affect the environment to assess how environmental quality is affected by trade reform. Economists clarify the effects of those policies by examining their effects on crop mix, input use, technological change, and investment in the agricultural sector.

Trade and agricultural policies subject to reform can be divided into broad classes: pricing policies, income policies, marketing subsidies, and structural subsidies (table 1). Pricing policies, which are used to raise or lower producer returns to farming, also affect crop mix, the location of production, and input use—all of which directly and indirectly affect environmental quality (Miranowski, Hrubovcak, and Sutton, 1991). For example, pricing policies, predominantly found in higher income countries, typically raise domestic prices relative to world prices, and these higher prices may encourage chemical overuse, mechanization, and land conversion—all of which can harm the environment. In contrast, some low-income countries protect consumers through low food prices that effectively tax farmers and discourage production, which can improve the rural environment by holding production below its free market level (table 2). Artificially low agricultural prices, however, may discourage sustainable farming practices and may encourage migration to urban centers, placing environmental stress on heavily populated areas.

Table 1—Instruments potentially affected by liberalizing trade policy

Policy	Instruments
Border measures and price supports:	
❖ Pricing policies	Tariffs Import/export subsidies Variable levies Export credit guarantees Marketing loans
❖ Quantitative restrictions	Import/export quotas Voluntary export quotas Licensing restrictions
❖ Qualitative restrictions	Labeling standards Safety and sanitary regulations Quality standards
Direct income support	Direct payments Deficiency payments Crop insurance Disaster payments
Input subsidies	Fertilizer subsidies Pesticide subsidies Irrigation subsidies Feed subsidies Concessionary interest rates Credit guarantees
Marketing subsidies	Transportation subsidies Marketing credit Promotional programs Inspection services
Producer levies	Taxes on output to reduce oversupply or fund research, waste disposal, etc.
Long-term structural measures	Research and development Extension services Rural development programs

Source: Economic Research Service, USDA, based on data adapted from Schwartz, Magiera, and Mervenne (1988).

Table 2—Government intervention in agricultural markets, 1992 selected examples

Region/country	Total PSE	Share of PSE
	- - Billion $US - -	*- - Percent - -*
EC[1]	82.8	47
Canada[2]	5.8	36
United States[2]	23.8	19
Japan[1]	36.1	71
Argentina[2]	-0.4	-11
China[2]	-57.3	-63
Egypt[2]	-0.1	-6
Mexico[2]	1.3	8

Note: Producer Subsidy Equivalents (PSE's) are aggregate measures of support that summarize the effects of a variety of government programs in a single number. A PSE represents the lump sum compensation that would be required to maintain sector income if government policies that affect agricultural markets were eliminated, assuming constant world prices and fixed output. A negative PSE represents a tax on producers. The total PSE is the net dollar sum transfer to producers, while the share of PSE is the total PSE divided by the producer's value of production.

[1]Source: OECD, 1994.

[2]Source: Economic Research Service, 1994.

Pricing policies and income supports have other, less obvious effects. For example, commodity price supports are capitalized into land values, which can result in input intensification as land prices increase relative to the prices of other inputs such as fertilizers and pesticides.[12] Farmers who substitute lower priced chemicals for land may contribute to water and soil degradation and increase concerns about food and farm worker safety, although degradation due to extensification may be reduced. Input intensification can also occur when land is required to be set aside (set-aside programs have been commonly used in the United States in conjunction with pricing policies). Set-asides induce scarcity of land, which increases land prices relative to the prices of other inputs; relatively higher land prices also act to slow natural exit from the sector. Consequently, government intervention increases the use of inputs and natural resources.

Pricing and income policies can provide further incentives to crop intensively. For example, deficiency payments in the United States were determined by base acreage, which is a farmer's historic acreage planted to program crops such as corn and wheat. Once base acreage was established, farmers had to continue to plant program crops to maintain their eligibility for deficiency payments. Consequently, farmers had little incentive to experiment with crop rotations that may be more environmentally friendly. Recognizing these constraints, the 1990 farm bill introduced the concept of flexible base acreage that permits farmers to plant a portion of their base acreage to certain allowed crops while protecting their historical base acreage. The 1996 farm bill (Agricultural Improvement and Reform Act) extends this flexibility by allowing farmers to plant any program crop on base acres.

Crop yield was the second component in the computation of deficiency payments. Prior to 1990, deficiency payments were based on the higher of average yield for the farmer's county or, if the farmer could provide proof, his/her own yield. Consequently, the farmer tried to increase yields to raise deficiency payments and hence tended to use more nonland inputs, including more agricultural chemicals (see Cochrane and Runge, 1992, for a discussion of U.S. agricultural policies). Legislation in 1990 changed the yield basis to a "farm program payment yield," which effectively froze yields for payment purposes at their 1986 level, thus cutting the tie between yield increases and larger government payments. In the 1996 farm bill, deficiency payments are eliminated, severing the link between income support, farm prices, and input decision making (Young and Shields, 1996).

Input subsidies, which reduce the cost of chemicals, irrigation, or credit, can also have negative environmental effects. Subsidized chemical prices can encourage chemical overuse, which can lead to surface and groundwater pollution, soil contamination, eutrophication, reduced soil fertility, food contamination, and human exposure to chemicals. Overuse or improper use of irrigation can lead to salinization of water and soil, increased nitrate pollution of ground water, depletion of water supplies, and contributions to water logging, soil erosion, and landscape degradation (table 3). A number of developing countries provided fertilizer subsidies (Kenya and Mexico, for example), but these policies have been largely eliminated in the 1990's.

Environmental Effects of Trade Reform

Most economists generally recognize that trade reform results in economic gain. These gains include "improved resource allocation; access to better technologies, inputs and intermediate goods; greater domestic competition; an economy better able to take advantage of economies of scale and scope; the creation of an environment conducive to growth" (Dornbusch, 1992). In the longer

[12]"Intensification" usually refers to a high ratio of nonland inputs to land and is sometimes used to describe agricultural production characterized by a heavy reliance on chemicals. Extensification, on the other hand, occurs when land is substituted for scarce labor, chemicals, or capital and the land-to-nonland input ratio rises.

Table 3—Potential negative environmental consequences of agricultural production, selected examples

Practice	Consequences
Irrigation	Salinization of water and soil Increased potential for nitrate pollution of ground water Depletion of water supplies Water logging Soil erosion Landscape degradation Reduction of ecological diversity
Fertilizer use	Nitrate leaching into soils and water Eutrophication Reduced soil fertility
Pesticide use	Food contamination Farmworker exposure to chemicals Water and soil contamination Loss or extinction of plant, animal, and insect species
Land conversion	Deforestation Habitat loss Degradation of water systems Erosion
Machinery use	Compaction of soil Reduced soil productivity Soil and landscape degradation Disturbance of soil ecosystems

Source: Economic Research Service, USDA, compiled from 1990 FAO data.

term, dynamic benefits of freer trade may include increased investment and savings rates and increased economic activity and/or the production of a new good, the introduction of a new method of production, or the opening of a new market (Dornbusch, 1992).

Conceptual Linkages: Policy Reform Effects on Environmental Quality

The environmental effects of trade reform are not easily identifiable. In the short and medium term, trade reform improves market access for goods previously governed by quantity restrictions (such as quotas and other nontariff barriers) and realigns domestic prices closer to world prices. Resource reallocation occurs as prices adjust in the post-reform period. As prices change, farmers respond by changing their crop mix, altering input use, buying or selling land, and investing in new machinery. In countries where reform leads to an increase in producer prices, farmers will respond by increasing output. Increased producer prices can lead to more intensive or extensive use of existing lands through land clearing or deforestation. But it is unclear if trade reform leads to more extensive land use for all countries due to constraints on land availability and relatively cheap chemical inputs that could be substituted for land. On the other hand, trade reform that leads to a decline in producer prices (relative to pre-reform levels) can reduce the pressure on land resources and/or reduce the use of agricultural chemicals. Environmental quality may also be affected by the general equilibrium effects of trade reform; if reform occurs in many sectors or substantially influences factor returns, labor and capital may move in or out of agriculture, depending on the relative, post-reform returns to these factors of production.

In the United States, the effects of multilateral trade reform on environmental quality have been further complicated by the use of annual land set-aside requirements to control supply and by the use of long-term land retirement programs such as the Conservation Reserve Program (CRP), which pays farmers to retire land (usually for 10 years) to meet conservation and environmental goals. Under the 1996 farm bill, CRP contracts can be extended and new areas enrolled. If multilateral trade reform increases the foreign demand for U.S. commodities, prices increase. Increased demand and higher prices create incentives to bring previously idled land back into production. Much of this land is highly erodible or highly vulnerable to chemical leaching.

Changes in the relative prices of commodities can also have environmental effects through regional shifts in production and through incentives created for environmentally friendly crop rotations. For example, high-cost fruit and vegetable producers in the United States may find it difficult to compete with Mexican producers who benefit from increased market access due to NAFTA. These U.S. farmers may find it more profitable to produce other commodities, which may be more (or less) chemical intensive or land using. In another example, should the price of corn increase relative to soybeans, farmers may be less likely to retain soybeans in their rotations, losing the nitrogen-fixing benefits of soybeans.

There is no single theoretical methodology that can embody all of the environmental implications of freer trade. Our framework shows that trade policy reform can augment output, alter input mixes, and deteriorate or improve environmental quality depending on the new input mix and technology (fig. 7). Anderson (1992a) uses a stylized analytical model to examine how economic welfare is affected as countries with environmental externalities in production and consumption liberalize trade. He shows that the economic welfare effects of freer trade are ambiguous, but welfare can be improved if the negative environmental externalities are internalized through environmental policies. Lopez (1992a) uses a different approach to focus on the growth effects

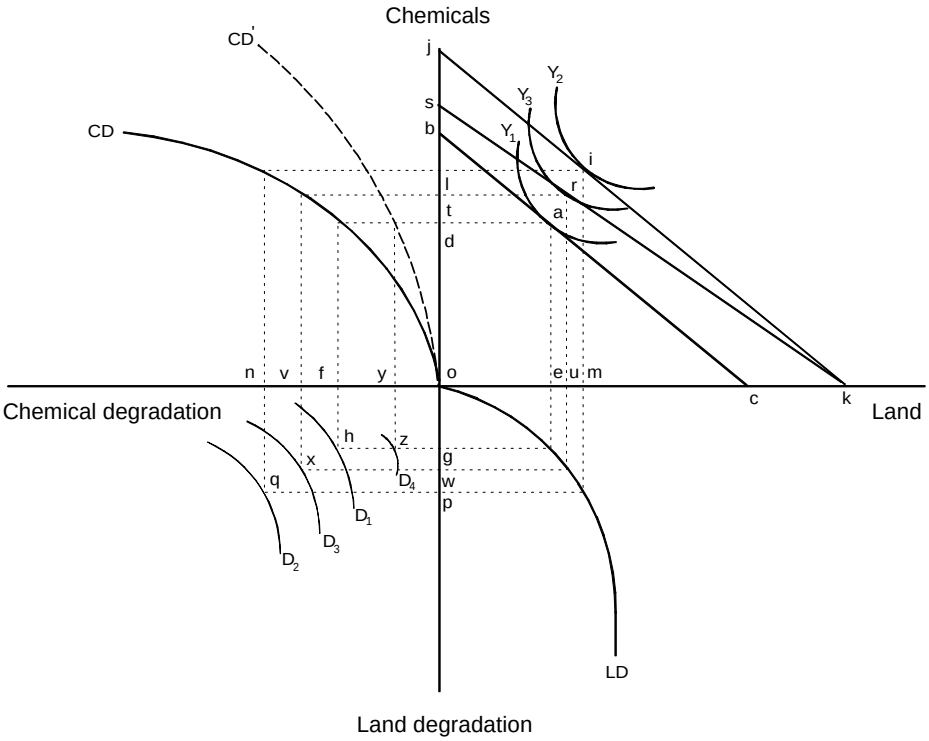
of liberalized trade. He employs a simple growth model to show that environmental degradation declines under unilateral trade liberalization as long as environmental costs are internalized; however, the environmental effects are unambiguously negative if environmental externalities are not internalized. In a related paper, Lopez (1992b) focuses on the effects of freer trade in poorer countries. He argues that trade reform in many developing countries raises the price of agricultural goods relative to the price of nonagricultural goods, which increases agriculture's profitability and attracts labor and capital into the sector. Production increases on the extensive margin, that is, liberalization raises incentives to clear forested land and produce in marginal areas.

Empirical Estimates

Accurate empirical estimates of the environmental consequences of trade policy reform are difficult to obtain for many reasons. Foremost, it is extremely difficult to model actual water or soil quality due to lack of physical data and an understanding of how economic activity affects physical variables. Additionally, trade reform is rarely confined to agricultural trade reform and will affect other sectors with an accompanying adjustment in the mix of national output. Resources may move out of agriculture into manufacturing or services or vice versa. The overall environmental effect of freer trade depends on the general equilibrium effects, which could be in the opposite direction of what occurs in any one sector (agriculture's contribution to environmental degradation may decline while manufacturing's contribution may increase). Failure to account for the general equilibrium effects of trade could miscalculate the aggregate environmental consequences.

Several recent empirical studies quantify the effects of trade liberalization (or domestic policy reform) on environmental quality. As with most empirical models, the studies we reviewed vary in terms of country, product, and sector coverage; type and degree of liberalization; baseline assumptions; substitutability among inputs and outputs; and the degree to which environmental variables are included. Using a partial equilibrium trade model (manufacturing and service sectors excluded), Anderson (1992b) estimates that under multilateral trade liberalization, world food production and prices change little and production declines in developed countries are offset by production increases in poorer countries. Due to the level of aggregation, Anderson does not specifically include indicators of environmental

Figure 7
Policy reforms and environmental quality



Source: Economic Research Service, USDA.

quality. However, he deduces that chemical use in developed countries falls substantially due to declines in production in these countries; while the increase in production in poorer countries is achieved through greater use of labor, rather than chemicals. In Anderson's model, world chemical use declines. Additionally, meat and milk production relocate from developed countries, where livestock production is grain-based, to poorer countries with less intensive pasture-based livestock sectors. Anderson's results also indicate that deforestation in developing countries is unlikely to accelerate due to trade liberalization because the supply of land is relatively unresponsive to changes in output price.

Lutz (1990) argues that multilateral trade liberalization lowers commodity prices in developed countries, reducing agricultural production and associated environmental degradation. International price variability is also increased, which increases incentives to diversify the crop mix. However, higher prices from trade liberalization in poorer countries induce expanded production with accompanying increases in land and chemical use and decreases in environmental quality.

Studies that explicitly account for changes in soil and water quality due to policy reform are typically micro-oriented and often lack multiple-country coverage or intersectoral trade-offs, primarily because the environmental and economic effects of policy reform are region-specific and depend critically on site-specific land, climate, and farm structure characteristics. For example, Painter and Young (1992) focus on two U.S. regions, the North Carolina Coastal Plain and the Washington-Idaho Palouse to assess how policy reform (decoupling or program removal) affects soil erosion and water quality.[13]

[13]Decoupling is the process of replacing policies that support farmers based on their production level with income assistance programs not linked to production. Coupled policies reward or tax producers on the marginal unit of production or consumption such that output or use decisions are directly affected by the policy (Josling, 1992). Decoupled policies remove such incentives.

Figure 7—*This figure illustrates some of the complex interactions among policy changes, input use, land use, and environmental quality. The upper right-hand quadrant shows the relationship between inputs and output. Each of the output curves, labeled Y, shows the various combinations of inputs required to produce a given quantity of output. Output remains constant along each output curve and output curves farther from the origin represent greater output. The shape of an output curve depends on the degree to which one input can substitute for another.*

Prior to any change in agricultural policy, production is defined by the output curve, Y_1, with land use oe and chemical use od. This level of output and input use is congruent with relative input prices indicated by the slope of bc. CD in the upper left-hand quadrant defines the relationship between chemical use and chemical-based degradation (pesticide contamination and fertilizer runoff, for example); LD in the lower right-hand quadrant defines the positive relationship between land use and land-based environmental degradation (such as deforestation or soil erosion). At the initial input levels, chemical degradation is of and land degradation is og. Total degradation, which is mapped in the lower left-hand quadrant, shows the various combinations of chemical and land degradation. Like the output curves, total degradation is constant along any of the degradation trade-off curves, D. At output level Y_1, total degradation occurs at h on the degradation trade-off curve D_1. An expansion in output due to an increase in producer prices or an increase in market access can be illustrated by a shift in the production function to Y_2. At the higher level of output, land use increases to om and chemical use increases to ol; these levels correspond to relative input prices indicated by the slope of jk (which, in this example, are unchanged by trade reform). In this example, the increase in chemical use is greater than the increase in land use. Chemical degradation increases to on, and land degradation increases to op. When combined, total degradation increases to q on D_2. In this example, output price reform leads to increased production, increased chemical and land degradation, and increased total degradation.

In many countries, domestic policy reform often accompanies trade reform. For example, Mexico has been reducing input subsidies (water and fertilizer), mostly to reduce budget outlays and encourage more efficient production. In this figure, reducing chemical subsidies (such as the fertilizer subsidy) raises the price of chemicals relative to the price of land (land is held fixed in this example). Higher chemical prices are represented by a rotation in the input price line to sk. As chemical prices increase relative to land prices, the relatively higher price of chemicals lowers output to Y_3 and reduces chemical use to ot and land use to ou. Total degradation occurs at x, on D_3, which is a greater level than under the initial equilibrium but less than when only output prices are reformed.[1] *In the longer run, the relationship between chemical use and degradation can be altered through technological change in agricultural production (resulting in less intensive production methods) or through technological change in chemicals (resulting in less polluting chemicals). The latter is illustrated by CD shifting to CD', where CD' is a new chemical degradation curve that represents less chemical degradation per unit of chemical used. Although total chemical use remains unchanged, the amount of chemical degradation declines to y and total degradation declines to z on the D_4 degradation curve.*

[1]*Removal of pesticide subsidies, for example, could result in the use of more traditional methods or pest control that may be less environmentally damaging. But if traditional methods are not as effective in controlling pests, agricultural productivity can decline and farmers may respond by cultivating land more intensively relative to pre-reform levels.*

Their mathematical programming model allows farmers to select alternative crop rotations as crop prices adjust to post-reform levels. Their results indicate that when cropping alternatives exist, program removal and decoupling can encourage planting flexibility, which leads to environmentally friendlier (low chemical input) production.

Economic Growth and Environmental Quality

One other environmental issue associated with freer trade is the implications of economic growth on polluting activities and the demand for environmental quality. As mentioned in the beginning of this section, economists widely recognize that trade reform can be a positive catalyst for economic growth, but the environmental effects of growth are not always readily apparent. Some argue that increased production accompanying economic growth leads to an increase in environmental degradation associated with additional output. However, economic growth can also change a country's output and input mix, resulting in a more efficient use of resources. Additionally, economic growth can be accompanied by an increase in the demand for cleaner technologies and environmental quality.

Even if growth leads to an increase in polluting production in the short run, there may be several factors that balance the additional costs or improve environmental quality over time. The costs associated with greater environmental pollution (such as an increase in nitrates or soil erosion) may be less than the benefits associated with economic growth (such as higher per capita income, greater production efficiency, and a more stable macroeconomy). For some economies, an increase in pollution is only temporary and is reduced as further growth occurs. This is generally thought to be the case for air pollution and pollution with no stock feedback effects.[14] These types of pollutants can frequently be controlled by modern technologies that are acquired as income increases. Further growth may bring no relief in other cases, however, particularly in industries that rely on resource stocks (for example, forests, soil depth, and water). An increase in production caused by economic growth can seriously deplete and affect the quality or quantity of a resource stock, often beyond its regenerative ability or assimilative capacity. For instance, excess withdrawal of water for irrigation has caused the volume of the Aral Sea to decline by two-thirds in the last 30 years (World Bank, 1992).

The view that open trade increases economic growth, therefore increasing the demand for environmental quality, is commonly used to justify the belief that free trade brings positive environmental effects. While there is empirical evidence that higher per capita income is positively correlated with a greater demand for environmental quality, these estimates are based on correlations between income and emission levels; the correlation between income and resource degradation (such as deforestation, loss of soil nutrients, and loss of water quality) is less clear and less quantifiable.[15] Several studies have noted an inverted-U relationship between per capita income and pollution emissions: emissions increase at low-income levels, but, once income reaches a certain threshold, emissions begin to decline. Estimates indicate that the demand for environmental quality becomes "important" at income levels of about $5,000 per capita (Grossman and Krueger, 1991). Antle and Heidebrink (1995), using a different measure for the demand for environmental quality, namely the number of parks and forests, find that this "environmental transition" occurs at lower per capita levels of income (approximately $1,200-$2,000). Many high-income countries have already experienced improvements in air quality and increases in forested area and protected habitats (World Bank, 1992). This argument is further developed by Antle and Trigo (1992). Their environmental transition hypothesis states: "economic growth is likely to be accompanied by environmental degradation at low-income levels but as income increases, the demand for environmental protection may bring about a path characterized by both economic growth and environmental improvement." Although preliminary work has been conducted on the role of economic growth and trade liberalization on environmental quality, more reliable data and studies are needed to better understand the open trade-environmental quality linkages.

Special Topics in Trade and the Environment

WTO contracting parties have a strong interest in: transparency of health and environmental measures; packaging and labeling requirements; measures relating to international environmental agreements; environmental taxes and charges; harmonization of health, safety, and environmental measures; and the use of trade instruments for environmental policy. Areas that may be most rele-

[14]Stock feedback effects occur when the quality or quantity of a resource is affected by production. For example, agricultural production can result in soil erosion; soil resources are depleted thus affecting future production.

[15]Although new methods of measuring environmental demand have been developed, these calculations have primarily been applied to local area studies. On a national basis, the level of emissions is often still used as a proxy for the demand for environment quality.

vant for the agricultural sector include harmonization of product and environmental performance standards and production and processing methods, as well as the use of trade instruments for environmental policy.

Harmonization of Product and Environmental Standards and Production and Processing Methods

Robertson (1992) defines harmonization as the "coordination of policies and instruments to reduce international differences and to facilitate international competition." Some environmental groups worry that trade agreements lower national environmental standards (*The Economist*, February 27, 1993). Some business representatives favor harmonization as a means of facilitating trade across national (or other jurisdictional) boundaries; but they may also disfavor it should harmonization put their own firms or industries at a cost disadvantage. Economic arguments both support and contraindicate harmonization in part depending on the unit of analysis.

Harmonization Taxonomy

The concept of harmonization may be applied to several different types of environmental policies. A discussion of the economics can be based on a taxonomy that divides harmonization of standards into three categories: harmonization of product standards; harmonization of environmental performance standards; and harmonization of production and processing methods (PPM's) (table 4).

The harmonization of product standards has already received attention in international forums. The basis for setting product standards pertaining to food safety was a component of Uruguay Round negotiations over rules for applying sanitary and phytosanitary (S&P) measures to imported products. During the S&P negotiations, one of the issues contracting parties discussed was the possibility of harmonizing requirements for legal limits on pesticide residues in foods. Under the negotiated S&P Agreement (Agreement on the Application of Sanitary and Phytosanitary Measures), countries have agreed to work toward harmonizing food safety and other S&P requirements based on international standards, guidelines, and recommendations. For food safety, the relevant international body establishing scientific bases for standards is the Codex Alimentarius Commission (CODEX) (see box—"Codex Alimentarius Commission"). Under the terms of the S&P Agreement, a country that restricts imports based on stricter standards than those under CODEX could be called upon to provide scientific justification (see box—"Sanitary and Phytosanitary (S&P) Measures and Technical Barriers to Trade (TBT)").

Product packaging and labeling requirements and guidelines for applying such domestic requirements to imported products were not discussed in the Uruguay Round, but these issues have been on the agenda of recent OECD and Committee on Trade and Environment/WTO meetings. Packaging regulations pertain to the materials used or the handling of the materials used in shipping. These regulations might, for example, require packaging to be recyclable or, if not, to be returned to the country of origin. Labeling requirements might mandate the provision of certain nutritional or other consumer information such as the environmental implications of a product's life cycle. "Dolphin safe" labels on tuna cans are an example of environmental labeling. Other product-related requirements might pertain to the procedures that must be followed for registering a new product, including numbers, types, and results of product tests that must be conducted before a product can be introduced to the market. Both the nature of those requirements and the processes that must be followed differ by country.

Table 4—Harmonization taxonomy

Product standards	Production and processing methods (PPM's)	Environmental performance standards
Food safety	Environmental control technology	Air quality standards
Packaging content (recyclable)	Harvesting methods (purse seine nets)[1]	Water quaility standards
Ecolabeling	Farming methods (IPM)	Soil quality standards
Regulatory processes (registration of pesticides; product testing requirements)	Certification requirements (defining organic production methods)	Protection of species: Existence values Genetic diversity

[1]Purse seine nets have been used to harvest tuna fish. See box, "Tuna-Dolphin Cases," on p. 14.
Source: Economic Research Service, USDA.

Codex Alimentarius Commission

The Codex Alimentarius Commission (CODEX) is a food standards organization and a subagency of the United Nations Food and Agriculture Organization (FAO) and World Health Organization (WHO). As of 1994, CODEX is comprised of 146 member nations and is open to all members of the FAO and the WHO. CODEX sets industrial guidelines for food safety that can be voluntarily adopted by its members. CODEX seeks to facilitate food trade while furthering consumer health, promoting fair practices in food trade, organizing food standards set by other international organizations, and ultimately publishing these guidelines in a Codex Alimentarius.

CODEX consists of 28 subject and commodity committees that evaluate and draft Codex Standards and seven general committees. Various member countries act as host to each of the seven general committees which decide issues on pesticide residues, food additives and environmental contaminants, food hygiene, analysis and sampling, general principles, drug residues, and food labeling. CODEX members include scientists, technical experts, and government regulators, with heavy industry representation and less representation from environmental and other public interest groups (Kramer, 1990; FAO, 1994).

Before a food standard or code of practice is approved for a particular use, CODEX looks at the volume of international trade, consumption, and production of the food product to determine whether the product needs a world standard to protect consumers from health risks and fraud. CODEX then has the appropriate committee submit a draft to member countries specifying quality, ingredients, sanitary and labeling requirements, adulteration limits, food additives, and sampling and analysis methods. The committee revises the draft to include suggestions or comments and resubmits it to the member countries. After it is reviewed, it is sent to all members of CODEX for final approval. If approved, it becomes a Codex Alimentarius Standard or Code of Practice (Morrison, 1983).

As an example of CODEX's role in international food trade, it has established standards for conventional labeling and regulations to control outrageous claims. Food labels have to contain the name of the food, list of ingredients in descending order, net contents and drained weight, country of origin, date marking and storage instructions, lot identification, manufacturer, and instructions for use. There are guidelines for a nutrition label as well, which include energy value, content of protein, fat, carbohydrates, vitamins and minerals, and a general standard for food additives. CODEX also has recommended international codes for good hygiene, which cover production/harvesting methods (including transportation), proper facilities, personnel hygiene, and hygienic processing requirements. CODEX hygienic advisories include hazard analysis critical control point (HACCP), an approach that identifies and monitors processing points where contamination may take place (FAO, 1994).

Harmonization of environmental performance standards has also been the subject of multinational talks, particularly when the environmental issue has a transnational or global dimension (such as protection of the atmosphere) such that the benefits of protection are widely shared across nations. Several International Environmental Agreements (IEA's) provide for cooperative approaches to addressing global environmental problems. The most ambitious IEA's aim to establish quantitative performance goals. Existing global IEA's address protection of wildlife (endangered species), habitat, oceans, atmosphere, and hazardous waste disposal. For example, the 1987 Protocol on Substances That Deplete the Ozone Layer (Montreal Protocol) requires nations to cut consumption of five chlorofluorocarbons and three halons by 20 percent of their 1986 level by 1994 and by 50 percent of their 1986 level by 1999, with allowance for increases in consumption by developing countries (World Resources Institute, 1992).

Harmonizing PPM's is the category most likely to generate debate in the WTO and other international forums. Some have argued that any international effort to regulate or coordinate PPM's would infringe on national sovereignty (Charnovitz, 1991). In one widely publicized case, a GATT panel sided with Mexico against a U.S. embargo on Mexican tuna that had been imposed because of Mexico's tuna harvesting methods, which were endangering dolphins (U.S. Congress, Congressional Research Service, 1991) (see box—"Tuna-Dolphin Cases," p. 14). However, different PPM's, such as low-input versus chemical-intensive farming, affect the environment differently and may be easier to monitor and regulate than environmental performance. Industry interests are also concerned with how national regulations of PPM's (for example, requiring the use of certain environmental control technologies or bans on certain agricultural chemicals) differ and affect their cost structures relative to their competitors in other countries.

One potential form of harmonization would make environmental policy instruments more similar among countries. Nations now take many different approaches to meeting environmental goals, and, even when performance standards are similar, policy instruments can differ markedly. Regulatory approaches are more common in

Sanitary and Phytosanitary (S&P) Measures and Technical Barriers to Trade (TBT)

The Sanitary and Phytosanitary Agreement (S&P Agreement) of the recently negotiated Uruguay Round provides that contracting parties may adopt or enforce S&P measures "necessary" to protect human, animal, or plant life or health, as long as they are not applied in a manner that would arbitrarily or unjustifiably discriminate between countries with similar conditions or act as a disguised restriction of international trade. Measures must be based on scientific principles and conform with the General Agreement on Tariffs and Trade, particularly Article XX(b) (see box, "GATT Article XX General Exceptions," p. 30). While these principles existed before the Uruguay Round Agreement, the S&P language more clearly details the rights and obligations of the contracting parties with the aim of avoiding any new trade barriers.

The S&P Agreement defines S&P measures as those that protect animal or plant life or health from the entry or spread of pests and diseases within the contracting party's territory; those that protect human or animal life or health from toxins, contaminants, additives, or disease-carrying organisms found in food, beverages, or feedstuffs; those that protect human life or health from diseases carried by animals, plants, or products or from the entry or spread of pests; and those that limit or prevent other damages from the entry or spread of pests. These measures can take the form of laws, decrees, regulations, requirements, testing procedures, inspections, and methods.

Contracting parties must base their measures on an assessment of the risks, circumstances, environmental conditions, available scientific evidence, and relevant production, testing, and sampling methods to determine the appropriate level of S&P protection. Contracting parties must also try to adopt the least trade-restrictive measure, taking into account technical and economic feasibility.

A chief concern surrounding S&P measures is the negative effect they may have on trade. As a result, contracting parties have agreed to work toward harmonizing S&P measures based on international standards, guidelines, and recommendations. These standards, guidelines, and recommendations are established by the CODEX for food safety, the International Office of Epizootics for animal health, the International Plant Protection Convention coupled with regional organizations for plant health, and other international organizations identified by the Committee on Sanitary and Phytosanitary Measures for all other matters.

Under the S&P Agreement, if an exporting party "objectively demonstrates" that its measures achieve the importing party's proper level of S&P protection, then the importing party must accept the measures as equivalent even when they differ. A contracting party that introduces a measure with a higher level of protection than those based on international standards, guidelines, and recommendations must provide scientific justification. Contracting parties have also agreed to address the special needs of developing countries by allowing longer timeframes for compliance, providing technical and financial assistance, and encouraging overall participation in international organizations.

In addition to the S&P Agreement, contracting parties negotiated a Technical Barriers to Trade Agreement (also called the Standards Code). The TBT Agreement covers technical requirements relating to S&P measures such as pesticide residue limits, inspection requirements, and labeling, as well as packaging, product content requirements, and processing methods that affect the characteristics of the product. As in the S&P text, the TBT Agreement calls for contracting parties to use relevant international standards, but national standards could be used to meet "legitimate objectives" including protection of the environment. However, importers must be treated the same as domestic producers and the TBT measure "shall not be more trade restrictive than necessary to fulfill a legitimate objective" (GATT, 1994 and 1991, and Charnovitz, 1991).

some countries, while other countries favor incentive-based instruments; some countries provide subsidies, particularly in the agricultural sector, while others levy taxes. The OECD has addressed this issue by encouraging its members to adopt common principles, such as the polluter-pays principle, that would underlie environmental policy design (see footnote 3).

Economic Arguments on Harmonization

Product standards, environmental performance standards, and PPM's vary among countries for a number of valid reasons. An important one is that community demands for environmental amenities often differ. In other words, if the production of a good carries with it both a private (or internal) cost and an external cost (the cost to society of pollution generated when the good is produced or consumed), some communities assign this social cost a higher value than others. Differing income levels may be an important factor contributing to these differing community demands. Some argue that richer communities have a greater capacity and preparedness than poorer communities to trade off goods consumption for a cleaner or better-preserved environment, although this might not mean that poorer communities desire an improved environment any less (Anderson, 1992a).

Similarly, different communities have different degrees of willingness to assume risk of hazard to environmental or human health.[16]

Another reason for diverging degrees of environmental protection may be that different environments have different "assimilative capacities." An environment's assimilative capacity is measured by its ability to take wastes and convert them back into harmless or ecologically useful products (Pearce and Turner, 1990). The steps a community takes to control soil erosion, for example, may depend on its perception of the ability of the environment to assimilate erosion sediments before commercial fishing, recreation activities, or fish populations are threatened.

In economic terms, if demand for and supply of environmental amenities differ among nations, then the optimal level of pollution or environmental externality will also differ and harmonization will not make economic sense. The socially optimal level of environmental quality is that for which the cost to society of the last unit of environmental damage (the marginal social damage) is exactly equal to the cost in terms of pollution abatement expenditures of removing that last unit (the marginal abatement cost).[17] At a higher level of pollution, the marginal social cost of pollution is higher than the cost of abating the pollution, so society will usually choose to reduce pollution. At a lower level of pollution, the cost of abating the pollution is higher than the value to society of abatement, so society will usually choose to allow pollution to increase. If pollution is at some nonoptimal level, then society's resources are inefficiently allocated between private goods and pollution and total social welfare could be enhanced with an environmental policy that corrects the balance. However, harmonization forces pollution levels to be the same among countries, thereby moving countries away from their optimal pollution level (fig. 8).

Two countries might have similar environmental standards but different pollution tax rates. For example, two countries might have like standards for water quality but might tax (or limit) the use of water pollutants, like nitrogen fertilizers, at very different rates. Can both countries' tax rates be optimal from national perspectives? The answer is yes, for several possible reasons. One is that producers in the two countries may respond very differently to the same tax. In one country a high tax might be required in order to limit nitrogen use sufficiently; the other country may have success with a lower tax. A second reason is that the environment may be more vulnerable to damage from nitrogen use in one country than in the other. This may be because of the relative permeabilities of the soils on which nitrogen is applied or the proximity of the nitrogen-using areas to water supplies. More vulnerable regions, everything else equal, may require higher tax rates.

Under NAFTA, and similarly in the S&P and the Technical Barriers to Trade sections in GATT, comparability of standards is to be promoted through the application of the following principles:

- **Transparency**—the disclosure of methods used in formulating and adopting health-related measures, the dispensing of information and advance, notification to the public, and the opportunity for public comment;
- **Equivalency**—the recognition that different methods may be used to achieve the same level of health protection;
- **Consistency**—avoiding arbitrary or unjustifiable distinctions across commodities in choosing the level of risk or the adoption of S&P and standard-related measures; and
- **Regionalism**—applying risk-assessment criteria on the degree of risk for an area within a region rather than the whole country being risk-free or not risk-free.

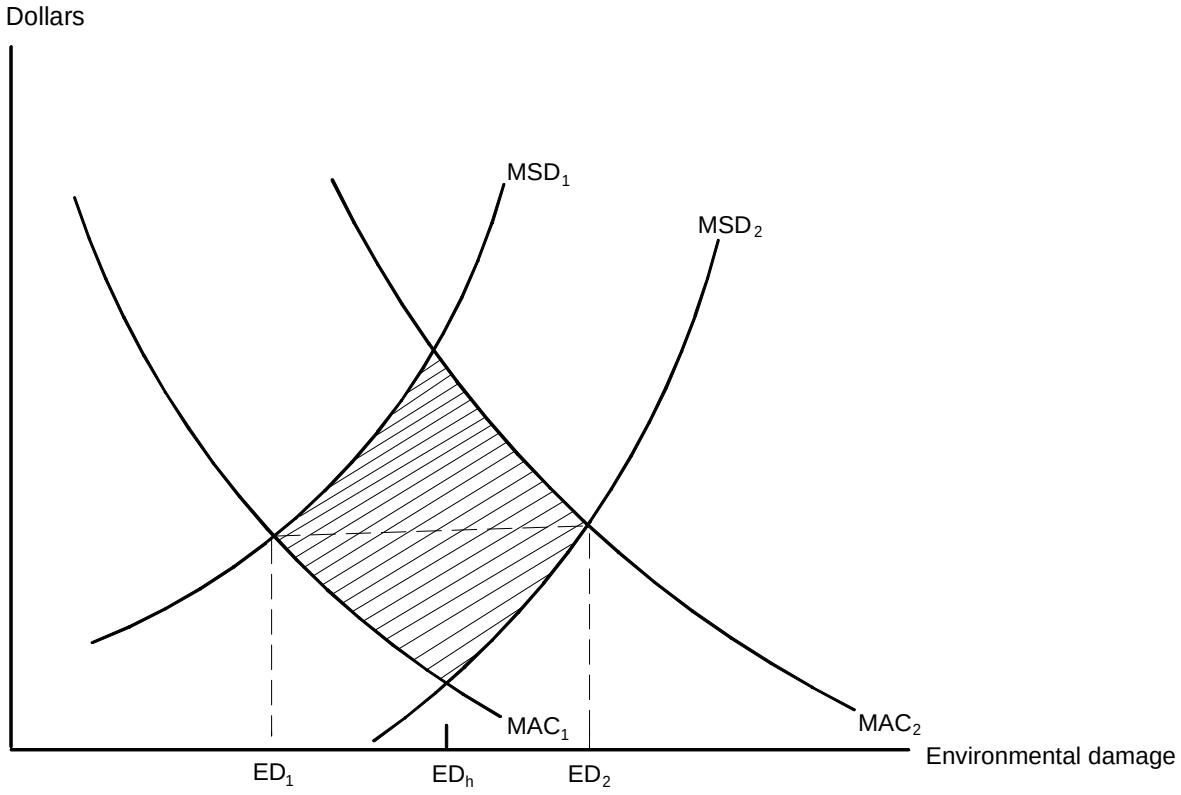
In sum, simple economic constructs suggest that harmonization may not be an efficient international policy. Differing national preferences for private versus public goods consumption may be a key factor underlying the international distribution of production and in establishing global patterns of trade. However, simple economic models abstract from many real world complexities. For example, they assume that social damage functions are known and represent the true (aggregated) preferences of each country's citizenry. Citizens' preferences are not always well known or well represented through the policymaking process.

Economic theory and concepts may also offer some support for harmonization, particularly for the case of product standards designed to protect health, safety, or

[16] An analog exists in the arguments regarding differences between Federal and State standards for environmental quality in the United States. The argument could also be posed in an intergenerational context. Wealthier communities may be more willing to sacrifice economic activity today in order to preserve the environment for the benefit of future generations; poorer communities may find that the sacrifice would be too costly.

[17] The cost of reducing pollution can be measured either in terms of foregone output and consumption of private goods or in terms of expenditures necessary to reduce pollution. If output reductions are the only way to reduce pollution, then the value of lost output equals the abatement cost. See Pearce and Turner (1990) for a discussion of how these two concepts are related.

Figure 8
Social welfare loss from harmonization



Source: Economic Research Service, USDA.

Figure 8—*This figure illustrates the social welfare loss to two countries when they harmonize their pollution levels away from their initial optimal levels. It shows marginal social damage functions (denoted MSD) and marginal abatement cost functions (denoted MAC) for countries 1 and 2. At first each country chooses its own optimal level of environmental damage (ED): ED_1 and ED_2. Country 2 prefers a higher level because of two factors: (1) for any given level of pollution, its abatement costs are higher, and (2) for any given level of environmental damage the social costs are lower. Later, the two countries compromise by harmonizing their standards at environmental damage level ED_h. At this harmonized level country 1 produces an inefficiently large amount of pollution and country 2 produces an inefficiently small level. The total social welfare loss is the shaded area bounded by the two countries' curves.*

the environment. If product standards differ markedly by country, firms that export to many countries may face significant transactions costs in acquiring information from many individual sources. Tailoring product characteristics to meet the unique requirements of many markets may be costly and hinder the ability of such firms to take full advantage of the economies of scale that international trade can offer. These costs are passed on, at least partially, to consumers. When these transaction and tailoring costs are taken into account, the benefits to the world consumer of product standards harmonization may be an empirical question. For example, there may be types of harmonization—like regulatory requirements for testing bioengineered products or standards for certifying a product is organic or environmentally friendly— that can improve international market performance by lowering transactions costs and improving the quality of consumer information.

An economic case for harmonization of environmental performance standards can also be made when consumers of the environmental amenity are distributed across national boundaries, but the actions of one nation can affect consumption of the amenity in other nations. The benefits of protecting the ozone layer and genetic diversity, for example, are broadly shared, although countries' abilities to contribute to a global effort may vary markedly. Water quality could also benefit from multinational standards because waterways and water sources are so often shared by two or more countries.

Performance standards could then be determined cooperatively, economizing valuable resources. Nonetheless, negotiations can be long and difficult due to differing preferences and financial resources among countries, and the difficulty of defining a consistent set of performance indicators to be applied across countries. Differing preferences and financial resources among countries may suggest a role for financial transfers from richer to poorer countries. Similarly, differing production technologies across countries suggest a role for flexible approaches, such as tradable pollution permits, to realize jointly set goals.

The harmonization of PPM's is the type of harmonization most difficult to support based on economic concepts, particularly when the environmental effects of the production technology are confined within national boundaries. For example, animal waste pollution in European countries may require an EU solution but pose no environmental issues in North America. Even when transboundary effects are present (like when water pollution flows from one country to another) economic arguments are likely, based on efficiency grounds, to support environmental agreements that emphasize performance rather than mandate or prohibit particular production techniques. Regulating practices can freeze the development of new and preferred technologies for the future. However, environmental performance (or the contribution of individual firms or producers to performance) can be very difficult to monitor and measure, particularly where nonpoint source pollution is involved.

Many harmonization issues potentially addressed in international negotiations are likely to be pertinent for agricultural production, food processing, and food and agricultural product trade. Today's food and agricultural products are widely traded and traditional impediments to trade generally low, so there may be growing interest in moving toward the harmonization of standards and technical requirements applied to these products. Many environmental concerns of global interest, such as biodiversity and habitat preservation, are related to agricultural production.

Use of Trade Measures for Environmental Purposes

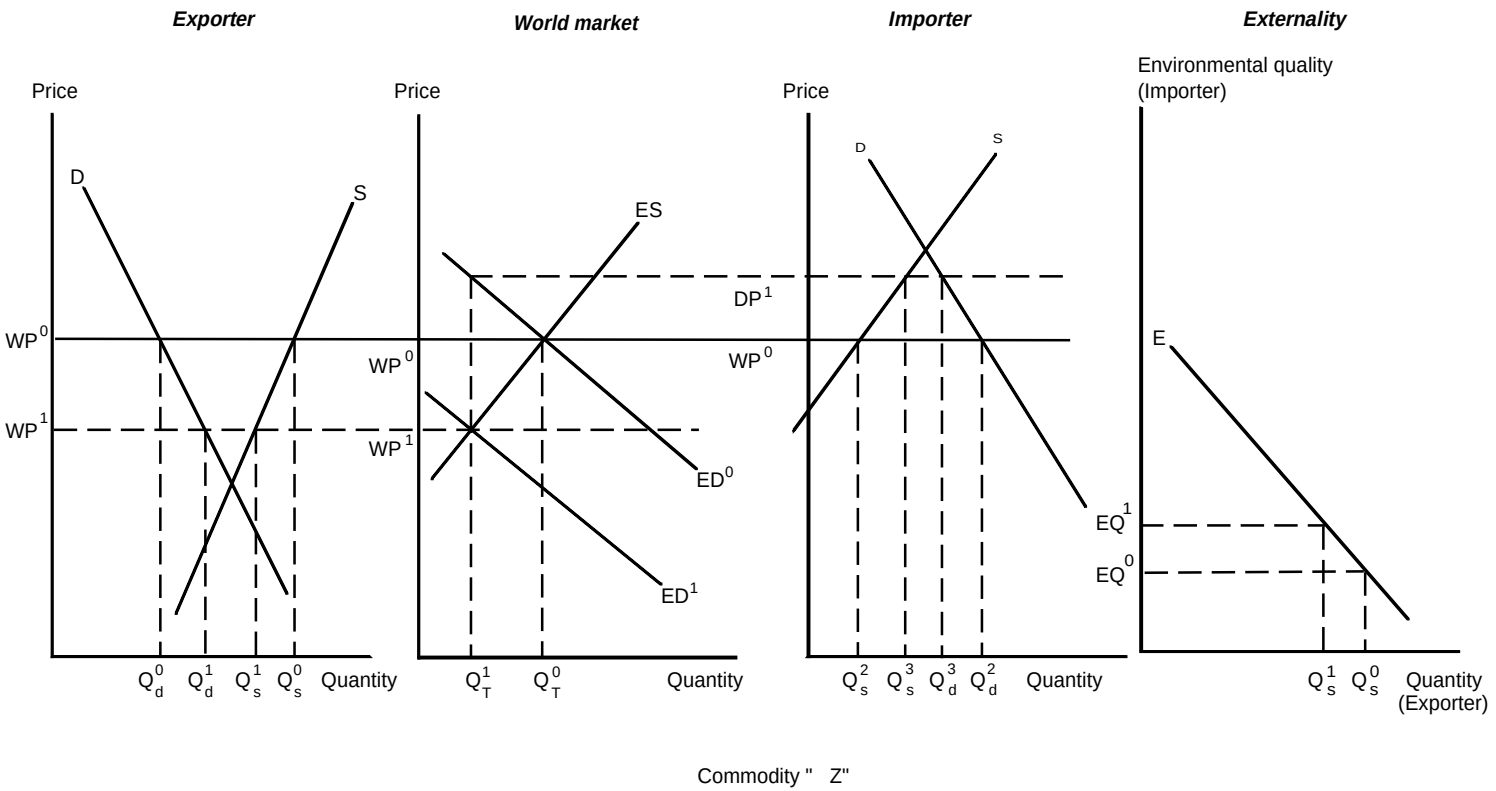
While international coordination to protect the environment can be achieved through voluntary negotiation, some nations have called for more forceful approaches—including trade sanctions and other restrictions. Future WTO talks will likely explore the extent to which its rules will allow a country (1) to use trade actions to force protection of the environment outside its own boundaries or (2) to correct for competitive differences in environmental standards. While some countries may wish to explore the use of trade actions for these purposes, current WTO rules prohibit making market access dependent on changes in domestic environmental policies or practices in an exporting country (GATT, 1992). Most countries discourage using forceful approaches, such as unilateral action that restricts market access or trade actions based on competitive concerns about differing environmental standards, to influence environmental policy. WTO considers environmental standards to be similar to other standards such as labor practices and education policies for which no special duties are allowed.

Trade Measures to Control Pollution Generated by a Trading Partner

Economists studying the trade and environment debate have recently revisited the theoretical role of trade policy in addressing environmental concerns (For a more detailed discussion of this topic, see Ludema and Wooton, 1992; Markusen, 1975; and Panagariya, Palmer, Oates, and Krupnick, 1993). A tariff may be a viable tool for a country wishing to control transboundary externalities emanating from the production of goods in another country, particularly if it cannot directly influence the other country's domestic taxes, subsidies or regulations. For example, a tariff imposed by a (large) importing country on the exporter's polluting good can, under certain conditions, result in a welfare improvement in the importing country and an improvement in environmental quality (fig. 9). An industrial example involves a factory producing export goods as well as emissions that cross the border into the importing country. An agricultural example might be the case of an upstream agricultural country polluting the water of a downstream country due to sedimentary runoff or chemical leaching.

Several important concerns related to the use of trade measures to achieve international environmental objectives exist. One is the costs of such measures relative to alternative strategies. For example, country 1 could encourage adoption of environmentally friendlier practices among farmers in country 2 by providing technical support. This alternative could be more cost-effective than country 1 imposing a tariff on country 2, particularly if the pollution of concern is coming from a particular locality and not from all producing regions, or if there is a likelihood of trade policy retaliation. A trade measure is likely to affect all production because it can have its most important effect on production not even located near the specific polluted area. However, a technical exchange program can be targeted to production regions most responsible for the pollution.

Figure 9
Effects of a tariff on transboundary pollution



Source: Economic Research Service, USDA.

Figure 9—*This figure shows the two-country, open economy case, along with an additional panel illustrating a transboundary effluent. Production in the exporting country does not affect environmental quality at home but does generate externalities in the importing country. The production of commodity Z in the exporting country and the level of environmental quality in the importing country consistently decline in panel 4. In the absence of international cooperation, the importing country may choose to impose a tariff to mitigate the pollution concern. The tariff would cause the domestic price in the importing country to rise (WP^0 to DP^1, panel 3) and the level of imports demanded to fall (panel 2). The excess demand curve shifts downward (ED^0 to ED^1), lowering world price and the price in the exporting country (WP^0 to WP^1, panel 1). Production in the exporting country drops (Q_S^0 to Q_S^1), and the associated externalities affecting the importing country decline (environmental quality increases from EQ^0 to EQ^1). The tariff has thus reduced transboundary externalities.*[1]

[1] *If production of the good in the importing country also generates an environmental externality internal to that country, then imposition of the tariff as above will reduce damage done by foreign producers but increase damage done by domestic producers.*

A second concern relates more broadly to the potential effectiveness of a trade measure for reducing transboundary problems. Suppose the world market is composed of other buyers of country 2's product as well. A unilateral action by country 1 may not affect country 2's production level enough to sufficiently curtail transboundary pollution. Country 1 may have to seek the cooperation of all or most importing countries. If other countries do not share country 2's environmental problems, they may not be willing to cooperate in applying a trade measure.

A cooperative approach to environmental policy is most likely where all involved countries benefit from the environmental outcome. Protection of the atmosphere, air quality, genetic biodiversity, and endangered species are, for example, broadly (although differently) shared environmental interests that can benefit from multinational cooperative approaches like IEA's.[18] IEA's sometimes do involve trade barriers, but participants are likely to give considerable attention to their appropriateness and cost effectiveness compared with other measures (see box—"Current Uses of Trade Measures in International Environmental Agreements (IEA's)"). Alternatives to trade measures might include financial transfers to polluters from those that benefit most from pollution abatement; internationally traded pollution permits; and programs designed to give local producers stronger incentives to protect their natural resources (see box—"Community Resource Management"). When international programs are efficiently designed, the world's economies give up less in terms of economic well-being in order to achieve environmental goals.

[18]See discussion in previous section on harmonization for an explanation of why countries price environmental amenities differently.

Trade Measures to Protect the Global Commons

Some trade measures involve the use of sanctions or measures to influence foreign production levels or methods that are perceived to degrade the "global commons" (including oceans and the atmosphere) or global public goods (such as biodiversity). Trade measures to protect endangered species or animal health and safety—such as bans on tuna caught with driftnets, bans on fur caught with steel leg-hold traps, or bans on poultry exports because of controversial production methods—might also be grouped here.

In considering the use of trade measures to protect the global commons and global environmental goods, the international community may have the option of alternatives that offer more effective incentives for sound environmental management. In the case of biodiversity protection, for example, incentives for wise habitat management might correct institutional failures, such as

Current Uses of Trade Measures in International Environmental Agreements (IEA's)

GATT has estimated that approximately 17 IEA's contain trade measures addressing issues from endangered species to hazardous wastes (GATT, 1992). Trade measures can accomplish environmental goals in a variety of ways. They can persuade countries to adopt IEA's and environmental standards, take away a country's economic incentives to engage in environmentally detrimental activity, and impede one country from frustrating the environmental efforts of another.

The Montreal Protocol on Substances That Deplete the Ozone Layer (Protocol), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, and the Convention on International Trade in Endangered Species (CITES) are all examples of IEA's that incorporate trade measures. Presently, the Protocol restricts the import and export of chlorofluorocarbons and other chemicals that deplete the ozone layer, as well as products that contain these substances. The Protocol has also proposed a process restriction on products made using ozone depleting substances. The Basel Convention places restrictions on trade between signatories and countries that lack regulations for proper disposal of hazardous and toxic wastes. Similarly, CITES prohibits the trade of endangered and threatened species and products that originate from them, such as ivory.

The principal concern surrounding the use of trade measures in IEA's is environmental effectiveness and economic efficiency. For example, since the CITES ivory trade moratorium, elephant poaching has dropped significantly. Yet the recent debate over proposed trade restrictions on tropical timber imports and exports exemplifies the difficulty of predicting the effectiveness of trade measures. Those in support of trade restrictions on tropical timber feel trade restrictions will preserve genetic diversity. Those against restrictions argue that they will be ineffective since more than 80 percent of tree cutting in developing countries results from agricultural land-clearing and fuel wood harvesting. Others feel that, although a total ban on tropical timber exports might not be effective, trade restrictions would be appropriate in those countries exporting a greater percent of their tropical timber (Office of Technology Assessment, 1992).

Community Resource Management

Successful community resource management may be a key component in preserving the natural resources of developing countries. Many governments, however, have taken control over natural resources without the specialized knowledge, presence, or personal interest that local communities possess. This has led to overexploitation of natural resources by outside entities and community members alike. With security of tenure, protection, and adequate authority over land use, communities may be best able to allocate resources efficiently (Panayotou, 1993).

In India an experiment was conducted in which villagers were given forest-related jobs in an effort to prevent deforestation. Villagers were responsible for planting seeds for trees and grass and protecting the forest from encroachment. Villagers were also awarded 25 percent of the selling price of mature trees. This experiment led to long-term forest management, leaving both the villagers and the forests in a better position. Since then, other villages have employed the same methods successfully (Panayotou, 1993).

Likewise, communal tenure in Papua New Guinea has resulted in sustainable and productive use of land. Communal lands, governed by local customs, are neither publicly nor privately owned. Rather, families have the right to plant crops freely, while the clan maintains the right to transfer property ownership. Clearer ownership rights and security of tenure have allowed community members to use forest land efficiently. Companies seeking logging rights deal directly with clan members who are less interested than the government in gaining short-term profits over long-term sustainability. As a result, out of 46 million hectares of forest land, only 6 million have been cleared for other purposes (Panayotou, 1993).

Community resource management has also been used to solve problems such as overgrazing, overfishing, and endangered species. For example, in Alanya, Turkey, an effective rotational system of fishing was created by local fishermen to reduce overfishing. Fishing locations are labeled and spread out along the shore from September to May. Fishermen are assigned a location and rotate each day to the next location. This allows fishermen to use large nets without interference and provides equal opportunity to fish at choice locations. The rotational system is heavily supported because it benefits everyone except those who once monopolized (Berkes, 1986).

Many feel that when communities control their own resources they are more apt to preserve them. For example, opponents of the CITES ivory trade moratorium who favor community resource management argue that "well-managed exploitation" of elephants will lead to species preservation since communities will gain long-term financial benefits. Although community resource management has met with mixed success, communities that have been successful suggest that an effective program of community resource management can be the best source of sustainable development (Office of Technology Assessment, 1992).

lack of property rights, that are at the root of habitat destruction. The programs of the World Bank and other international development institutions already confront many such environmental problems with global dimensions, suggesting a role for constructive dialogue between such institutions and the WTO's Committee on Trade and Environment (World Bank, 1992). Because the international community will at times agree to use trade measures to enforce provisions of IEA's, a key issue of international law is the relationship of such multilateral agreements to countries' obligations under the WTO. Developing formal mechanisms for IEA consultations with WTO may help in designing trade measures that are least restrictive.

Trade Actions Taken Against Imported Products Not Meeting Domestic Standards

Product standards, as discussed above, may differ by country for very legitimate reasons, and these differences can be the source of significant trade frictions. Because previous GATT negotiations significantly lowered traditional trade barriers, nations may now focus on addressing the trade effects of differences in product standards and regulations. Product standards are often set to address the asymmetric information and uncertainty problem or consumption externalities. Examples of trade actions associated with imported products might include banning imported wines not meeting domestic tolerances for fungicide residues or banning food products not meeting domestic labeling or packaging requirements.

The WTO is relatively accepting of a nation's right to require all products, whether domestically produced or imported, to meet national standards for health and safety of consumers, plants, animals, and the environment (see box—"GATT Article XX General Exceptions"). For instance, a recent GATT panel ruled in favor of U.S. regulations requiring a corporate average fuel efficiency (CAFE) standard, luxury tax, and gas guzzler tax, which the EU had protested as discriminatory against imports.

GATT Article XX General Exceptions

Article XX furnishes signatories with 10 exceptions to GATT's guidelines aimed at limiting trade restrictions. Trade measures that fall under Article XX are permitted on the condition that they "are not 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." Although Article XX makes no direct reference to environmental concerns, subparagraphs (b) and (g) respectively relate to measures that are "necessary to protect human, animal, or plant life or health" and measures for "the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption."

Environmental measures that may require analysis under Article XX include process restrictions. The Montreal Protocol's proposed ban on the import of products made using ozone-depleting chemicals is an example of a process restriction. WTO members are currently debating whether subparagraphs (b) and (g) cover these trade measures.

As nations struggle to achieve environmental goals, it is difficult to predict whether a given environmental trade measure will pass a strict interpretation of Article XX. However, with the influx of transboundary pollution and concerns over the ozone layer, it may become increasingly difficult to reject trade measures based on jurisdictional and necessity grounds. (Office of Technology Assessment, 1992).

Economic, legal, and scientific issues are raised when trade actions are used to force conformity with national product standards. Tuna-dolphin trade disputes among the United States, Mexico, and the European Union highlight many of these issues (see box—"Tuna-Dolphin Cases," p. 14). For example, the WTO is concerned with finding a scientific basis for national standards and (under the terms of Article XX) establishing the nondiscriminatory treatment of domestic and foreign products. While the GATT panel ruled in favor of the United States in the CAFE standard case, it also sided with the EU on a provision in the CAFE law that establishes separate domestic and imported fleet requirements. WTO may have to determine if and to what extent a product standard gives the domestic product an unfair advantage. For example, is it reasonable for a country to require—as Germany has considered doing—foreign car manufacturers to take back and recycle old cars (*The Economist*, Feb. 27, 1993)?

Trade Actions To Level the Playing Field

Domestic firms and industries (including those with subsidiaries outside the United States) may seek protection from competition from foreign firms or industries subject to lower environmental control costs. Livestock producers, for example, would benefit from protection against imports from countries with less demanding requirements for animal waste management. Economists see little justification for trade measures designed to correct for these cost differences, especially if these differences reflect underlying contrasts in social preferences, resource endowments, and environmental conditions. This is likely to be a tremendously challenging area for trade negotiators, as it will be difficult to establish the legal and technical bases for defining legitimate differences in countries' environmental standards that will be acceptable to both environmental and business groups. It is also difficult to distinguish disguised protectionism from genuine environmental concerns. Finally, when a legitimate environmental issue is identified, it may be hard to identify when one country has a right to pressure another to accept its environmental goals and, possibly, its methods of achieving them.

Economists are likely to recognize that trade measures can be used to achieve international environmental objectives but argue that there may be better approaches. In the case of agriculture-related environmental concerns, the problems may be sufficiently local that a trade measure does not constitute a well-targeted, cost-efficient approach. Trade liberalization can reduce environmental quality, but sound environmental policy directed at the problem is preferred on global efficiency grounds to restricting trade.

Conclusions

This report has explored the linkages between agriculture, trade, and the environment. Many of the interactions can be understood in theorectical terms; to facilitate an understanding of these conceptual constructs, the relationships have been described and illustrated. Empirical studies particularly pertinent to the food and agricultural sector also have been discussed. Applied research efforts have been limited and tend to be based on a paucity of cross-country environmental data.

In general, the studies have found current levels of environmental regulation improving environmental quality

in various countries, but the effects of regulation on agricultural production, trade, and competitiveness tend to be small. Also, little evidence suggests that regulations have caused large shifts in production to less regulated countries. Although some sectors are faced with additional costs from the regulations, society as a whole benefits if the environmental policies are well designed and reflect social preferences. Furthermore, over the long run, environmental policies can stimulate technological change and even enhance competitiveness.

Freer trade can bring economic efficiency and growth, but its effect on environmental quality often depends on the environmental policies that are in place. The recent WTO and NAFTA accords acknowledged the trade and environment debate but did not fully address concerns raised by the environmental community. However, trade agreements may not be the best place to remedy most environmental problems. Trade agreements are designed to remove or reform trade-distorting policies, not to provide disincentives to pollute.

Trade liberalization and environmental goals can work in tandem. Trade agreements can help remove policies that support or protect environmentally harmful practices; they can also help establish common health or environmental standards on traded goods. Trade liberalization can also contribute to economic growth, a crucial factor in increasing demand for environmental quality.

Harmonization of some environmental policies and product standards can facilitate trade, but may be best done on a cooperative basis and only to the extent that harmonization promotes standards that are protective in accordance with social benefits and costs in individual countries. While some international environmental agreements have used trade measures to ensure the environmental goals of their member nations, the unilateral or coercive use of such measures may be open to WTO challenge. International environmental agreements are the preferred, although often more difficult, method of achieving international or transboundary goals.

Much of what was discussed in this report is drawn from a body of literature that grew over the last several years. While there has been discussion about issues, principles, and typologies, much remains uncertain and subject to change. If environomental control costs become a larger component of costs, or if transboundary or feedback effects exert stronger pressures on the environment, the interactions among agriculture, trade, and the environment could become better defined and pronounced. The nature of the discussion may change.

The rules of discussion may also change. As with many contentious issues, debate will evolve as countries devise new policies and cases are brought before the WTO. While WTO panel rulings, as GATT panel rulings before, do not constitute a body of precedence, they strongly influence international approaches toward trade and environment issues. Thus, while this paper attempted to conceptually and empirically explore the linkages, the issues will continue to warrant investigation and discussion.

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