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ENVIRONMENTAL EFFECTS OF TRADE IN THE AGRICULTURAL SECTOR

A CASE STUDY

PREPARED FOR THE ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD) ENVIRONMENT DIRECTORATE PARIS

by

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C. Ford Runge

Environmental Effects of Trade in the Agricultural Sector:

A Case Study

I. INTRODUCTION AND OVERVIEW

1. Agriculture has been at the center of conflicts over world trade from the beginning in 1986 of the eighth, Uruguay Round, of multilateral trade negotiations. Yet it is only in the final phases of the Round that linkages from trade to the environment have come to the fore. In this paper, the specific linkages from trade to the environment in the agricultural sector are developed. The impacts of trade flows and policies on environmental quality in agriculture have features which make them unusually difficult to resolve. In many respects, the same domestic agricultural policies at the root of trade distortions also encourage environmental damages. Hence, reforming these domestic and trade policies would be a partial, though not a complete, step in the direction of greater environmental benefits. A complete set of policies will require targeted environmental interventions as well.

2. Market failures in agricultural production and consumption have widespread effects on soil, water, human health, and natural ecosystems which are difficult to monitor and therefore to estimate. These market failures are generally reinforced by government policies which distort the prices of agricultural products and inputs (water, fertilizers, pesticides). These distortions occur in agriculture to a greater extent than in many sectors of both developed and developing countries. Trade flows and policies are a direct result of these domestic distortions.

3. This case study will consider market failures with adverse environmental impacts in agriculture and their interaction with failures in agricultural trade policy in developed and developing countries. Section II develops a theoretical perspective on market and government failures in agriculture. In it, a simple model is discussed which emphasizes the distinction between the welfare effects of trade liberalization with and without appropriately targeted environmental policies. Section III provides some concrete examples of trade flows in agriculture and their environmental impacts in developed and developing countries, and analyzes the domestic policies at the root of distortions in agricultural trade. Section IV considers the likely impact of agricultural trade liberalization on market failures with adverse environmental effects, and the need to integrate environmental and trade policy reforms. Section V discusses the relationship between trade and environmental policy instruments in this context, and proposes some principles to guide trade and environmental policy in the agricultural sector. Section VI offers a summary and some proposed guidelines for the agricultural sector.

II. A THEORETICAL PERSPECTIVE

A. MARKET FAILURE AND GOVERNMENT FAILURE IN AGRICULTURE

4. In comparison with other sectors, the impacts of agricultural trade on environmental quality reflect a double dilemma. First, agricultural production is replete with examples of market failure;[1] that is, the prices of inputs and outputs in agricultural markets do not fully reflect the social costs of soil and water depletion, nonpoint source pollution, deforestation, and other adverse impacts of agricultural production. These externalities and "public bads" are not restricted to agriculture, and characterize many other sectors as well, leading to recent calls to bring such "external" factors into the accounting framework of private and public decision makers.[2]

5. Yet market failures in agriculture are especially difficult to monitor and to estimate. Soil losses due to erosion, for example, occur over large areas and are borne by both wind and water, leading to many costs that occur far from the site of the damage. Similarly, contamination of underground aquifers with farm chemicals occurs in underground hydrological systems and over many years. Until quite recently, these nonpoint pollution problems confounded the ability to identify "the polluter" and thus to allocate the costs of this pollution to individuals and firms in ways which efficiently and fairly "internalized" the externality.[3] This is one reason agricultural conservation policy has tended toward subsidies (bribes) to induce more environmentally responsible behavior. There are also political explanations for this tendency, which are related to a second dilemma in resolving problems of adverse environmental impacts from agriculture.

6. The second dilemma is that agriculture faces a problem of government or "nonmarket" failure.[4] This failure is the subject of a large literature, because dysfunctional agricultural policies are endemic to both developed and developing countries.[5] These failures appear worse in agriculture than in many other sectors. In developed countries, agricultural interest groups have spawned policies which support output prices well above market-clearing levels, and in some cases input prices (e.g., water) well below these levels. In developing countries, output prices are generally held below world market levels as a subsidy to urban consumers, while input prices (credit, fertilizer, water) are manipulated by government agencies either to tax or subsidize farmers.

7. The double dilemma faced by the agricultural sector is that these government failures tend to reinforce rather than mitigate market failures, compounding the adverse impacts of agriculture on the environment.[6] When output prices are held artificially high and input prices held low, the effect is to encourage excessive soil and water degradation as farmers intensify production and expand to more vulnerable soils and streambeds.[7] Conversely, when farm incomes are taxed by artificially lowering food prices to subsidize consumers, and input markets are distorted, as in many developing countries, deforestation and other land misuses are encouraged.[8] Many advocates of correcting market failures in agriculture

presume that governments are able and willing to develop accounting frameworks and regulations to internalize external costs. But given the record of government mismanagement in agriculture, it would be more accurate to say that the accounting framework and regulatory environment have been manipulated in a way that encourages negative externalities. It follows that if these market failures are to be mitigated, government policies which distort agricultural markets must also be squarely addressed.

8. Almost all agricultural trade policies emanate from domestic price manipulation. As D. Gale Johnson has noted,

> "The trade measures that each country adopts are an adjunct of its domestic farm policies. In most cases, a specific trade restrictive or interfering device has been adopted, not for its particular direct benefits, but because it is a device that will make it possible for a domestic measure to function."[9]

There is thus a close linkage from agricultural trade reform, based on revisions in domestic policies in both developed and developing countries, and environmental policy reform to correct market failures in agriculture. The same domestic policies in the name of which trade is distorted are also responsible for a large share of the environmental damages in agriculture. Of course, even if such reforms were undertaken, high commodities prices arising from market forces could also lead to environmental stress on land and water resources. While domestic policy reforms are not likely to be sufficient to address a variety of environmental problems in agriculture, they are nonetheless necessary if these market failures are to be confronted. Such measures would generally work in the same direction as more targeted environmental interventions.

B. TARGETS, INSTRUMENTS, AND THE EFFICACY OF INTERVENTION

9. In his classic analysis of government policy, Tinbergen argued that in general, each target of policy merits a separate instrument aimed at this target.[10] Environmental targets, in other words, are generally best met by environmental policies; and domestic agricultural and trade targets by domestic agricultural and trade policies. The distinction between market and government failure should not be confused with this targets and instruments distinction. Whereas environmental problems may be reinforced by domestic agricultural and trade policies, they are unlikely to be best resolved through such measures alone. Instead there will be some combination of domestic agricultural and trade policies, and environmental policies, which is most efficient.[11] In fact, it can be shown that the advantages of agricultural policy reform can be lost if appropriate environmental actions are not undertaken jointly. Put the other way round, environmental and domestic agricultural and trade policy reforms can be shown to be mutually consistent in welfare terms, as well as in political and budgetary terms.

10. The interdependence of trade and environment has gained the attention of both the environmental and trade communities in large measure because critics contend that trade liberalization is likely to exacerbate environmental problems. It will be argued here that if this interdependence is acknowledged, and appropriately targeted environmental interventions accompany domestic agricultural and trade policy reform, such fears are less warranted. Indeed, if an appropriate combination of environmental and agricultural policy measures is found, addressed to market and government failure in agriculture, the result can be both welfare gains from domestic agricultural and trade reforms and from improvements in the level of environmental quality.

C. THE WELFARE ANALYTICS OF TRADE AND ENVIRONMENTAL POLICY[12]

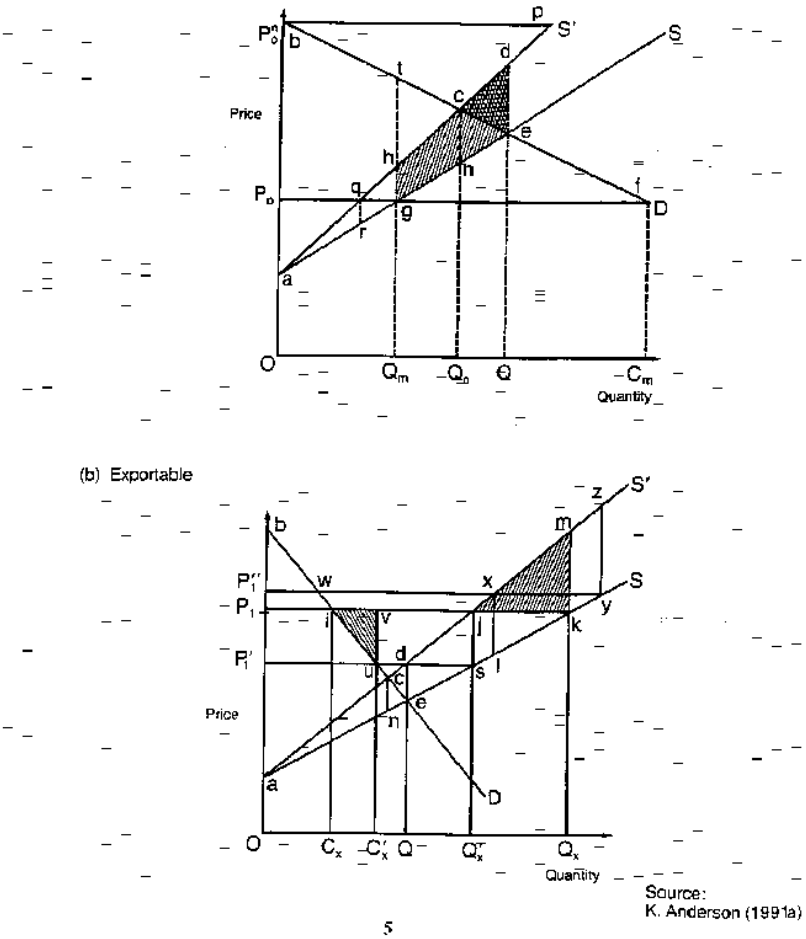
11. Anderson presents a simple analytical description of trade and environmental policy interaction which clarifies many of these issues, as well as underscoring how difficult they are to resolve. Using partial equilibrium, comparative static analysis, he first describes a small country facing both market failures and the prospect of trade liberalization, in which its own actions do not affect the rest of the world. He then considers the large country case, in which they do have global effects.[13]

12. Suppose a small country produces or consumes an agricultural commodity, such as maize, in which an externality results from the market's failure to reflect the impact of its (and only its) production or consumption on the natural environment. An example of a production externality might be soil erosion which reduces the productivity of agricultural lands and lowers water quality. An example of a consumption externality might be water pollution from farm chemicals which raises the risk of water-borne disease.[14]

13. The result of the externality is to drive a "wedge" between private and social costs of production, reflected in the divergence of S and S′ in Figure 1. These alternative supply curves measure marginal private and social costs, respectively. The demand curve, D, measures marginal private benefits. The price axis refers to the price of maize relative to all other prices in the economy, which remain constant throughout.

14. In this case, OQ is the level of maize production without either (a) international trade or (b) measures to "internalize" environmental impacts such as erosion. Production occurs at point e, the intersection of private marginal benefits and costs. Net social welfare is given as the sum of producer and consumer surplus,[15] minus the social costs of the external effect, or abe – ade. Now assume that the country shifts from autarchy (no trade), to open trade. If OP_0 is the prevailing international (border) price, as in Figure 1(a), production would fall to OQ_m, consumption would rise to OC_m and Q_mC_m units of maize would be imported. Net social welfare is now abfg – ahg, and the welfare gain is defgh. This gain from trade is both positive and greater than it would have been if no externality had existed in the form of erosion, by the shaded area degh. In effect, the

Figure 1. Effects of opening up a small economy to trade in a product whose production is pollutive



country benefits because it imports maize more cheaply than it can producer it, and benefits by reducing soil erosion as well. Imports are "substitutes" for erosion.

15. On the other hand, suppose OP_1 is the prevailing international (border) price, as in Figure 1(b). The country would thus become a net exporter of C_xQ_x units of maize if it moved to open trade. Net social welfare would be abik – amk, so the welfare effect of trade liberalization without any action to internalize the effects of erosion would be eik – edmk, which could be a net gain or net loss, depending on the relative magnitude of the gain from trade versus the loss from increased erosion as production expanded from Q to

Q_x.

16. From Anderson's analysis, several propositions follow. The first is that liberalizing trade in a good with adverse environmental impacts which are left uncontrolled improves a small country's welfare if following liberalization it imports the good; but if it exports it, the negative environmental effects are subtracted from the gains from trade, and the welfare effect is ambiguous. By importing the polluting good, a country lets some other country worry about its polluting properties. By exporting it, it continues to face the social cost of these externalities in the home market.

17. Now suppose that instead of leaving erosion uncontrolled, the small country combined trade reform with an environmental policy intervention sufficient to internalize the externality. Such an intervention could take the form of a tax, charge, or equivalent regulation or change in property rights.[16] Given such an environmental policy intervention, the gain from trade liberalization is qcf in Figure 1(a) and cij in Figure 1(b), depending on whether maize is imported or exported. In contrast to the situation in which no environmental intervention occurs, this is a net gain in either the importing or exporting case.

18. It is important to note, however, that without environmental intervention, the benefits of liberalization for the exporter would be even greater, by cde. Hence, an incentive exists for net exporters to forego environmental interventions because the benefits from trade are reduced somewhat by the production declines resulting from such environmental policy interventions. In this restricted sense, it is accurate to say that environmental interventions reduce an exporting nation's "competitiveness." But the larger loss is in net welfare, in that without such interventions, it is not clear that expanded exports will improve net welfare at all.

19. However, whether a small country is an importer or an exporter, there is a welfare gain from trade for a small country provided that a targeted (nearly optimal) environmental policy is introduced.

20. A third proposition of direct relevance to agricultural trade concerns the relative efficacy of trade and environmental policy instruments. Suppose that instead of targeted environmental policy interventions aimed at erosion control, it was proposed to use a trade instrument such as an export tax aimed at the same target. This is shown in Figure 1(b). An export tax could be used equal to js to lower the price producers receive from P_1 to P_1', reducing production and lowering exports form C_xQ_x to $C_x'Q_x'$. This would lower the marginal cost of production to a level equivalent to an environmental intervention, producing a welfare gain of shaded area jmk. But the export tax causes consumers to pay $P_1'P_1$ below the opportunity cost of OP_1, leading to a deadweight welfare loss due to excess domestic consumption C_xC_x', equal to the shaded area iuv. Hence, using a trade policy instrument reduces environmental degradation as much as an environmental production tax policy set at the same rate, but at higher cost.[17]

Trade instruments can be used to reduce environmental degradation by a given amount, but they generally will improve welfare less than a more direct intervention at the source of the environmental pollution, and may even worsen welfare.[18]

21. Moving from the small to the large country case, it is possible that the liberalization and/or environmental policies undertaken will affect world prices, so that the price lines in Figures 1(a) and 1(b) are no longer horizontal. Moreover, the environmental policies and polluting activities of large countries such as the United States or European Community will have global impacts, spilling over and ultimately back into home markets and welfare. Finally, policy changes in large countries may have demonstration or leadership effects on other countries.[19]

22. In summary, the welfare effects of liberalizing trade are ambiguous if environmental externalities are left uncontrolled; but if they are largely internalized by an appropriately targeted environmental policy, the joint "liberalization effect" and "environmental effect" on welfare is positive.[20]

23. Simple welfare analysis thus offers an analytical foundation for issues in agricultural trade and the environment. At an empirical level, however, there is still very little understanding of the effects of trade liberalization on the environment, and how different commodities and countries will be affected. Trade liberalization is also unlikely to be total or all inclusive, so that distortions and adverse environmental impacts will remain. And higher prices and levels of economic activity following liberalization can have the same effects as artificial price supports, encouraging resource degradation, unless targeted environmental policies accompany them.

24. Such analysis also has limits imposed by technical measurement problems and the political realities of policy formulation. First, it has been difficult to measure the divergence between marginal private and social cost for an externality such as erosion or water pollution for the reasons mentioned above. Without an estimate of this divergence, designing appropriate taxes or regulations to internalize the externality has been problematic. Second, even if governments had reliable estimates of these damages (which are now increasingly available), successful intervention faces several forms of nonmarket or government failure. The political influence of agricultural interests has allowed them to remain largely removed from most environmental regulations until quite recently. In the United States, for example, agriculture has been largely exempted from the Clean Water Act, as amended. Third, agricultural policies themselves have actually contributed to and reinforced the environmental externalities above. In the face of such distortions, more than optimal environmental policies are necessary: substantial reforms in agricultural price and trade policies are required as well.

III. TRADE FLOWS IN AGRICULTURE: POLICY DISTORTIONS AND ENVIRONMENTAL IMPACTS

25. In this section, some concrete examples of trade flows in agriculture and their environmental impacts are discussed, focusing first on developed and then on developing countries' policies. In both cases, the relationship between domestic agricultural and trade policies, and environmental damages, is complex. While growing agricultural trade in the post-war period has added to general pressure on land, water and forest resources, this volume of trade has also responded to important demands. On the one hand, it has occurred in response to domestic and foreign population and income growth. On the other, it has resulted from agricultural and related trade policies which have artificially supported the prices of some crops relative to others, and subsidized the prices of many inputs, such as water, fertilizers and pesticides.[21]

26. Broadly speaking, it is the commodity composition of agricultural trade, together with the increasing use of water, fertilizer and chemical inputs, in food production, which account for the majority of environmental concerns in agriculture.[22] Commodity composition refers simply to the mix of farm products produced. Agricultural production has become increasingly specialized at the farm level since the 1950s, especially in the OECD countries. Specialization occurs naturally in the course of trade, but the degree of specialization at the farm level in such crops as maize or cotton, as well as the concentration of livestock production in limited geographic areas, has been driven in many developed countries less by market demand than by domestic and related trade policies that subsidize this narrow production focus directly and indirectly. The increasing use of chemical inputs has occurred in large part because the demand for them is derived from the demand for farm output, whether the demand arises in the market or from government subsidies and purchases. As it happens, the same crops which governments have subsidized have accounted for the bulk of irrigation, fertilizer and pesticide applications.[23] In addition to the derived demand for water, fertilizer and chemicals, many governments have further subsidized the use of these inputs by tax allowances or price markdowns that make them less expensive to use.

27. Many of these changes in production, especially in developing countries, have been justified as necessary to feed growing populations or to increase food self-sufficiency as a matter of trade policy and national security. The result has been that adverse environmental consequences have been treated as unfortunate but probably justifiable by-products (externalities) in meeting these challenges. As this perspective changes, especially in the OECD countries, the demand for new environmental regulations will effectively raise the cost of environmentally irresponsible farm production methods, inducing new, more environmentally benign technologies.[24] However, this process is just beginning, and the market and government failures of the post-war period have clearly generated substantial environmental damages. And as long term population growth continues to require increases to food production, environmental issues in agriculture are likely to remain important.

28. Throughout this section, the same points noted above recur: policies that distort trade in agriculture can also have adverse environmental impacts, so that reducing these distortions will be likely to move in a positive environmental direction. However, more carefully targeted environmental interventions must also be undertaken to enhance landscape, water and soil quality. This section thus provides descriptive evidence for the points outlined in Section II, in which welfare gains were shown to depend on a joint undertaking of domestic agricultural and trade policy, and environmental policy, reform, with appropriately targeted interventions in each area.

A. EXAMPLES IN DEVELOPED COUNTRIES

1. The United States

(a) Federal Agricultural Policies

29. Both the commodity composition and levels of input use in U.S. agriculture are a direct function of the complex schemes used to support domestic agricultural prices at levels higher than generally prevail in world markets. These subsidies take various forms but their overall effect is artificially to support the prices of a selected set of "program commodities," notably maize and wheat (which accounted for half of total budgetary outlays for the commodity programs in 1990), barley, oats, cane and beet sugar, rice, cotton, tobacco, peanuts, honey, dairy, wool and mohair. Farmers, when faced with a choice of growing a highly subsidized crop such as maize or cotton with minimal rotations, as opposed to a greater annual rotation with less subsidy, do what is "boundedly rational." They tend to grow the subsidized crops year after year.

30. Given that domestic price levels for these crops are set higher than global prices, import duties or quotas must also be established so that the schemes are not undermined by cheaper imports. And because these schemes generate chronic surpluses, mechanisms of surplus disposal, including export subsidies, are used to remove them and their price depressing effects from the domestic market. Hence both import barriers and export subsidies derive in the first instance from decisions to pay more than market prices through commodity-by-commodity subsidies for a specific subset of crops farmers can potentially grow. This is the origin of the "Section 22" exclusion sought by the U.S. and granted in GATT, which allows import protection for a variety of program commodities such as milk and sugar. It is also the main origin of the Export Enhancement Program (EEP) initiated in the 1985 Farm Bill to subsidize exports of surplus stocks.[25]

31. While the trade impacts of these policies show up in confrontations over tariff and nontariff barriers in GATT, the specific impacts of these distortions on the environment are less apparent at the level of international trade. It is at the farm level that the distortions do their environmental damage, by sending signals to farmers about what crops to plant, how

often to plant them in relation with other crops or fallow, and how much water, fertilizer and chemical pesticides to apply to them. Farmers are not unaware of these signals but have little incentive to change decisions which are rewarded by government policies. All of these decisions in turn affect levels of soil erosion, water pollution in streams due to soil and fertilizer runoff, as well as leaching of pesticides and nitrogen from fertilizers and manure into underground water supplies. In addition to these effects on soil and water, reduced crop diversity and chemical pollution threaten wildlife habitat and recreation opportunities for fishing, hunting, boating and the appreciation of natural plant and animal populations.[26] Excessive levels of pesticide, herbicide and pesticide applications near human settlements have caused poisonings, and their long term health effects are under investigation by epidemiologists and toxicologists.[27]

32. The essential explanation for these environmental impacts is that markets neither penalize farmers for them, nor offer rewards for avoiding or reducing them. Government attempts to do so, such as the Conservation Reserve Program (CRP) and "sodbuster and swampbuster" legislation have been only marginally effective. Overriding these efforts are government price support payments which have encouraged a commodity mix narrower than would be the case if payments were not restricted to certain crops, and have promoted high levels of water, fertilizer and chemical use.

33. Consider two examples: one on the output side and the other on the input side. The output is cotton. The input is water. Cotton is erosive, highly irrigated and treated with a variety of chemicals to prevent insect infestations and plant diseases. It is grown intensively in California's Central Valley and in other regions where it consumes large quantities of water, which leads in turn to leaching of chemicals into surface and groundwater. Without substantial subsidies paid in the form of marketing loans and deficiency payments as well as input subsidies that provide irrigation water virtually free to many cotton producers, it is doubtful that U.S. production would be as intensive, creating opportunities for lower-cost imports from developing countries. The environmental consequences in the form of chemical contamination of soils are sufficient, in the words of one environmental toxicologist and public health specialist, to make some areas of the Central Valley "unfit for human habitation."[28]

34. In the South Central U.S., water for irrigation is pumped from a huge aquifer, the Ogallala, at rates demonstrably above recharge capacity. Extraction has been encouraged by tax laws that allow a "water depletion allowance." Rather than "internalizing" the negative external effects of irrigation, they have actually been encouraged. In 17 Western states of the U.S., 40-50 million acres are under irrigation, which accounts for 90 percent of the consumptive use of water. It is estimated that 90 percent of the capital costs of irrigation conducted under the federal Bureau of Reclamation are subsidized for irrigating farmers. Farmers in the West San Joaquin Valley of California, for example, pay less than 10 percent of the delivery cost of water.[29]

35. The effect of agricultural price manipulation on production decisions and commodity composition has thus been large. Over the 1980s, government payments were a growing fraction of net farm income, especially in regions where program crop production predominated. Commodity composition responded directly and significantly to these payments.[30] In recent years, between 80 and 95 percent of program crop acreage has been enrolled in the federal commodity programs.[31] Because acreage reduction programs are also necessary in order to damp down surpluses resulting from price supports, it is difficult for the government to guess how much the supply control "brake" should be applied in the face of the "accelerator" of both market and government price signals. Moreover, farmers regularly retire acres of lowest productivity, leading to substantial "slippage" in the amount of production actually reduced through mandated acreage reductions. Over time, growing surpluses have generated pressure in turn for export subsidies to clear domestic markets.

36. Despite their failings, domestic agricultural and trade policies in the U.S. simplify a key issue at the farm level: what to plant? If government provides deficiency payments well above the market price for maize, compared with soybeans, farmers will be inclined to plant maize. If retaining eligibility for government price support payments for maize requires continuous cropping, then farmers will be inclined to forego rotations with other crops. Finally, since government deficiency payments have been based on a farm's or a county's average yields, farmers will be inclined to raise yields, beyond the point that market forces might dictate. All three of these judgments: what to plant, how often to plant in rotation with other crops, and how far to push yields, have direct implications both for commodity composition and water, fertilizer and chemical use. Planting decisions on the farm are increasingly tied to deficiency payment announcements rather than market conditions (farmers refer to this as "farming the government"). The result is to reduce the diversity of cropping and to encourage crops that depend heavily on chemical inputs. Corn and wheat now account for over 50 percent of all nitrogen fertilizer applications in the U.S.[32]

37. A related issue concerns the mix of crop and livestock production. Livestock production (except dairy and wool) receives no direct government price supports. Traditionally, in addition to off-farm income augmentation farmers kept livestock (poultry, hogs, cattle) as one form of insurance against price fluctuations in grain crops. Livestock also utilized available labor more effectively and were an on-farm source of manure. Over the 1970s and 1980s, increasing government subsidization of grains and oilseeds made this crop/livestock insurance less necessary. In addition, legislation restricting practices on feedlots encouraged many farmers to reduce livestock and to specialize in "cash grains," thus increasing their reliance on purchased fertilizer nutrients instead of manure nutrients from livestock or legume nitrogen from crop rotations. (Manure itself may have adverse environmental impacts, and usually can supply only a fraction of total fertilizer demands.) Poultry and other livestock production have increasingly become separate specialties, leading to large feeding operations which pose major problems of waste disposal.

38. A second major effect of government programs concerns how often a certain crop is planted in rotation with others. U.S. commodity programs have included acreage "bases" for each of several crops. This "base acreage" entitles the farmer to crop price support payments in relation to its size. But retaining the base has also required that the specific crop continue to be grown on the farm year after year: program "base" has generally been decreased if the acreage planted declines. This is a disincentive to rotate program crops, such as maize, wheat and barley, with non-program crops, such as grasses, alfalfa, or other specialty crops that are less prone to soil erosion, and might decrease the need for some fertilizer nutrients and chemical inputs.

39. Third, government program benefits have also been calculated according to average yields, sometimes referred to as "yield base". Prior to the current farm bill, farmers have had an economic incentive to increase yield if the higher yield in one or more years would increase the yield base and thus returns from the government program over a number of years in the future. In a recent study in Minnesota, Lyman, et. al., found that farmers choosing green manure rotations (e.g., alfalfa) were seriously penalized by loss of wheat and barley base, creating a dilemma -- between choosing more agronomically sound rotation practices and foregoing future program benefits -- or protecting base acres at the expense of environmental considerations. This is what Lyman, et. al., called a "vise grip." The specific consequences of this "vise grip" for environmental quality were explored more recently by a research team from the World Resources Institute, which examined two case study farms in Pennsylvania and Nebraska.[33] The study compared the effects of these policies on the two farms with a 1985 baseline, using a resource accounting framework consistent with internalizing the external costs of soil erosion. In both case studies (discussed in greater detail in Section IV), they found that domestic agricultural and trade policy reforms based on "decoupling" payments from specific crops produced the greatest net economic values, inclusive of the cost of resource depletion due to soil erosion. The benefits varied greatly depending on tillage methods, but reforms based on "decoupled" payments resulted in higher net economic values for all rotations and treatments with the best results if environmental policies were closely targeted. The study also concluded that the "polluter pays" principle should be applied more widely to agriculture.

40. In summary, because of U.S. commodity and acreage reduction programs, risks have been reduced if farmers grow a relatively restricted group of crops. The effect has been to encourage the intensive cultivation of these crops, to the exclusion of rotation and diversification. The overriding importance of agricultural price and income support policy at the federal level creates major opportunities to improve the agronomic and environmental impacts of farming practices through changes in those policies over time. However, even if such changes were undertaken, and farmers were allowed to plant more freely in response to markets, there would still be conflicts between some of these signals and reduction in environmental concerns. High commodity prices raise the opportunity costs of rotations, whether these prices originate from government subsidies or the market alone. For this

reason, targeted environmental policies will continue to be important in promoting improved impacts of agricultural practices. The question is: are current U.S. environmental policies doing this? The evidence suggests that the sort of targeted, "nearly optimal" environmental interventions discussed in theory above are a long distance from current realities.

(b) Environmental Regulations

41. Three main issues dominate the U.S. environmental policies as they affect agriculture.[34] The first is water pollution. The EPA has identified agriculture as the largest nonpoint source of surface water pollution.[35] As Clark, et al. (1985) note:

> In addition to biological damages, the off-farm cost of agricultural runoff from increased flood damages, impaired recreational opportunities, and interference with water conveyance facilities, industrial and municipal uses has been estimated at $2.2 billion per year.[36]

The second and related issue is the safety of groundwater supplies. Approximately 50 million people in 1,437 counties rely on potentially contaminated groundwater for drinking. These problems tend to be localized in areas of concentrated agriculture and/or specific geologic formations that are conducive to rapid transport of contaminants to the water table. The third area of concern is fragile land areas such as wetlands and native prairie. Approximately one million acres of wetlands are drained each year, the vast majority for agriculture, threatening the breeding ground and habitat for approximately two thirds of the major commercial fish species and many types of waterfowl.[37]

42. The primary mechanisms to deal with these issues are the "conservation compliance," "sodbuster" and "swampbuster" provisions of the 1990 Farm Bill, together with the Conservation Reserve Program (CRP). Conservation compliance requires farmers to develop conservation plans for their farms, and after 1990 penalizes farmers who fail to do so or cultivate highly erosive land by loss of all farm program payments for all crops grown on the entire farm. While a seemingly draconian measure, conservation compliance has several essential design flaws that make it difficult to implement. First, in times of high reliance on government deficiency payments (and other government payments) for net farm income, it has come to be viewed by farmers and their elected representatives in Congress as an excessively punitive measure, out of proportion to the environmental damages likely to occur. Thus, when farm income payments are high due to low prices, enforcement is problematic, and a variety of loopholes have been created through legislative and administrative means. Noting weakened standards in the key farm states of Iowa and Nebraska in April, 1990, the Center for Rural Affairs (1990) raised the concern that "The Soil Conservation Service [of USDA] is sending a signal to other regions and states that weaker erosion standards are acceptable."[38] But even when market prices rise (reducing deficiency payments), the incentive to undercut conservation compliance remains, because

when prices are high, conservation is most threatened by the incentive to farm every available acre. And when prices are high, the penalty for noncompliance -- the deficiency payment -- is low.

43. The "sodbuster" and "swampbuster" provisions suffer from related problems. The first is designed to limit the plowing of cropland designated as highly erosive; the second to limit the conversion of designated wetlands to croplands. To do either leads, in principle, to the future loss of eligibility for all farm programs. Again, these laws are likely to be undercut precisely when they are most needed by administrators and legislators who view the penalties involved as excessive. The National Wildlife Federation, after seeking access to USDA records under the Freedom of Information Act, found that as of April, 1989, "there are only 26 producers in the entire United States who have actually lost benefits as a result of swampbuster violations which occurred between December 23, 1985 and April 15, 1989."[39]

44. One obvious amendment to the provisions would be to impose mandatory financial penalties (fees) for lack of conservation compliance as well as sodbusting and swampbusting on a graduated basis, depending on the number of acres affected and the degree of damage. These fees can be allocated based on estimates of damages from hydrological and land use data increasingly available to government agencies. They could either be subtracted from deficiency payments or (since many farmers receive few if any such payments) simply assessed through the EPA or Department of the Treasury, entirely outside the USDA enforcement apparatus. By graduating penalties to fit the magnitude of the damage, and divorcing them from commodity programs, environmental goals consistent with the polluter pays principle and the targets and instruments distinction noted in Section II would be achieved.

45. The other major program designed to promote environmental conservation is the Conservation Reserve Program (CRP). Unlike the above programs, its primary objective is temporary acreage retirements through voluntary ten year bid contracts, in which landowners with eligible acres (previously cropped land designated as highly erosive) are paid rent by USDA to convert it to conservation uses, such as grass and forest cover, for which USDA may share the costs. At the end of the ten year contract, some of this land is likely to be subject to conservation compliance, swampbuster and sodbuster provisions, although the enforcement problems cited above will remain.

46. The CRP currently has enrolled about 34 million acres, and has a goal of 45 million. The program has been afflicted with problems in targeting lands most subject to environmental damage. Departing from the "polluter pays principle," the federal government instead opted to "pay the polluter," leading to anything but optimal environmental interventions. While modest land improvements are required under the program, in essence it pays polluters not to pollute, rather than rewarding farmers for

environmental "affirmative actions." And in emphasizing ten-year contracts, it has not allowed sufficiently for permanent retirement of vulnerable lands through easements. Indeed, farmers whose land has been carefully protected from erosion find themselves ineligible. Instead, farmers are asked to "bid" how much they need to be paid in per-acre rent to remove land already eroding at high levels from production. Even in the low commodity and land price environment of the mid-1980s, these bids were pushed up by the high levels of acreage retirement then already in force, together with the fact that the CRP reduced farm base, and thus eligibility for future deficiency payments. Combined with an administrative imperative to get as many acres into the CRP as possible, accepted bids have substantially exceeded market rental values in many areas, predictably adding hundreds of millions of dollars a year to the cost of the program.[40]

47. In addition to its excessive costs, the design of the CRP has failed to make use of information available to USDA to target lands most in need of retirement, some of the same information available to allocate fees and penalties. Despite massive computerized information gathering exercises (Natural Resource Inventories) conducted by the federal government in recent years to determine the vulnerability of various land categories to environmental damages, this information has not been applied systematically to distinguish the vulnerable lands that are low in productivity (and thus relatively inexpensive to retire from production) from those that are highly productive and/or not vulnerable at all.

48. A third main area of environmental regulation impinging on agriculture is the Clean Water Act, as amended. Until recently, agriculture has received a blanket exemption from the Act. However, under 1987 amendments to the Act, EPA is given authority to require states to submit groundwater protection plans, which may include agricultural leaching of fertilizers and chemicals including pesticides. These state plans, if enforced, may lead to increasingly stringent restrictions on farm input use, although such restrictions have yet to be widely felt. EPA has adopted a state-by-state approach to such regulation, which leads to the devolution of responsibility from federal to state agencies.

49. While arguably more efficiently targeted, in the sense that each state's problems differ, this approach relegates difficult decisions to state agencies with comparatively limited resources, and raises the distinct and important problem of a patchwork of different standards and regulations to which input suppliers will be forced to respond. In particular, a lack of state resources may contribute to a growing movement to tax fertilizer and chemical inputs, such as Iowa's recent tax on nitrogen fertilizers. These taxes will raise revenues, but also farm costs, and do not really target polluters, since all users of nitrogen pay the tax regardless of their management practices. The available evidence suggests that they would need to nearly double the price of fertilizer to have any major impact on use. For example, Hrubovcak, LeBlanc and Miranowski (1990) concluded that a 10 percent tax on agricultural chemicals would only decrease use by 6 percent, and a 100 percent tax (doubling the price) would decrease chemical use by 34 percent. And reducing commercial fertilizer use would not necessarily reduce total applications of nitrogen fertilizers, since some manure might be substituted.[41]

50. Even more significant are recent developments in U.S. liability laws involving holding farmers financially responsible for nonpoint source pollution (such as contaminated wells). Here the polluter pays principle has been enforced by the courts. Farm lenders have also been found potentially liable, extending the polluter pays principle to include what in U.S. legal circles is known as the "deep pockets" principle. It is possible that farmers and their lenders may be found financially liable for damages resulting from non-point source pollution which was previously untraceable and is increasingly defined as a contestable damage under law. The U.S. Committee on Irrigation and Drainage, for example, recently convened a panel of water experts who saw such legal developments leading to the possible "end of the Agricultural Exemption from the provisions of the Clean Water Act."[42]

51. In summary, environmental policies both within the ambit of the Farm Bill, and outside it, such as the Clean Water Act, as amended, each impose both direct and indirect requirements on farmers to comply with a variety of new and changing regulations. These regulations are not likely to ease in the future, and instead will become more binding. However, they can all be substantially improved on both environmental and domestic agricultural and trade policy grounds by (a) better targeting of land use policies and (b) more refined applications and extensions of the polluter pays principle to agriculture.

2. The European Community.

(a) The Common Agricultural Policy (CAP)

52. While different in character, the Common Agricultural Policy (CAP) of the European Community (EC) functions in much the same way as price supports in the U.S., insofar as it encourages excess production in the subset of commodities receiving this support; this excess production reduces the diversity of cropping practices on-farm, and encourages continued planting of crops with reduced rotations. Export subsidies and import levies are necessary to insulate the EC from foreign competition. In order to maximize yields per hectare (since payments are made on units of production) extremely high levels of fertilizer and chemical inputs are applied, the demand for which is derived in part from the levels of subsidy paid to output. The consequence is to increase soil losses due to erosion, but in Europe the primary impact is on water quality. In the livestock sector, concentrated production units also create major waste disposal problems.

54. The history and functioning of the Common Agricultural Policy are beyond the scope of this paper, but it is important to emphasize that its original objectives revolved around trade policy and food security, and that environmental considerations were clearly secondary. Over time, however, the intensification and specialization of European agriculture has begun to arouse alarm in environmental circles.[43] The Food and Agriculture

Organization (FAO) in their 16th Regional Conference for Europe, identified four major environmental problems resulting directly from European agricultural production, summarized in Box 1.[44] These are:

- -- Pollution and contamination of soil, water, air and food resulting from increased agrichemical use and livestock effluents;
- -- Degradation of natural resources, and particularly, deterioration in the quality of soil, water, forests and traditional rural landscapes;
- -- Disturbance and reduction of biotopes and wildlife habitats;
- -- Reduction in wildlife species and loss of biological and genetic diversity.

55. Specific examples of these problems cited by FAO (1990) include soil contamination and air pollution from ammonia in animal wastes in the Netherlands and Denmark due to concentrated cattle and hog facilities which have responded to subsidies in the livestock sector. In addition, pesticide residues and high nitrate levels in drinking water in many areas of Europe have pushed drinking water contamination levels beyond those recommended by the World Health Organization (WHO) and sometimes past the maximum acceptable levels set by WHO. Surface and groundwater quality have also fallen for non-drinking uses. "Among the most disturbing developments," the FAO report noted, "are the growing presence of nitrates and pesticide residues in deep water aquifers; changing of groundwater levels as a result of irrigation and drainage; contamination of shellfish and other forms of aquatic life; and eutrophication of both fresh and marine water bodies from phosphates and nitrates" [in fertilizer].[45]

56. The policies giving rise to these effects are primarily price interventions. While some moderation in the level of support has occurred due to the price packages (combined with inflation) undertaken especially since 1988, the overall signals sent by policy to farmers in the Community remain strongly in favor of intensive cultivation of cereals and concentrated livestock production. Because of growing concern over the environmental consequences of these interventions, however, a new layer of policies has been imposed on farmers by the EC and individual member states.

57. In the 1980s the European Community established "environmentally sensitive areas" (Article 19 Regulation 797/85) and programs for set-aside, extensification and conversion to woodlands (Regulation 1094/88). These regulations are also designed to enhance landscape quality, regarded as an important positive externality from agriculture. The pastiche of national regulatory responses varies greatly by country. Ironically, while most Community-wide policies amount to "paying the polluter," at the national level, input taxes have gained favor, and are justified by the polluter pays principle. Finland, Austria and Sweden have introduced taxes and levies on fertilizers and pesticides to promote more environmentally sound management practices, although the revenues have also

Box 1: Effects and Consequences of Intensive Cropping Practices in the European Community

Intensive agricultural practices	Pollution and Contamination					Natural Resource Degradation			Biotope and habitat disturbance	Loss of wildlife and genetic diversity
	Soil	Water	Air	Food	Soil Quality	Water/aquatic Resources	Forest Resources	Landscape amenities		
Drainage of wetlands, land reclamation	Accelerated pollution due to loss of "ecosystem services"	Accelerated pollution due to loss of "ecosystem services"			Soil dehydration, degradation	Changes in ground water table, water cycles		Loss of natural areas valued for conservation	Negative effects on water-related ecosystems; loss of terrestrial and aquatic habitats	Loss/extinction of flora and fauna species, particularly fish and water fowl
Conversion of pastures, forests, etc.					Reduction in nutrients; changes in soil hydrology; erosion	Flooding, siltation, sedimentation of water systems	Loss of forest vegetation, ground cover; loss of pasture for game/ domestic animals	Decrease in recreational amenities; loss of heritage values; degradation of rural landscapes	Loss of complex biotopes of special ecological value, e.g., natural forests; destruction of habitats	Loss/extinction of species; diminished variety of wild life; loss of genetic resources
Consolidation of fields, removal of hedges, walls, etc.					Inadequate management leading to degradation	Negative effects on water conservation and management		As above	Reduction in number and complexity of habitats maintained by the traditional agricultural ecosystems	Loss of species abundance and diversity, particularly birds and insects
Tillage, use of heavy machinery			Combustion gases		Compaction of soil; wind and water erosion; reduced productivity	Heavy silting, sedimentation of water systems		Landscape degradation	Disturbance of soil ecosystems	Adverse effects on soil organisms, microflora and microfauna
Application of synthetic fertilisers	Nitrogen saturation; concentration of heavy metals	Nitrates, heavy metals leached into surface and ground water	Evaporation	Nitrate contamination of food crops, shellfish	Reduced fertility; accumulation of heavy metals	Eutrophication; contamination of aquifers	Loss of alluvial forests	Loss of recreational amenities	Distruction of biotopes and loss of terrestrial and aquatic habitats due to pollution, contamination and eutrophication	Loss/extinction of wide range of species; diminished diversity of plant and animal life; adverse effects on soil organisms, etc.; loss of genetic resources
Spreading of manure, slurry	Nitrogen saturation contration of phosphates, heavy metals	Nitrates, phophates, heavy metals leached into surface and ground waters	Release of ammonia leading to acidification	Nitrate contamination of food crops, shellfish	Reduced fertility; acidification; structural damage	Eutrophication; contamination of aquifers	Damage from acidification	Loss of recreational amenities, aesthetic values	As above	As above
Application of pesticides	Residues, degradation products	Residues, etc. leached into surface and ground waters	Evaporation; spray drift	Residues in food crops, livestock	Accumulation of residues	Contamination of aquifers	Loss of alluvial forests	Loss of recreational amenities	As above	Loss/extinction of non-target flora and fauna, particularly fish, birds and insects; build-up of resistence in plants and insects
Irrigation	Excess salts	Salinization; accelerated pollution			Salinization; water logging; erosion	Saline contamination of aquifers; reduction in ground water levels		Landscape degradation	Negative effects on aquatic ecosystems, habitats	Loss/extinction of species; reduction in ecological diversity
Straw-burning			Local pollution					Reduction in local landscape amenities and aesthetic values	Disturbance of biotopes, habitats; risk of destruction by spreading fire	Reduction in species
Abandonment of marginal lands					Erosion, rural desertification	Silting, sedimentation of surface waters		Landscape degradation	Loss of activity supporting biotopes; decline in number and complexity of habitats	Reduction in species

Sources: FAO, 1990. Adapted from information provided by FAO, OECD, ISEP and CEC.

been used to subsidize crops and exports. Management agreements are used in France and Germany in which cash, tax relief or in-kind payments are made for specific environmental actions, such as reduced nitrogen applications. At the same time, many irrigation subsidies remain which have increased cropping in environmentally sensitive zones. Other countries have imposed direct bans on some activities, such as certain insecticides in Belgium while crops are in flower, and straw burning in Denmark, the Netherlands and (after 1992) in the U.K. France, Austria, and Germany are restricting some fertilizer and pesticide use along rivers and streams.[46]

58. Despite this panoply of (often contradictory) actions, penalties on agricultural polluters are rare, and it is doubtful that the environmental policies above can overcome the powerful incentives represented by crop-specific price interventions. As the 1990 FAO study notes, substituting "decoupled" direct income supports for price supports could "contribute to creating a less intensive, less specialized, and less concentrated agrarian structure."[47]

59. Whether input taxes will be successful in reducing use, or will primarily serve as an additional source of revenue (to be used among other things as a source of export subsidies, as in Sweden), remains an open question. While data from some European research suggests that such taxes are more effective in reducing input use than reductions in output prices,[48] U.S. research has come to different conclusions.[49] While apparently consistent with the polluter pays principle, if such input taxes are accompanied by other subsidies or tax relief as compensation to farmers, or by higher support prices, then the overall impact on input use will be marginal. And because they are paid by all farmers, not just the "polluters," the incentives they create are only superficially consistent with the OECD polluter pays principle.

60. The set-aside developed by the EC in the late 1980s suffers from problems similar to those of the CRP in the U.S., on which it is partially modeled.[50] While purportedly targeted at environmental problems, the program confuses this target with supply reductions. Because of producer incentives to retire low productivity land, rather than land especially vulnerable to environmental damages, the consequence is that neither supply control nor environmental goals are accurately targeted. Even within the category of environmental damages, individual regions and states face widely varying problems to which the set-aside is not attuned. In Spain, for example, erosion is more important than groundwater pollution. In Portugal, which shares many of these erosion problems, and in which 25 percent of the land under cultivation is estimated to be unsuitable for cropping, the set-aside has not been implemented at all.

(b) The Veneto Region and the Need for Targeting

61. The need for both reformed price intervention schemes and more clearly targeted

environmental policies in the EC is most clear at a more detailed level of analysis. The Veneto region of Italy provides a useful case in point. The Po and Brenta Rivers empty into the Adriatic after flowing through some of the richest and most productive farmland in Europe. Their terminus is a large marsh and lagoon on which medieval Venice was constructed, and which served as habitat for a wide variety of land and sea creatures for much of its history. Tidal action and the flow of these rivers together cleansed the system and allowed Venice to use the ocean and lagoons as a sink for its own wastes for centuries without serious environmental impacts. Beginning in the 1950s and 1960s, however, several developments conspired to create what is now an environmental crisis. First, construction of refineries and highways blocked the tidal flow in and out of the lagoons, causing stagnation and eutrophication. Second, population pressures increased along the coast. Third, and perhaps least well understood, the farmland in the Po and Brenta basins began to receive levels of fertilizer and chemicals unprecedented in the thousands of years of their cultivation. These input applications were derived in part from the increasing specialization and concentration of crops grown in response to intervention prices under the Common Agricultural Policy. Between 1960-61 and 1980-81 average nitrogen applications per hectare of farmland in Italy rose from 15.6 units to 57.5 units, or by 268 percent.[51] Average fertilizer applications to maize in Italy in 1979-81 were calculated as 518 units, compared with 297 units in the U.S., 405 units in France and 540 units in Germany. The intensity of maize production in Italy, much of it grown in the Po basin, thus employed nearly twice the levels of fertilizer as in the U.S. As a proportion of total costs of production, the Veneto region's farmers paid 32.0 percent of total costs for fertilizers in 1975, and slightly less, 28.5 percent, by 1984.[52] Agricultural use of phosphorus, often the limiting nutrient leading to algae blooms and eutrophication was 1-2 kilograms per hectare per year in Italy in the 1980s, compared with 0.3 kilograms on non-agricultural and forest lands and 0.75 kilograms in urban areas. Nitrogen use in Italian agriculture was 8.25 kilograms per hectare per year, compared with 4 kilograms on non-agricultural and forest lands and 15 kilograms in urban use.[53] The concentration levels of nitrogen, phosphorus and potassium in the Veneto are shown in Maps 1, 2 and 3, which are drawn from a 1990 final report of the regional impact of agriculture on environmental quality.[54] The outwash of these nutrients is a major cause of high levels of surface water pollution, eutrophication, and groundwater contamination in the region.

62. When data for the Veneto were analyzed in greater detail, focusing specifically on subregions, several important conclusions emerged. First, the application levels of the above nutrients were major determinants of pollution. Second, they were significantly correlated with the crops grown (notably highly subsidized maize and sugar beets). Third, they varied substantially by geophysical land unit.[55] These results parallel findings in the U.S., where pollution from fertilizers and agricultural chemicals is shown to be significantly related to the type of crops grown and their rotations, and land surface and subsurface characteristics.[56]

63. The overall implications of this body of research are that distortions of agricultural

markets leading to specialized and intensive cultivation of subsidized crops provides a major impetus to agricultural pollution. Second, even if these pressures were reduced through agricultural policy reforms, effective environmental policy in agriculture will require more highly targeted interventions focusing on specific attributes of land surfaces and subsurfaces. The need for both policy reforms in agriculture and highly targeted environmental interventions in the Veneto region confirms the intuition provided by the model in Section II, but underscores how far current policies are from this objective.

B. EXAMPLES IN DEVELOPING COUNTRIES

64. In developing countries, farmers are typically taxed rather than subsidized, in the form of food prices held below market levels in response to the political influence of urban consumers.[57] While depressing production, these policies do not necessarily conserve natural resources, for two reasons. First, poor farmers are often compelled to farm marginal lands subject to erosion and runoff, or to clear forests which have held soil in place, in order to earn a subsistence level of income. If the household is already operating at or near subsistence, lower prices do not cause reduced output. Second, subsidies are sometimes paid to reduce the costs of farm inputs (fertilizer, chemicals) which lead to overapplications and consequent water and soil contamination. While fertilizer, in particular, has been vital to meeting food demands, many government policies have had untoward effects on the environment. Although insufficient research is available, several studies suggest that the impacts of government policy in developing countries are at least as important as in developed countries, both in distorting trade and harming the environment.[58]

65. While all of the market failures associated with agriculture in the developed countries are replicated in the developing world, the incapacity of government to intervene effectively to regulate the environment is even more evident. Environmental quality is a "superior good," the demand for which rises increasingly in proportion to increases in income. By contrast, food production is an "inferior good," the demand for which falls in proportion to increases in income (Engels' Law).[59] In the high-income developed countries, for example, regulations affecting pesticide use have become more stringent in the last two decades. Food quality increasingly dominates food quantity as concerns over environmental health and safety grow. In low-income developing countries, by contrast, the political and economic constituencies of most interest to governments are composed of urban consumers of food who demand low prices. Environmental quality has a weaker constituency. Food producers are a large and politically unorganized source of revenues, and are thus generally taxed, in large part by extracting their product at below market prices. In partial compensation, input subsidies are paid to increase yields. In some cases, these subsidies may be justified to maintain soil fertility through nutrient applications. In other cases, the environmental effects are clearly negative.

66. The trade impacts of these trends on input use and environmental quality in

developing countries are worth noting. Consider sales of pesticides. By 1986, the U.S. pesticide industry exported 34 percent of its total sales value ($1.4 billion) compared with 26 percent in 1965. Pesticide imports by developing countries grew from $328 million in 1967 to $1,489 million in 1986, or by roughly 350 percent.[60] In developing countries, these inputs are aggressively marketed and subsidized, yet farm level education (including the basic literacy necessary to read package instructions) is often lacking. Human poisoning in developing countries due to overapplication is common, but poorly documented. One estimate in seven countries of Central America was that pesticide poisonings occurred at a rate 1,800 times higher than in the U.S.[61] In Columbia, Repetto (1985) found that pesticide subsidies as a percentage of full retail costs were 56 percent, in Honduras 71 percent, and Ecuador 59 percent. In Africa, the same study found pesticide subsidies in Senegal of 11 percent, Ghana of 33 percent, and in Egypt 17 percent. In Indonesia and China, the subsidies were 18 and 81 percent respectively, for an overall average of roughly 50 percent.[62] In the Indonesia case, application levels were so high that crop damage was done, and yields actually were falling until subsidies were scaled back.

67. It has become popular in some circles to ascribe these adverse environmental effects to trade itself, and by implication to suggest that trade liberalization would cause further environmental damages in developing countries. This reasoning argues against trade reform because it produces greater "dependency" by the South on the North, as well as greater environmental damages. It implies that greater self-sufficiency and protectionism would be "better" for the environment.[63]

68. Yet careful evaluation of these claims suggests a different interpretation. In Indonesia, for example, the primary motivation for excessive fertilizer and chemical input applications was self-sufficiency in rice. As an analyst of Indonesian policy put it: "food self sufficiency is neither inherently more nor inherently less environmentally sustainable than export oriented agricultural development."[64] Many developing countries have encouraged clearing of marginal land subject to environmental degradation for the production of both export crops and domestic food supplies. The incentives giving rise to these unsustainable practices reflect both domestic policies of taxation for the farm sector, and the protectionism of wealthy developed countries. Farmers in developing countries face low prices caused by a combination of their own domestic distortions (taxes), reinforced by developed country policies which close off market access and depress agricultural prices through subsidized exports of surpluses. In order to maintain per capita levels of living at the household level in the face of population growth, and to repay debt obligations at the national level, these countries are often obliged to "borrow from the future" by mining their soil, water, forest and mineral resources at levels unsustainable in the longer run. As a recent UNCTAD background paper noted:

> The major cause of unsustainable land use in the agricultural sector in developing countries is the inappropriate incentive structure under which both the export crop sector and the domestic food supply

> sector are operating. In many developing countries, the agricultural sector is heavily taxed or otherwise controlled to generate revenue for industrial expansion and to suppress the cost of living of the urban poor... These problems are worsened by increased agricultural protectionism in developed countries and their subsidization of food exports that compete with certain developing country commodities such as rice, sugar, soya beans and maize.[65]

69. The adverse environmental impacts of agriculture in developing countries are thus tied to their agricultural income problems which arise from both domestic and international trade distortions. In order to resolve these interrelated dilemmas, three types of policy reforms would have to occur together. First, developing countries would have to be prepared to reform domestic policies which tax farmers and lower incentives to produce. Second, developed countries must be prepared to open market access to developing country exports, and to reduce the level of surpluses and export subsidies used to dump these surpluses on world markets. Together, these two reforms would lead to higher prices and expanded commodity trade for developing country agricultural producers, resulting in income growth (see Section V). Given this increase in growth per capita (assuming that debt burdens do not draw off these gains), developing countries would then be positioned to undertake the third measure: the expensive regulatory task of environmental intervention now only beginning in the OECD countries, in which lands sensitive to environmental damages are protected from unsustainable practices.

70. It would be naive to suppose that these three reforms can be accomplished over a short period. Current preferential trading arrangements between developed and developing countries, for example, have encouraged production patterns which are detrimental in the long run both to balanced trade and environmental protection, but will require time in order to be dismantled. Preferential treatment of tapioca imports from Thailand and beef from Botswana in the EC have both been associated with soil and water depletion in those countries, yet the EC maintains these arrangements. In the case of tapioca, a primary beneficiary is the pig industry of the Netherlands, which has expanded due to the attractive feed prices it receives under the arrangement. This industry is a prime example of the problems of concentrated animal wastes resulting from bought-in feeds.[66]

71. In sum, policies in both developing and developed countries must change so that both income growth and environmental quality are given equal weight. It will be argued in Section V that there is an important relationship between the income potentially generated by the liberalization effect of domestic agricultural policy and trade reform in agriculture, and the ability of developing countries to develop meaningful programs of environmental intervention, capturing the welfare benefits of environmental improvements. For example, Messina and Seale (1990) note that in the case of the U.S. sugar program, a modest adjustment in the quota granted to Carribean Basin nations would have greater impact than all of the U.S. Carribean Basin Initiative spending of the last ten years. As the 1991

UNCTAD document stated:

> The adjustment of existing production and trade patterns and the introduction of sustainable resource management practices not only takes time, it also has to be financed. Poverty and financial constraints can only be overcome by more economic growth and this implies increasing pressure on the resource base.
>
> However, increasing environmental pressures due to economic growth can hardly be used as an argument against open markets in the developed world because the aggregate effect of prolongation of existing trade protection would be even worse. The challenge is to offset as much as possible negative impacts of economic growth by more effective and efficient resource management and conservation practices.[67]

Although problems of government failure will continue to plague the implementation of environmental policy in developing countries, an even deeper issue is this: Whereas large developed countries can presumably choose to implement either domestic agricultural and trade reform and/or environmental interventions, developing countries are unlikely to be able to afford meaningful environmental programs without the income growth that domestic agricultural and international trade reform can bring.

IV. PROJECTED IMPACTS OF TRADE LIBERALIZATION ON ENVIRONMENTAL QUALITY IN AGRICULTURE

72. The analysis of previous sections has suggested that reforms in agricultural policy are generally likely to be consistent with improvements in environmental quality. Yet, as Section II emphasized, without accompanying environmental interventions, agricultural policy reforms will not necessarily lead to improvements in net welfare. This section tests this claim more rigorously, considering recent empirical evidence on the projected environmental consequences of domestic agricultural and trade policy reform. It focuses first on the U.S., then on more global models of the process, with emphasis on the relative interests of developed and developing countries. Unfortunately, the empirical evidence on specific areas is currently inadequate.

73. Nonetheless, the available research strongly supports the positive impacts of agricultural trade liberalization on environmental quality, particularly in developed countries. This result is not surprising if the argument above is valid: That trade distortions in developed countries have their roots in domestic policies which have reinforced environmental damages. However, both the type of agricultural policy reforms, and the combination of these reforms with particular environmental interventions, will determine the overall impact. These issues will be taken up in more detail in Section V below.

74. An interesting duality in the situations of developed and developing countries emerges from the analysis. Whereas developed countries increasingly find relatively strong public support for environmental quality goals, their policies of protection and subsidy to a relatively few, rich farmers have thusfar resisted change. In developing countries, these priorities are generally reversed: a relatively small constituency exists for environmental quality goals, and policies of taxation are applied to a large, poor and unresisting agricultural sector. One of the most potentially constructive effects of the interdependence of trade and environmental issues is that in developed countries, accompanying environmental interventions can help to "sell" trade reform in agriculture to a broader public. In developing countries, on the other hand, the benefits of trade reform, including market access, higher prices and expanded exports, can help these nations "buy" needed environmental improvements.

A. DEVELOPED COUNTRIES: THE U.S. CASE

75. In Section III, brief reference was given to an empirical study undertaken by a team from the World Resources Institute (WRI).[68] By carefully examining the impacts of current policies at the farm level, using data from Nebraska and Pennsylvania case studies, the researchers were able clearly to document the environmental damages encouraged by current policies. They then went beyond the current situation to simulate the effects on these farms of multilateral trade liberalization, among other options.

76. The trade liberalization simulation was based on the multilateral "decoupling" of commodity programs tied to production, defined as the elimination of current price support payments, with supports converted to direct income payments not tied to specific crops. The scenario also assumed that all major trading countries eliminate import barriers and export subsidies. This simulation led to an increase in prices, and exports, similar to the situation modelled in Figure 1(b). These results were based on the compilation and synthesis of various studies of liberalization developed by Blandford (1990).[69] What is remarkable about the WRI study is that in addition to the "liberalization effect," they also included estimates of the "environmental effect" utilizing a natural resource accounting framework in which the negative external effects of soil depreciation due to erosion and off-site costs due to water pollution were "internalized." This accounting framework is one of the few empirical examples of the polluter pays principle applied to production incentives in agriculture.

77. Table 1 shows the effect of natural resource accounting when the benefits of baseline (1985) policies were estimated in terms of net farm income on the Pennsylvania farm, assuming conventional maize-soybean rotation. Column 1 shows a typical analysis of net

farm income, in which soil erosion costs (soil depreciation) are excluded from the analysis. As a consequence, the gross and net margins are both $45, given simply as crop sales less variable production costs. Government subsidies of $35 are then added (giving an indication of their relative importance in a conventional rotation scenario) adding to $80. In contrast, Column 2 shows what happens when a "soil depreciation allowance" of $25 per acre is subtracted (based on estimates from USDA data of the present value of future soil productivity losses). With the same government payments, net farm income falls by over 30 percent to $55.

78. When viewed from a broader social perspective, however, the polluter pays principle requires that both on-farm and off-farm costs of soil erosion must be internalized. Full internalization of these costs would account for negative off-farm effects including sedimentation and water pollution. Table 2 shows the effect of including these costs in the net economic value (to society) of production by the Pennsylvania farm. Government subsidies are not included, since they are simply transfers. When the total in Column 1 of Table 1 (Net Farm Income Without Natural Resource Accounting) is compared with the total in Column 2 of Table 2 (Net Economic Value With Natural Resource Accounting), what appears at the farm level to be a per acre gain of $80 appears to society to be a per acre loss of $27. This measures the "wedge" between private and social cost accounting when externalities are present.

79. This framework was applied to simulate a variety of different crop rotation possibilities, as well as four policy scenarios, for both the Pennsylvania and Nebraska farms. As noted above, in both case studies, "a policy of multilateral decoupling produces the greatest net economic value of any of the policy alternatives considered."[70] Tables 3 and 4 present the results of multilateral decoupling for a variety of different crop rotations on the Pennsylvania and Nebraska farms. The Pennsylvania table shows a "transition period" and a "normal period" corresponding to field data which indicate that changes in crop rotations affect yields at first slowly (or even negatively) and then assume a more normal pattern. Even more significant than the effect of liberalization on net economic value is that, when the external costs of soil erosion are internalized, greater incentives exist to switch to crop rotations which are more soil conserving. This is especially true in Pennsylvania where soil loss damages are greatest. <u>This clearly illustrates the reinforcing character of the "liberalization effect" and "environmental effect."</u>

80. In Pennsylvania, where soils are shallow and the terrain is hilly, fertilizer and farm chemicals drain rapidly into streams that feed urban water supplies. The resource conserving practice (labelled ACG and ACGF, coupled with reduced tillage) emerge as comparable with conventional methods under a regime of trade liberalization through multilateral decoupling. In Nebraska, where soils are deep, the terrain is relatively flat, and population is less dense, the costs of fertilizer and farm chemical runoff are lower. Even so, "alternatives to the predominant high input, corn bean rotation were found to be environmentally superior and economically competitive," under trade liberalization,

although corn-bean rotations remain "economically superior."[71] Nebraska, a major exporting state, illustrates that a continuing comparative advantage in maize and soybeans can be combined with reduced environmental damages under multilateral decoupling. Together, the two case studies show why differences in vulnerability to erosion and productivity demand carefully targeted environmental interventions. In addition, the study noted that once the "transition period" is over, a combination of trade reform and altered rotations of crops with direct income support payments made to farmers will require much lower levels of transfer payments, yielding substantial budget savings.

81. In summary, the WRI study concluded that:

> Multilateral decoupling provides the greatest net economic value of the policies we tested. The simple fact that income support is not tied to commodity production allows market signals to reach farmers, encouraging them to use their resources in ways that are inherently more efficient. In areas with high resource costs, farmers who take a long view would likely shift to resource-conserving rotations, while in regions with low resource costs, farmers would shift to less chemical-intensive methods.[72]

These results depend, as emphasized, on the fact that the external effects of intensive agricultural practices are internalized in farm level decisions as a result of environmental policies, so that farmers "take the long view." Yet, the report notes that current U.S. environmental policies do not accomplish this.

> Environmentalists in particular should recognize that the answer to agriculture's environmental problems is not to tie on more regulations and cross-compliance provisions but to make the fundamental incentives farmers face consistent with the true values of the production systems available to them.[73]

B. DEVELOPED COUNTRIES: INTERNATIONAL ENVIRONMENTAL EFFECTS

82. Only recently have efforts to model the global distribution of gains and losses from domestic agricultural and trade policy reform been extended to consider impacts on environmental quality. A priori analysis has assumed that if liberalization lowered the relative prices received in developed country markets due to expanded market access and reduced subsidies, and raised relative prices in developing countries, the pressure on land, water and labor would fall in the developed countries, but would rise with prices in developing countries. While this may in fact occur, some analysts suggest that the increases in output in developing countries will be more at the extensive margin than in developed countries, and that excess labor absorbed in commercial agriculture due to output and

income increases will help to relieve pressure on marginal lands. This is not to suggest that either developed or developing countries can be sanguine about the environmental impacts of trade reform without additional policy interventions, particularly regarding land uses. But in the developing countries, income growth is an important precondition for the investments in environmental regulation required, as well as the emergence of a larger constituency devoted to improvements in environmental quality.

83. Utilizing historical data from the United States, several researchers at the World Bank[74] have deduced that trade liberalization would cause rapid short run global adjustments in fertilizer and pesticide use, and wages of hired labor, and longer run adjustments in capital and land in agriculture. In the developed countries, a fall in prices following liberalization would therefore reduce pressures on the environment. In addition, the expected increase in domestic price variation would increase incentives to diversify the commodity composition of crops grown. But in developing countries, they argue, higher prices would largely have the opposite effect. Using evidence from Brazil, Lutz (1990) concludes that small farms would respond less than larger farms, but that the larger farms would dramatically expand production, land and labor use, and input use, with negative environmental consequences overall.

84. The empirical base on which these projections are made is the application of historical data from the U.S. in the 1930s to developed countries today, together with elasticity estimates and a Ph.D. dissertation conducted in the 1970s. More extensive empirical analysis of the international distribution of environmental impacts from trade liberalization in agriculture has recently been undertaken by Anderson[75] based on earlier modeling work with Tyers.[76]

85. Making use of a multi-commodity simulation model of world markets in grains, meats, dairy products and sugar, covering 30 countries, a reference simulation base of 1990 is compared with two scenarios: (1) liberalization in all developed industrial countries but not developing countries, and (2) liberalization in both developed and developing countries (but not Eastern Europe and the USSR). In both cases, technologically driven shifts in the aggregate supply function are assumed to be induced by increases in agricultural prices. This is an important source of growth in developing countries, leading some net food importing countries to become net exporters post-liberalization. The fact that net importers become net exporters, moving from the situation depicted in Figure 1(a) to Figure 1(b), subjects them to the ambiguity of welfare effects associated with liberalization unless it is accompanied by specific environmental interventions.

86. Generally, the impact of liberalization in developed countries only is to raise food prices by an average of 26 percent, while if both developed and developing countries liberalize, global food prices would remain essentially unchanged, since declines in production in the North would be offset by increases in production in the South. Globally, grain production would fall and livestock production would increase through more

pasturing and less bought-in feeds. Welfare gains would occur for all of the industrial countries, as well as for most developing countries save those with strong comparative disadvantages in food production: Middle East oil producers and newly industrializing countries of Northeast Asia. The reason that developing countries do better than often envisioned in welfare terms is that the price effects of liberalization are allowed to be passed through to farmers, with induced supply responses the result.[77] These results are summarized in Table 5.

87. The environmental impacts of these changes are then considered. Consistent with the projections of the World Bank studies, variable input use of fertilizer and farm chemicals would fall substantially in the developed countries, and the commodity mix would become less narrowly focused on grains and oilseeds. Citing data on fertilizer use (Tables 6 and 7), the strong correlation with levels of output prices received discussed above is corroborated for a cross-section of countries. By shifting production from developed to developing countries, not only would fertilizer and chemical use decline in the North, but labor would be substituted for them in the South, which would reduce substantially the use of chemicals in world food production. Shifts to less bought-in feeds in livestock production would also reduce environmental problems of waste disposal in developed countries, and would move livestock production to the extensive margin in both developed and developing countries, with more pasturing, often as a substitute for cereals. Over the longer term, surplus labor would be absorbed in a more dynamic commercial farm sector in developing countries.

88. While Lutz' (1990) projects of increased environmental pressures on land, water and soils in developing countries following liberalization, Anderson argues that an expanding commercial labor force in agriculture would help reduce in-migration to urban areas, reducing urban environmental problems. Land use in commercial agriculture would increase, but increased agricultural incomes would reduce the incentive of poor subsistence farmers to cultivate marginal lands or to deforest them for fuelwood, so that "agricultural trade liberalization per se is unlikely to bring forth wholesale destruction of tropical rain forests."[78]

89. Additional evidence of the positive impacts of income growth on expenditures for environmental improvements has recently been reported by Grossman and Kreuger (1991), who studied the impacts of income growth in a cross-section of countries on pollution, finding that at low levels of income, pollution was greatest, but as per capita incomes rose above $5,000 per annum, pollution levels fell.[79]

90. This point is reflected in the UNCTAD background paper on environment and North-South trade relations, which concludes that:

> The evidence that agricultural protection in the industrialized countries is on balance detrimental to sustainable resource management in developing countries is quite convincing. World market prices for agricultural products (excluding typical tropical products such as coffee, tea and spices) would, on average increase by more than 20 percent if

> industrial market economies eliminated all assistance, without having any significant effect on consumer prices in these countries...
>
> In both food importing and exporting countries, higher world market prices are most likely to reduce shifting cultivation and other unsustainable resource management [practices] because of the possible increase in added value accruing to the farming sector.[80]

91. In any event, this global modeling work underscores the analytical point made in Section II: liberalization can offer advantages to developing countries which can be accompanied by targeted environmental interventions aimed specifically at problems of land use such as deforestation. This does not imply that liberalization is always and everywhere likely to have positive environmental effects. In many areas it may not. But it may not. But it does create the wherewithal to undertake environmental improvements. Thus, "because there are more efficient policy instruments than trade policies for preserving the natural environment, trade liberalization not only need never be put off for environmental reasons but its benefits can be enhanced if appropriate environmental instruments are introduced at the time of liberalization."[81] Yet despite this assertion, there are reasons to believe that from a political perspective, liberalization can be more easily put off if there is not greater assurance that environmental reforms will accompany the liberalization process.

C. DEVELOPED AND DEVELOPING COUNTRY INTERESTS

92. The relative incapacity of many developing countries to afford the expensive undertaking of environmental regulation, especially reforms affecting environmentally vulnerable lands and their use, reemphasizes the relationship between income growth following liberalization and the capacity to use this "growth dividend" to advance environmental objectives. This point is no less valid in developed economies, although there is already a strong and growing constituency in these countries for environmental actions. In the wealthy countries of the North, the problem is less one of creating a constituency, than of targeting environmental interventions in agriculture accurately and fairly. As Section III emphasized, many improvements in programs such as the Conservation Reserve Program (CRP) in the U.S. and set-aside in Europe are possible. If anything the resistance in the developed countries is greater against liberalization of trade than against appropriate environmental policies in agriculture. But in developing countries, the problem is less one of refining and targeting environmental interventions than of having a program of environmental policy at all.

93. It has been argued by some developing country representatives that they therefore should demand "compensation" in order to undertake such programs as part of the liberalization process, or that liberalization should occur more slowly in order to protect certain environmentally sensitive areas. Yet the analysis above suggests that liberalization

itself will pay a far higher dividend to most developing countries than any "compensation," which in any event is unlikely to be paid. It is out of this dividend that environmental interventions can and should be undertaken. Conversely, the strong support for the environment in developed countries can provide an important and broad constituency for trade reform in agriculture, if environmental groups believe that adverse effects of agriculture will be confronted with the same vigor as trade protectionism.

V. NATIONAL AGRICULTURAL AND ENVIRONMENTAL POLICY INSTRUMENTS: PRINCIPLES OF MATCHING AND MISMATCHING

94. This section considers the relationship between agricultural and environmental policy instruments and the targets at which these instruments are aimed. It extends the analysis of previous sections beyond the proposition that agricultural trade liberalization and environmental intervention should be undertaken jointly, to the principles according to which specific instruments might be employed in each area. Even if it is granted that trade instruments are generally best aimed at trade targets, and environmental instruments at their own targets, the question of what combination of instruments to employ remains.[82] There may also be exceptions to the matching rule, but how does one decide when such exceptions are justifiable? In agriculture, the situation is further complicated by the domestic origins of trade distortions, which do not allow border measures (trade instruments) to be manipulated independently of domestic policies. Finally, it is unreasonable to suppose that the same combination of policies will be suitable for all countries. Not only will developed and developing countries need to employ different approaches, but different countries within these groups will find different combination better suited to their political and economic situations.

95. Despite these complexities, principles of policy can be developed to serve as guidelines for the agricultural sector. Below, four such principles will be illustrated with some examples of policies in use. Together, these principles can serve as a focus of discussion, and hopefully as a basis for reform. The first principle simply restates the logic of matching targets and instruments. The second two consider agricultural and environmental policies, respectively, and how the domain of each might reasonably be determined in practice. The fourth principle extends this logic to the multilateral setting.

A. PRINCIPLE ONE: MATCHING TARGETS AND INSTRUMENTS

96. In general, domestic agricultural and trade targets in agriculture should be matched with domestic agricultural and trade instruments, and environmental targets with environmental instruments. Yet this principle is not inviolate, and some "cross-matching" may be justified.

97. For the reasons developed above, targets and instruments in agriculture include domestic price and income supports, output taxes and input subsidies as well as border measures. Examples of mismatching include the U.S. Conservation Reserve Program and

EC set-aside, which by aiming at both supply control and environmental improvements, have failed to accomplish either as effectively. By targeting such programs directly at lands highly vulnerable to environmental damages (in effect converting them purely to environmental policies), their impacts and cost-effectiveness would both be enhanced.[83] A second example of a mismatch is Sweden's tax on nitrogen use in agriculture, the proceeds of which, while purportedly aimed at environmental improvement, have been used to subsidize grain exports of surpluses resulting from price supports, thus further stimulating production and nitrogen use. Austria has followed a similar policy, utilizing proceeds from its "soil protection fee" to finance grain exports.[84] These examples raise some troubling questions about input taxes in agriculture to be discussed under Principles 2 and 3 below. An example of a trade measure mismatched by being directed at environmental problems is the subject of a recent GATT and U.S./Canada panel ruling that Canadian landing restrictions on U.S. salmon and herring fishing boats were not primarily aimed at environmental targets but were in fact primarily intended as trade restrictions.[85]

98. The 1989 U.S./Canada case provides insights into what criteria can guide when "cross-matching" is justifiable, and when it is not. While the case involved fisheries, its lessons are generalizable to agricultural policies, insofar as it concerns whether specific trade restriction policies are structured "proportionately" to achieve "legitimate objectives" of environmental protection.[86]

99. The case involved a panel established to hear testimony over Canadian restrictions on exports of Pacific Coast unprocessed salmon and herring. Such restrictions date to 1908, but were found GATT-illegal in 1987 after the United States complained that they were unjustifiable restrictions on trade. In 1988, Canada accepted the GATT finding, but stated that it would continue a "landing" requirement for foreign boats which would allow inspection of their catch. The ostensible reason for the requirement was an environmental one: to allow the fish harvest to be counted and monitored so as to preserve the fishery from overexploitation.

100. According to the United States, the requirement that its boats must land in Canada constituted an export restriction, because of the extra time and expense U.S. boats must incur in landing and unloading, as well as due to dockage fees and product deterioration. The Canadians held that they were pursuing "conservation and management goals" for five varieties of salmon (some of which had previously not been covered by the landing requirement) as well as herring. Essentially, the Canadians sought to justify under Article XX of the GATT (the "General Exceptions" Section: to be considered further below) what had otherwise been found GATT-illegal, by appealing to an environmental claim under Article XX(g): conservation of exhaustible natural resources.

101. The U.S. argued that although the new herring and salmon regulations "are carefully worded to avoid the appearance of creating direct export prohibitions or restrictions, their clear effect is to restrict exports." Moreover, the Canadian landing requirement was argued

not to be "primarily aimed" at the conservation of herring and salmon stocks, which had been the interpretation given to Article XX(g) by the 1987 GATT ruling. Thus, the U.S. held that the Canadian landing requirement was being justified as an environmental policy when it was primarily no more than an unwarranted restriction on international trade. Canada argued that the landing requirement was "primarily aimed" at the conservation of the salmon and herring fisheries.

102. In a significant decision, the panel found that if the effect of such a measure is to impose "a materially greater commercial burden on exports than on domestic sales," it amounted to a restriction on trade, whether or not its trade effects could be quantitatively demonstrated. The panel "was satisfied that the cost of complying with the landing requirement would be more than an insignificant expense for those buyers who would have otherwise shipped directly from the fishing ground to a landing site in the United States." With regard to the Article XX(g) exception, the panel was conscious "of the need to allow governments appropriate latitude in implementing their conservation policies," and that the trade interests of one state should not be allowed to override the "legitimate environmental concerns of another." "If the measure would have been adopted for conservation reasons alone," the panel found, "Article XX(g) permits a government the freedom to employ it." However, balancing this is the "primarily aimed at" test, which determines whether the measure is part of a genuine conservation or environmental policy, or is in fact primarily intended as a barrier to trade.

103. This line of reasoning led the panel to two conclusions. First, "since governments do not adopt conservation measures unless the benefits to conservation are worth the costs," the magnitude of costs to the parties--foreign and domestic--who actually bear them must be examined. Second, "how genuine the conservation purpose of a measure is, must be determined by whether the government would have been prepared to adopt that measure <u>if its own nationals had to bear the actual costs of the measure</u>." In this case, the panel was unconvinced that the measure would have been imposed on all Canadian boats primarily for conservation reasons. Specifically, the panel found that Canada would not have adopted such a measure "if it had required an equivalent number of Canadian buyers to land and unload elsewhere than at their intended destination." Alternative methods of monitoring catch rates were available which posed far fewer restrictions on trade.

104. Generalizing from this case, it seems possible to envision the development of criteria based on (a) estimated costs of trade restrictions justified as environmental regulations; (b) evidence on who bears these costs; and (c) judgments of whether such measures would be imposed domestically, <u>in the absence of any trade effects</u>. Such criteria can serve as a basis for the development of standards determining which environmental and health measures constitute unnecessary obstacles to trade.

105. Consider a specific example arising from the 1989 United States decision to embargo Chilean fruit and vegetable imports after traces of cyanide were found in two grapes.

Would the costs imposed on Chile by a complete embargo have been imposed on domestic U.S. interests if two California grapes had been adulterated? In estimating these costs, and their trade effects, differences in national levels of living must also come into play. Since Canadian and U.S. fishing interests are in the main a homogenous group, the problem does not arise. Where measures promulgated in one country loom much larger in relation to incomes in another (e.g., Chile and the U.S.), an a priori argument for a differentiated approach exists.

B. PRINCIPLE TWO: AGRICULTURAL POLICY AND TRADE TARGETS AND INSTRUMENTS

106. Agricultural policies (including domestic instruments affecting output and inputs) should aim to minimize distortion of market signals, while remaining environmentally neutral. If these policies nonetheless create (or fail to reduce) adverse environmental impacts, then a separate environmental intervention should be addressed to the problem.

107. It follows from the previous sections that developed countries will have greater ability to reduce trade distortions in the form of both import barriers and export subsidies if their domestic policies are targeted at maintaining farm incomes directly, rather than via crop-specific price supports. In addition, subsidies paid to inputs which are scarce natural resources (e.g., water) should be reduced or eliminated. For example, if the U.S. or EC were to move dramatically in the direction of "decoupling" payments to farmers from specific crop "bases" (in the U.S.) or quantities (in Europe) substantially greater targeting efficiency would be possible to smaller- and medium-sized farmers.[87] Yet despite the fact that such policies would reduce incentives to intensify production and thus environmentally harmful agricultural practices, it would be naive to suppose that they will be sufficient to eliminate adverse environmental impacts from agriculture. Additional policies targeted specifically at harmful agricultural practices and vulnerable lands will be necessary since market failures will persist. These environmental instruments will be more efficient if they are targeted directly at the problem, rather than operating obliquely such as "cross compliance" measures and the U.S. "sodbuster" and "swampbuster" programs, which are tied to crop-specific subsidies.

108. In developing countries policies which now tax the farm sector should instead allow price incentives to be passed through from markets to producers. Without such price depressing taxes, input subsidies will be less necessary. Income growth per capita will result, especially if greater market access is granted due to simultaneous reforms in developed countries. Again, however, substantial environmental interventions will continue to be necessary, which will become more affordable if incomes per capita increase.

C. PRINCIPLE THREE: ENVIRONMENTAL TARGETS AND INSTRUMENTS

109. Environmental policies in agriculture should aim to minimize distortions in the use of natural resources due to market failure, while remaining trade neutral. If these polices nonetheless create trade distortions, then separate trade policy interventions should be addressed to them.

110. Minimizing distortions due to market failure by internalizing agricultural externalities, even with the agricultural policy reforms discussed under Principle Two, will require substantially greater interventions than undertaken to date. The polluter pays principle, which has thusfar been applied mainly through input taxes (e.g., on nitrogen) should instead focus primarily on graduated fees and penalties for a wide array of environmental damages. These should be targeted to individual land owners (including corporations and absentee land owners) found to have engaged in (or failed to prevent) environmentally harmful practices as defined by the regulatory authority. In contrast to input taxes levied on all users, such policies would focus specifically on the polluter. They would probably generate less revenue than input taxes, but this would decrease the temptation to funnel this revenue to perverse uses (e.g., export subsidies) and would reduce calls for farmer compensation, both of which undercut the efficacy of the polluter pays principle.

111. In addition to a system of graduated fees and penalties paid by land owners, land areas targeted because they are vulnerable to a variety of environmental damages should become the primary focus of land retirement schemes such as the CRP in the U.S. and set-aside in Europe. Restrictions on farming practices on these lands, which would trigger fees and penalties if violated, are within the administrative capacity of most governments. Although such intervention schemes are subject to political interpretation, they are far less likely to be abused than tax schemes which generate large flows of funds. In both developed and developing countries, the designation of protected land areas together with fees and penalties may not work well, but it will work better than a scheme of input taxes, which will be afflicted with the same problems of favoritism and corruption that have hampered the administration of input subsidies.

112. For the same reasons that graduated penalties and fees targeted specifically to "polluters" in agriculture are more efficient than input taxes, so graduated rewards for environmental "affirmative actions" can be targeted specifically to farmers willing to undertake soil and water conservation projects, experiments in input reduction, and other actions designated as environmentally positive. It should be emphasized that such rewards are not simply payments not to pollute, but to improve the quality of the environment from a current baseline.[88]

113. If such policies result in trade distortions, then a trade instrument is better able to resolve the issue. For example, U.S. vegetable growers have contended that current U.S. restrictions on pesticide use put them at a competitive disadvantage vis-a-vis Mexican

growers, who are subject to more lax restrictions. Rather than reducing the level of U.S. regulation, an appropriate response is to negotiate, bilaterally or multilaterally, equivalent standards in the Mexican case, or to demonstrate that the Mexican standards justify an import restriction under Article XX of the GATT (see Principle Four). This has been the general approach taken in the U.S./Mexico negotiations, in which the promise of greater market access (and income growth) has impelled an upgrading of some of Mexico's environmental policies.

114. An interesting instance of a trade measure misapplied to a domestic environmental problem is the recent pork export charge by the government of Taiwan.[89] A charge of 3.75 U.S. cents per kilogram of whole carcass exported, which will double in 1992, is to finance regulations designed to put small pig raisers out of business. Whether the tax will solve the water pollution problem from pig wastes, or simply concentrate production, aggravating the problem, remains an open question. Farm level fees and charges would be more targeted to the environmental problem than export taxes.

115. Many environmental groups have remained unconvinced that multilateral or bilateral trade negotiators are able (or willing) to upgrade environmental standards. At the same time, developed countries are suspicious of "harmonization" as leading to a "least common regulatory denominator." Developing countries, meanwhile, sometimes perceive of harmonization as a way of closing off market access to their products. As a result, they have called on governments to take unilateral actions, such as banning imports of beef treated with hormones or halting pesticide exports in order to break the "circle of poison." In so doing they have allied themselves with protectionist elements. The growing volume of agricultural trade suggests that only through the search for greater equivalency in standards can such problems be addressed.

D. PRINCIPLE FOUR: MULTILATERAL APPROACHES TO MATCHING TARGETS AND INSTRUMENTS

116. The logic of targets and instruments at the national level, when extended to the international level, implies that trade will be less distorted, and the global environment more readily protected, if national governments pursue similar policy targets. These targets should be based on the free movement of goods and services and the reduction in global environment damages. Both are forms of "public goods." Thus, multilateral organizations seek to promote consensus agreements over the objectives of trade and environmental policy. This consensus is not a substitute for national policies, nor does agreement on targets (e.g., chloroflorocarbon emissions) imply that the requisite actions will be undertaken to alleviate them.[90] A major question, assuming agreement over targets can be reached, is the degree of uniformity to be sought in instruments.

117. National governments must be granted the flexibility to achieve similar targets through different, but "equivalent" instruments. In agricultural trade policy, the Uruguay Round has barely reached agreement over targets; it is evident that different instruments will be required. To achieve more "decoupled" forms of income support to farmers, for example, the U.S. will likely pursue greater separation of payments from specific crop "bases," while the EC will pursue limits on the proportion of output eligible for subsidy. Developing countries, even if agreed on less distorting measures of agricultural trade policy, will seek special and differential treatment.

118. In environmental policy, the issue of harmonization versus equivalency in agriculture is particularly difficult.[91] While equivalency has greater appeal, insofar as it allows for different conditions and endowments by countries seeking to achieve similar targets, it is also subject to disguised protectionism. This makes the issues of harmonization versus equivalency, and the degree to which environmental standards constitute effective barriers to the free movement of goods and services under GATT Articles, an increasingly important question.

119. There has been longstanding recognition of the possibility for conflicts between national environmental policy and more liberal international trade. The GATT Articles, adopted by the contracting parties in 1947, explicitly recognize the possibility that domestic health, safety and environmental policies might override general attempts to lower trade barriers. GATT Article XI, headed "General Elimination of Quantitative Restrictions," states in paragraph (1):

> No prohibitions or restrictions other than duties, taxes or other charges, whether made effective through quotas, import or export licenses or other measures, shall be instituted or maintained by any contracting party on the importation of any product of the territory of any contracting party or on the exportation or sale for export of any product destined for the territory of any other contracting party.

Yet Article XX, headed "General Exceptions," provides

> ...nothing in the Agreement shall be construed to prevent the adoption or enforcement by any contacting party of measures:
>
> ...(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption; provided that such measures:
>
> ...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.

120. A similar set of exceptions was applied to health related measures under Article XX(b). GATT law emphasizes that any restrictions posed on foreign practices for environmental or health reasons must also reflect a domestic commitment, so that the exceptions cannot be misused as a disguised form of protection.

121. It would seem necessary to go beyond the language of Article XX, and to develop principles and protocols to guide national and international judgments about the appropriate matching of agricultural targets and instruments. While this may not be possible until after the Uruguay Round, it is likely to remain a highly visible set of issues. The U.S./Canada case cited above provides insights, but these have not been translated into more specific guidelines. And as noted, there are important reasons to believe that the level and enforcement of environmental standards affecting agriculture will not be the same in developed and developing countries.[92]

122. Despite the view in some quarters that environmental issues should be kept out of the trade realm, it is very doubtful that it will be possible to do so as global agricultural trade becomes more integrated. While matching targets and instruments provides a basis for ordering the relationship of agricultural trade and environmental issues, it in no way suggests that they are, or can be made, independent. The entire thrust of this analysis is that they are analytically, economically and politically linked. The challenge is to clarify these linkages, and to establish guidelines for actions which jointly pursue trade reform, and improved environmental quality, in ways that are most efficacious from the point of view of national governments and the international trading system.[93]

VI. SUMMARY AND CONCLUSIONS

123. The impacts of trade flows and trade policies on environmental quality in agriculture are complex and difficult to resolve. Agriculture is replete with examples of market failure, yet these externalities and public bads have, until recently, been difficult to monitor and to estimate. Government policies in agriculture have tended to reinforce, rather than to mitigate, these market failures.

124. Failures in agricultural trade policy emanate from domestic price manipulation. The same domestic policies which have distorted trade are also responsible for a large share of the environmental damages in agriculture, especially in developed countries. While reforming these policies would not address all of these problems, it would alleviate many distortions as well as many of the incentives leading to intensive cropping and excessive input use.

125. Whereas environmental problems may be reinforced by agricultural trade and domestic policies, they are unlikely to be resolved through changes in these policies alone. In fact, if environmental policies internalizing externalities do not accompany trade reform,

the welfare effects of trade liberalization are ambiguous, and could be negative. In contrast, if agricultural policy reform is accompanied by targeted environmental interventions which largely internalize externalities, the welfare effects will generally be positive. There is, for each country, a combination of agricultural and environmental policies which will be most efficient.

126. The environmental impacts of trade flows in agriculture revolve around two main issues: the commodity composition of agricultural trade and the increasing use of water, fertilizer and chemical inputs. The composition of crops grown has become increasingly specialized in high income developed countries since the 1950s, in part in response to market forces, but also due to subsidies that have sheltered producers of a subset of commodities from market risks. These subsidies have generated chronic surpluses of these commodities well in excess of market demands, creating several economic distortions. On the trade side, support prices higher than world market levels have necessitated import barriers, closing off market access to developing countries capable of lower cost and lower intensity production. Chronic surpluses have necessitated export subsidies to clear domestic markets, lowering world market prices and depressing production in low income countries. On the environmental side, the same subsidies have reduced farm level diversification, contributing to a more narrow range of crops grown, and reduced annual rotations of grains and oilseeds with other crops that would help replenish soil nutrients, reduce erosion, and require fewer applications of water, fertilizer and chemicals. It is the excessive applications of these inputs, and the effect of these excesses on soil and water quality that, together with less diversified commodity composition, pose the greatest environmental challenges in developed countries. In addition to these problems, the increasing concentration of livestock production (again in large part a response to a variety of subsidies) has posed serious problems of waste disposal which were less serious when diversified crop/livestock production was the norm.

127. In developing countries, the effect of depressed global prices is reinforced by government policies which tax the agricultural sector and subsidize urban consumers, lowering incentives to produce. However, because so much of household production is at or near subsistence levels, farmers continue to cultivate crops on marginal soils and to deforest environmentally vulnerable lands. The environmental damages on these lands are aggravated by policies which seek to increase yields by subsidizing fertilizer and chemical inputs. Excessive applications of these inputs results, with adverse impacts on soil, water and human health.

128. The policies underlying these problems in both developed and developing countries have powerful constituencies: wealthy farmers in the North, and urban consumers in the South. Yet the policies are the creation of governments, and can be changed by them if the political and economic logic of reform is compelling. In developed countries, concern with the environment has the potential to broaden the constituency for agricultural trade reform, if environmental groups are persuaded that trade liberalization and environmental responses

to market failure in agriculture will be jointly and vigorously pursued. In developing countries, the willingness to undertake environmental initiatives is conditional on the income growth that only agricultural trade liberalization, coupled with reduced taxation of farmers, can bring. Without access to industrial country markets it is unrealistic to expect developing countries to undertake a process of environmental regulation of agriculture, a process which is really only beginning in the OECD countries.

129. In most developed countries, environmental policies affecting agriculture continue to operate at the margin, and are overwhelmed by price subsidies coupled to specific crops. If a program of "decoupling" were to emerge from the trade liberalization process, or in response to budget pressures domestically, the effect on the environment would be salutary. But environmental regulations themselves would still be required, aimed at better targeting of lands and soils highly vulnerable to damages from agriculture, and more refined applications of the polluter pays principle. The current impetus toward input taxes in agriculture is a crude application of the principle, which taxes all users, not only or even necessarily the polluters. Graduated fees and penalties to be paid by polluting land owners, together with rewards for environmental affirmative actions, are more consistent with the principle. In addition, land targeting making use of information available on soil and water use could help to bring the penalties and awards to bear on the areas most in need of attention.

130. In developing countries, it is less a question of refining and targeting environmental policies in agriculture, than of developing such policies at all. Those policies are expensive to undertake, and will require investments which are unlikely without income growth. Income growth, as noted, is linked in turn to trade reform.

131. The empirical evidence on the environmental effects of domestic agricultural and trade policy reform in developed and developing countries is not large, and is quite recent. However, several studies point to the positive empirical validity of not only the "liberalization effect," but the reinforcing character of the "environmental effect," on welfare. In a detailed case study of the United States, multilateral decoupling, as called for in the Uruguay Round, has a beneficial effect on farm income which reinforces incentives to move to more sustainable agronomic practices. In recent global models of trade liberalization, welfare benefits are widespread, creating the wherewithal for targeted environmental improvements in developing countries. The shift in production to the extensive margin, and the absorption of labor in commercial agriculture, also may have positive environmental impacts in developing countries. This does not suggest that environmental problems will be overcome by liberalization per se, but that the opportunity to confront them effectively will be enhanced with higher incomes. The dividend from trade reform is much greater than any compensation likely to be paid to developing countries for environmental improvement.

132. Given that agricultural policy reform and environmental improvements are both

welfare enhancing, what principles can guide the application of specific policy instruments to these targets? First, it is important to remember that while generally mutually reinforcing, they are separate targets of policy, requiring separate instruments. Where environmental instruments aim at domestic agricultural and trade targets, or domestic agricultural and trade instruments at environmental targets, the result is likely to be inefficiency due to some combination of political manipulation, ineffectiveness, or protectionism. Yet there may be cases in which such "cross-matching" is justified. Restraints on trade in order to protect environmental quality may be justified if they are primarily aimed at an environmental target, and not a disguised form of tariff or subsidy to trade. One way in which to determine this is to ask whether the costs of the policy would have been incurred if they were fully borne by domestic, rather than foreign interests. Conversely, if an environmental policy is aimed at foreign interests, would the costs proposed for the foreign interests also be borne fully in the home market?

133. A second principle, applicable to domestic agricultural and trade targets and instruments, is that they should aim to minimize distortions of market signals, while remaining environmentally neutral. If environmental problems remain, they should be addressed directly. This principle reinforces the separation of these targets, but does not imply that environmental objectives are residual, to be considered after the fact. The welfare analysis of Section II makes it clear that instruments employed to achieve environmental objectives are in fact a sine quo non for welfare improvements from liberalization.

134. A third principle is that environmental policies in agriculture should aim to minimize distortions in the use of natural resources due to market failure, while remaining trade neutral. If trade distortions result, then separate instruments should be addressed to them. The most effective way to minimize market failures is by targeted application of the polluter pays principle.

135. Finally, the relationship between the agricultural and environmental targets and instruments of many countries, acting together, must be considered. If these targets are largely similar (the minimization of trade distortions and market failures) then the coordination of policies is likely to be easier. Even so, it is unrealistic to expect the instruments used to be the same. For this reason, equivalent, rather than strictly harmonized, instrumental approaches are likely to be more practical.

136. In the final analysis, the increasing integration of world markets continues to tie the interests of various nations more closely together. The flow of agricultural goods and services will be rationalized, and human welfare most improved, if unfettered by outmoded policies designed to protect special interests. At the same time, the costly flow of "bads" and "disservices," the environmental consequences of market failure, are also increasingly in evidence. A corresponding effort to staunch this flow through policies which acknowledge and account for these costs is an equal requirement of global market integration.

ENDNOTES

[1]The classic analysis is Bator (1958). More recently, see Randall (1983) and Dahlman (1979). The theoretical approach taken to agricultural policy in this paper is largely consistent with Stiglitz (1987), who observed that: "The design of agricultural policies should be viewed as an exercise in the theory of the second best, an exercise requiring detailed information about a country and careful judgement about the nature and relative importance of the market (and non-market) failures" (p.53).

[2]See Lutz and Young (1990); Young, 1991; Young (forthcoming); Repetto, et. al, (1989); and Ahmad, et. al., (1989).

[3]These examples of nonpoint source pollution demonstrate the pervasive incentive problems categorized as "principal-agent" dilemmas in environmental economics, in which a regulating "principal" does not have sufficient information accurately to alter the behavior of the regulated "agents." See Segerson (1988). Recently, however, the development of computerized information bases on surface land categories and damages, together with hydrological models capable of estimating groundwater damages, have improved the ability to allocate responsibility for agricultural damages to the environment.

[4]The first contemporary statement of "nonmarket failure" is Charles Wolf, Jr. (1979). See also Stiglitz (1987).

[5]Agricultural examples of this literature include D. Gale Johnson (1991), Anderson and Hayami (1986), M. Olson (1985), and R. Bates (1981).

[6]See Hoekman and Leidy (1991).

[7]Faeth, et. al. (1991); Creason and Runge (1990); OECD (1989); Phipps and Reichelderfer (1989).

[8]Southgate (1988); Repetto (1985).

[9]Johnson (1991), p. 5.

[10]Tinbergen (1950). Formally, Tinbergen was appealing to the concept of a fully identified set of relationships in which the numbers of variables at least equaled the number of equations used to solve for them.

[11]Krutilla (1991).

[12]This section is based on K. Anderson (1991a; 1991b). I benefitted from helpful discussions during its preparation with Kym Anderson and Richard Blackhurst of the GATT Secretariat, Division of Economic Research and Analysis, Geneva, Switzerland.

[13]The assumptions underlying the model include the usual ones of partial equilibrium analysis in a trade setting (see Houck, 1986), augmented by standard externalities theory. While subject to criticism by advocates of empirical general equilibrium analysis (see Hazilla and Kopp, 1990; and Merrifield, 1988), the approach is sufficient for clarifying analytical issues of relevance to public and environmental policy. Among the key underlying assumptions are that (1) transactions costs prevent spontaneous negotiated "internalization" of the external effect, ruling out a "Coasian" solution; that taxes-cum-subsidies are lump sum (nondistorting); that the externality can be accurately measured; that it is a "product" rather than "process" externality; that all curves are linear and that the externality begins with the first unit of production; and that the marginal benefit and cost curves fully incorporate feedback effects from the rest of the economy. See Anderson, 1991a, pp. 2-3.

[14]See Sullivan, et. al. (1991).

[15]The empirical use of consumer and producer surplus measures is itself fraught with difficulty. See Boadway and Bruce, (1984).

[16]See Lloyd (1991). The "equivalence" of these measures is of course not guaranteed in practice as discussed in Baumol and Oates (1975). The effect of such a policy would be to eliminate the "wedge" between S′ and S, so that marginal social costs of production would equal marginal social benefits. In the case of no trade, such intervention would be equivalent to a tax of cn per unit, which would reduce maize production from OQ to OQ_0 in Figure 1(a). The welfare benefit from internalizing the externality would be the shaded area cde, due to the reduced erosion resulting from the production fall. From a welfare perspective, we can thus isolate a welfare improvement due to the "environmental effect," of targeted environmental intervention, assuming no "liberalization effect."

[17]Anderson, 1991a, p. 5. What of the behavior of other trading nations in the world? Suppose that a large trading partner of the small country were to liberalize its agricultural trade in maize and/or undertake environmental policies designed to reduce soil erosion as well? In this case, either the "liberalization effect" and/or the "environmental effect" on welfare could occur in tandem in both countries. The effect on the small country of either more liberal trade and/or increased environmental intervention (and reduced production) in the large country would be to raise maize prices. If the international price of maize rose from OP, to OP_1'' in Figure 1(b), the "liberalization effect" would rise from cij to cwx, or by iwxj given an environmental intervention which raised the equivalent tax on erosion from js to xl. But if no such environmental policies were taken, gains from the "liberalization effect" (ikyw) would be reduced by the losses from erosion (mkyz), which might be a net gain or loss, depending on both the increase in price and, most importantly, how great the divergence was between S and S′: in other words, how serious the impact of erosion on welfare.

[18]Anderson demonstrates eight propositions in all. They are:

(1) Liberalizing trade in a good with adverse environmental impacts which are left uncontrolled improves a small country's welfare if following liberalization it imports the good; but if it exports it, the negative environmental effects are subtracted from the gains from trade, and the welfare effect is ambiguous.

(2) There is a welfare gain from trade for a small country provided that a targeted (nearly optimal) environmental policy is introduced, even in the export case.

(3) Trade instruments could be used to reduce environmental degradation by a given amount, but they will improve welfare less than a more direct intervention at the source of the environmental pollution and may even worsen welfare.

(4) The welfare gains to a small country of trade liberalization if its exportable product price rises are greater than losses due to increased pollution from production, given a sufficiently small divergence between S and S′ (private and social marginal cost) and/or an environmental policy which imposes an equivalent tax sufficient to largely internalize this externality.

(5) If a small country shifts from being an importer to an exporter of a polluting product following an international price rise, its welfare may fall (rise) depending on the distance from S to S′, and/or the level of equivalent pollution tax.

(6) Even a small country which remains a net importer could benefit from an international price rise if two assumptions are changed, so that (a) domestic production is discouraged by assistance to other sectors; or (b) other sectors were more pollutive so that attracting resources to this sector increased the "environmental effect" on welfare.

(7) In the case of a negative consumption externality, liberalizing trade improve both the environment and welfare if the country exports the good, but worsens the environment and may reduce welfare it if imports it, unless an equivalent (nearly optimal) pollution tax is in place.

(8) Where consumption of the imported product is less pollutive than consumption of a domestic substitute, an import barrier may be more rather than less costly than is conventionally measured when pollution is not accounted for.

[19]In the section to follow, both the price support policies and conservation set asides of the U.S. and the European Community will serve as examples of large country behavior which affects international supply and demand.

[20]Anderson (1991a), p. 18.

[21]An econometric decomposition of these three sources of demand in the U.S. (Runge and Halbach, 1990) showed that export demand and government payments have been the major factors explaining farm income changes in the period 1949-85.

[22]A related and significant concern, especially in developing countries, is deforestation in areas opened to agricultural cultivation. Since a separate case study is in preparation for the forestry sector, the issue of deforestation will not be given substantial attention here. This should not lead to underestimates of its importance, nor inattention to the linkages from deforestation to inappropriate agricultural policies and inadequate environmental regulations, especially in developing countries.

[23]A detailed statistical summary of fertilizer, herbicide and insecticide applications is provided for the U.S. and its five major producing states by crop for the period 1949-88 in Runge, et. al. (1990).

[24]This process may be modelled as a case of induced institutional innovation in the presence of negative external effects. See Runge (1987), Creason and Runge (1990), and Munson and Runge (1990), for a discussion of the induced innovation model and a catalogue of institutional and technological responses to environmental concerns in agriculture.

[25]See D. G. Johnson (1991) and Cochrane and Runge (1992). While EEP has been defended as a "bargaining chip" and as appropriate retaliation for EC export subsidies, it could not function without the surplus commodities in which benefits are paid in-kind to exporting firms in order to lower their prices to foreign customers.

[26]Kozloff (1989).

[27]Sullivan, et. al. (1991).

[28]Runge and Krieger (1990).

[29]Frederick (1982).

[30]Houck, et. al. (1976).

[31]National Research Council (1989).

[32]The Economist (1989).

[33]See Lyman, et. al. (1989); Faeth, et. al. (1991).

[34]See Batie (1990) and Capalbo and Phipps (1990).

[35]National Research Council (1989), p. 3.

[36]Clark, et. al. (1985).

[37]Church (1989), p. 6.

[38]Center for Rural Affairs (1990), p. 3.

[39]Quoted in Hayden (1990), p. 583.

[40]Taff and Runge (1988). In 1989, the U.S. General Accounting Office (GAO) confirmed this design flaw, noting that:

> CRP costs could have been reduced by about $300 million a year with minimal impact on the benefits achieved... USDA's bid acceptance process was not competitive but was essentially an offer system wherein CRP payment rates frequently were set much higher than local cash rental rates to induce enrollment in areas with large amounts of eroding land.... In many parts of the country, this process resulted in CRP rental rates that were 200 to 300 percent higher than local cash rental rates. GAO estimates that, as a result, USDA could be paying as much as $296 million a year more than necessary for CRP rental payments.

[41]Hrubovcak, LeBlanc and Miranowski (1990).

[42]Fairweather (1989).

[43]World Wildlife Fund (1988). Bonnieux and Rainelli (1988). DeWit (1988). On the history of the Common Agricultural Policy see Fennel (1979) and Tracy (1989).

[44]FAO (1990).

[45]FAO (1990), p. 7.

[46]See the European Commission study on "Intensive Farming and the Impact on the Environment and the Rural Economy of Restrictions on the Use of Chemical and Animal Fertilizers" (1990). A good recent study of European environmental policies affecting agriculture is FAO (1991).

[47]FAO (1990), p. 18.

[48]See Young (1989). This evidence is briefly reviewed in Bonnieux and Rainelli (1988).

[49]See Hrubovcak, LeBlanc and Miranowski (1990); and Ogg (1989).

[50]See Ervin (1988).

[51]Stellin (1987), p. 61.

[52]Stellin (1987), p. 66, Table 3.

[53]Bendoricchio, et. al. (1988), pp. 29-30, Tables 1 and 2.

[54]Stellin, et. al. (1990), pp. 129-131.

[55]Giupponi (1991), p. 9; Dosi, et. al. (1991), p. 12.

[56]Halbach, Runge and Larson (1987).

[57]Anderson and Hayami (1986), Lutz and Saadat (1988).

[58]Repetto (1985); Southgate (1988); Binswanger (1989).

[59]See Runge (1990b).

[60]Swanson and Dahl (1989). Pesticide imports calculated from Lutz and Young (1990), Table 1, p. 16.

[61]Leanard (1989).

[62]Repetto (1985). These data are reproduced in Lutz and Young (1990), Table 2, p. 14.

[63]See, for example, Morris (1990); and Shrybman (1990).

[64]Barbier (1989), p. 892.

[65]UNCTAD (1991), pp. 4-5.

[66]See Opschoor (1989), pp. 139-140.

[67]UNCTAD (1991), p. 27.

[68]Faeth, et. al. (1991).

[69]Blandford (1990).

[70]Faeth, et. al. (1991), p. 12.

[71]Faeth, et. al. (1991), p. 11.

[72]Faeth, et. al. (1991). p. 20.

[73]Faeth, et. al. (1991), p. 21.

[74]See Lutz (1990); and Schuh (1990).

[75]Anderson (1991b).

[76]Anderson and Tyers (1990).

[77]For a discussion of the induced supply response issue in connection with the objections of food importers to trade reform, see Runge (1991).

[78]Anderson (1991b), p. 13-15.

[79]Grossman and Kreuger (1991).

[80]UNCTAD (1991), p. 25.

[81]Anderson (1991b), p. 16.

[82]An excellent formal analyses of this problem is Krutilla (1991). Just and Antle (1990) propose a conceptual framework. In a legal analysis, Stevens (forthcoming) proposes the division of trade measures undertaken to protect the environment into those (a) complementary to domestic policy; (b) coercive of other countries; (c) countervailing other countries' trade policies; (d) multilateral actions taken jointly by a group of countries.

[83]Taff and Runge (1988).

[84]FAO (1991), pp. 5-8.

[85]The analysis and quotations of the U.S./Canada case are from Runge (1990b). I am grateful to Robert Hudec, a panel member in the case, for helpful suggestions.

[86]See OECD (1991) and Grimmett (1991).

[87]For very good overviews of decoupling issues see Meyers, et. al (1990) and Favrat (1990). The relative efficiency and equity of such reforms are analyzed in Cochrane and Runge (1992).

[88]This point is also made strongly by Young (1990) and the same author in a forthcoming volume, which argues for extensions of the Polluter-Pays-Principle to include a "Beneficiary Compensates Principle" and a "User Pays Principle." The Beneficiary Compensates Principle requires that any additional costs associated with the provision of positive nonmarket benefits (e.g., landscape quality) be compensated. The User-Pays-Principle requires that those who benefit from an investment (e.g., educational or research expenditures) should also help pay for it.

[89]Journal of Commerce (1991).

[90]See Robertson (1990).

[91]See Young, forthcoming, Chapter 5.

[92]See James (1982), as quoted in Runge (1990b). A recent defeat of U.S. use of environmental standards as a trade barrier is the U.S./Mexico dispute over tuna (International Herald Tribune, 1991).

[93]See "GATT to focus on trade and environment link," FOCUS GATT Newsletter, Vol. 85, October 1991, pp. 1-6.

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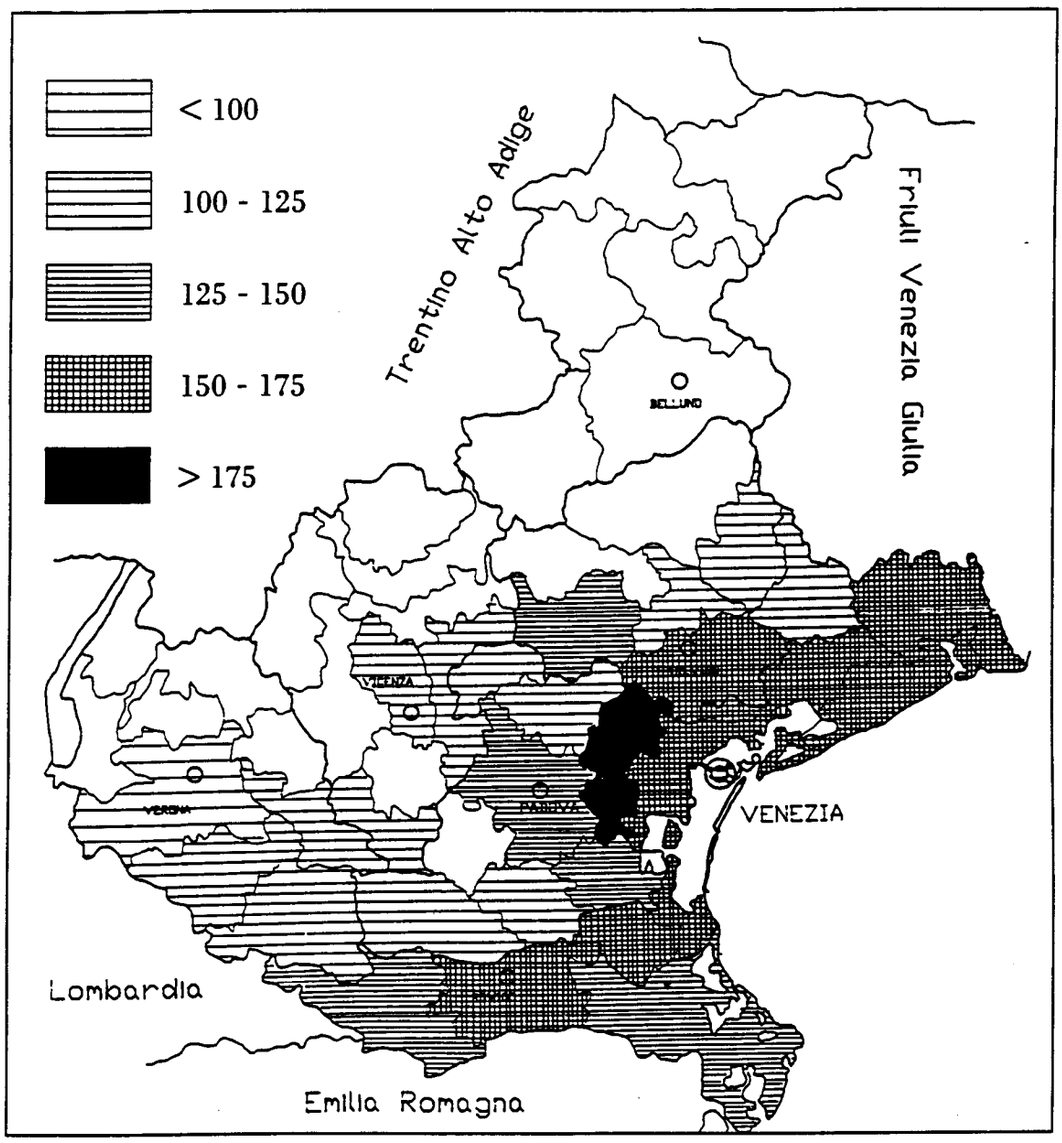
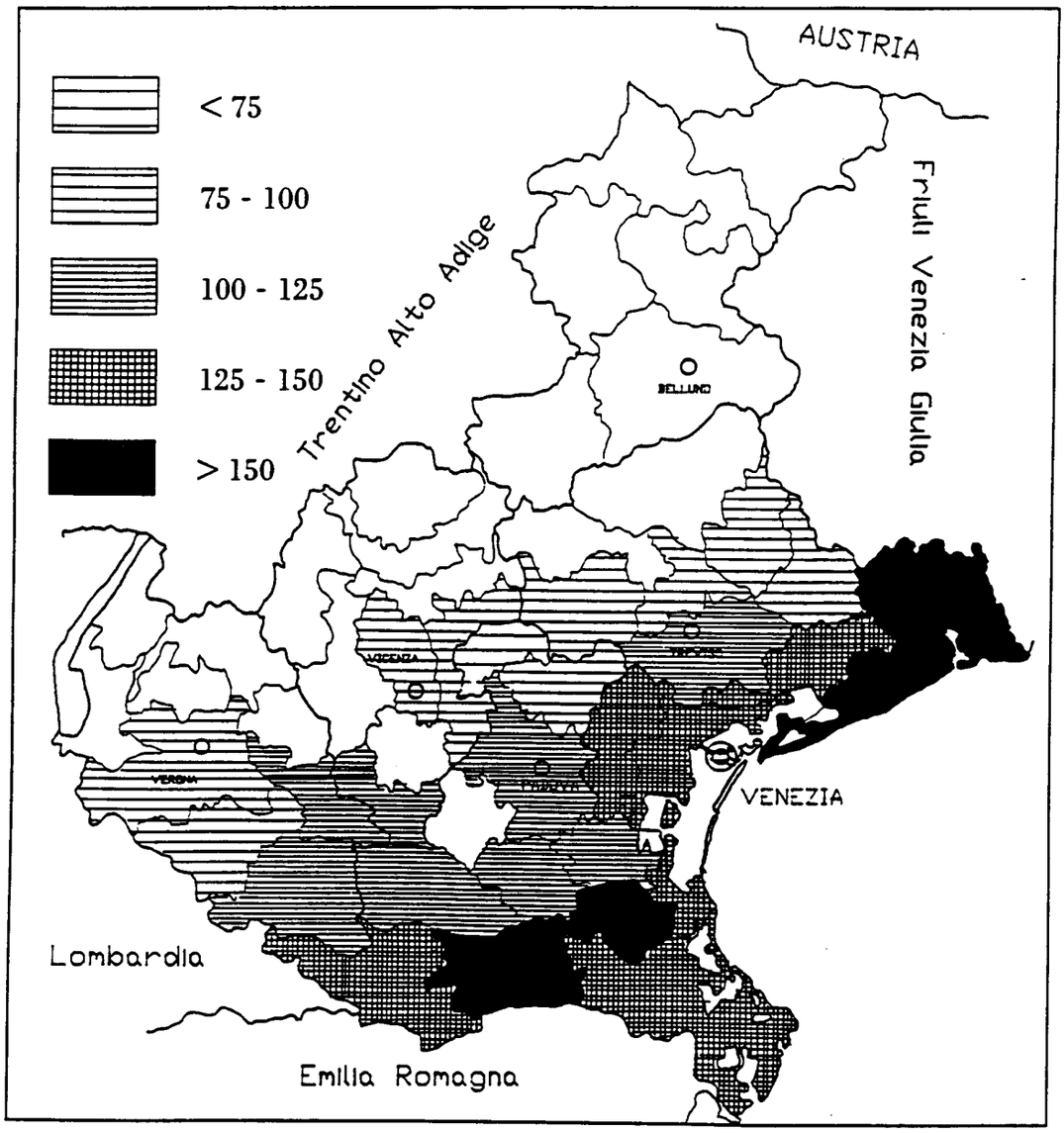
Map 1. Nitrogen Deposited in the Veneto Agricultural Plain (kg/ha).



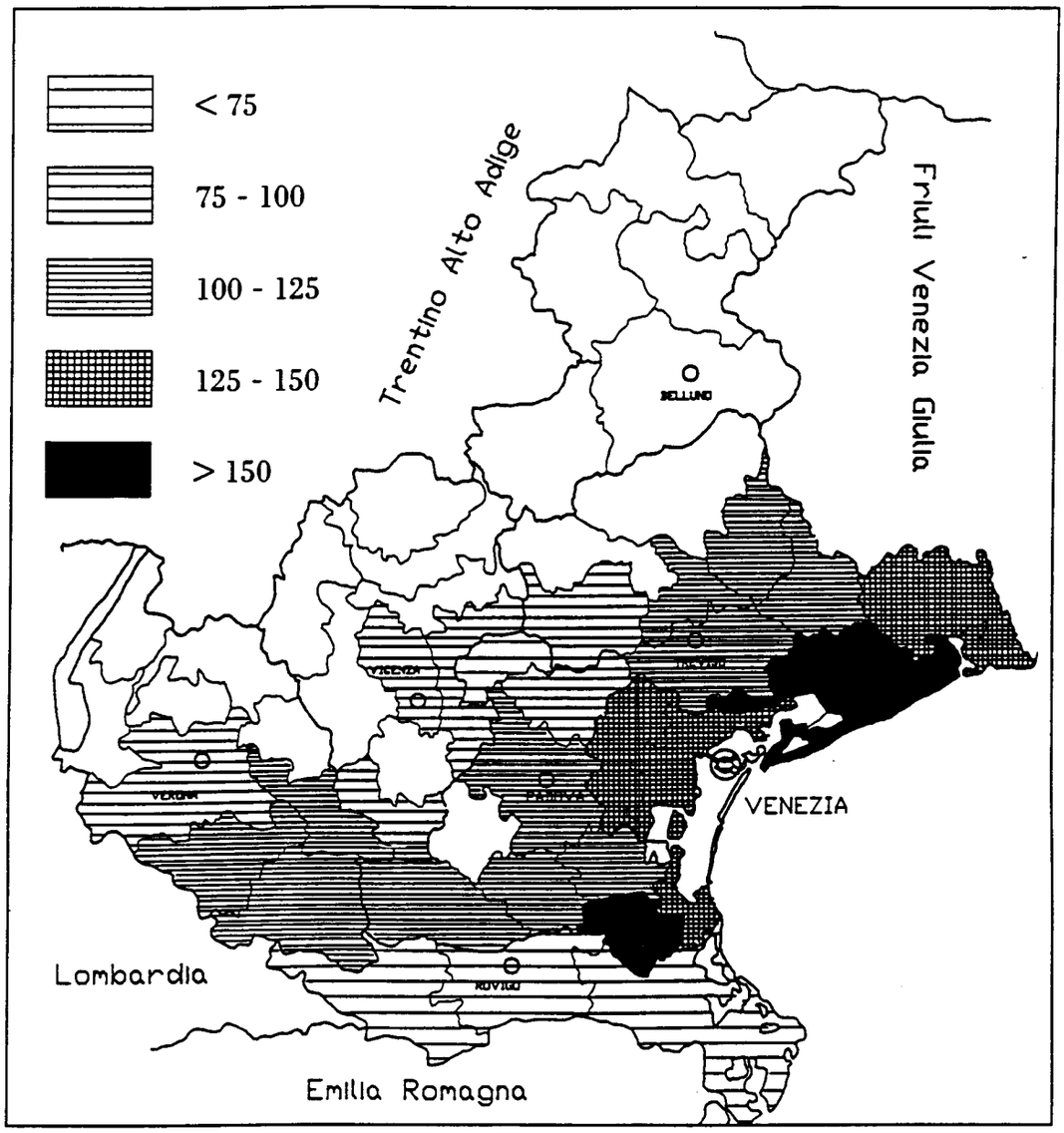
Source: Stellin, et. al. (1990), p. 129.

Map 2. Phosphorus Deposited in the Veneto Agricultural Plain (kg/ha).



Source: Stellin, et. al. (1990), p. 130.

Map 3. Potassium Deposited in the Veneto Agricultural Plain (kg/ha).



Source: Stellin, et. al. (1990), p. 131.

Table 1

CONVENTIONAL AND NATURAL RESOURCE ACCOUNTING

ECONOMIC FRAMEWORKS COMPARED:

NET FARM INCOME[a]

Net Farm Income ($/acre/year)		
	Without Natural Resource Accounting	With Natural Resource Accounting
Gross Operating Margin	45	45
Soil Depreciation	-	-25[b]
Net Farm Operating Income	45	20
Government Subsidy	35	35
Net Farm Income	80	55

[a]Pennsylvania Case Study using conventional corn-soybean rotation under baseline (1985) policies. Net farm income defined as crop sales less variable production costs.

[b]See Faeth, et. al. (1991), Appendix B, p. 62.

Source: See Faeth, et. al. (1991), Table 14, p. 33.

Table 2

CONVENTIONAL AND NATURAL RESOURCE ACCOUNTING
ECONOMIC FRAMEWORKS COMPARED:
NET ECONOMIC VALUE[a]

Net Economic Value ($/acre/year)		
	Without Natural Resource Accounting	With Natural Resource Accounting
Gross Operating Margin	45	45
Soil Depreciation	-	-25[b]
Net Farm Operating Income	45	20
Off-Farm Costs	-	-45[c]
Net Economic Value	-	-27

[a]Pennsylvania Case Study using conventional corn-soybean rotation under baseline (1985) policies.

[b]See Faeth, et. al. (1991), Appendix B, p. 62.

[c]See Faeth, et. al. (1991), Appendix A, p. 61

Source: Faeth, et. al. (1991), Table 14, p. 33.

Table 3

INCREASE IN NET ECONOMIC VALUE POSSIBLE
FROM A MOVE TO MULTILATERAL DECOUPLING[a]
Pennsylvania
Net Economic Value (NEV) and Increase in Net Economic Value

	Conventional Tillage				**Reduced Tillage**			
	CC	CCBCB	ACG	ACGF	CC	CCBCB	ACG	ACGF
				Transition Period ($/acre/5 years)				
Baseline NEV	(575)[C]	(132)	(88)	5	(510)	(112)	(58)	41
MLDC NEV	(307)	19	10	55	233	40	43	92
Increase	(175)	151	142	187	(101)	172	175	224
				Transition Plus Normal Period[b] ($/acre/10 years)				
Baseline NEV	(919)	(61)	208	345	(796)	(23)	264	413
MLDC NEV	(359)	251	438	466	(222)	290	500	536
Increase	(298)	312	499	527	(161)	351	561	597
				Normal Period ($/acre/5 years)				
Baseline NEV	(344)	71	296	340	(286)	89	322	372
MLDC NEV	(52)	232	428	411	11	250	457	444
Increase	(123)	161	357	340	(60)	179	386	373

CC - Conventional continuous corn
CCBCB - Conventional corn-beans
ACG - Alternative Cash Grain--Organic corn-barley/soybean-wheat/clover-corn-soybeans
ACGF - Alternative Cash Grain w/Fodder--Organic corn-beans-wheat/clover-clover-corn silage
MLDC - Multilateral Decoupling

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

$$(\text{MLDC NEV}_{\text{ROTATION}} - \text{Baseline NEV}_{\text{CCBCB}} = \text{Increase}_{\text{ROTATION}})$$

These calculations assume output prices as in Table 4 of Faeth, et. al. (1991) for Multilateral Decoupling.

[b]Normal period values have been discounted.

[c]Figures in parenthesis are negative.

Source: Faeth, et. al. (1991), Table 6, p. 14.

Table 4

INCREASE IN NET ECONOMIC VALUE POSSIBLE

FROM A MOVE TO A MULTILATERAL DECOUPLING[(a)]

Nebraska
Net Economic Value and Change in Net Economic Value
($/acre/4 years)

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

CC - Conventional continuous corn
HFCB - Conventional corn-beans, w/herbicides and fertilizer
FOCB - Corn-beans w/fertilizer but no herbicides
ORGCB - Organic corn-beans
HFROT - Corn-beans-corn-oats/clover w/herbicides and fertilizer
FOROT - Corn-beans-corn-oats/clover w/fertilizer but no herbicides
ORGROT - Organic corn-beans-corn-oats/clover

MLDC - Multilateral Decoupling

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

$$(\text{MLDC NEV}_{\text{ROTATION}} - \text{Baseline NEV}_{\text{FOCB}} = \text{Increase}_{\text{ROTATION}})$$

These calculations assume output prices as in Table 4 of Faeth, et. al. (1991 for Multilateral Decoupling.

[(b)]Figures in parenthesis are negative.

Source: Faeth, et. al. (1991), Table 7, p. 15.

Table 5. Effects on Net Economic Welfare (Conventionally Measured) and on Food Production of Liberalizing World Food Markets, 1990

	Reform in advanced industrial economies only				Reform in industrial and developing economies			
	Change in annual net economic welfare (1985 US$ billion)	Change in production, 1000 tonnes (& %)			Change in annual net economic welfare (1985 US$ billion)	Change in production, 1000 tonnes (& %)		
		grain	beef and sheepmeat	sugar		grain	beef and sheepmeat	sugar
Australasia	3.0	790 (3)	420 (11)	280 (8)	0.5	-2,140 (-9)	50 (1)	-690 (19)
Japan	23.0	-5,190(-45)	-410(-77)	-770(-72)	40.8	-5,650(-49)	-450(-84)	-840(-79)
North America	5.5	10,050 (3)	1,160 (10)	-860(-14)	7.8	-23,410 (-6)	-1,240(-10)	-1,650(-26)
Western Europe	15.1	-32,980(-20)	-5,190(-50)	-5,060(-28)	24.2	-40,330(-25)	-7,880(-76)	-7,810(-44)
TOTAL, Advanced Industrial Economies	46.6	-27,330 (-5)	-4,020(-15)	-6,410(-23)	73.3	-71,530(-12)	-9,520(-36)	-10,990(-40)
Bangladesh, India, Pakistan	1.4	1,710(1)	250(13)	130(1)	1.6	-2,000(-1)	230 (11)	930 (4)
China	2.9	7,950(2)	520(26)	650(8)	12.9	8,100 (2)	1,730(102)	1,230 (15)
Indonesia, Philippines, Thailand	0.9	1,680(3)	300(38)	440(6)	0.6	1,270 (2)	-60 (-7)	-1,632(-21)
South Korea, Taiwan	-1.1	0(0)	10 (6)	40(6)	6.9	-1,710(-18)	-80(-50)	-100(-16)
Other Asia	0.5	90(0)	120(12)	30(2)	1.7	660 (1)	240 (23)	80 (4)
SUB-TOTAL, Developing Asia	4.6	11,430(2)	1,200(21)	1,290(3)	23.7	6,320 (1)	2,060 (36)	510 (1)
Argentina	5.4	4,310(11)	1,420(37)	0 (0)	5.1	4,180 (11)	3,710 (97)	1,500(111)
Brazil	2.9	3,750 (8)	560(19)	2,370(23)	0.8	6,530 (14)	1,260 (43)	3,470 (34)
Mexico	1.2	2,840(12)	130(11)	-220(-5)	0.9	1,530 (6)	540 (45)	2,960 (69)
Other Latin America	3.2	910 (5)	940(31)	710 (4)	0.8	3,310 (18)	1,730 (58)	5,090 (26)
SUB-TOTAL, Latin America	12.7	11,810 (9)	3,050(28)	2,860 (8)	7.6	15,550 (12)	7,240 (66)	13,020(38)
North Africa and Middle East	-2.6	-210(-0)	150 (5)	130(3)	-0.2	-220(-0)	490 (17)	-20(-0)
Sub-Saharan Africa	1.9	880(1)	680(17)	120(2)	2.2	5,900 (9)	1,930 (47)	2,970(42)
SUB-TOTAL, Africa and Middle East	-0.7	670(0)	830(12)	250(2)	2.0	5,680 (4)	2,420 (35)	2,950(26)
TOTAL, Developing Economies	16.6	23,910(3)	5,080(22)	4,400(5)	33.4	27,550(4)	11,720 (50)	16,480(19)
TOTAL, WORLD[a]	62.5	-3.560(-0.2)	1,600(2.6)	-2,000(-1.5)	106.5	-45,950(-2.8)	2,690(4.4)	5,450(4.2)

[a]Includes the (small) effects in Eastern Europe and the USSR.

Source: Printouts from the Tyers model used by Anderson and Tyers (1990), reprinted in Anderson (1991b), p. 26.

Table 6. Agricultural Producer Subsidy Equivalents and Use of Chemical Fertilizer per Hectare, Various Market Economies, 1979 to 1989

	Agricultural producer subsidy equivalent (%), 1979-89	Chemical fertilizer use[b] (kg per ha of arable land and permanent crops), 1985
Argentina[a]	-38	4
Thailand[a]	-4	21
India[a]	-2	50
Australia	11	24
Indonesia[a]	11	94 [c]
New Zealand	20	30
Brazil[a]	22	42
United States	30	94
Canada	35	50
Austria	36	255
European Community-10	39	303
Sweden	46	141
South Korea[a]	61	376
Finland	62	210
Japan	68	427
Switzerland	71	437
Norway	73	277

[a]PSE for 1982-87 only, from Webb, Lopez and Penn (1990). All other PSEs are from OECD (1990b).

[b]Total consumption of nitrogenous, phosphate and potash fertilizers.

[c]The Indonesian government provides nitrogenous fertilizer (produced domestically from local petroleum) at very low cost to farmers.

Sources: OECD (1990b). Webb, Lopez and Penn (1990). Food and Agriculture Organisation, Fertiliser Yearbook 1986, Rome. Reprinted from Anderson (1991b), p. 27.

Table 7. Producer-to-border Price of Rice and Use of Chemical Fertilizer and Pesticides per Hectare, Various Asian Economies, 1970s

	Producer-to-border price of rice, 1976-80	Chemical fertilizer use per ha. of agricultural land, kg per year, 1976-79	Pesticide use per ha. of agricultural land, kg per year, 1970-78
Burma	0.37	9	0.16
Thailand	0.70	11	0.97
Sri Lanka	0.76	65	0.11
India	0.76	32	0.33
Philippines	0.77	29	1.36
Bangladesh	0.93	11	0.02
Indonesia	0.98	57	0.38
Taiwan	1.68	205	3.48[(a)]
West Malaysia	1.73	97	1.92
South Korea	1.87	311	10.70
Japan	3.91	340	14.30

[(a)]Based on cultivated land area only, for 1979-81, from Department of Agriculture and Forestry, Taiwan Agricultural Yearbook, Taipei, 1988.

Source: Barker, Herdt and Rose (1985, pp. 77, 89 and 237). Reprinted from Anderson (1991b), p. 28.