Environmental Impacts of Agricultural Trade Under NAFTA

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Abstract

NAFTA was the first trade liberalization agreement to explicitly include environmental provisions. Both agricultural trade and U.S. FDI in the Mexican food processing and agricultural sectors have increased since NAFTA's implementation. Environmental implications include a greater emphasis on the environment in Mexico as well as positive and negative impacts due to changes in scale, structure and technology in those sectors. Increased use of chemicals due to both increased outputs and a shift to greater horticultural crop production have negative impacts on the Mexican environment but improved technologies in processing produce favorable effects.

Key words: Mexico, environment, NAFTA, trade, foreign direct investment

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U.S. agricultural trade with Mexico and Canada has increased since the implementation of the North American Free Trade Agreement (NAFTA). While NAFTA is primarily concerned with trade, environmental issues became an important factor in gaining support for its approval and, while covered to an extent in the main treaty, a side agreement–the North American Agreement on Environmental Cooperation (NAAEC)–was developed to further address those concerns(CEC 1999b, de Janvry, Sadoulet and Davis; Hufbauer, et al.; Kotvis; USTR 1999). A result of this agreement was the creation of the Commission on Environmental Cooperation (CEC) with membership from Canada, Mexico and the United States. This was the first time that environmental issues became an important component of an international trade liberalization agreement. The CEC (1999a) developed a framework for analyzing the environmental impacts of NAFTA related trade activities, although it is often difficult to separate such effects from the many other forces influencing agriculture, trade and the environment (see, also, Hufbauer et al., pp. 17-39).[1]

Many of the NAFTA related environmental concerns are derived from perceived deficiencies in Mexican environmental laws, regulations and practices vis-à-vis those of the United States and Canada (Anderson; Kolstad; McFadyen). Simon, in summarizing the environmental situation in Mexico, quotes Julia Carabrias, former Head of the Mexican Environmental Protection Ministry (Secretaria de Medio Ambiente y Recursos Naturales y Pescas–SEMARNAP): "In terms of environmental degradation we have reached a critical point. We have extremely high levels of deforestation–the highest in Latin America. Every one of our watersheds is contaminated. All the large cities have air pollution. We are rapidly losing our biodiversity; it is a loss that has not been evaluated... The situation is grave" (p. 238). Simon (pp. 39-55) attributes most of the environmental degradation in the agricultural sector to the economic development and agricultural policies pursued by Mexican governments under the Revolutionary Institutional Party (PRI) during the last fifty years with special emphasis given to those followed in implementation of the green revolution technologies. While recognizing that rapid population growth probably affected the degradation of the environment, Simon concluded that the relationship is "far from exact" (p. 245; see Ness for a discussion of the effects of population on the environment). However, population growth combined with a lack of alternative employment opportunities contributed substantially to the increased

[1]This paper does not address the issue of whether environmental issues should be included in trade agreements. Many economists believe that they generally should be treated in separate agreements/treaties as typical prior to NAFTA (see, for example, Bhagwati or Eglin). Krissof et al. address the relationships of agricultural trade and the environment and conclude that "economic concepts justify the use of trade measures in some cases" (p. iv), but that often global environmental concerns are better addressed separately. Some analysts make strong arguments for including environmental provisions in trade agreements, e.g.: "Analysis yields compelling evidence that international agreement on environmental policy as a part of trade liberalization accords is mutually beneficial" (Gray, Krissoff and Tsigas, p. 175). The environment, thus, now has a more prominent role in trade negotiations.

farming on marginal lands in many areas of Mexico and, thus, was an important factor in land degradation.

There is little doubt that the resource degradation has occurred and that the environment has been severely and adversely affected in recent decades. A question that remains is whether NAFTA is causing additional adverse impacts that offset the gains from trade or, alternatively, if it is producing net positive effects. De Janvry, Sadoulet and Davis in an "early assessment" of the impacts of NAFTA on agriculture indicated that the agreement had produced positive impacts, raising public awareness of environmental issues and laws in Mexico, and through development of a mechanism, the CEC, for addressing trinational environmental issues. They state that bringing pressure on the Mexican government to enforce its environmental laws is "one of the very significant achievements of NAFTA..." (p. 13). However, they also concluded that the environmental side agreement had not achieved its full potential for improving the situation (p. 15). Hufbauer and Orejas and Hufbauer et al., reach similar conclusions, i.e., that the impacts have been positive but that the full potential of the CEC has not been realized. The election of Vincente Fox as Mexico's President and the defeat of the Institutional Revolutionary Party (PRI) may further enhance the role of the environment in that country's policy agenda. President Fox has indicated that improving the environment is an important policy of his administration. For instance, in his first report to the Mexican Congress he said: "... a fundamental decision of my administration is that the protection of the environment is not the function of a single department, it is for all departments, all of the government" (Fox, p. 14, translation by the author).

A purpose of this paper is to examine the environmental impacts of agricultural trade utilizing the CEC's framework and related approaches. It focuses on U.S.-Mexico trade and impacts on the Mexican environment, due to both space limitations and the complications introduced by the earlier implementation of CUSTA with respect to U.S.-Canadian trade. First, the environmental side agreement is briefly discussed, followed by a summary of the CEC's framework and other approaches to determining the environmental impacts, then by sections on the impacts of NAFTA on agricultural trade and foreign direct investment, and, finally, an analysis is made of trade and investment impacts on the environment that result from NAFTA activities. This latter includes agricultural producer and processor efforts to reduce their costs and enhance their competitive position as well as the changing role of Mexican environmental laws, regulations, and their enforcement.[2]

The NAFTA Environmental Agreement

Before the Clinton administration would agree to NAFTA, they insisted on developing side agreements to address labor and environmental problems. These agreements, essentially, created trinational commissions to handle the issues. For environmental issues, the North American Agreement on Environmental Cooperation (NAAEC) was negotiated and signed. It operates through the Commission for Environmental Cooperation which is a three-member commission with "cabinet level or equivalent representatives," a secretariate seated in Montreal, and a channel for NGO input,

[2] See, for example, Colyer (2001), de Janvry, Sadoulet and Davis, or Rossen for additional information on the agricultural impacts of NAFTA.

the Joint Public Advisory Committee (CEC 1999b, de Janvry, Sadoulet and Davis; Hufbauer, et al., pp. 17ff; Kotvis). The NAAEC contains three important principles: 1) the three countries agreed not to induce investment by becoming pollution havens; 2) they established rules about the use of regulations to protect consumer, plant, animal and environmental health; and 3) they gave priority to international treaties. The primary gist of the agreement is that each country should enforce its own environmental laws, although the CEC has some enforcement powers. The CEC has the functions of overseeing the implementation of the agreement, providing a forum for discussing issues, cooperating in solving environmental problems, and adjudicating complaints about the failure of governments to enforce their environmental laws. It operates through both cooperation and contention. Cooperation involves the exchange of information, technical assistance, consultation, and coordination of environmental laws, while contention is based on provisions for observing/monitoring, receiving and evaluating complaints, and enforcement if the complaints are judged valid (de Janvry, Sadoulet and Davis, p. 13: Kotvis). Governments, organizations including NGOs, firms, and individuals can file complaints with the CEC when they believe environmental laws are not being enforced. The complaints are referred to the Evaluation Committee of Experts and then, if judged appropriate, to dispute resolution panels. Trade and/or monetary sanctions may be used to enforce the findings although Canada is excepted since it did not agree to these provisions (Hufbauer et al., p 18).

Environmental Impact Analysis

Krisoff et al. contain excellent theoretical analyses of both the impacts of environmental regulations on trade and of trade on the environment, as well as a discussion of the appropriateness of including environmental issues in trade agreements, but does not provide guidance on appropriate methods for determining the impacts. The CEC developed framework for analyzing such impacts, but it does not propose specific techniques for analyzing the effects of NAFTA on the environment (CEC 1999a). Instead, the framework provides an approach to be used in defining issues and problems in a consistent and effective manner for determining effects of changes induced by NAFTA on the environments of the participating countries. The framework includes environmental, economic, social and geographic contexts; relates connections of these to NAFTA through its rule changes, institutions, resulting trade flows, and transborder investments as well as other conditioning economic factors; identifies their linkages to the environment through production, technology and management, infrastructure, social organization, and government policy; and establishes environmental indicators for air, water, land and biota. It is "designed to identify positive and negative effects in North America that are associated with NAFTA," i.e., to establish and quantify connections between NAFTA and changes in the environment in the three countries (CEC 1999a, p. 8). According to the CEC, NAFTA may affect the environment directly but is more likely to have indirect effects as "its rules and institutions alter trade and transborder investment flows and influence and interact with production, infrastructure, social and government processes" (p. 16). The most important NAFTA rules are those related to the reductions in and eventual elimination of tariffs for all products with interim minimum access guaranteed via tariff rate quotas that increase with time. In addition, there are rules on sanitary/phytosanitary requirements, domestic content, labor, etc. The institutions are the intergovernmental bodies established to carry out the provisions of the agreement; there are 26 of these (CEC 1999, p. 18) although many others have been and will be

established by each of the countries. Three of the more important are the councils on trade flows, the environment, and labor; others include those for handling disputes, and a special group concerned with environmental issues on the U.S.-Mexican border.

The agricultural sector is identified in the framework as a relevant sector to study since it relates directly to important environmental media and natural resources, raises major environmental concerns in all three countries, is subject to important impacts due to NAFTA, has experienced increased post-NAFTA trade, and is receiving increased foreign investment under NAFTA[3]. With respect to environmental media and natural resources, the sector uses arable land, impacts on water use and scarcity, has environmental impacts due to fertilizer and chemical uses, and affects migration and emigration, social issues with potential environmental consequences. Issues of public concern arise from reductions in subsidies and their effects on cultivation of marginal land as well as activities being undertaken to make production more efficient and competitive. Rule changes include tariffication of non-tariff barriers, reductions and eventual elimination of all tariffs, and sanitary/phytosanitary provisions of the agreement. Agricultural trade is important, especially that between the U.S. and Mexico since the U.S. accounts for around 70 percent of Mexico's agricultural exports and 70 percent of its agricultural imports; in addition to the effects related to production there are environmental consequences of the transportation of products, especially since most of this is by truck. U.S. foreign direct investment (FDI) in the Mexican agricultural sector, especially food processing, has increased and has implications for the environment. These may be beneficial as newer investments are expected to utilize more efficient technologies with fewer unfavorable environmental impacts than existing facilities, but increased economic activities can produce negative effects.

Other approaches to address the environmental effects of trade agreements are given by the U.S. government's Quantitative Analysis Working Group (QAWG) in an October 2000 report to the FTAA Interagency Environmental Group. They categorize ways in which trade liberalization might affect the environment (pp. 10-11) and discuss methods for addressing each category. They delineate five types of effects that can impact on the environment: 1) scale effects, those associated with the overall level of economic activity; 2) structural effects, those arising from changes in the patterns of economic activities; 3) technology effects, those related to the way products are made; 4) product effects, those associated with increased trade in particular products; and 5) regulation effects, those related to the legal and policy aspects of the trade agreement on environmental regulations and standards. Each of the types of effects can have positive or negative impacts. Runge outlines a similar set including allocative efficiency, scale of economic activity, sectoral composition of output (including intrasectoral composition), and policy or politics (pp. 6-7). The QAWG sees the use of computable general equilibrium models together with corresponding large scale environmental models as an appropriate methodology for determining the impacts due to scale, structural, and(to an extent) the technological factors, while indicating that partial equilibrium models can be used for analyzing the product effects. They say, however, that the regulation effects "may best be undertaken in the non-quantitative portion of the environmental review" (p. 11). Krisoff et al. delineate three effects: scale, composition (structure), and technique (technology) while Vasavada

[3] Two agricultural issues on the environment are outlined in the framework as examples: 1) maize (corn) production in Mexico and (2) beef production in concentrated feedlots.

and Nimon add a transportation effect. Other approaches to evaluating environmental effects have included simulation (Anderson and McKibbin; Lindsey and Bohman; Williams and Shumway), game theory (Hauer and Runge), welfare analysis (Helm), and econometric models (Barrett and Graddy; López; Williams and Shumway). Harwell et al. use a qualitative ranking of environmental risks to evaluate the impacts of free trade on the environment of Venezuela. Huang and Labys review the techniques used as well as the results of trade-environment studies.

Agricultural Trade under NAFTA

Results of the analyses of trade data indicate clearly that agricultural trade between the U.S. and Mexico has increased significantly since NAFTA was implemented. Total annual U.S. agricultural exports to Mexico averaged $5.2 billion in 1994-99compared to $3.4 billion in the five years prior to NAFTA's implementation (1989-93) and Mexico's exports to the U.S. averaged $4.3 billion compared with $2.8 billion (Figure 1). Trade in most major agricultural products also has increased; data on pre- and post-NAFTA total agricultural trade and data for ten of the more important U.S. exports to and imports from Mexico are shown in Table 1. There were declines for a few products, the differences were not statistically significant while most of those with increased levels of trade had statistically significant differences. For more details on trade see, among others, Colyer (2001), de Janvry, Sadoulet and Davis, Link and Zahniser, or Rosson. Carpentier (2001, p. 2) compares pre- and psot NAFTA predictions and comments that "predictions for broad commodity categories were generally in the right direction, though rarely of the right magnitude."

Regression results for total agricultural trade are shown in Table 2 and those for the same twenty commodities listed in Table 1, are given in Table 3. For both total U.S. exports to and imports from Mexico, the coefficients for the trend line, dollar-peso exchange rates, and GDP per capita were statistically significant but those for the NAFTA dummy variable were not. The equations for the individual commodities also included price as an independent variable (except where value was the dependent variable). Except for two of the export and one import equation, the trend variable was significant but the NAFTA dummy was only significant for three of the export and one of the import equations. The exchange rate variable was significant for three of the export and three of the import equations, while the price variable was significant for two commodities in each group–see Colyer (2001) for more detail and an analysis for an expanded list of agricultural commodities traded (models with GDP per capita were also estimated but did not improve the results for the individual products).

In addition, a counterfactual analysis of U.S.-Mexico total agricultural trade was made using the approach of de Janvry, Sadoulet and Davis (see, also, Colyer 2001). Under this approach, regression equations of trade were estimated for a pre-NAFTA period, 1976-93 with the value of trade being a function of per capita GDP (U.S. for imports, Mexican for exports) and the real exchange rate. The expected values for the years 1994-99 were estimated and compared with actual U.S. agricultural exports to and imports from Mexico (Table 4). In every year the actual values traded were higher than those predicted with the pre-NAFTA equations; the differences tended to increase over the six-year period. These results seem to indicate that NAFTA has had a positive impact on U.S. agricultural trade with Mexico.

Foreign Direct Investment

The second major area where NAFTA has had impacts that can affect the environment is through increased foreign direct investment (FDI) by in the food processing industry as well as in agricultural production (Bolling, Elizalde, and Handy; Bolling, Neff and Handy; Federal Reserve Bank of Dallas; Ministry of Finance and Public Credit). Investments in the food processing industry as well as directly in agricultural production produce linkages between investments and the environment (Bolling, Elizalde, and Handy; Bolling, Neff and Handy). While some investment by Mexican firms has occurred in the U.S., most of the flows have been from the U.S. to Mexico, with smaller flows from Canada, Europe, Japan other countries–the U.S. accounted for about 41 percent of the FDI in food processing from 1994 to 1998 (Bolling, Elisalde and Handy). Although NAFTA gave greater emphasis to investment and caused Mexico to further revise its investment procedures, it was a continuation of a liberalization process started in the 1980s (Colyer 1998, Ministry of Finance and Public Credit).

U.S. investment in the food and kindred products industry has increased very substantially since the early 1980s (Figure 2). After rising slightly in the early 1980s, it dropped to a low of $69 million in 1988, but has risen steadily since then and was nearly $5.7 billion in 2000. As reported by Bolling, Elisalde and Handy, U.S. FDI in the Mexican food processing sector includes investments in firms producing snack foods, edible vegetable oils, mayonnaise and salad dressing, meat and poultry, concentrates and flavorings, and pasta. In addition, they reported that there was about $45 million of investments directly in the Mexican farm sector from 1994 to 1997, primarily in fruits, vegetables and flowers.

Previous Studies of Environmental Impacts

Abler and Pick, in a pre-NAFTA analysis of the potential impacts of NAFTA on the environment due to changes in agriculture, thought that a principal impact would be from the potential shift of horticultural production from the U.S. (mainly Florida) to Mexico (mainly Sinaloa), with the result being a small negative impact on the environment in Mexico and a possible improvement in the U.S. environment. The negative impacts could come from increased pesticide residues on fruits and vegetables, pesticide poisoning of Mexican farm workers, water pollution from increased use of chemicals and fertilizers, and water logging and salinization of soils from increased irrigation. Williams and Shumway use an econometric analysis of pre-NAFTA data and simulation to show the potential impacts of NAFTA on increased chemical use (fertilizers and pesticides) and consequent impacts on the U.S. and Mexican environments. They predict considerable increases in the use of chemicals in both countries, although the simulations indicate a decreased use of pesticides in Mexico by 2005, a result that is counter intuitive and that seems to be in disagreement with actual results to date. Anderson reviewed the expected environmental impacts and found "It is unlikely that freer trade will improve or worsen the quality of Mexico's agricultural environment beyond what would be expected without trade reform" (p. 72). This result was expected due to offsetting changes in the anticipated production levels and composition of the agricultural production. Beghin et al. (1997) use what they term a Trade and Environment Equilibrium (TEQUILA) model the Mexican agricultural to test for the anticipated environmental impacts of the free trade regime. They found that agricultural production would decline moderately and be accompanied by pollution abatement, "win-win case for agriculture" (p. 128), but that this "dissimulates a substantial change in commodity composition of agriculture as well as the implied

pollution abatement" (p. 130). Parris (2002) discusses the use of environmental indicators and assesses some environmental impacts of agriculture in NAFTA countries but does not directly tie these to trade except to indicate that the trade affects agricultural production and, therefore also affects environmental quality.

Agriculturally Related Environmental Impacts

Data for the analyses in this paper come from various sources including FAO, OECD (1996, 1995-2000), SEMARNAP, and WRI (1994, 2000), as well as studies cited in the following sections. The approach is to examine the data on changes in the agriculture of the two countries to evaluate the environmental impacts from a non-quantitative standpoint. These data seem to indicate that NAFTA has resulted in changes in all five of the categories where trade can affect the environment, i.e., in scale with increased production and trade, structure with changes in the patterns of production and trade, technology with changes in techniques of production and processing, product due to characteristics of the particular products involved in trade, and regulations due to the requirements of NAFTA and changes in country laws, rules, and policies induced by NAFTA (particularly in Mexico).

Regulatory/Policy Impacts

A major impact of the NAFTA negotiations and the Clinton Administration's insistence on a side agreement to deal with the environment was to raise the level awareness of environmental issues in Mexico and, consequently, to induce new legislation, policies, and appropriations for improving the environment, including establishing a Ministry for administering and enforcing environmental laws and regulations (Clinton; de Janvry, Sadoulet, and Davis; Hufbauer and Orejas; Hufbauer et al.; U.S.-Mexico Chamber of Commerce). Thus, NAFTA helped produce improvements in the regulatory category of effects in Mexico, although it should be noted that the process had been initiated prior to NAFTA; similar changes were not needed in the U.S. and Canada which already had strong programs, although the NAFTA agreement may have resulted in increased activities by environmental groups who feared that the agreement would result in a race to the bottom as firms moved to the country with lower environmental standards.[4] The agreement and the discussions that accompanied it, thus, may have invigorated environmental groups and led to agitation for improvements in U.S. regulatory activities.

Mexico is financially less able to invest in and carry out programs similar to those of the U.S., since its average per capita income is much lower than those of the U.S. and Canada. Despite this, Mexico spends a higher proportion of its GNP on the environment than its two northern neighbors according to Hufbauer et al. (p. 49), who report that in 1999 Mexico spent $9 per capita on the environment compared with $35 for the U.S., but only $13.50 for Canada. The OECD (1995-2000) reported that Mexico was spending 0.8 percent of its GDP on pollution abatement in the late 1990s

[4]Gallager (2000), however, has indicated that inspections of industrial operations, which had increased during the debate on NAFTA, have declined since its implementation although remaining higher than prior to the NAFTA debate.

(no data was given in the 1995 report) and that it had increased its percentage of R&D expenditures from 0.5 percent to 0.7 percent from the mid- to late-1990s. Data from SEMARNAP also indicate that the country has increased the amount land under conservation management in areas at risk of degradation; the managed area increased from 10.7 thousand hectares to 15.2 thousand hectares between 1997 and 1998. While this is small compared to the estimated more than 1.2 million square kilometers of degraded land, it is an indication of increased concern and attention given to environmental effects of agricultural production.

Scale, Structure and Technology Impacts

Impacts of the increases in trade on the environment due to scale, structure and technology effects are less easily determined than the changes in trade because of the relatively short time span since NAFTA's implementation for the impacts to be determined and studied, a lack of both good baseline and current data for some of the relevant measures such as soil degradation and pesticide use, offsetting effects, and the complexity of the issue, as well as the existence of disagreements about appropriate environmental measures, their causes, and consequences. However, much of the recent growth in Mexican agriculture can be attributed to NAFTA, particularly that in fruits and vegetables which have been the main products with increased exports, although increases in population and incomes also contribute to that growth (and account for substantial amounts of the continued Mexican agricultural growth, particularly for staples).

Determining the impacts of NAFTA on the environment is further complicated since both the U.S. and Mexico have implemented important changes in their agricultural policies which also affect the environment and may swamp the trade effects, particularly for the U.S. The United States affected its policy regime significantly with passage of the Federal Agricultural Improvement and Reform Act (FAIR) in 1996 and Mexico did so with its PROCAMPO program and other agricultural policy changes, including amending the constitution (Burfisher, Robinson, and Thierfelder; Davis; Deininger and Bresciani; Diego, Conchiero and Pérez; Harvey). The adoption in the U.S. of the 1996 farm bill, the FAIR Act, probably had more environmental consequences in the U.S. than NAFTA, since it resulted in an expansion of the area being farmed by removal of the set aside requirements for eligibility to receive benefits, i.e., subsidies; although it also contains many provisions for conservation and environmental enhancement (see, for example, Warman). The changes in Mexico reduced and redirected domestic support programs, halted land distributions under its agrarian reform, and altered major provisions of its *ejido* program to allow members of the *ejidos* to obtain titles to land and, consequently, to mortgage and sell their properties.

Basic data on Mexican agriculture indicate that production has increased substantially since the adoption of NAFTA. The index for all agricultural production averaged 99 for 1986-88 and 119 for 1996-98, but index for per capita production was 105 in both time periods since population increased at about the same rate as food production (WRI). During the same period cereals production increased by18 percent and livestock production by 44 percent. Cropland increased from 25.5 to 27.3 million hectares, with all of the net increase coming from forestland, where the area decreased from 57.9 to 55.4 million hectares. Davis surveyed *ejiditarios* to determine changes in agricultural practices following the reforms in Mexico's agricultural policies, although he did not address environmental issues. He found increases in corn and beans, basically subsistence crops, as well as increases in pasture and livestock production. Average farm size also increased and there were

increases in chemical use with most of the increases occurring on the larger farms. Off farm work appeared to be more important on the smaller farms.

Despite the complications in determining impacts on the environment, changes in land and water use, fertilizers, chemicals and pesticides provide a basis for making judgements about the direct environmental impacts; there also are indirect impacts such as those resulting from processing and transporting the export commodities (Sierra Club and Holbrook-White). Although U.S. exports to Mexico have increased, they are still a relatively small proportion of U.S. production and probably have had relatively minor impacts on the environment. However, Mexican exports to the U.S. (as well as its imports from the U.S.) are a more important proportion of its production for many of the commodities traded and changes in their importance can be expected to have significant environmental impacts. The preliminary results, however, give mixed signals. There have been increases in the acreages in vegetables and fruits, in irrigation, and in use of some chemicals and pesticides, although apparently not in fertilizers. Mexican agriculture also was significantly affected by the 1995 economic crisis and changes in agricultural policies as well as by NAFTA, although the effects of the economic crisis were relatively short lived due, at least in part, to financial aid provided by the Clinton administration. Thus, the scale and structural effects of NAFTA on Mexican agriculture are probably negative since there has been growth in the sector as well as significant shifts in production patterns; some positive effects might result from decreased production (or less of an increase)of imported products such as wheat, as well as from utilization of improved technologies, especially in food processing.

Mexican agriculture, according to FAO data, has grown since the adoption of NAFTA, the acreage of land in farms has increased from an average of 103.6 million hectares in the seven years prior to NAFTA to an average of over 107 million hectares in the seven subsequent years; the average irrigated acres increased from 5.6 million hectares to 6.5 million hectares. The environmental consequences of this growth, probably a result of both population growth and increased trade, depend on a number of factors including the quality of the land, the farming practices used, and the quantities and type of inputs used. Fertilizers and chemical inputs, such as pesticides and herbicides, can have unfavorable environmental consequences due water pollution, food contamination, farm worker exposure to chemicals, etc. Thus, data on their use is an indicator of environmental effects.

Fertilizer use in Mexico has changed little since the implementation of NAFTA despite the increases in agricultural production and trade. FAO data indicate that fertilizer use declined slightly during the first six years after NAFTA was implemented–it averaged 1,777.7 thousand metric tons per year in 1988-93 and only 1,637.6 in 1994-99. However, there probably were shifts in the crops on which it was being used with less on the staple crops and more on vegetables and fruits, including the major crops with increased export levels. Reductions and shifts in subsidies for the staples tended to make them less profitable while the production and yields of many fruits and vegetables increased substantially. Data on area, yields and production for selected fruits, vegetables, and grains are given in Table 5. Increased use of fertilizers can be inferred from the substantial increases in the yields of most of vegetables, whereas similar increases did not occur for some grains, especially wheat. For most of the staples, there were either decreases in area and production or yields were relatively constant. Corn, one of the more important staple crops in Mexico where it is grown primarily for food, has had increases in both area and production. However, average yields are relatively low, only around two metric tons per hectare, indicating a relatively low level of

technology. Under the revised agricultural program in Mexico, price subsidies have been eliminated with income support being substituted. While the area planted to corn and corn production have increased, yields have changed very little. Further, Mexico is now importing corn from the U.S. with tariff rate quotas being used until trade becomes completely free under NAFTA at the end of a 15-year period.

Information on use of other agricultural chemicals is not complete, but SEMARNAP data indicate that use of insecticides has increased during the post-NAFTA era. Similarly, FAO data on imports of chemicals by Mexico indicate that they have increased since the implementation of NAFTA (Table 6). The use of these in agricultural production presents a *prima facie* case for negative effects on the environment, primarily through water pollution and probably also means that the health of farm workers could be affected, if these are inappropriately applied by inadequately trained personnel (Krisoff et al., p. 17, table 3). It could also result in residues on products that people and/or animals consume; the latter could contribute to species extinction and the loss of biodiversity.

Transportation Effects

Transportation may be considered a separate effect although it is largely a consequence of increased scale, and it is possible that increased trade and transportation could occur without increased total production. The increased levels of trade require the transportation of agricultural products from Mexico to the United States and *vice versa*. A very large share of this is accomplished by trucks which contribute substantially to air pollution and add to the greenhouse gases that are producing global warming; Coyle documents the increase in truck traffic that has resulted from NAFTA, as well as the congestion it has created at border crossings. The Sierra Club and Holbrook-White, in a paper presented at the CEC Conference, examined the effects of increased transportation due to NAFTA on the environment, although they did not separate out the agricultural effects. The negative impacts included air pollution, water pollution, increased noise, reduced biodiversity, and, potentially, effects of hazardous material from spills. Agricultural trade contributes to these effects since a large share of the agricultural trade moves by truck transportation. Some agricultural products move by rail and ocean transport, including a growing share for grain, but some 60-80 percent is transported by trucks (Coyle).

Conclusions

This paper examines the impacts of increased U.S.-Mexico agricultural trade and investment under NAFTA on the environment with emphasis on Mexican environmental conditions. Agricultural trade and investment in the agricultural and food sectors have increased very substantially since NAFTA was implemented in 1994, although they had been increasing rapidly for several years prior to that date. A major conclusion is that the impacts are on the environment are mixed; comparative advantage is promoting economic efficiency but changes in land and water use, chemicals, fertilizers and pesticides are having some adverse impacts in Mexico, with, perhaps some offsetting favorable impacts in the U.S. However, improved technology from the increased investment, especially in food processing, probably has produced some positive environmental impacts, while the greater attention to environmental issue that resulted from the inclusion of

environmental issues in the NAFTA agreements has been positive. Mexico has become more aware of environmental issues and problems and has improved its legal and regulatory mechanisms for handling environmental problems and expenditures for pollution abatement have increased. It also appears to have increased enforcement procedures to make its existing regulatory framework more effective. Thus, inclusion of environmental provisions in the NAFTA agreements, or at least the discussions surrounding and influencing their inclusion, and the subsequent actions seem to have had positive effects in reducing and/or mitigating the negative environmental impacts from increased production and processing of agricultural products from increased production and marketing of agricultural products for international trade, although they were not eliminated. There also is a relatively common view that the CEC and NAFTA have missed an opportunity to adequately integrate trade and environmental concerns (see, for example, Sonnenfeld and Mol 2002). These results do not necessarily justify the inclusion of environmental provisions in trade liberalization agreements, but they do lend support to the arguments of those who favor this approach in relation to those who advocate separate agreements for trade and environmental issues.

The environment also became a major issue in the Uruguay round of the General Agreement on Trade and Tariffs (GATT) negotiations and, while not integrated to the same degree as in NAFTA, they are a factor in the World Trade Organization that was created from those negotiations (Eglin). Environmental concerns also are affecting negotiations for the new round as well as those for the Free Trade Area of the Americas (FTAA) with U.S. policy being to include them in sections dealing with investment, agriculture, etc., rather than as a separate part of the agreement (USTR 2001). Trade is also a factor in negotiations for international environmental agreements; trade sanctions may, for example, be used as an enforcement mechanism as part of an international environmental agreement, although such an approach might violate WTO principles. While not responsible for these trade/environmental activities, one effect of the NAFTA Environmental Side Agreement has been to enhance the role of environmentalists and others with concerns about perceived negative effects on the environment by trade liberalization and other aspects of globalization. Eglin (p. 262) states "Environmental and sustainable development issues have now been brought into the mainstream of WTO work, and WTO's handling of its trade and environment work programme will be viewed critically from many points of view as a gauge of its success." Thus the NAFTA approach to the environment has helped assure that environmental issues will receive greater emphasis than would have occurred without the NAFTA side agreement.

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Table 1. Pre- and Post-NAFTA Trade in Selected Agricultural Products

Variable	1989-93	1994-99	Difference	t	Prob.
Total US Exports--$M	3,144.6	5,093.7	1,949.1	4.352	0.001
Beef & Veal--mt	45,477.6	93,492.2	48,014.6	2.181	0.033
Chicken–mt	61,006.6	112,760.8	51,754.2	4.489	0.001
Corn–mt	2,014.2	4,181.8	2,167.6	2.297	0.023
Cotton–mt	61,406.2	200,602.0	139,195.8	2.773	0.012
Fruit, Fresh–mt	99,282.4	198,035.0	98,752.6	2.86	0.009
Nuts & preparations–mt	1,556.8	2,832.2	1,275.4	3.989	0.001
Vegetables., Fresh-mt	62,845.6	79,887.8	17,042.2	1.052	0.161
Soybean Meal–mt	286,137.6	257,319.7	(28,817.9)	0.464	0.327
Soybeans–mt	1,391.4	2,550.2	1,158.8	3.801	0.003
Wheat–mt	492,263.0	1,241,828.7	749,565.7	3.242	0.006
Total US Imports–$M	2,506.0	4,030.3	1,524.3	5.032	0.001
Bananas & Plantains–mt	234,822.2	176,357.2	(58,465.0)	1.047	0.171
Beef & Veal–mt	636.0	3,446.5	2,810.5	4.517	0.002
Cauliflower & Broccoli–mt	158,416.2	192,698.5	34,282.3	3.114	0.007
Coffee-mt	196,931.2	182,106.2	(14,825.0)	0.919	0.191
Flowers, cut–$1000	12,926.4	22,352.2	9,425.8	4.786	0.002
Fruit, Fresh & Frozen–mt	537,877.8	903,579.0	365,701.2	4.052	0.003
Malt Beverages-hl	1,843.8	4,762.3	2,918.5	3.26	0.011
Melons–mt	286,566.8	383,344.2	96,777.4	1.779	0.055
Peppers & Pimentos–mt	2,951.4	3,719.2	767.8	1.782	0.063
Sugar & Related–$1000	37,300.0	124,175.5	86,875.5	5.023	0.001

Table 2. Regression Results for Total U.S. Agricultural Trade with Mexico, 1989-99

	Constant	Trend	Dummy	X Rate	GDP/Cap.[a]	R^2
U.S. Imports	-6249.02	154.850**	-291.478	325.983*	0.248*	0.99
t-values		(2.551)	(-1.382)	(3.704)	(3.247)	
U.S. Exports	8820.238	300.372*	1109.692	-774.752**	-1.022***	0.92
t-values		(3.1586)	(1.5596)	(-2.245)	(-1.710)	

* = significant at 1% level; ** = significant at 5% level; *** = significant at 10% level

[a] Mexican GDP per capita for exports, U.S. GDP per capita for imports (real)

Table 3. U.S. Mexico Agricultural Trade Regressions for Selected Products

U.S. Exports	Trend	NAFTA Dummy	X Rate	Price	R^2
Beef & Veal--mt	11953.1***	-1316	-28857.9	-75	0.77
Chicken–mt	7102.2*	11683.9***	-9362.6*	-31.1	0.99
Corn–mt	107.7	955.2	1207.6	9.1	0.52
Cotton–mt	33406.1**	-20697.3	-23686.4	-3104	0.74
Fruit, Fresh–mt	-1264.5	124959.9**	-76071.0*	251.4	0.87
Nuts–mt	188.5*	531.3	-74.5	2.2***	0.97
Vegs., Fresh-mt	3196.4***	32691.5*	-38445.4*	-207.1**	0.95
Soybean Meal–mt	-35663.6	165143.5	-14444.8	-2532.6	0.33
Soybeans–mt	276.9*	-218.6	-111	2.9	0.97
Wheat–mt	219470.9*	-544313	119499.4	2012.8	0.86
U.S. Imports					
Bananas & Plantains–mt	9858.3	-132500	-52445.3	813.5	0.66
Beef & Veal–mt	604.5*	-829.7	609.1	-0.5	0.91
Cauliflower & Broc.-mt	9200.8*	-24791.2	-4117.2	-231.7	0.83
Coffee-mt	1827.9	-19182.9	34071.6**	-17.8	0.5
Flowers, cut–$1000	1938.2*	-2496.7	2766.7**	N.A.	0.93
Fruit, Fresh & Frozen–mt	108409.7*	-213126	98908.8***	-837.3	0.92
Malt Beverages-hl	992.3*	-2187.4***	314.9	-247.7***	0.89
Melons–mt	34281.8***	-127024	81154.7	-60.1	0.55
Peppers & Pimentos–mt	383.4**	-663.2	-288.6	-4.9**	0.72
Sugar & Related–$1000	15697.2*	-8452.3	19707.9	N.A.	0.89

* Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level

Table 4. Results of the Counterfactual Analysis ($ Million)

Exports	Estimate	Actual	Difference
1994	4058	4593	535
1995	2698	3539	841
1996	3089	5447	2358
1997	3796	5183	1387
1998	3742	6163	2421
1999	4403	5637	1234
Imports			
1994	2729	2895	166
1995	2822	3836	1014
1996	2937	3765	828
1997	3131	4112	981
1998	3272	4691	1419
1999	3434	4883	1449

Exports: -1953.806 + 1.1058396GDP + 183.26179RER, R^2=.87

(0.1176386) (96.154299)

Imports: -213.2370 + 0.1162707GDP - 8.56533RER, R^2=.90

(0.0099923) (46.612787)

Table 5. Mexican Production of Selected Agricultural Products for Pre- and Post-NAFTA Periods

	Pre-NAFTA Average (1987-93)			Post-NAFTA Average (1994-2000)		
Crop	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)
Asparagus	8095.9	34695.3	4.28	12000	43026.9	3.59
Carrots	8305.9	205297.1	24.72	11784	278926	23.67
Chiles and Peppers	78679.7	721297.6	9.17	115127	1369402.7	11.89
Cucumbers and Gherkins	15186.9	267684.7	17.63	15956.1	369926.7	23.18
Lettuce	7031.6	140026	19.91	8080.3	160073.1	19.81
Tomatoes	101121.6	2026444	20.26	93499.9	2259832.1	24.17
Other Fresh Vegetables	20808.6	140982.4	6.78	23527.3	180382.9	7.67
Avocados	75245.3	653920.6	8.69	87969.6	830438.7	9.44
Citrus Fruits	286429	3371386.4	11.77	430479.4	5045892.6	11.72
Mangoes	110479.9	1098425.7	9.94	144993.4	1371687.3	9.46
Pineapples	7784.6	345298.7	44.29	9253.4	381554	41.23
Strawberries	5616	87611.7	15.6	6560.3	124441.4	18.97
Corn	7975000	15985000	2.21	7908911	18256924	2.3
Wheat	955000	8799000	4.09	894000	3577000	4.23
Barley	289000	541000	2.03	261000	452000	2.03

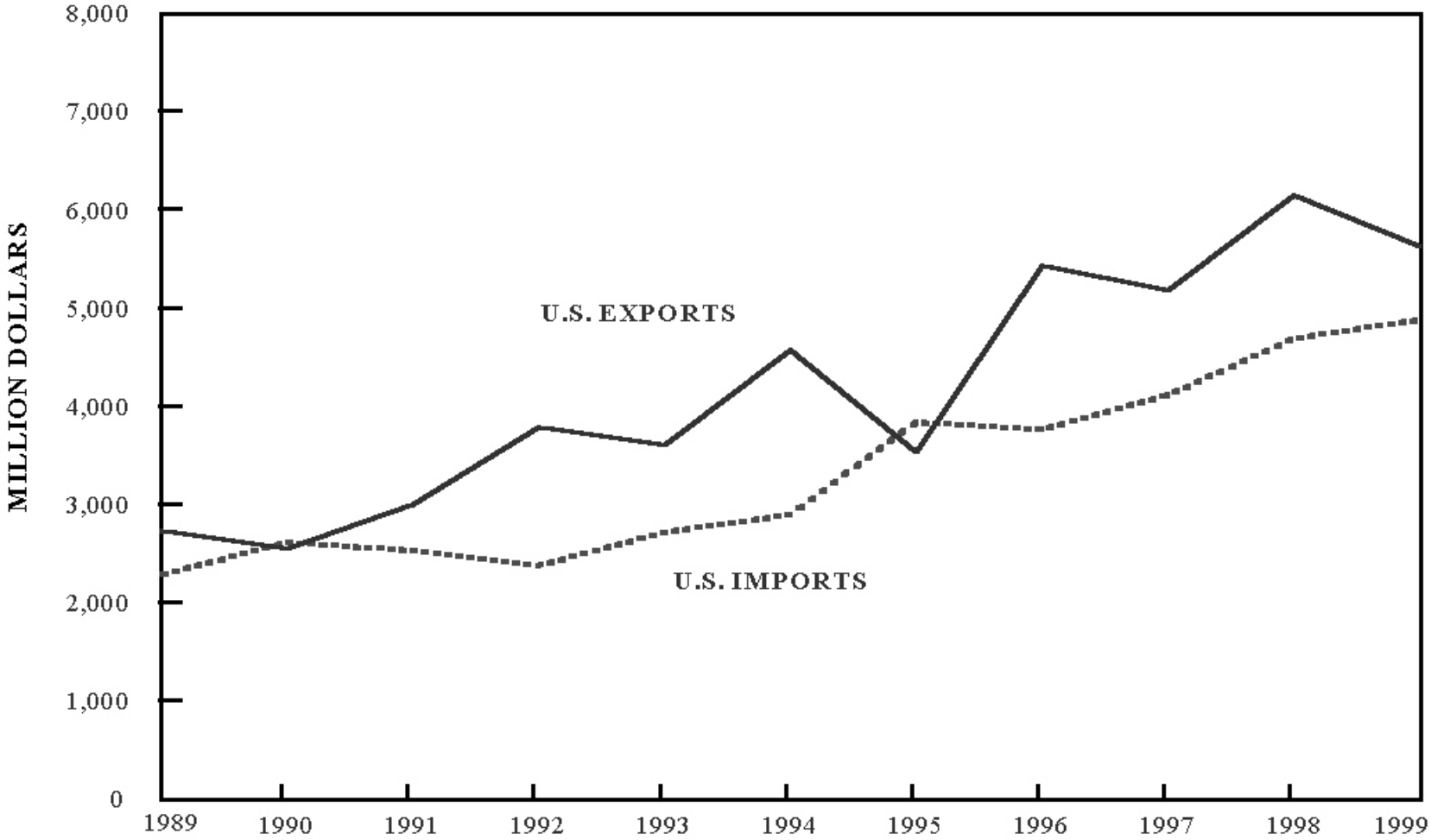
Source: FAOStat Database

Table 6. Average Annual Use or Imports of Fertilizers and Chemicals

Input	Pre-NAFTA (1988-93)	Post-Nafta (1994-99)
Fertilizers Use (1,000 metric tons)	1777.7	1637.6
Pesticide Imports (million dollars)	56.9	206
Insecticide Imports (million dollars)	14.5	55.2
Fungicide Imports (million dollars)	23.4	50.4
Herbicide Imports (million dollars)	21.0	86.4

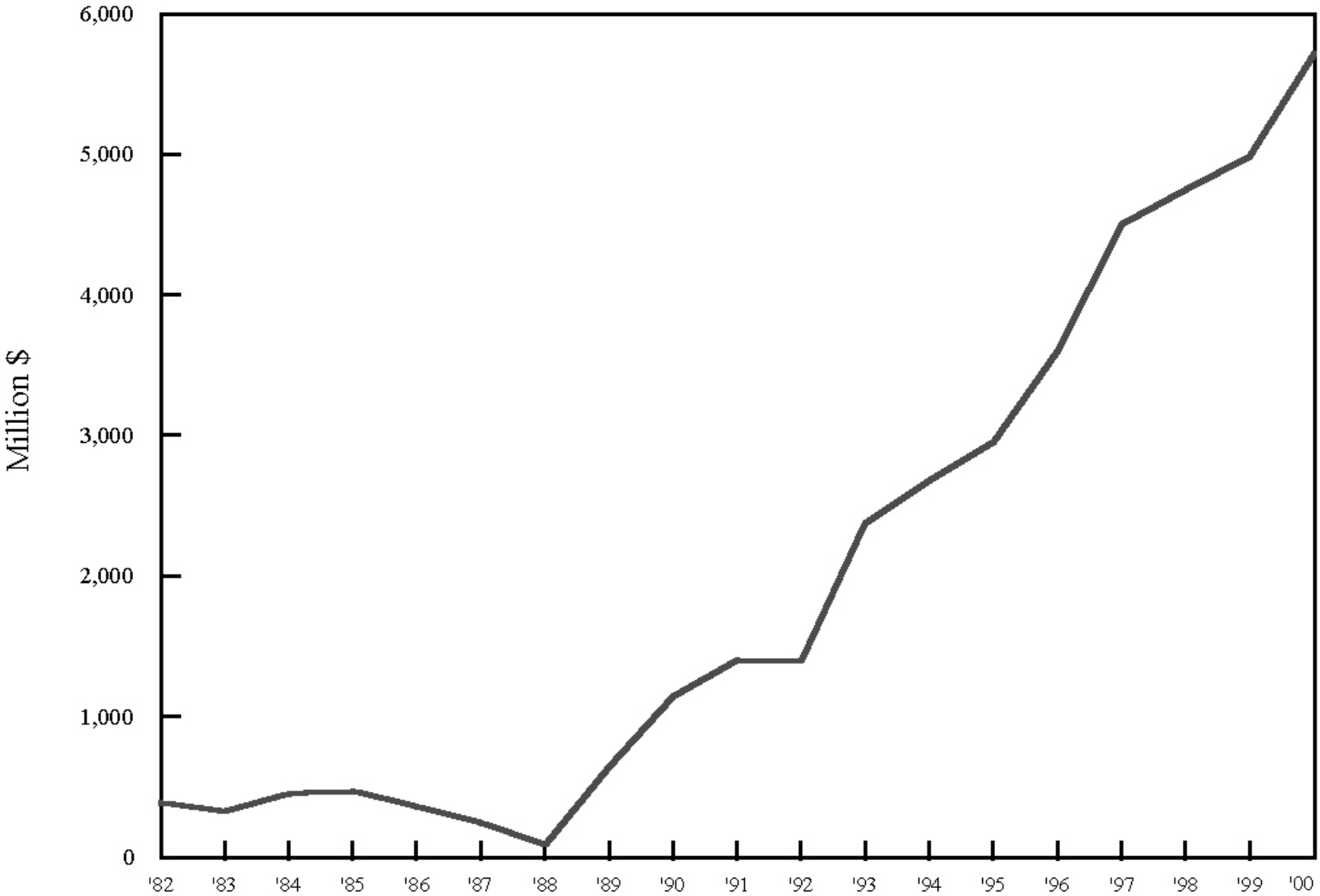
Source: FAOStat Database

Figure 1. U.S. AGRICULTURAL TRADE WITH MEXICO



Source: Economic Research Service, USDA

Figure 2. U.S. FDI in Mexico in Food and Kindred Products



Source: Bureau of Economic Analysis, USDC