Agricultural Trade Liberalization and The Environment in North America: Analyzing the "Production Effect"

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I. Analyzing the Environmental Impacts of Agricultural Trade Liberalization

The two most important regional or multilateral trade liberalization agreements in agriculture thus far, the Uruguay Round Agreement and the North American Free Trade Agreement have now been implemented for eight and nine years, respectively. The availability of trade and production time series data up to 2000 now makes it possible to analyze the environmental implications of both those agreements for different economic sectors, by focusing on specific sub-sectors in the detail necessary to trace the linkages between trade shifts and environmental issues. The objective of this paper is to estimate the impacts of the NAFTA and the Uruguay Round Agricultural Agreement (URAA) on environment stresses in three key North American agricultural sub-sectors: beef, corn and vegetables.

Much of the literature on the analysis of environmental impacts of trade liberalization agreements (e.g., OECD, 1994; Commission on Environmental Cooperation, 1996; Runge et al, 1997; Cole *et al*, 1998; Ervin, 2000; CEC Secretariat, 2000; Abler and Shortle, 2001) emphasizes the indirect and longer-terms effects of trade on the environment. The "scale effect" has been conceived in terms of the broader process of economic growth, which is associated statistically with greater trade at the national level, not with the immediate relationship between trade liberalization and increased production. The " composition effect" has been defined as the effect of economic growth in shifting either to or from sectors with higher levels of pollution. The "technology" or "product effect" relates to the allocation of production in countries where technology is more advanced and perhaps cleaner, and to the increased dissemination of clean technologies.

These familiar analytical concepts do not help understand the way in which trade liberalization affects environmental change in agriculture. Economic theory, however, suggests that trade liberalization should alter levels of production of a given agricultural product through the price mechanism. As one recent study (OECD Directorate for Food, Agriculture and Fisheries and the Environment Directorate, 2000), argues, an agricultural sector in which producer prices increase relative to production inputs as a result of trade liberalization will experience "intensified and expanded" production, with greater amounts of agrochemicals, whereas those sectors within countries where producer prices fall relative to the prices of inputs will use less fertilizer, pesticides and irrigation water. The OECD study calls the effect of trade liberalization in providing economic incentives to expand or contract production of a particular product the "production effect."

This paper focuses on the how the production effect has operated in the cattle, corn and vegetable sub-sectors. Each of these is not only important to one or more of the economies in North America, but experienced sharp increases in North American trade following the NAFTA. Furthermore all of these sectors are well-known to have their serous impacts on the environment. The cattle and beef sector not only presents problems of nutrient runoff from manure, but also consumes large amounts of grain for feed, with the chemical inputs and water use that go with it (Runge and Fox, 1999). The corn sector, accounting for 23 percent of pescticide use in crop production (Gianessi and Marcellli, 1997), is the most intensively user of pesticides among major U.S. agricultural crops, with 8.3 lbs of active ingredients per hectare, compared with only 3.6 pounds per hectare for sorghum and .6 pounds per hectare for wheat (Runge and Fox, 1999; FAPRI, 2002). It is also very dependent on nitrogen fertilizer, which accounts for up to 50 percent of total crop yield. Indeed, because continuous corn cultivation depletes he soil of its nutrients, its dependence on nitrogen fertilizer has been growing, as the ratio of fertilizer to yield in the U.S. corn crop has increased by more than 20 percent since 1985 (Stewart and Roberts, 2002).

Mexican maize production has been marked by the extreme overuse of pesticides and lack of safety precautions for pesticide use in the absence of adequate regulation. Although no quantitative data is available on pesticide use in the sector, maize-growing areas of Guerrero and Jalisco have shown evidence of soil degradation from pesticide residues, and Guerrero has suffered pesticide pollution of underground aquifers (Nadal 2000b). On average, more than 3,000 cases of intoxication of Mexican farm workers from exposure to pesticides occurred in the 1995-1997 period (Nadal, 1999).

Growing tomatoes consumes more water per acre than any other crop in the United States – nearly 3 acre feet per acre, which is nearly three times more than grain corn, and roughly twice as much as wheat and barley (Runge and Fox, 1999). Pesticide use in Mexico’s tomato industry has gone unregulated and has been responsible for thousands of serious illnesses of farmworkers (Schrader 1995). Overuse of nitrogen fertilizer has polluted the soil and underground water in one Mexico’s leading tomato growing areas (Romero *et al*, 2002).

The first challenge in analyzing the production effects of trade liberalization on these three sectors is to distinguish the impact of the trade liberalization agreement from those of exogenous variables. Weather conditions, exchange-rate movements, macroeconomic performance, changes in consumer preferences, differences in the growth of real incomes or wage rates, as well as population growth all play important roles in determining the rates at which exports in an agricultural product grow or contract.   Analyzing this problem may be relatively simple if trade liberalization removes a quantitative restriction on trade, because imports above the level set by the quantitative restriction can be considered to be result of the liberalization of trade. If the issue is one of tariff reductions, however, partial equilibrium or general equilibrium models are used to make a quantitative estimation of the influence of other economic factors by simulating a counter-factual "without liberalization" scenario (Gallagher et al, 2002).

Such estimates always represent a degree of uncertainty. For those cases where tariff reductions are the issue, this analysis relies on estimates published by the Economic Research Service (ERS) of the U.S. Department of Agriculture. These estimates represent a combination of partial equilibrium modeling or computable general equilibrium modeling and informed judgments by those familiar with the modeling (Zahniser, pers. Com.) With regard to the removal of quantitative restrictions on beef and corn by the NAFTA, however, I have based my own analytical judgment on the total historical record of trade policies rather than on a comparison of the simple projection of the continued quantitative restriction against the actual NAFTA trend line. That is because some quantitative restrictions are not actually applied, as was the case in both Canadian and U.S. beef import laws.

Analyzing the production effect – the causal relationship between changes in trade and production levels -- presents a different analytical challenge. Contrary to economic theory, in some agricultural sub-sectors, producers do not respond to price signals by reducing or increasing production in the same way that manufacturers do. The marked price inelasticity of supply in agriculture is related to three characteristics of agricultural production: (1) land, labor and other capital inputs are employed fully; (2) factors of production are not mobile, and (3) farmers are disinclined to switch to non-agricultural production sectors (Gabre-Madhin *et al,* 2002).

The problem of price inelasticity in cattle-raising is somewhat different. The relatively long lag time between production decisions and bringing cattle to market means that cattle-raising is subject to cycles of expansion and contraction which over-ride trade-related price signals. This biological time-lag creates the phenomenon of "cattle cycles" – recurring phases of expansion, consolidation and contraction of cattle herds, which occur regardless of price trends (Trapp, 1986; Rosen *et al*, 1994; Matthews *et al*, 1999). One of the characteristics of the cattle industry is that owners are not capable of responding to price signals by adjusting cattle supply except over several years (Van Eenoo *et al*, 2000). Cattle cycles are an extreme example of price inelasticity in which the data suggests that supply actually changes in the opposite direction from prices under circumstances that have occurred in the recent past (Prevatt and VanSickle, 2000). This bio-economic pattern in cattle-raising makes that sector particularly insensitive to the effects of trade liberalization, as will be documented in this study.

The more the sector is geared to the export market or is affected by imports from competitive foreign producers, of course, the more sensitive it will be to the price signals associated with trade liberalization. The production decisions of both Mexican and U.S. tomato producers, for example, were quite responsive to the price changes created by NAFTA's liberalization. Even if there is a relatively direct correlation between increased exports and increased production, however, the environmental impact of the production effect may be dampened or even eliminated by a second factor: technological changes affecting the yield per unit of land in cultivation. Improved technologies that bring about increased yield may accommodate even significant increases in production in response to new trade opportunities without increased use of chemical inputs or water. This "technological change effect" on production of a specific crop can make the difference between increased chemical input and water use and no increase or even a decrease in input use. Historical data on crop area planted or harvested, its yield per hectare and total production shows whether the technology change effect has played a role in reducing or eliminating the production effect of trade liberalization on a crop sub-sector. The implications of the technology change for the intensity of input use are equally important, however, in calculating the environmental impact of that factor.

Price inelasticity and exogenous technological change are significant factors in determining how trade liberalization has changed production patterns and/or the incidence of environmental stresses in the three North American agricultural sub-sectors that are the subject of this study. The influence of these two factors will not be relevant to all agricultural sub-sectors in all countries. Nevertheless, focusing on the role of these two effects in mediating the effects of trade liberalization on three important agricultural sub-sectors in North America may help to clarify at least some key features of the problem of analyzing the impact of trade liberalization on agriculture.

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II. NAFTA, Agriculture and the Environment

1. NAFTA's Agricultural Trade Liberalization Commitments

Five years before the NAFTA, the United States and Canada reached the Canada-US Free Trade Agreement (CUSTA), which contained provisions for liberalizing agricultural trade that became the basis for some of NAFTA's provisions. The CUSTA provided for mutual exemption from quantitative restrictions on beef imports that had been imposed at times in the past by both countries and for the reciprocal ten-year phase-out of tariffs on imports of live cattle as well as fresh, chilled and frozen beef and veal. Under the NAFTA, the exemption from quantitative restrictions on beef was extended to Mexico, and the schedule for the tariff phase-out was then accelerated, so that tariffs were eliminated when the agreement went into effect January 1, 1994.

More generally, the CUSTA eliminated all agricultural tariffs between the United States and Canada over a period of ten years, although Canada was allowed to restore tariffs on fresh fruits and vegetables on a temporary basis for 20 years if prices remained depressed and average acreage remained constant or declined. Canada agreed to eliminate import licenses for wheat, barley and oats when U.S. grain support levels became equal to those of Canada. But both countries retained the right to re-impose restrictions on imports if changes in grain support programs resulted in significant increases in imports. Canada and the United States agreed to harmonize their technical regulations on such matters of meat inspection to ensure that they would not be barriers to trade. Finally, both countries were already prohibited from using export subsidies in their bilateral trade, a commitment that was then was incorporated into the NAFTA.

Under the NAFTA agreement, without affecting the existing U.S.-Canadian commitments to a ten-year tariff phase-out, the three North American trade partners committed themselves to the ultimate elimination of all tariffs on trade with one another within 15 years, i.e., by the end of 2008. Along with beef cattle and beef, many other agricultural tariffs were eliminated immediately, whereas others were to be phased out over 5, 10 or 15 years. However, Mexico's beef tariffs had already been at zero prior before the imposition of 20 percent and 25 percent tariffs on fresh beef and frozen beef, respectively, during the NAFTA negotiations in late 1992 (Zahniser and Link, 2002). The products selected by the United States for a 15-year phase-out were orange juice, sugar, peanuts, certain fresh vegetables and melons. Mexico chose a 15-year transition for maize, dry beans and powdered milk. Canada chose dairy, poultry, eggs and margarine (FAS, 2000).

Prior to NAFTA roughly 25 percent of US agricultural exports to Mexico by value were subject to restrictive import licensing requirements. Under the agreement, Mexico converted these quantitative restrictions on certain products including tobacco, cheese, evaporated milk, wheat and certain shipments of grapes, to tariffs to be phased out by 2004. The licensing requirements for other products, including corn, dry beans, poultry, malting barley, animal fats, potatoes and eggs, were converted to tariff-rate quotas (TRQs). Under TRQs, a certain quantity of the product can enter duty-free, but anything over that amount was subject to an over-quota tariff. That tariff rate was equivalent to the border protection that had been provided by the previous quantitative restriction. Mexico converted its import licensing regime to TRQs on imports of corn, dry beans, milk powder, poultry, barley/malt, animal fats, potatoes, eggs and some lumber products from the United States. The United States converted import quotas for dairy products, cotton, products containing sugar and peanuts to TRQs

The tariff rates on Mexican products were to be reduced by 24 percent in equal annual installments over the first six years and then by a straight line phased out over four years, except for corn, dry beans and powdered milk, which are on a 15-year phase-out schedule.   The over-quota tariff rate on U.S. corn, based on the "tarrification" of its import licensing regime, was initially equal to $206 per metric ton, or 215 percent of the value, whichever was lower. By 1998, the tariff rate on corn had fallen to $165 per metric ton or 172 percent of the value, whichever was lower. Mexico's initial duty-free quota for corn exports to Mexico was 2.5 million metric tons of corn in 1994. The volume subject to quota limitations was to increase at annual compounded rate of 3 percent, except for a 5 percent annual increase for barley/malt (FAS, 2000).

With regard to domestic support measures, the agreement required no commitments beyond compliance with GATT/WTO obligations (FAS, 2000). Neither the United States nor Mexico may use export subsidies on agricultural export to the other country, without 3-days notice to that country. If any exporting NAFTA country believes another NAFTA country is importing agricultural goods from a non-NAFTA country that benefit from export subsidies it may request consultations with the importing country on measured to taken against such subsidized imports, and if the importing country adopts mutually agreed measures to counter the export subsidies, the exporting country may not introduce export subsidies on agricultural exports to the importing country (FAS, 2000).

NAFTA side agreements also included special provisions for two particularly sensitive U.S. products: sugar and frozen concentrated orange juice. Mexico and the special safeguard provisions provide relief against import surges on those items. For another group of sensitive products, the agreement provided for TRQs on a specified quantity of imports at preferential NAFTA duty rates, with higher tariffs to be automatically triggered when imports exceeded the quota. The United States applied such special safeguard TRQ on imports of onions, tomatoes, eggplants, chili peppers, squash, and watermelons. Mexico applied these TRQs on live swine and most pork products, apples, and potato products.

The NAFTA imposes disciplines on the development, adoption, and enforcement of sanitary and phytosanitary (SPS) measures, which are ostensibly to protect consumers from unsafe products and domestic crops and livestock against introduction of pests or diseases, in order to ensure that they are not used to protect domestic producers. Each country can determine set more stringent standards than prevailing or global standards, as long as they are scientifically based. The NAFTA also permits U.S. state and local governments to adopt more stringent standards than those adopted at the national level, again provided they are scientifically defensible and are administered fairly.

2. NAFTA Implementation

The actual quotas and tariff rates implemented by the United States and Mexico under the NAFTA have departed from the formal agreement in some significant ways. The most important divergence from formal commitments adopted under the agreement has been the Mexican government's allocation of the right to duty-free imports of corn, dry beans and poultry to U.S. exporters. All three items were subject to TRQs under the agreement, with strict limits on the amounts that could imported duty free. From the beginning of the implementation period, however, these quotas were waived by Mexico (USTR, 1997). The original duty-free corn quota for 1996 was 2.65 million tons. However, the official allocation of corn imports for that year was just over 7 million tons (USDA FAS, 1996). The actual corn imports in 1996 (5.9 million metric tons) were 64 percent higher than the tariff-free quota established for 2007 (Nadal, 1999). Starting in June 2001, however, Mexico temporarily imposed minor tariffs on over-quota imports of 1 percent on yellow corn and 3 percent on white corn (Zahniser and Link, 2002). These allocations above scheduled quotas were driven primarily by the desire of the Mexican government to liberalize its agricultural sector in order to provide cheaper food for its urban population and to satisfy the needs of its livestock and starch industries.

Other departures from the formal agreement occurred because of trade disputes generated by producers whose interests were harmed by reduced protectionism. The most heated of these disputes was over the growth in Mexican tomato exports to the United States. Florida tomato growers charged in 1996 that

Mexican exporters were "dumping" tomatoes on the U.S. market at less than the cost of production. As noted above, tomatoes were subject to variable preferential tariffs for a quota of imports, depending on the season, which were to be phased out over 5 or 10 years. But the devaluation of the peso by 40 percent in 1994 further reduced the costs of production for Mexican producers, and along with U.S. consumer preferences for vine-ripened Mexican tomatoes, resulting in a surge of Mexican imports. The charge of dumping was initially rejected by the Clinton administration, but the Commerce Department, under political pressure, eventually threatened Mexico with countervailing duties under U.S. trade law unless it agreed to a price floor for its tomato exports. Mexico agreed to a settlement that imposed a minimum price of $.21 per pound on tomatoes exported to the United States, effectively increasing the U.S. tariff above what had been agreed to in NAFTA (NFAPP, 1996).

Mexican producers initiated a similar anti-dumping petition against U.S. exports of apples in 1997, which resulted in the imposition of a 101 percent duty. That dispute was also settled by the negotiation of a suspension agreement under which American suppliers accepted a minimum import price. In 1999 Mexico imposed anti-dumping duties on all slaughter hogs from the United States, after imports from the United States more than tripled in January 1999 (ERS, 2002).

3. Impacts of NAFTA on Trade, Production and Environmental Stresses

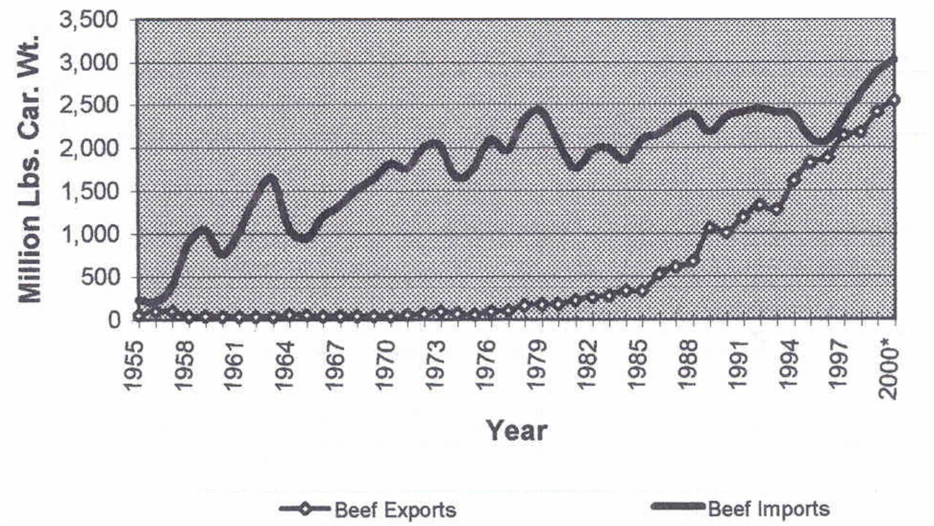
Live Cattle and Beef: Trade, Prices and the Cattle Cycle

Trade in live cattle and beef between Canada and the United States America, and particularly Canadian exports of cattle and beef to the United States, increased considerably after trade the Canada-U.S. Trade Agreement (CUSTA) and even more so after NAFTA. But the relationship between this trade pattern and the trade liberalization agreements requires further analysis. What is clear is that Canadian and U.S. beef sectors were in fact already well advanced toward being integrated into a single market even before the CUSTA in 1989. U.S. tariffs on cattle and beef were already low -- only 1.7 cents/kg on live cattle and 3.9 cents/kg on beef carcasses, which were not considered as a significant barrier to trade (Rude, 2001; Marsh, 1998). From 1984 to 1988, before the CUSTA, Canadian beef exports to the United States had already increased by 57 percent over the average for the previous five-year period, and U.S. beef exports to Canada had tripled from 20 million pounds in 1983 to 74 million pounds (Ontario Cattlemen's Association, 2002).

Whether the U.S. Meat Import Act had been a major factor in U.S.-Canada beef trade is far from clear. The U.S. exemption of Canada and Mexico from the U.S. Meat Import Act imposing import quotas on beef has been cited as the primary reason for increased Canadian been exports to the United States (Zahniser and Link, 2002). The U.S. law required the President to impose import quotas on beef if the Secretary of Agriculture estimated total annual imports would exceed approximately 7 percent of U.S. production (USTR, 1994). Rude (2001) argues, however, that it was seldom applied and represented more of an annoyance than an actual quantitative restriction on Canadian exports.

Historical data on the history of U.S. beef production and trade and of Canadian cattle and beef exports to the United States suggests that Rude's observation is correct. The Meat Import Act ostensibly functioned as a counter-cyclical insurance against beef oversupply in the United States that could drive down U.S. beef prices (USTR, 1994). Thus, the higher U.S. production in relation, the less imports would be allow. It was passed in 1979 – a year when beef imports were at their highest level in history. Figure 1 shows annual U.S. imports and exports of beef from 1955 to 2000. When the Meat Import Act was passed, US beef exports were still negligible, so they could not have been a factor in calculating the threat posed by beef imports. In the 1980s and 1990s, however, the United States became a major beef exporter, and the gap between beef imports and exports rapidly narrowed. A shown in Figure 1, by 1993, the level of net imports – the difference between U.S. beef imports and beef exports – had fallen by 55 percent from its 1979 high. The spectacular rise of U.S. beef exports would explain why the Meat Import Act was not needed to restrict beef imports during the 1880s and early 1990s.

Figure 1: US Beef Imports and Exports: 1955-2000



Source:Lambert, 2002.

In any case, the record of U.S. imports suggests that the Meat Import Act did not actually restrict beef imports in relation to US production at any time from 1985 through 1993. Table 1 shows the beef imports from Australia and Canada, total imports, total beef production and the proportion of imports to production for 1985 through 1999. It shows that total beef imports were allowed to rise to between 9.4 and 10.4 percent of beef production during those years. Even after the Meat Import Law was replaced by a beef TRQ under the URAA in 1995, moreover, total imports continued to go as has high as 10.3 percent percent of domestic production. The reason, of course, was that U.S. beef exports reduced the level of *net* imports to only a fraction of that percentage.

Table 1: U.S. Beef Imports and Beef Production, 1985-1999

Year	Imports from Australia	Imports from Canada	Total U.S. Imports	Total US beef production	imports as % of production
1985	795	240	2,088	23,557	8.9
1986	946	213	2,156	24,213	8.9
1987	997	191	2,294	23,405	9.8
1988	1,081	172	2,406	23,424	10.3
1989	818	239	2,178	22,974	9.5
1990	1,084	222	2,356	22,634	10.4
1991	1,048	223	2,406	22,800	10.5
1992	1,012	331	2,440	22,968	10.6
1993	906	407	2,401	22,942	10.4
1994	876	463	2,371	24,278	9.7
1995	670	446	2,103	25,115	8.3
1996	520	536	2,072	25,419	8.2
1997	485	639	2,344	25,384	9.2
1998	429	594	2,643	25,653	10.3
1999	640	673	2,873	26,386	10.9

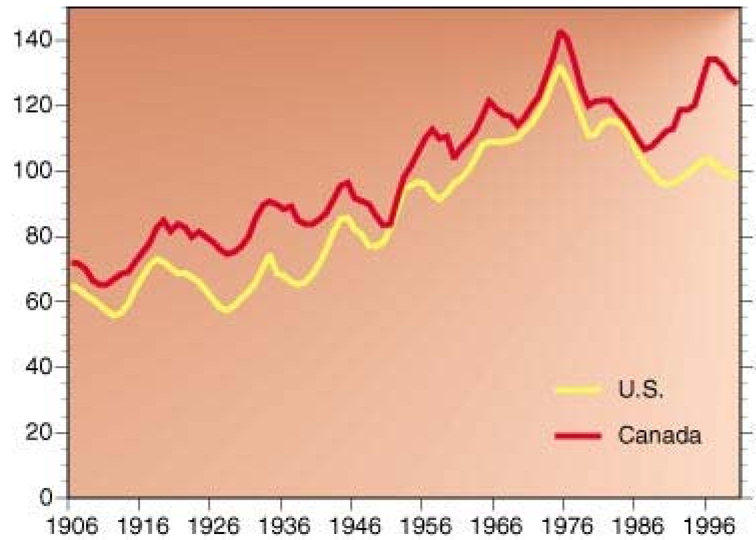
(millions of pounds, carcass weight)

Sources: Imports from Australia and Canada, 1985-96 from Morgan 1996; production and total imports from USDA, ERS 2002c; Imports from Australia, 1997-1999 from Australian Department of Agriculture, Fisheries and Forestry, 2002; Imports from Canada, 1997 from Ontario Cattlemen’s Association, 2002.

An analysis of Canadian beef and live cattle exports to the United States further underlines the point that the U.S. Meat Import Act did not constrain those exports up to 1989, nor did it cause the upsurge in Canadian exports from 1989 through 1993. The changing trends in Canadian beef and live cattle exports to the United States are governed by four factors: the difference between the price of fed cattle in the two countries, the size of the Canadian cattle inventory, the cost of feed-grain to Western Canadian cattlemen, and the Canadian-U.S. exchange rate. Canadian exports of both cattle and beef to the United States increase when the Canadian dollar is weak. Canadian slaughter prices are higher when the cattle inventory is shrinking rather than growing, so more beef supply is available for export at lower prices. Lower feed grain costs lead to larger cattle herds and more fed cattle exports.

The keys to Canadian cattle and beef trade, therefore, are the Canadian cattle cycle and the Canadian-U.S. exchange rate. Each Canadian cattle cycle takes ten or twelve years to go from trough to peak and back to trough again, just as it does in the United States. It is closely related to the price of barley, the primary feed grain for Canadian cattle. Canadian cattle cycles from 1906 to 2002 are shown in Figure 2. Barley prices from 1982 to 1998 are shown in Table 2, and the Canadian-U.S. exchange rate from 1971 to 2001 is shown in Figure 3

Figure 2: Canadian Cattle Inventories 1906-2000 ('000 head)



Source: *Canadian Cattlemen*, May 2000

Table 2: Canadian Barley Prices, 1982-1998

($Canadian/ton)

1982	100
1983	130
1984	133
1985	103
1986	81
1987	78
1988	120
1989	117
1990	94
1991	87
1992	97
1993	91
1994	123
1995	169
1996	137
1997	134
1998	117

Source: Agriculture and Agri-Food Canada, Market Analysis Division, 2002

Figure 3: Canada-US Exchange Rate, 1971-2001
(Canadian dollars per U.S. dollar)

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Source: Research Department, Federal Reserve Board of Cleveland, 2001

By comparing the trends lines on Canadian beef exports to the United States in Table 1 with these three trend lines we can readily explain the pattern of Canadian beef exports. From 1982 to 1987 the Canadian cattle cycle was in its contraction phase, as feed grain prices were up and cattle inventories fell 14 percent, steadily increasing domestic prices for beef. But the Canadian dollar was weakening against the U.S. dollar, making Canadian beef more attractive to the U.S. market. Thus Canadian beef exports to the United States increased from an average of 80 million pounds annually from 1975 through 1980 to an average of 191 million pounds annually from 1982 through 1987. Meanwhile, live cattle exports fell to a low point in 1987.

At that point the Canadian cattle cycle began a new phase of expansion, spurred by the combination of lower barley prices and the record high prices for fed cattle in the United States. The Canadian cattle inventory increased by nearly 15 percent during that period, and with the growing margin of difference between higher prices for fed cattle in the United States and lower prices in Canada exports of feeder cattle across the border soared from a little over 200,000 head in 1987 to 1.3 million head in 1992. During the expansion phase, the cattle owners reduced cow culling and diverted heifers from slaughter into breeding herds (Young *et al*, 1997). In this phase, more cattle were available for export at lower prices, so live cattle exports increased (USDA FAS, 2002). Canadian beef prices increased, and with the Canadian dollar appreciating against the U.S. dollar, Canadian beef exports to the United States remained at lower levels from 1989 through 1991, despite the fact that Canada was exempted from the U.S. Meat Import Act.

The expansion phase of the Canadian cattle cycle, which had begun before the CUSTA, continued through the early 1990s. Again, the Canadian cattle cycle determined the pattern of Canadian beef and cattle exports to the United States during this period, not the exemption of Canada from the Meat Import Act. From 1992 to 1994, barley prices were low and the exchange rate was increasingly favorable to Canadian exports to the United States. Furthermore, U.S. packing companies made major investments in new slaughter facilities in Alberta. The exemption of Canada from the U.S. Meat Import Law was undoubtedly one factor in those investments, but certainly not the only one. As a result of the convergence of these three factors, both beef and live cattle exports were higher than in the previous period.

Even after barley prices rose from 1994-1996, there was rapid expansion of the cattle inventory and record high exports of both cattle and beef across the border because exchange rate was so favorable to Canadian exports and because of the anticipated increase in slaughter capacity had not been realized (USDA FAS, 2002c).

The cattle cycle reached its peak in 1996, after which a new decline in herds began, largely in response to higher feed-grain prices and the narrowing of the margin of difference between U.S. and Canadian fed cattle prices. Fewer cattle were exported and more were slaughtered and thus more beef was exported to the United States.

The increase in Canadian beef and cattle exports to the United States in the 1990s had very little to do, therefore, with the exemption of Canada from the Meat Import Act. At most, the CUSTA played a role in the decision of U.S. packing companies to invest in slaughter facilities in Alberta. A powerful trend toward the integration of Canadian and U.S. beef markets had already begun earlier, however, making it very likely that such investments would have been made in any case.

Based on the assumption that the Meat Import Act had constrained beef imports, ERS (2000) estimates that Canada would have been able to export only 135 million pounds under the quota associated with the Meat Import Law from 1989 to 1994. This would have represented roughly one-fourth of the actual amount that Canada exported during the period, and ERS interprets the difference between the two export levels as the increase in exports attributable to CUSTA/NAFTA. As the data in Table indicate, however, the Meat Import Law was not applied at all during the 1989-1994 period. Even without CUSTA, therefore, it is unlikely that imports from Canada would have been restricted prior to the URAA.

The ERS analysis suggests that the increase in Canadian exports to the United States attributable to NAFTA can be estimated by comparing its actual beef exports to the United States with the share of the tariff rate quota for beef that Canada would have had under the U.S. beef TRQ in the absence of CUSTA or NAFTA. ERS estimates that Canada would have had a quota share of 145 million pounds after 1995, which was roughly one-fourth of its actual exports to the United States during the 1995-2000 period. This would suggest that annual Canadian beef exports to the United States were roughly 450 million pounds higher because of CUSTA/NAFTA.

This calculation assumes that Canada's quota share of the TRQ would have been based on a 9.4 percent share of U.S. beef imports, whereas Canada's share of total beef imports was already about 20 percent as of 1994. So the Canadian share of the total U.S. beef TRQ of 1.532 billion pounds (Leuck 2001) should have been 306 million pounds. Furthermore, if Canadian access to the U.S. beef market had been restricted by a TRQ, Canadian cattle owners would undoubtedly have exported more live cattle to the United States than was the case rather than slaughtering them for beef exports. The actual impact of NAFTA on the combination of Canadian live cattle and beef exports to the United States, therefore, would be considerably less than 300 million pounds annually. A more realistic rough estimate might be that CUSTA/NAFTA increased Canadian exports of beef or live cattle by 150 million pounds annually. This volume of cattle would represent 20 percent of the *increase* in Canadian beef production between 1994 and 2000 and 5.6 percent of Canada's annual beef production – the total meat obtained from Canadian-raised cattle, whether in Canada or in foreign countries (Young et al 2001; Canfax 2002).

The next problem for analysis is the production effect of additional Canadian beef exports on the number of cattle being raised in Canada – or even in Alberta, where the bulk of the cattle slaughtered for the U.S. market were raised. In economic theory, the additional demand for Canadian beef should have an effect on supply by raising prices for Canadian beef (OECD, 2000). The problem the price elasticity of cattle-raising is different from the problem in crop production, because of the existence of longer-term cattle cycles, in which herds expand and contract over a total of 10 to 12 years. In economic theory, a 5.6 percent increase in beef production might be expected to increase the price of fed cattle, and the price change in turn should lead to some expansion of herds. But the cattle cycle is governed not by prices of beef or of cattle but the biological constraints inherent in cattle-raising and cattle –marketing. As noted by specialists on cattle cycles, when a beef heifer is kept for breeding, her first calf does not reach the market for nearly three years, and the productive life of the heifer lasts up to ten years (Trapp, 1996; Rosen et al, 1994; Aadland, 2002). The result is that when calf prices are profitable for the cattle-raiser, more heifers are kept for breeding, but don't contribute to beef production for three years, and eventually, oversupply of beef leads to lower prices. When prices fall below the break-even point, cattlemen begin to liquidate their herds, until prices return to a profitable level (Prevatt and VanSickle, 2000).

Under these circumstances, cattle inventories are not only price inelasatic; their trend may well be the opposite of prices. The calf price elasticity and cattle price elasticity of the inventory of cattle and calves in the United States has been calculated for each year of the past five cattle cycles by Prevatt and VanSickle (2000). The results are shown in Tables 3 and 4. For the last 26 years, the sign of cattle price elasticity of cattle and calves inventories in all but four years, was negative, meaning that higher prices were associated with lower inventories or vice-versa. In the previous 24 years, moreover, half the years had positive signs and half had negative signs for price elasticity. Fir calf prices, the results are even more extreme: only two years out of the last 26 have had a positive relationship between calf prices and inventories.

Table 3: Calf Price Elasticity of U.S. Cattle and Calves Inventory, 1949-1999

Item	1949-58	1958-67	1967-79	1979-90	1990-?
Year 1					
Year 2	0.09	0.74	0.11	-0.06	-0.23
Year 3	0.25	-0.30	0.05	-0.44	-0.62
Year 4	-0.42	-1.53	0.63	-0.29	0.91
Year 5	-0.17	0.51	0.29	0.18	-0.21
Year 6	-0.82	-0.59	0.20	-0.45	-0.23
Year 7	-0.38	-0.32	0.13	0.52	-0.14
Year 8	0.16	0.10	-0.27	1.89	-0.26
Year 9	-0.22	-0.01	-0.34	-0.21	0.33
Year 10	-0.08	-0.16	-0.73	-0.29	
Year 11			-2.01	-0.69	
Year 12			-0.16	-0.14	
Year 13			-0.16		
Estimates represent *arc elasticities* [(Q2-Q1)/(Q2+Q1)]/[(P2-P1)/(P2+P1)]					

Source: Prevatt and VanSickle, 2000.

Table 4: Calf Price Elasticity of U.S. Cattle and Calves Inventory, 1949-99

	1949-58	**1958-67**	**1967-79**	**1979-90**	**1990-?**
Year 1					
Year 2	0.10	0.43	0.11	-0.02	0.24
Year 3	0.26	-0.20	0.04	-0.15	-0.12
Year 4	-0.33	0.44	0.23	-0.14	0.67
Year 5	-0.16	0.47	0.36	-0.12	-0/40
Year 6	-0.84	-0.90	0.14	0.49	-0.10
Year 7	0.53	-0.20	0.13	-0.94	-0.03
Year 8	0.17	0.13	-0.11	2.41	-0.06
Year 9	-0.22	-0.01	-0.13	-0.13	
Year 10			-0.14	-0.19	
Year 11			-0.54	-1.65	
Year 12			-0.12	-0.19	
Year 13			-0.12		
Estimates represent *arc elasticities* [(Q2-Q1)/(Q2+Q1)]/[(P2-P1)/(P2+P1)]					

Source: Prevatt and VanSickle, 2000.

Canadian tariffs on beef were too low to be a hindrance to U.S. exports, so the effect of CUSTA/NAFTA on U.S. beef exports to Canada also turns on the whether or how much Canadian quantitative restriction on imports would actually have restricted U.S. imports in the absence of CUSTA/NAFTA. Canada also had a Meat Import Law, which had restricted imports prior up to 1985, but the law had not been invoked since then (ERS, 2000). Nevertheless, had the United States been subjected to the TRQ adopted after the Uruguay Round, it is estimated that its beef exports to Canada would have been only half to two-thirds of what they have been since then

(ERS, 2000). U.S. beef exports to Canada have averaged around 200 million pounds annually since 1991 (Ontario Cattlemen's Association, 2002), so the ERS estimate suggests that the NAFTA increment in U.S. exports is roughly 70 to 100 million pounds annually. That figure represents less than one-half of one percent of annual U.S. beef production. But in any case, whatever price effect NAFTA may have had on U.S. beef prices has been irrelevant to the expansion and contraction of U.S. cattle inventories during the U.S. cattle cycle that started in 1990 and is still underway, as shown in Figures 3 and 4.

The removal of the 20 percent Mexican tariff on beef under the NAFTA agreement is said to have increased U.S. beef exports to Mexico by some 10-15 percent (ERS 2000). That would represent only about 5,000 to 7,000 metric tons out of the 120,000 metric tons increase in annual average beef exports to Mexico achieved by 1999-2000 over the average of 49,000 metric tons in the 1990-1993 period. The primary reason for this expansion of beef exports to Mexico is the improvement in the Mexican economy in the second half of the 1990s (ERS 1999). It should be recognized, moreover, that the imposition of the 20 percent Mexican tariff on beef occurred in late 1992 during the NAFTA negotiations (Zahniser and Link, 2002). In the broader context, therefore, it would be more accurate to analyze both the imposition and removal of that tariff as a result of the NAFTA negotiations.

The effect of NAFTA on Mexican exports of cattle to the United States was negligible. U.S. tariff levels on cattle prior to NAFTA amounted to 1.2 percent of value and were not a significant factor in determining trade patterns. During the 1985-1995 decade (i.e., before NAFTA, Mexican cattle exports to the United States tripled, not because of any change in trade policy but because of stabilization of the Mexican cattle industry, successful efforts to control disease and genetic improvement in Mexican herds. It was not NAFTA but a combination of the Mexican peso crisis of 1995, general macroeconomic instability, a long drought in Northern Mexico, that resulted in the 80 percent increase in Mexican feeder cattle exports to the United States to more than 1.3 million head during 1995. In 1996, the liquidation of the Mexican herd because of economic crisis and drought reduced Mexican exports to just 230,000 head during the January-August period (USDA, ERS 2001; Becker 1996). The Mexican drought continued through the latter half of the 1990s, resulting in a 20 percent reduction in the Mexican cattle inventory between 1994 and 1999 (USDA FAS 1999). Exports to the United States never returned to the levels of the early 1990s before NAFTA (USDA, FAS 1999; USDA, FAS 2002c).

To summarize the evidence on the impact of NAFTA and its predecessor, the CUSTA, on environmental stresses in the cattle and beef sub-sector, the one trading relationship in North America in which the NAFTA has caused substantial changes in exports and imports is in Canadian beef exports to the United States. But the production effect of that increase has been nullified by the dynamics of the cattle cycle, which responds to price signals only in a confused and contradictory manner. Without a clear production effect, no impact on environmental stresses from cattle and beef can be shown.

Corn and Maize: Price Inelasticity and the Production Effect

NAFTA was followed by a significant increase in U.S. exports of corn to Mexico, as shown in Table 5 . U.S. corn exports to Mexico increased from average of 2 million tons in the 1989-1993 period to an average of 4.3 million metric tons in the 1994-2000 period. Mexico's NAFTA commitments alone, however, only account for a small fraction of the increased U.S. corn exports. If the extremely low 1993 volume is eliminated from the calculation the average volume of U.S. exports from 1989 to 1993 was 2.44 million metric tons, whereas Mexico's NAFTA tariff rate quota for corn, combined with a prohibitively high above quota tariff, would have limited Mexican imports to an average of 2.74 million metric tons during the 1994-2000 period. Strictly speaking, therefore, the NAFTA agreement itself only permitted a 12 percent increase in U.S. corn exports to Mexico.

In reality, of course, Mexico consistently ignored the NAFTA TRQ on corn imports throughout the period, as shown in Table 5. Mexico had subsidized corn for human consumption in part by prohibiting its use as a feed grain. But growth in demand for feed-grains for the livestock sector and the maize processing sector was so great that the Mexican government took a series of steps going beyond the agreement to ensure that the demand for imported corn could be met, including an end to price supports for corn and to the ban on feeding corn to livestock (Rosenzweig, 2001; ERS, 2000). Mexico's commitment to liberalizing its agricultural sector was not dependent on NAFTA, and almost certainly would have continued even without it (Burfisher *et al*, 2001b). Nevertheless, because Mexico was motivated to accept much higher U.S. corn imports by the desire to liberalize its agricultural economy, the entire increase in U.S. corn exports can also be considered as the result of trade liberalization.

Table 5: Mexican TRQs and Actual Imports of US Corn, 1989-2000
(Millions of metric tons)

Year	Quantitative level of TRQ	Actual U.S. Exports
1989	n.a.	3.844
1990	n.a.	3.486
1991	n.a.	1.316
1992	n.a.	1.137
1993	n.a.	.288
1994	2.500	3.054
1995	2.575	2.858
1996	2.632	6.314
1997	2.732	2.566
1998	2.831	5.246
1999	2.898	5.052
2000	2.985	5.194

Source: Zahniser and Link 2002

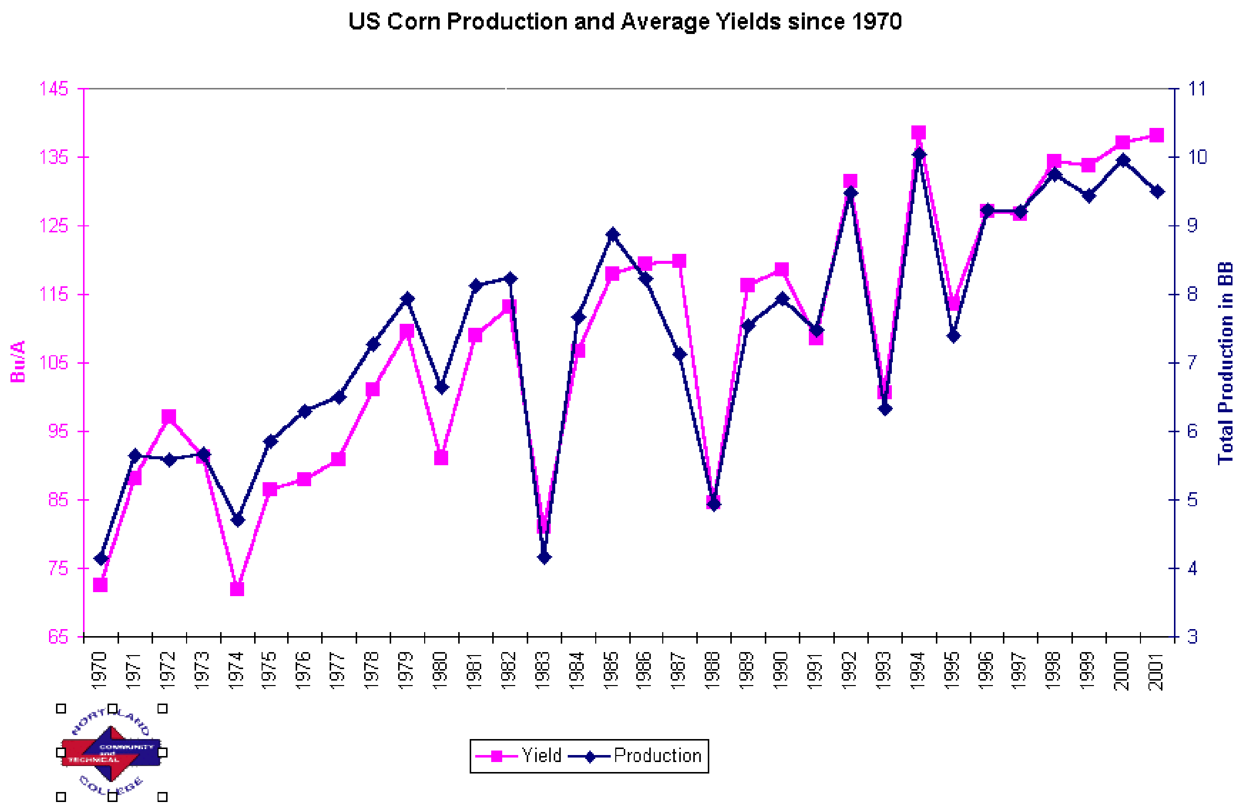
The roughly 2 million additional metric tons of corn exports to Mexico that have resulted from this broader Mexican policy of trade liberalization represents slightly less than one percent of the average of 232 million metric tons of U.S. corn production annually in the 1994-2000 period. It is reasonably certain that this small NAFTA-related increase in U.S. corn exports had no bearing on the area planted to corn in the United States. The price elasticity of U.S. corn production is extremely low. Individual farmers cannot calibrate their output to demand in order to influence the price. Farmers do shift acreage between soybeans and corn from year to year, but very seldom take land out of production or increase total planted area in response to price changes. The acreage planted to corn is generally determined not by corn prices but by soil conditions at planting time, government loan rates and changes in the cost of fertilizer (Ray, 2000; Anon., 2002).

Prices generally rise and fall from one year to the next, moreover, in response to changes in yield, which have tended to grow rapidly, rather than because of changes in demand or deliberate farm decisions on production (Ray, 2001). Figure 4, which shows U.S. corn production and average yields since 1970, illustrates how closely production has been linked with changes in yield per acre. It shows a pattern of wild fluctuation in both production and yields that began in the early 1980s and lasted until 1996, when both began to stabilize.

Table 6 shows acres planted to corn, yields, total production and price per unit from 1990 to 2001. These data indicate that major swings in corn acreage up to 1996 were responses to the wild fluctuations in price, which were in turn caused by the large increases and decreases in yield from year to year. Although producers did undoubtedly respond to these very large shifts in prices of 20 to 40 percent, they were overwhelmingly determined by unpredictable yield changes. When prices were more stable, however, planting decisions were determined by other considerations.

These data also indicate that average annual yields have increased by 14 percent over the 1990-1993 average, while acreage planted to corn has increased by only 3 percent over the 1990-1993 average. That means that, in theory, the NAFTA increment in corn exports was responsible for an increase in area planted of just .25 percent.

Figure 4:



Source: Toolshed Ag Information Network

Table 6: U.S. Corn Area Planted, Yield, Production and Price: 1990-1999.

Year	Planted Area (thousands of acres)	Yield (bushels/acre)	Production (millions of bushels)	Price ($/bushel)
1990	74166	118.5	7.934	2.28
1991	75957	108.5	7.474	2.37
1992	79311	131.5	9.476	2.07
1993	73239	100.7	6.337	2.50
1994	787921	138.6	10.050	2.26
1995	71479	113.5	7.400	3.24
1996	79229	127.1	9.232	2.71
1997	80165	126.7	9.206	2.43
1998	90165	134.4	9.758	1.94
1999	77431	133.8	9.437	1.90
2000	79552	137.1	9.788	n.a.
2001	75752	138.0	9.550	n.a.

Sources: Wisconsin corn agronomy home page, College of Agriculture and Life Sciences, University of Wisconsin Madison; *Weekly Outlook*, Department of Agricultural Economics, College of Agriculture, Purdue University, and Department of Agricultural and Consumer Economics, College of Agricultural Consumer and Environmental Sciences, University of Illinois, January 22, 2002; NASS Monthly Ag. Newsletter, National Agricultural Statistics Service, November, 2001.

Unlike the NAFTA's lack of impact on corn production in the United States, it had a pronounced production effect in Mexico. The area on which maize was harvested in Mexico fell by 3 percent from an average of 8 million hectares in the

1992-1993 period to 7.8 million hectares in the seven years after the NAFTA was signed (FAPRI, 2002). Maize production, however, fell by 4.7 percent from an average of 18.88 million metric tons in the 1992-1993 period to 17.99 million metric tons on average in the seven years subsequent to the NAFTA (FAPRI, 2002). Thus maize yields decreased by 2 percent on average between the immediate pre-NAFTA and post-NAFTA periods.

The data on production can be further broken down, however, between irrigated and rain-fed sub-sectors of the Maize sector, as shown in Table 7. The actual contraction was in the higher-yield irrigated sector, which had been growing by more 200 percent from 2.72 million metric tons in 1989 to 8.58 million metric tons in 1994. From 1995 through 2000 production on irrigated land averaged only 5.91 million metric tons -- a 31 percent decline from its 1994 peak. In 1999 and 2000, the irrigated corn area was actually 40 percent smaller than during the peak year. Meanwhile, average rain-fed maize production during the 1995-2000 period was 18 percent higher than the average rain-fed production in the previous six years.

Table 7: Mexican Maize Production (Rainfed and Irrigated): 1989-2000

Year	Total Production (Millions of MT)	Rainfed	Irrigated
1989	10,953	8,229	2,724
1990	14,635	11,327	3,309
1991	14,252	9,979	4,273
1992	16,929	11,528	5,401
1993	18,125	10,422	7,704
1994	18,236	9,660	8,575
1995	18,353	12,070	6,283
1996	18,026	12,315	5,709
1997	17,656	10,734	6,922
1998	18,455	12,350	6,104
1999	17,706	12,641	5,065
2000	17,091	11,774	5,417

Sources: FAO and SAGAR

The environmental significance of these data lies in their implications for pesticide use in maize cultivation. Many subsistence producers do use pesticides (Nadal, 1999). However, the poorest corn producers in Mexico, working on small plots of less than 2 hectares and lacking access to credit, farm with relatively little chemical inputs except for nitrogen fertilizer (Nadal, 2000b; Louette,1995). The area cultivated by the irrigated sector, which applies more pesticides, appears to have contracted by 33 to 40 percent since NAFTA, while the rain-fed sector, which uses significantly less pesticides, has expanded. This suggests that the percentage reduction in the use of pesticides has been much greater than the relatively small percentage reduction in area on which maize was harvested, although it is not possible to estimate the change..

On the other hand, the extensification of maize cultivation, particularly in upland areas, has undoubtedly resulted in an increase in deforestation and soil erosion.   Nadal (2000b) reports that in Chiapas, Guerrero, and Michoacan, intermediate corn producers have carried out significant expansion of corn production at the expense of forests since the NAFTA.   Since the rain-fed maize sector has increased by 18 percent, the intrusion of maize farming into forests could represent a significant change.

Mexico is not only the country of origin of the wild relatives of maize but the center of genetic diversity in maize. Another environmental issue associated with the impact of NAFTA is whether it has contributed to genetic erosion in regard these traditional landraces of maize.   Genetic erosion occurs when traditional landraces or local cultivars are replaced by modern improved varieties or hybrids or are lost through the clearing of large areas where those landraces flourished (National Research Council, 1993; FAO, 1998).   Another cause of loss of genetic diversity, however, is the loss of the knowledge of cultivating landraces. When cultivators of traditional landraces are forced to depend more on non-farm sources of income, they reduce their ability to maintain these local varieties (Tripp and van der Heide, 1996).

One issue raised about NAFTA's impact on genetic erosion in Mexican maize is whether of the increased U.S. imports of corn would exert pressure on producers of maize who have continued to use only local landraces to shift to improved, hybrid varieties of maize (Ackerman *et a*l, 2002). Hybrid varieties of maize have already made headway into the irrigated sector, but penetration into the rain-fed sector, particularly in regions with steep slopes, poor soil quality and weather extremes, has been very limited. In these regions, traditional landraces have long been a strategic defense against crop losses, although yields are far smaller than in irrigated cultivation on higher quality soils (Nadal, 1999; Nadal, 2000b). Mexico's agricultural liberalization strategy, of which NAFTA was a key part, raised the possibility that the small subsistence producers of maize who were the guardians of indigenous landraces would be forced to switch to improved varieties, to switch to a different crops or to seek non-farm employment.

Thus far, the actual evolution of maize production since the NAFTA has defied the predictions of economists. Instead of contracting sharply, the cultivation of maize has actually remained relatively stable in the years following NAFTA, although average yields dropped slightly. Rain-fed production, which includes both intermediate producers who may produce a small maize surplus for sale on the market and subsistence producers who depend on off-farm activities to supplement maize cultivation, increased substantially over pre-NAFTA levels. Both groups of producers have apparently chosen to increase the area under maize cultivation as a strategy of maintaining their incomes rather than adopting more improved varieties of maize, shifting to other crops or dropping out of agriculture altogether. Nadal (2000b) concludes that fears of genetic erosion in maize through the adoption of hybrids are groundless.

The other danger to genetic diversity of corn -- the gradual lose of traditional knowledge of local landraces -- may have been accelerated by NAFTA-induced economic pressures. One of the factors affecting the ability of communities to maintain this knowledge of local landraces is migration of trained labor out of the regions that have relied most heavily on local landraces. Although no quantitative data are available, such migration has apparently increased as a result of reduced rural employment opportunities, as intermediate producers cut back on hired farm labor, adding to the pressure on traditional knowledge of genetic variability in landraces (Nadal, 1999; Nadal, 2000b). This phenomenon, which began well before NAFTA is taking place over a relatively long period of time, as noted by Nadal (2000b).

In summary, the potential impact of the NAFTA-related increase in U.S. corn exports to Mexico has been swallowed up by the size of the U.S. domestic market and by the failure of price changes to bring about a production effect, because of the price inelasticity of corn production. The impact on the environmental stresses associated with maize production in Mexico, on the other hand, has been quite pronounced. The price changes have fallen mainly on the irrigated sub-sector, which uses substantially more chemical inputs than the rain-fed sub-sector. The result has been an unknown but potentially significant reduction in pesticide use Although the evidence is less clear, it appears that increased maize production in the rain-fed sector has also caused an increase in the rate of deforestation and some increased long-term risk of loss of traditional maize varieties.

Vegetables: Mexican Tomato Exports and the Technology Effect

Vegetables dominate U.S.-Mexican trade in fresh produce, and tomatoes are by far the largest vegetable traded, accounting for 24 percent of all U.S. vegetable imports from its NAFTA trading partners (Pena, 2000). U.S. fresh tomato imports from Mexico increased by 83 percent between 1993 and 1998 (ERS 2000). U.S. tariffs on tomatoes were scheduled to be phased out over ten years, but they were not high to begin with, and constitute only a small proportion of total costs of production and export (Plunkett, 1996; VanSickle 2000).

Factors other than tariff reductions under NAFTA accounted for most of this increase, including differential growth rates of U.S. and Mexican real wages and per capita income as well as in more rapid growth in Mexican production technology as expressed in yields (Malaga *et al* 2001). In the mid-1990s, the peso devaluation contracted the domestic market in Mexico, reduced input costs in dollar terms and made Mexican exports more competitive in the U.S. market. Meanwhile, the increasing consumer demand in the United States for fruits and vegetables has boosted the potential market for horticultural exports from Mexico (Beghin, 2001). Weather also played a key role in the 1994-95 season as a tropical storm damaged crops in Florida, while unusually favorable weather increased production in Mexico's largest tomato-growing state, Sinaloa (ERS, 2000). Trade in tomatoes has been limited, however, by price floors implemented under an agreement settling the anti-dumping case brought by Florida growers (Zahniser and Link 2002). Holding other factors unchanged through economic modeling, ERS (2000) has estimated that

NAFTA's tariff changes would have increased tomato imports from Mexico by 8-15 percent compared with the situation without NAFTA.

The role of NAFTA in Mexico's exports of bell peppers, cucumbers and squash, the second, third and fourth most important Mexican vegetable exports to the United States was even more limited. Annual U.S. tariff reductions of just one percent annually on bell peppers accounted for very little of the 53 percent increase in imports between 1993 and 1998. Cucumber imports from Mexico increased by 50 percent during the same period, whereas tariff reductions alone would have accounted for an estimated 3 percent increase in imports above what would have occurred in their absence. In both cases, increased U.S. demand, peso devaluation and weather conditions were much more important to the trade pattern than trade liberalization. Similarly, squash imports from Mexico have grown 83 percent in the 1993-1998 period, but tariff changes alone account for an increase in imports of squash from Mexico of less than 1 percent (ERS 2000). In each of these cases, the impact of NAFTA has clear been too small to have any impact on production decisions.

Mexico's tomato exports to the United States averaged 714,000 metric tons annually in the 1994-2000 period, which was about 34 percent of its total tomato production. That compared with an average of 399,000 metric tons annually in the five years before NAFTA, or 25 percent of its production (ERS 2000; FAO 2002). Post-NAFTA tomato exports thus increased by 75 percent over the four-year pre-NAFTA period. An 8-15 percent increase in exports to the United States attributable to NAFTA would represent an additional 33,000 to 61,000 metric tons of Mexican exports to the United States annually. Based on this calculation, the NAFTA-induced increase in Mexican tomato exports to the United States was about 1.6 to 3 percent of average total Mexican production of 2.05 million metric tons during the 1994-2000 period (Plunkett 1996; FAO 2002).

To estimate the impact of the increase in 33,000 to 61,000 tons of tomatoes exported to the United States on Mexican production, it is necessary to take account of the bifurcated structure of the tomato industry in Mexico. Mexico's major tomato export regions are Sinaloa and Baja California, both of which accounted for 75 to 90 percent of its exports and exported well over half their production to the United States (Plunkett, 1996). These export regions have higher yielding tomatoes than those in the rest of the country which produce for the domestic market. The impacts of NAFTA on production, therefore, are focused on these two regions, which together have accounted for an average of more than 700,000 tons of exports and 1.2-1.4 million tons of total production annually since 1994. The additional exports attributable to NAFTA, therefore, represent between 6 to 10 percent.of total production in those advanced segments of the Mexican tomato industry.

Sinaloa, the main tomato-growing area in Mexico, has long been known for its very heavy use of pesticides, and for high rates of pesticide poisoning among its workers. In the mid-1990s, some 3,000 field workers were being hospitalized annually for "pesticide intoxication" (Schrader, 1995). The Mexican government has not had a good record of regulating pesticide use and does not release any data on pesticide use in the country (Abler and Pick 1993). Researchers have also reported that tomato growers in Sinaloa have been overusing nitrogen fertilizer, applying nearly twice as much as is needed for crop requirements (Romero *et al,* 2002). In the second largest tomato-growing region, in of Baja California, groundwater availability is limited, and the rapid expansion of irrigation for export tomato production drew down the aquifer and caused saltwater intrusion during the late 1980s (Cook, 1993).

It would be logical to assume, therefore, that the NAFTA-induced increase in Mexican tomato exports has been responsible for increased use of chemical inputs and water, polluting soil and water and further depleting groundwater. The evidence indicates, however, that the additional of tomato production attributable to NAFTA-induced exports did not cause any cultivation of additional farmland for tomatoes, nor did it result in any intensification of production. The reason is the role of technological change in the tomato export sub-sector in absorbing the production effect of NAFTA export increment. Increases in yields achieved in Mexican tomato cultivation because of technological improvement have made possible large increases in production per hectare harvested without while actually decreasing both the amount of land used and the amount of inputs used per hectare.

Table 6 shows the area harvested, yields, production, exports and domestic use of Mexican tomatoes from 1989 through 2000. Although these data cannot be reconciled with annual production data for Sinaloa, Baja California and other states in an ERS source (Lucier and Plumber, 2001), they do provide a useful overview of trends in area, yields and production. Between 1989 and 1994, the average annual yield for all tomato production declined sharply, because serious problems of disease plagued Sinaloa's tomato sector (Cook, 1993). But in 1995, the average yield increased dramatically and remained at a plateau for the next three years, then rose even more sharply in 1998 and have remained there. Meanwhile, total area under tomato cultivation remained stable until 1998 and then suddenly plummeted by roughly 25 percent.

Between 1990-91 and 1995-96, tomato yields in Sinaloa increased by 50 percent, from 22.66 tons per hectare to 34 tons per hectare, according to figures provided by the growers (Rindermann and Cruz, 1997). According to ERS data, Sinaloa and Baja California combined to harvest 32,388 hectares of tomato and produced a total of 1.27 million metric tons, for an average yield of 39 metric tons per hectare (Love and Plunkett, 1996; Lucier and Plumber, 2001). Thus, Sinaloa's yields were 32 percent above the national average in 1966, and both areas combined were 41 higher than the national average.

Table 8: Area Harvested, Yield, Production, Exports and Domestic Use of Mexican Tomatoes, 1989-2000

Year	Area Harvested (ha.)	Yield (MT/ha.)	Production (000s MT)	Exports (000s MT)	Domestic Use (000s MT)
1989	98,497	21.75	2,143	439	1,704
1990	105,124	20.52	2,158	393	1,795
1991	103,152	20.60	2,152	423	1,729
1992	101,830	16.46	1,667	192	1,475
1993	107,528	19.22	2,068	487	1,581
1994	92,456	18.52	1,713	460	1,253
1995	104,922	22.01	2,309	717	1,592
1996	102,633	23.29	2,392	754	1,638
1997	102,872.	22.55	2,320	687	1,633
1998	78,784	28.58	2,519	888	1,631
1999	82,559	29.20	2,411	665	1,746
2000	74,629	27.95	2,086	689	1,397

Source: FAOSTAT database

In 1998, Sinaloa produced 923,865 tons of tomatoes (roughly 36 percent of the national total) on 22,000 hectares, for an average yield of 42 tons (Lucier and Plumber, 2001; Romero, 2002). This spectacular increase in tomato yields in Sinaloa and Baja California is not attributable to the use of increased chemical inputs but to the adoption of extended shelf-life varieties, drip irrigation and plastic mulch technologies. These technologies not only made it unnecessary to plant tomatoes on additional land but actually reduced significantly the total land surface needed for tomato cultivation and as well as the use of herbicides, fungicides and insecticides as well as irrigation water per hectare (Cook, 1993; Plunkett, 1996; Love and Plunkett, 1996). Based on figures provided by Lucier and Plumber (2001), Lindermann and Cruz (1997) and Romero et al (2002), harvested area for tomatoes in Sinaloa dropped 16 percent from 26,400 in 1996 to 22,000 in 1998, even as production increased from 900,000 tons to 923,000 .

These technological changes cannot be considered as a “technology effect” of trade liberalization, because their adoption began in the 1980s, well before the negotiations on the NAFTA (Cook, 1993). The Mexican tomato export sector is still far from an environmentally sustainable industry, given its continued overuse of fertilizer even after adopting the “fertigation” technique, and pesticide use is still not adequately regulated. Nevertheless, technological improvements in the tomato industry has prevented any additional environmental damage from the increased Mexican tomato production attributable to NAFTA .

Meanwhile, the impact of the shift of production of tomatoes to Mexico reduced tomato production in Florida by 20 percent from the average production level of the six years prior to NAFTA. This led to a fall in the area planted to tomatoes in Florida from an average of 20,000 hectares in 1988-89 to 1993-94 to an average of 15,600 in 1996-97 and 1997-98 (Florida Department of Agriculture and Consumer Services, 1999). Although no time series data are available on the level of pesticide use in cultivated tomatoes in Florida, Abler and Pick (1993) asserted that Florida’s tomato production at the time of the NAFTA was even more chemically intensive than Sinaloa’s both per hectare per metric ton of production. The large reduction in area planted to tomatoes can be taken as evidence of a commensurate reduction in the total use of pesticides by the Florida-based tomato-growing sector. Recalling that the shift in trade was primarily brought about by other factors, only a relatively small proportion of this reduction can be credited to NAFTA.

In tomato production, as in corn and maize production, the impacts of NAFTA-induced trade changes on the environment were very different in the exporting country and the importing country. The production effect of NAFTA-induced increases in tomato exports was counteracted by the technological improvement in Mexico's tomato industry, which allowed much greater production without increased use of chemical inputs and water. In the United States, on the other hand, there was a decided production effect from the loss of domestic market to Mexican imports, which translated into reduced area cultivated and less chemical input use.

III. The Uruguay Round Agreement on Agriculture (URAA) and North American Agriculture

A. The URAA: Commitments and Implementation

In relation to the international disciplines on agricultural subsidies that existed at the time, URAA agreed to in 1994 as part of the GATT Uruguay Round agreement represented a radical departure. It established commitments to increase market access, and to reduce domestic support and export competition for the first time. On market access, non-tariff border measures were to be converted to bound tariffs (i.e., maximum tariffs that could not be changed without notification and compensation) providing protection equivalent to the quotas being replaced. Industrialized countries were to reduce the tariffs resulting from the "tariffication" of non-tariff barriers as well as bound tariffs by an average of 36 percent over six years. Developing countries had ten years to reduce these tariffs by 24 percent, and the least developed countries undertook no commitments to such reductions.

The market access provisions of the URAA also required that existing market access opportunities would not be reduced and established minimum access tariff quotas, with a tariff rate lower than the over-quota rate, on those products on which imports that had been previously restricted and existing access was less than 3 percent of domestic consumption. That minimum access quota had to be expanded to 5 percent before the implementation period had ended. A "special safeguard" provision allowed the importing country to apply additional duties up to one-third of the original duty if an import "surge" occurred or if the price of the good fell below 90 percent of the 1986-88 average of a reference price.

The URAA's disciplines on domestic support require that industrialized countries reduce the sum of all agricultural support programs that are not exempt under the agreement – called the Aggregate Measurement of Support (AMS) -- by 20 percent from the average levels of support across all commodities for the base period 1986-88 during the six-year implementation period. Developing countries must reduce the AMS by 13.3 percent during that period, with least developed countries exempt from reduction commitments. Domestic support programs that have a minimum impact on trade, such as general services, income support that is "decoupled" from production, and direct payments for implementing environmental measures, are put in a "Green Box" and need not be included within the AMS. Also exempt from the AMS are support measures representing less than 5 percent (10 percent for developing countries) of the total value of production of the agricultural good or, in case of measures that are not product-specific, of the total value of agricultural production. Finally, some direct payments that are related to past production but not current production, including payments that limit production to fixed areas and yield, fixed numbers of livestock or to 85 percent or less of production in a base period, are in a "Blue Box" which is also exempt from reduction commitments.

The agreement's disciplines on export subsidies require industrialized countries to reduce the value of such subsidies to levels 36 percent below those of the 1986-90 base period and the quantity of the exports subsidized by 21 percent over the same six-year implementation period. Developing countries are required to reduce the same subsidies by 24 percent and 14 percent, by value and volume of exports subsidized, respectively, over a ten-year implementation period. Least developed countries are again exempt from reduction commitments. New export subsidies are prohibited.

Despite these apparently far-reaching commitments to liberalization of agricultural trade policies, the URAA had so many loopholes and weaknesses that they systematically undermined its ostensible objective. The effect of the tariffication provision was diminished by the selection of 186-88 as the base year, because those were years in which the use of border protection measures was at its peak. Furthermore, the lack of rules for setting bound tariffs in the tariffication of quantitative restrictions allowed countries to establish tariffs that represented much higher levels of protection than afforded by the quotas previously used, and thus to make little or no reductions on the most sensitive agricultural goods (Inco, 1995, Hathaway and Inco, 1997; Diakosavvas, 2001). The agreement allowed member countries to choose whatever base period they preferred, whether base period quantities were gross or net, and even whether the calculations were product by product or for highly aggregated product groups (De Gorter, 1999). Disciplines on tariff reductions were eviscerated by allowing the averaging of cuts across each tariff line, exacerbating the problem of wide differences in tariff levels between countries (Sumner and Tangermann, 2001).

Domestic support disciplines were rendered meaningless by using 1986-88 as the base year. That was a period of extraordinarily high domestic support for agriculture in OECD countries. By the time of the URAA, the total value of support included in the AMS was only about 60 percent of the level of the base period

(Normile, 1998). Since the commitments were to reduce AMS by only 20 percent over the implementation period, this feature of the agreement actually allowed OECD countries to increase the level of trade-distorting support measures by up to 25 percent while remaining within their URAA commitments.

The same thing occurred in regard to commitments to reduce export subsidies. The base period chosen, 1986-1990 was one of intense export subsidy competition between the EU and the United States (Ackerman, 1998), so export subsidy levels were at an all-time high. Subsidies had already return to a more normal level before the completion of the URAA negotiations (Sumner and Tangermann, 2001; Dixit et al, 2001). The cushion built into those commitments was so large that member countries used less than 40 percent of the subsidy outlays permitted in the aggregate during the five years from 1955 to 1998 (Dixit et al, 2001).

Under these circumstances, major subsidizing countries could again actually increased their use of export subsidies substantially without violating their commitments. Table 9 shows the export subsidy expenditures for the four top subsidy users from 1995-99. The EU, by the largest user, increased its export subsidies by 12 percent during the period, while Norway and the United States by more than 100 and 500 percent, respectively, from much smaller bases. Only Switzerland actually reduced its subsidies during the period. In aggregate, the four largest users increased their export subsidies by 13 percent in the first five years of the URAA.

Table 9: Export Subsidy Expenditures for Major Users, 1995-1999
(Billions of $ US)

	1995	**1996**	**1997**	**1998**	**1999**	**1995-99 % change**
European Union	8.842	9.372	8.372	9.811	10.080	+12
Norway	.071	.042	.075	.100	.142	+100
Switzerland	.419	.413	,444	.438	.287	-30
United States	.054	.128	.107	.146	.336	+523
Totals	9.386	9.955	8.998	10.455	10.845	+13

Sources: Burfisher, 2001; WTO, 2002a; WTO, 2002b)

The verdict on the URAA must be that it failed to have any substantial effect on liberalizing world trade in agricultural goods. Tariffication of quantitative restrictions, tariff reductions and minimum access requirements brought about very little reduction in border measures. It represents progress only if compared with the most excessive period of protectionist measures in history, rather than with the status quo as of the time of the agreement. AMS has grown since the agreement went into effect, as have export subsidies. The overall effect of the URAA has certainly been to legitimize increased protection of agriculture by OECD governments rather than to reduce it.

Impacts of the URAA on North American Agriculture

Beef is a highly protected product in a number of countries, and the URAA did little to liberalize international trade in it. According to one study, the agreement actually resulted in greater protection of beef worldwide, because the minimum quantity of beef that countries allowed was smaller than the amount of imports in most years prior to the agreement (Sumner, 1995). Of ten OECD countries and the EU, only Japan, Australia and New Zealand did not have *ad valorem* tariff rates on beef in 1995 that were higher than the estimated equivalent of *ad valorem* rates during the base period. Five of those countries (Austria, Finland, Norway, Switzerland and Turkey) had rates that were ranged from 239 to 479 percent of the value of the beef imported (Fabiosa, 1999).

The countries that were obliged to adopt TRQs to replace quantitative restrictions on beef imports were the United Sates, Canada and the EU. The EU has a non-concessional TRQ that allows market access for only 165 million pounds of beef annually (Rae, 2001). That represents just 2.2 percent of annual EU beef production. The tariffs for the non-concessional TRQ system are a complex combination of *ad valorem* customs duties and bound tariffs with a wide range of values depending on the cut. For U.S. fresh or chilled beef, the combined effect of these rates would range from 59 percent to 98 percent of the U.S. price (Leuck, 2001).

An additional 311 million pounds can enter the EU market with a 20 percent customs duty but no tariff on the condition that the beef is certified as free of synthetic growth hormones or at a very low tariff rate under special concessions to African, Caribbean and Pacific countries or Eastern European countries. A further 116 million pounds of lower grade frozen beef can be imported from any country with a 12.8 percent customs duty (Leuck, 2001). The EU bound tariff for beef imported outside these various TRQs remains prohibitively high at 111 percent, which represents the end result of the 36 percent cut from the base rate claimed by the EU in the URAA (Rae, 2001).

It is arguable that the impact of the URAA on the U.S. beef market was to make it more restrictive rather than less restrictive than it had been before. As noted in the discussion of NAFTA, the U.S. Meat Import Law had not been invoked formally since the mid-1980s. The Meat Import Act's original rationale had long since been overtaken by the U.S. shift to being a major beef exporter. Furthermore, the U.S. market was far from being under pressure from imports. Australia was then the largest beef exporter to the United States, accounting for 40-46 percent of all U.S. beef imports from 1990 to 1993. But by 1995, when the United States imposed a TRQ on beef, Australian beef was already becoming less competitive in relation domestic U.S. beef, because of reduced U.S. domestic prices and the appreciation of Australian dollar (Australian Bureau of Statistics, 2001). This loss of competitiveness explains why Australian beef exports to the United States tumbled from 906 million pounds in 1993 to only 536 million pounds in 1998. The quota allocated to Australia under the 1995 TRQ was much higher than Australian exporters were capable of filling in the second half of the 1990s. It was only after reduced U.S. beef production and higher prices, combined with a weaker Australian dollar, made Australian beef more competitive that Australia was able to finally meet its

It seems doubtful that, in the absence of the URAA negotiations, the United States would have moved toward such import restrictions. Prior to the URAA, U.S. tariffs on beef for non-NAFTA countries were quite low at 3.9 cents per kilogram on beef carcasses and ranging from 4 to 10 percent on most cuts of beef (Marsh, 1999). The URAA actually permitted the United States to subject imports from countries other than Canada to above-quota tariff rates of 31.1 percent (ultimately reduced to 26.4 percent in 2000) that had not existed previously (Leuck, 2001; Rae, 2001).

Canada's beef import regime similarly became more restrictive under the URAA than it had been before. In place of a Meat Import Law that had not been applied since 1985, Canada established and rigidly enforced quota that limits the rest of the world beyond the United States to 231 million pounds of beef exports to Canada annually. Although Canada's tariffs for imports within the TRQ are at zero, its very low beef tariffs prior to the URAA were replaced by above-quota tariffs of 37.9 percent, which were reduced to 26.5 percent by 2000 (Rae, 2001).

The URAA did increase U.S. access to the Japanese market, which was already the largest market for U.S. beef in the world, accounting for half of U.S. beef exports in 1995. Even before the URAA, Japan had already taken the biggest step toward liberalizing its beef trade regime by replacing its beef import quota with a 70 percent *ad valorem* tariff and had reducing that tariff to 50 percent. Under the URAA, that tariff was to be reduced to 38.5 percent by 2001, although Japan obtained special safeguard rights beyond what was available to all other member countries, allowing it impose additional duties if beef imports increased by more than 17 percent in any given year (Marsh, 1998; Brester *et al*, 2000).

According to one econometric analysis (Miljkovic *et al*, 2000), if other factors had remained unchanged, this 24 percent reduction in tariffs would have translate into a 43.7 percent increase in Japanese beef imports from the United States, representing a 27 percent increase in U.S. beef exports worldwide. According to the same analysis a 26 percent increase in U.S. beef exports would have caused an increase in the price of U.S. fed cattle of roughly one percent and of feeder cattle of .5 percent above the mean prices from 1990 to 1994.

However, the effect of Japanese tariff reductions were partially offset by the depreciation of the Japanese Yen in relation to the dollar (39 percent from 1995-1998), which reduced Japanese demand by 29 percent (Miljkovic *et al*, 2000). In actuality, Japanese imports of U.S. beef increased by 28 percent after the URAA from an average of 772 million pounds in 1990-1994 to an average of 1.058 billion pounds from 1995 to 1999. This represented 60 percent of the overall increase in U.S. beef exports during the latter half of the 1990s compared with the first half (USDA ERS, 2002c).

Korea had also agreed to discard its quantitative restrictions on beef imports before the URAA, but accepted a commitment to increase its minimum import levels annually from 270 million pounds to 485 million pounds by the year 2000 and to eliminate the quota entirely by 2001. That would mean scrapping the system under which a “supergroup” of importers coordinates beef imports and domestic prices. However, domestic political pressures on the Korean government from the beef sector are extraordinarily intense. The Korean beef sector is made up of a large number of small producers whose life savings are committed to their beef animals and has responded to previous price reductions with riots and suicides. If Korea had implemented the URAA commitment, its beef prices would have declined by an estimated 50 percent (Brester et al, 2000). It is not surprising that Korea failed to meet its minimum access commitments each year from 1997 through 1999. The United States brought the issue to a WTO Dispute Settlement Panel, complaining about restrictions on the sale of imported beef, imposition of excessive duties on beef imports and failure to implement commitments to reduce domestic support for the beef industry. Although the Panel upheld the U.S. complaint, the issue remained unsettled as of 2001 (USTR, 2001).

The moderate opening of the Japanese market has been the only substantial result of the URAA on U.S. beef exports. U.S. exports of beef and veal by destination country from 1987 to 1998 are shown in Figure 5. With Korea's brief opening having closed by 1998, the only change since 1995 change in markets from Non-NAFTA trading partners other than Japan is an increase totaling roughly 70 million pounds from all other countries. Even of the entire increment from all other countries is attributed to the URAA, the additional export markets represent only about 1 percent of U.S. beef production, and, for the reasons cited in the analysis of the CUSTA/NAFTA increment for Canadian beef exports, it could not have influenced U.S. cattle inventories. Even though it would have a slight affect on cattle and calf prices, price changes simply do not influence the actual number of cattle being raised. As discussed above, U.S. cattle cycles are a function of "biological lags" which make it impossible to adjust the size of herds to economic signals. The effect of cattle cycles in frustrating the purpose of price signals has been further exacerbated by technological change in the beef industry. Although cattle prices declined by 19 percent from 1990 to 1998, total U.S. beef supply increased from 25 billion pounds to 28.5 billion pounds, even though total inventories went from a trough to a peak and then back down again. The reason is the increased productivity of the herd, because of improved genetics and feeding programs (Brester, 1999; Brester and Marsh, 1999). Beef production per head of cattle increased during that same period by 8 percent from 570 pounds in 1994 to 620 pounds in 2000 (USDA NASS 2001). Even a dramatic increase in U.S. beef exports from just over 1 billion pounds in 1990 to more than 2 billion pounds in 1998 (See Figure 1) did nothing to prevent this receding tide, because the increase in exports was only one-third as large as the increase in domestic beef supply.

Figure 5: U.S. Beef and Veal Exports by Destination Country, 1987-1998

(See Fig. 3.5)

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Source: Livestock Marketing Information Center, as cited in Brester *et al*, 2000

Corn

The URAA has had much less impact on the corn sector in North America than on beef. Major markets or potential markets for U.S. corn exports have not opened their markets significantly because of the URAA's market access provisions. The tariffication and tariff reductions by the EU for corn left above-quota tariffs in place that were still 198 percent of value – much too high to affect U.S. exports to that market. In Asia, moreover, major potential markets for U.S. corn, such as Thailand and the Philippines still had very high above-quota bound tariffs (82 and 65 percent of value, respectively) and TRQ systems that effectively limited imports (ABARE, 2002; Phillips, 1999). The problem with India's market was that state power over trade still prevented private traders and non-feed users of corn from importing it (Phillips 1999).

The impact of the URAA on trade in tomatoes in North America is too small to have had any effect on vegetable production in the NAFTA countries. Vegetables have not been a protected sector in North America, so tariffs were already quite low. According to an estimate based on econometric simulation, when other factors are held constant, including the impact of NAFTA, URAA-induced U.S. tariff changes on tomatoes would have increased U.S. imports of Mexican tomatoes by only about 2 percent, or 14,000 metric tons (ERS, 2000). That represented only one one percent of the tomato production by the tomato export sector in Mexico, and would not have changed the production effect – or lack of it – from the NAFTA analyzed above.

The URAA has thus had no discernible impact on the three sectors examined in this study. The effect of the increase in U.S. beef exports to Japan because of the URAA-induced tariff reductions was again overwhelmed by the size of the U.S. domestic market and the impossibility of adjusting herd inventories to price changes. Meanwhile, tariffs on corn and tomatoes simply have not come down sufficiently because of the URAA to affect the production decisions in the United States and Mexico respectively.

IV. Conclusion

This examination of the effect of trade liberalization agreements on environmental stresses in the beef, corn and vegetable sub-sectors in North America underlines the uniqueness of the agricultural sector in the analysis of the environmental consequences of trade liberalization. It demonstrates the importance of studying the details of the linkage between trade changes brought about by trade liberalization and production changes in each agricultural sub-sector. The production effect of increased exports is mediated, and often is nullified, by the technological and biological characteristics of the particular sub-sector. Yield enhancing technologies reduce or eliminate environmental damage from additional production, and biological lags frustrate price signals sent by increased exports. The fact that agricultural producers almost always employ most of their productive capacity in the absence of specific economic incentives to do otherwise further muffles price signals.

These three case studies illustrate three variations on the theme of intermediate factors that have greater influence on production levels than price changes associated with trade liberalization. The dynamics of cattle cycles in both Canada and the United States are determined largely by the biological lag between decisions on herd management and bringing cattle to the market, the constant increase in beef production per head of cattle, and the prolonged periods of non-profitability for producers. Price signals work only at the threshold of profitability, which is only once every few years. Corn producers are also subject to yield changes that may be far larger than changes in price from trade liberalization, and when yields are relatively stable, are likely to decide on planting corn or soybeans for reasons other than shifts in corn prices. In either case, the responsiveness of agricultural producers to price signals associated with trade changes is very low.

Tomato growers, on the other hand, are much more likely to be responsive to price changes in regard to either production or marketing decisions, depending on the markets for which they produce. The Mexican tomato industry's export sector was able to absorb the additional production for export attributable to NAFTA without increasing input use, because of the technological improvements in yield that allowed them to actually reduce the area cultivated. The Florida-based industry, however, had to reduce its area planted because of loss of market to the Mexican industry, and thus used less inputs. This case suggest the possibility that trade liberalization can create win-win outcomes for the environment when yield-enhancing technological improvements loom large enough in the sector. This favorable outcome was facilitated, however, by the differences in the structure of the two competing industries: the Florida-based industry is dependent on the same U.S. market as that served by the Mexican export sector, but the Mexican producers can shift production from their own domestic market to export market, depending on market conditions.

It may be asked how typical these case studies are of agricultural production in other parts of the world. The extremely size of trade changes in relation to total production which characterized U.S. beef and corn sub-sectors is, of course, attributable to the atypical size of the U.S. domestic market. But the mechanisms that moderate or even eliminate productions effects and thus environmental impacts of trade changes appear to be much more widespread, although certainly not universal.

Cattle cycles are certainly not limited to the United States and Canada. As Munlak and Huang (1996) have documented the fact such cycle characterize the dynamics of cattle-raising in all countries where cattle is produced for the market. Dramatical technology change that is constantly raising yields also characterizes both grain and beef sub-sectors in many countries. The production technologies that dramatically boosted yields in the Mexican tomato industry's export sector are increasingly available to vegetable industries competing in global or regional markets around the world.

The general characteristics of grain producers that make price signals relatively unimportant in attempting to calculate the production effects of trade liberalization --- the inability to adjust production levels to price signals, the full use of productive assets, and the inability or unwillingness to shift to other sectors – are clearly applicable to farmers producing for markets everywhere. The unexpected lack of impact on production levels that could be attributable to increased exports in these case studies may therefore have much wider applicability in analyzing the environmental effects of trade liberalization.

This study also dramatizes the extremely limited the impact that global trade liberalization has had on agricultural markets and production. It has been too little recognized that the multiple levels of freedom that the URAA gave WTO member countries to maintain or even increase protectionist measures have made that agreement a dubious contribution to agricultural liberalization. The general result was that products that already had low tariffs were further liberalized, whereas highly protected sub-sectors remained almost entirely unchanged. It should come as no surprise that the instances of meaningful tariff reductions or markedly increased market access (such as Japanese beef) were few and far between in the three sub-sectors covered in this study. In some ways, as noted in the discussion of U.S. and Canadian beef import regimes, the URAA represents a net setback for trade liberalization. There are undoubtedly many other examples. Students of trade and environment should not expect to find much evidence of significant environmental consequences from the URAA for the simple reason that it did very little to alter agricultural trade patterns.

Bibliography

Aadland, D. (2002). Cattle Cycles, Heterogeneous Expectations and the Age Distribution of Capital. Unpublished paper. July.

ABARE. (2002) Global Grains Policy and WTO Agricultural Negotiations. *ABARE Current Issues*. 02.2 (January).

Abler, D. and D. Pick (1993). NAFTA, Agriculture and the Environment in Mexico. *American Journal Agricultural Economics* 75: 794-798.

Abler, D. G. and J. S. Shortle (2001). Decomposing the Effects of Trade on the Environment. *In* J. S. Shortle and D. G. Abler, eds., *Environmental Policies for Agricultural Pollution Control*. Walingford, UK: CAB International.

Ackerman, F., L. Ney, K. Gallagher and R. Flores (2002). Environmental Impacts of the Changes in U.S.-Mexican Corn Trade Under NAFTA. Unpublished paper.

Ackerman, K. Z. (1998). Export Subsidy Commitments: Few Are Binding Yet, But Some Members Try to Evade Them. In *Agriculture in the WTO: Situation and Outlook Series.* Washington, D.C.: USDA ERS.

Agriculture and Agri-Food Canada (2001). Profile of Production Trends and Environmental Issues in Canada's Agriculture and Agri-Food Sector. Online at http://www.agr.gc.ca/cal/epub/1938e/1938_toc_e.html

Agriculture and Agri-Food Canada (2002). U.S.-Canada Quarterly Grain Trade Consultations, May 2002. Online at http://agr.gc.ca/policy/winn/biweekly/English/commerce/may2002ecanus.htm

Agriculture and Agri-Food Canada, Market Analysis Division (2002). Archives. Online at http://www.agr.gc.ca/policy/winn/biweekly/English/gosd/2002/Sep2002ecz.htm

Agriculture and Agri-Food Canada (2001). Profile of Production Trends and Environmental Issues in Canada's Agriculture and Agri-Food Sector. Online at http://www.agr.gc.ca/cal/epub/1938e/1938_toc_e.html

Anderson, D., W. A. Kerr, G. Sanchez and R. Ochoa (2002). Cattle/Beef Subsector's Structure and Competition Under Free Trade. *In* R. M. A. Loyns, K. Meilke, R. D. Knutson, and A. Yunez-Naude, eds., *Structural Change as a Source of Trade Disputes Under NAFTA.* Altona, Manitoba: Texas A&M University, University of Guelph and El Colegio de Mexico.

Andrews, N., R. Nelson and S. H. Hirad (2002). Global Grains Policy and WTO Agricultural Negotiations. *ABARE Current Issues* 2.2 (January):1-8.

Anonymous (2002). USDA: More Corn, Less Soybeans This Year. Ag Answers. March 29. Online at http://www.agriculture.purdue.edu/aganswers

Australian Bureau of Statistics, International Accounts and Trade (2001). Australia's Exports Markets, 1991-92 to 2000-01. *International Merchandise Trade Australia* (June).

Australian Department of Agriculture, Fisheries and Forestry (2002). Red Meat Export Statistics, 1997-2000. Online at http://www.affa.gov.au/

Becker, G. S. (1996). *Cattle Prices: Questions and Answers*. CRS Report for Congress. November 14. Washington, D.C.: Congressional Research Service.

Beghin, J. C. (2002). NAFTA: Implications for Mexican and Midwestern Agriculture. *Iowa Ag Review Online* 7/1 (Winter)

Blandford, D. (1999). *The Upcoming Round of Trade Negotiations: Possible U.S. Objectives and Constraints.* Agricultural Policy Discussion Paper No. 15. Palmerston North, New Zealand: Centre for Applied Economics and Policy Studies, Massey University.

Brester, G. W. (1999). U.S. Beef and Cattle Imports and Exports: Impacts on U.S. Cattle Prices. Briefing No. 3. Bozeman, Montana: Trade Research Center, Montana State University. February.

Brester, G. W. (2000). The Intricate Dynamics of Trade: U.S. Beef and Cattle Imports and Exports, January-April 2000. Briefing No. 10. Bozeman, Montana: Trade Research Center Montana State University. July 25.

Brester, G. W. and J. M. Marsh (1999). U.S. Beef and Cattle Imports and Exports: Data Issues and Impacts on Cattle Prices. Policy Issues Paper No. 9. Bozeman, Montana: Agricultural Marketing Policy Center, Montana State University. Online at http://ampc.montana.edu/publications/policypapers/pp9.html

Brester, G. W., D. Hayes and R. L. Clemens (2000). Negotiating Issues for Beef. *In* L. M. H. Young, J. B. Johnson and V. H. Smith, eds., *WTO Negotiations: Issues for the Northern Plains and Rockies*. Bozeman, Montana: Agricultural Marketing Policy Center, Montana State University.

Burfisher, M. (ed.). (2001). *The Road Ahead: Agricultural Policy Reform in the WTO—Summary Report.* Agricultural Economic Report No. 797. Washington, D.C.: Economic Research Service, U.S. Department of Agriculture.

Burfisher, M., S. Robinson and K. Thierfelder (2001). The Impact of NAFTA n the United States. *Journal of Economic Perspectives* 15/1 (Winter): 125-144.

Cole, M.A., A. J. Rayner, and J. J. Bates (1998). Trade Liberalization and the Environment: The Case of the Uruguay Round. *The World Economy* 21/3 (May): 337:347.

Commission for Environmental Cooperation (1996). *NAFTA Effects, A Survey of Recent Attempts to Model the Environmental Effects of Trade: An Overview and Selected Sources.* Environment and Trade Series, no. 1. Montreal: Commission for Environmental Cooperation.

Commission for Environmental Cooperation Secretariat (2000). Key Approaches Us3ed in Past Environmental Reviews of Trade Agreements. In *Assessing the Environmental Effects of Trade Liberalisation Agreements: Methodologies*. Paris: Organisation for Economic Co-operation and Development.

Cook, B. (1993). The Evolving Bilateral U.S.-Mexico Horticultural Tardiang Relationship: Trends and Issues. Online at http://cook.ucdavis.edu/usmbt/usmexevo.htm

De Gorter, H. (1999). Market Access, Export Subsidies and Domestic Support Measures: Issues and Suggestions for New Rules. Paper presented at the Conference on Agriculture and the New Trade Agenda in the WTO 2000 Negotiations. Geneva, October 1-2.

Diao, X., A. Somwaru and T. Roe (2001). A Global Analysis of Agricultural Trade Reform in WTO Member Countries. University of Minnesota, Economics Development Center

Diakosavvas, D. (2002a). *The Uruguay Round: An Evaluation of the Impacts on Agriculture in the OECD Countries*. Paris: OECD.

Dixit, P., T. Josling and D. Blandford (2001). *The Current WTO Agricultural Negotiations: Options for Progress.* Commissioned Paper No. 18. The International Agricultural Trade Research Consortium.

Dyck, J. (2001). Japan's Changing Agricultural Policies. *Agricultural Outlook* (April): 13-19.

Edney, M. J. (1997). *Quality of Western Canadian Feed Barley and Julless Barlely 1996*. Crop Bulletin No. 229. Winnipeg, Manitoba: Grain Research Laboratory, Canadian Grain Commission.

Ervin, D. (2000). Taking Stock of Methodologies for Estimataing the Environmental Effects of Liberalised Agricultural Trade. In *Assessing the Environmental Effects of Trade Liberalisation Agreements: Methodologies.* Paris: Organisation for Economic Co-operation and Development.

Fabiosa, J. F. (1999). *Institutional Impact of GATT: An Examination of Market Integration and Efficiency in the World Beef and Wheat Markets under the GATT Regime.* Working Paper 99-WP 218. Ames, Iowa: Center for Agricultural and Rural Development, Iowa State University.

Faeth, P. (1995). *Growing Green: Enhancing the Economic and Enviornmental Performance of U.S. Agriculture*. Washington, D.C.: World Resources Institute.

Florida Department of Agriculture and Consumer Services (1999). *Florida Agriculture Facts Book.* Online at http://www.florida-agriculture.com/about.htm

Food and Agriculture Organization of the United Nations (FAO) (1998). *State of the World's Plant Genetic Resources*. Rome: FAO.

FAO (2002). FAOSTAT Agricultural Data. Online at http://apps.fao.org/cgi-bin/nph-db.pl?subset=agriculture

Food and Agricultural Policy Research Institute (FAPRI) (2002a). Database online at http://cardsrv6.card.iastate.edu/scripts/fapri

Fuller, F., J. Beghin, S. De Cara, J. Fabiosa, C. Fang and H. Matthey (2001). *China's Accession to the WTO: What is at Stake for Agricultural Markets?* Working Paper 01-WP 276. Ames, Iowa: Center for Agricultural and Rural Development, Iowa State University.

Gabre-Madhin, E., C. B. Barrett and P. Dorosh (2002). *Technological Change and Price Effects in Agriculture: Conceptual and Comparative Perspectives*. Wasahington, D.C.: International Food Policy Research Institute.

Gale, F. (2001). Subsidized Corn Exports Help Prices Rebound. In H-H. Hsu and F. Gale, coordinators, *China: Agriculture in Transition*. USDA Economic Research Service International Agricultural and Trade Report WRS012. Washington, D.C.: USDA ERS.

Gallagher, K., F. Ackerman and L. Ney (2002). *Economic Analysis in Environmental Reviews of Trade Agreements: Assessing the North American Experience.* Working Paper No. 02-01. Medford, Mass.: Global Development and Environment Institute, Tufts University.

Gianessi, L. P. and M. B. Marcellli (1997). Pesticide Use in U.S. Crop Production. At www.nfap.org

Green, R. (2000). The Uruguay Round Agreement on Agriculture. Paper presented at Symposium on The First Five Years of the WTO, Georgetown University Law Center, 21 January.

Hathaway, D. E. and M. D. Inco (1997). Agricultural Liberalization and the Uruguay Round. In W. Martin and A. Winters (eds.). *The Uruguay Round and the Developing Countries.* Cambridge, U.K.: Cambridge University Press.

Heeringk, N. B. M., J. F. M. Helming, O. J. Kruik, A. Kuyenhoven, and H. Verbruggen (1993). *International Trade and Environment*. Wagingen Economic Studies 30. Wagingen.

Inco, M. D. (1995). *Agricultural Trade Liberalization in the Uruguay Round: One Step Forward, One Step Back?* Policy Research Working Paper. Washington, D.C.: World Bank International Economic Department, International Trade Division.

Kennedy, L., L. Brink, J. Dyck and D. MacLaren (2001). *Domestic Support: Issues and Options in the Agricultural Negotiations*. Commissioned Paper No. 16. The International Agricultural Trade Research Consortium.

Lambert, C. (2001). U.S. Beef and Cattle Imports, Exports and Balance of Trade. Online at http://www.beef.org/documents/TRADE%20Facts%201-01.doc

Lawrence, J. D. (1999). North American Beef Production, Demand and Trade Challenges and Opportunities: A Perspective from the United States. Paper presented at a conference in Guadelajara, Mexico. June.

Leuck, D. (2001). *The New Agricultural Trade Negotiations: Backgrounds and issues for the U.S. Beef Sector*. LDP-M-89-01. Washington, D.C.: Economic Research Service.

Louette, D. (1995). Seed Exchange among Farmers and Gene Flow among Maize Varieties in Traditional Agricultural Systems. In J. A. Serratos, M. C. Willcox and F. Castillo, eds., *Gene Flow among Maize Landraces, Improved Maize Varieties and Teosinte: Implications for Transgenic Maize*. Proceedings of a Forum, El Batan, Mexico, 21-15 September 1995. Mexico City: International Maize and Wheat Improvement Center.

Lucier, G. and C. Plumber (2001). *Vegetables and Melons Outlook*. VGS-288, December 14. Washington, D.C.: USDA Economic Research Service

Malaga, J. E., G. W. Williams and S. W. Fuller (2001). US-Mexico Fresh Vegetable Trade: The Effects of Trade Liberalization and Economic Growth. *Agricultural Economics* 26/1 (October): 45-55.

Marsh, J. M. (1998). NAFTA and GATT: Implications for U.S. Beef Market Prices. In *Markets, Prices, Policies and Risks: The Economic Future of Agriculture in the Northern Plains.* Bozeman, Montana: Agriculture Marketing Policy Center, Montana State University--Bozeman.

Marsh, J. M. (1999). U.S. Beef Trade and Price Relationships with Japan, Canada and Mexico. Policy Issues Paper No. 12. Bozeman, Montana: Trade Research Center, Montana State University.

Matthews, K. H., W. F. Hahn, K. E Nelson, L. A. Duewer and R. A. Gustafson (1999). *Cattle Cycles, Price Spreads and Packer Concentration.* Technical Bulletin No. 1874. Washington, D.C.: USDA, ERS.

Miljkovic, D., J. M. Marsh and G. W. Brester (2000). Japanese Import Demand for U.S. Beef and Pork: Effect on U.S. Red Meat Exports and Livestock Prices. Unpublished paper. Online at http://iatrcweb.org/oldiatrc/Papers/Miljkovic.pdf.

Morgan, T. H. (1996). U.S. Beef Imports: Changes in Levels and Composition. Morgan's Beef Articles and Commentary. August 12. Online at http://www.ag-web.com/beef/articles/1996ap19960812w01.html

Mundlak, Y. and H. Huang (1996). International Comparisons of Cattle Cycles. *American Journal of Agricultural Economics* 78 (November): 855-68.

Nadal, A. (1999). Maize in Mexico: Some Environmental Implications of the North American Free Trade Agreement. In *Assessing Environmental Effects of the North American Free Trade Agreement (NAFTA): An Analytical Framework (Phase II) and Issue Studies*. Montreal: Commission for Environmental Cooperation.

Nadal, A. (2000a). Corn and NAFTA: An Unhappy Alliance. *Seedling: The Quarterly Newsletter of Genetic Resources Action International* 12/2 (June).

Nadal, A. (2000b). *The Environmental and Social Impacts of Liberalization on Corn Production in Mexico.* Gland, Switzerland and Oxford, UK: WWF International and Oxfam GB.

National Food and Agricultural Policy Project (NFAPP) (1996). *Economic Analysis of the Mexico/Florida Fresh Winter Tomato Dispute*. NFAPP Policy Paper Series. June

National Research Council (1993). *Managing Global Genetic Resources: Agricultural Crop Issues and Policies.* Washington, D.C.: National Academy Press.

Normile, M. A. (1998). Uruguay Round Agreement on Agriculture: The Record to Date. *Agricultural Outlook* (December): 28-33.

Ontario Cattlemen's Association (2002). Industry Statistics. Online at http://cattle.guelph.on.ca/statistics/index.html

Ontario Farm Animal Council (2002). Beef Cattle Farming in Ontario – Fact Sheet. Online at http://www.ofac.org/factsheets/fact7.html

Organisation for Economic Co-operation and Development (OECD) (1998a). *Improving the Environment Through Reducing Subsidies, Part II: Analysis and Overview of Studies.* Paris: OECD.

OECD (1998b). *The Environmental Effects of Reforming Agricultural Policies*. Paris: OECD.

OECD (2002). Agricultural Policies in OECD Countries: Monitoring and Evaluation. Paris: OECD.

OECD Directorate for Food, Agriculture and Fisheries and Environment Directorate (2000). *Domestic and International Impacts of Agricultural Trade Liberalisation.* COM/AGR/ENV(2000)75/FINAL. 8 November.

OECD Environment Directorate and Trade Directorate (1994). *Issues Paper: Trade Liberalisation and the Environment.* Joint Session of Trade and Environment Experts, CM/ENV/TD(94)136. December 14-16.

Parris, K. (2002). Environmental Impacts in the Agricultural Sector: Using Indicators as a Tool for Policy Purposes. Paper presented to the Commission for Environmental Cooperation Meeting, "Assessing the Environmental Effects of Trade," Montreal, 17-18 January.

Pena, J. G. (2000a). NAFTA's Effect on the North American Beef Industry. *Ag-Eco News* 16 (September 7).

Pena, J. G. (2000b). Export Trade Through NAFTA Helping Sluggish Ag Eoconomy. *Ag-Eco News* 16 (May 3).

Pierce, R. and R. Sharma (2000). Export Subsidies. In *Multilateral Trade Negotiatioins on Agriculture: A Resource Manual*. Rome: FAO.

Phillips, K. (1999). Statement by National Corn Growers Association before Senate Committee on Agriculture, Nutrition and Forestry. September 30. Online at www.senate.gov/~agriculture/Hearings/Hearings_1999.phi9993-.htm

Plunkett, D. J. (1996). Mexican Tomatoes—Fruit of New Technology. *Vegetables and Specialties S&O/VGS-268*. USDA Economic Research Service Report. April.

Prevatt, J. W. and J. VanSickle (2000). United States Cattle Cycles: Perspectives on U.S. Cattle and Calves Inventories and Prices. Institute of Food and Agricultural Sciences, Cooperative Extension Service, University of Florida. Online at http://edis.ifas.ufl.edu/BODY_FE164.

Rae, R. N. (2001). Trade in Livestock Products and the WTO Millennium Round: Projections to 2005 and Problems with TRQs. Paper presented at the International Agricultural Trade Consortium Symposium on Trade in Livestock Products, Auckland, New Zealand, 18-19, January.

Ray, D. E. (2001). Crop Agriculture Faces Long-Term Price and Income Problems. Testimony before the Committee on Agriculture, U.S. House of Representatives, February 14, 2001.

Rindermann, R. S. and M. A. G. Cruz (1997). Competitividad de la Produccion Horticola Mexicana en el Mercado Norteamericano: Tendencias a Tres Anos del TLC. Presented at the 1997 meeting of the Latin American Studies Association, Guadalajara, Mexico, April 17-19.

Roberts, I. (1998). Agriculture and EU Politics. In *Liberalizing World Trade in Agriculture: Strategies for the Cairns Group Countries in the WTO*. Barton, Australia: The Rural Industries Researach and Development Corporation.

Romero, M. V., R. S. G. Estrada, T. O. Enciso and A. D. A. Bojorquez (2002. Nitrogen Rate and Source Effect on Yield and Postharvest Quality of Tomato, Grown in Fertigation Conditions. *Terra* 20 (3).

Rosen, S. K., M. Murphy and J. A. Scheinkman (1994). Cattle Cycles. *Journal of Political Economy* 102(3): 468-92

Rosenzweig, A. (2001). Mexican Agricultural Trade Under NAFTA: An Assessment After Five Years of Implementation. In R. M. A. Loyns, K. Meilke, R. D. Knutson and A. Yunez-Naude, eds., *Trade Liberalization Under NAFTA: Report Card on Agriculture*. Altona, Manitoba: Texas A& M University, University of Guelph and El Colegio de Mexico.

Rude, J. (2001). Impact of CUSTA/NAFTA: A Canadian Perspective. Paper presented to Conference n North American Trade Relationships: Poilcy Challenges for 2002 and Beyond. Chicago, December 6.

Runge, C. F. (1996). Environmental Impacts of Agricultural and Forestry Subsidies. In *Subsidies and the Environment: Exploring the Linkages*. Paris: OECD.

Runge, C. F. with G. Fox (1999). Feedlot Production of Cattle in the United States and Canada: Some Environmental Implications. In *Assessing Environmental Effects of the North American Free Trade Agreement (NAFTA): An Analytic Framework (Phase II) and Issue Studies*. Montreal: Commission for Environmental Cooperation.

Runge, C. F., E. Cap, P. Faeth, P. McGinnis, D. Papageorgiou, J. Tobey and R. Housman (1997). *Sustainable Trade Expansion in Latin America and the Caribbean: Analysis and Assessment*. Washington, D.C.: World Resources Institute.

Salcedo-Baca, S. (1998). Discussion: SERFIN. *In* R. M. A. Loyns, K. Meilke, R. D. Knutson, eds., *Economic Harmonization in the Canadian//U.S./Mexican Grain/Livestock Subsector*. Altona, Manitoba: Texas A& M University, University of Guelph and El Colegio de Mexico.

Schrader, E. (1995). A Giant Spraying Sound. *San Diego Earth Times*. May. Online at http://www.sdearthtimes.com/et0595/et0595s6.html

Statistics Canada (2002a). 1996 Census of Agriculture. Online at www.statcan.ca/english/agcensus1996/tables.pdf

Statistics Canada. (2002b). 2001 Census of Agriculture. Online at http://www.statcan.ca/english/agcensus2001/pdf

Stewart, W. M. and T. L. Roberts (2002). Inorganic Nutrient Use. *Better Crops* 86/2: 4-5.

Sumner, D. A. (1995). *Agricultural Trade Policy: Letting Markets Work.* Washington, D.C.: American Interprise Institute for Public Policy Research.

Sumner, D. A. and S. Tangermann (2001). International Trade Policy and Negotiations. In B. Gardner and G. Rausser, (eds), *Handbook of Agricultural Economics*. North Holland: Elsvier

Tangermann, S. (1996). Implementation of the Uruguay Round Agreement on Agriculture: Issues and Prospects, *Journal of Agricultural Economics* 47/3: 315-337.

Tangermann, S. (2001). *Has the Uruguay Round Agreement on Agriculture Worked Well?* International Agricultural Trade Research Consortium Working Paper 01-1. October

Trapp, J. N. (1986). Investment and Disinvestment Principles with Nonconstant Prices and Varying Farm Size Applied to the Beef-breeding Herds. *American. Journal. of Agricultural Economics* 68 (August): 691-703.

Tripp, R. and W. van der Heide (1996). The Erosion of Crop Genetic Diversity: Challenges, Strategy and Uncertainties, *Natural Resource Perspectives* 7 (March)

Tweeten, L., G. Gray and S. Salcedo (2002). Structure of Farming under Freer Trade among NAFTA Countries. In *Structural Change as a Source of Trade Disputes under NAFTA*, R. M. A. Lyons, K. Meilke, R. D. Knutson and A. Yunez-Naude, eds.. Altona, Manitoba: Texas A&M University, University of Guelph and El Colegio de Mexico.

United States Department of Agriculture (USDA) (2002). Livestock Data. Online at www.cattle-fax.com/data/

USDA, Economic Research Service (ERS) (1999). NAFTA. Situation and Outlook Series. WRS-99-1. August.

USDA, ERS (2000). *NAFTA Commodity Supplement*. May.

USDA, ERS (2001). Mexican Cattle Exports to the U.S.: Current Perspectives. *Agricultural Outlook*. June-July.

USDA, ERS (2002b). European Union: Policy. Briefing Room. Online at http://www.ers.usda.gov/briefing/European Union/PolicyUruguay.htm

USDA, ERS (2002c). *Red Meats Yearbook*. Online at http://www.ers.usda.gov/data/sdp/view.asp?f=livestock/94006/

USDA, Foreign Agriculture Service (FAS) (1996). Mexican Tariff Rate Quotas. Attache Report from American Embassy, Mexico City. October 11. On line at http://www.fas.usda.gov/scripsw/attacherep/display_gedes_report.asp?Rep_ID=10007259

USDA, FAS (1998). Mexico Announces New Corn Import Allocations. Attache Report from American Embassy, Mexico City. June 17. online at http://www.fas.usda.gov/scripsw/attacherep/display_gedes_report.asp?Rep_ID=25331330

USDA, FAS (1999). Prolonged Mexican Drought and Effects on U.S.-Mexican Cattle Trade. Online at http://fas.usda.gov/dlp2/highlights/99-06/wmr_0618.htm.

USDA, FAS (2000). NAFTA Fact Sheets. online at http://fas.usda.gov/itp/policy/nafta/nafta.html

USDA, FAS (2002a). Mexico's Cattle and Beef Situation. Online at www.fas.usda.gov/dlp/circular/2002/02-03LP/mxbfsit.pdf

USDA, FAS (2002c). FAQs Regarding U.S. Cattle and Beef Imports from Canada. Online at http://www.fas.usda.gov/dlp/Canada/questions.htm

USDA, FAS (2002d). Meat Situation in the European Union in 2002. FAS Online. http://www.fas.usda.gov/dlp/circular/2001/01-10LP/EUmeat.html

USDA, National Agricultural Statistics Services (NASS) (2001). *U.S. Cattle Supplies and Disposition*. Washington, D.C.: USDA, NASS.

USDA, NASS (2002). Census of Agriculture, 1997. online at www.nass.usda.gov/census/

United States, International Trade Administration (2002). Fact Sheet: Termination of Agreement Suspending an Anti-Dumping Investigation on Impacts of Fresh Tomatoes from Mexico. No date. Washington, D.C.: International Trade Administration. Online at www.ita.doc.gov/media.

United States Trade Representative (USTR) (1997). *Study on the Operation and Effect of the NAFTA.* Washington, D.C.: USTR.

USTR, FTAA Interagency Environment Group (2000). *Report of the Quantitative Analysis Working Group.* Washington, D.C.: USTR.

USTR (2001). *National Trade Estimate Report on Foreign Trade Barriers*. Washington, D.C.: USTR.

Van Eenoo, E., E. Peterson and W. Purcell (2000). Impact of Exports on the U.S. Beef Industry. Paper at NCR 134 Conference on Applied Commodity Price Analysis, Forecasting and Market Risk Management, Chicago, April 17-18.

Von Meijl, H. and van Tongeren, F. (2002). The Agenda 2000 CAP Reform, World Prices and URAA GATT-WTO Export Constraints. *European Journal of Agricultural Economics* (December).

VanSickle, J. (2000). Vegetables and the World Trade Organization. Online at http://cnas.tamu.edu/publications/8Vegs.pdf

WTO (1999). *Committee on Agriculture-- Notification—Norway—Export Subsidies*. G/AG/N/NOR/23. November 16. Geneva: WTO.

WTO (2002a). *Committee on Agriculture--Notification—Switzerland—Export Subsidies*. G/AG/N/CHE/25. March 25. Geneva: WTO.

WTO (2002b). *Committee on Agriculture--Notification—United States—Export Subsidies*. G/AG/N/USA/39. April 25. Geneva: WTO.

Young, C. E., M. Gehlhar, F. Nelson, M. E. Burfisher, and L. Mitchell (2001). Options for Reducing the Aggregate Measurement of Support in OECD Countries. *In* Burfisher, M. (ed.). *The Road Ahead: Agricultural Policy Reform in the WTO—Summary Report.* Agricultural Economic Report No. 797. Washington, D.C.: Economic Research Service, U.S. Department of Agriculture.

Young, L., D. Barber and G. Fetterby (1997). *Report on Canadian Beef Supply and Disposition with Beef Quality Categorization.* Ottawa: Economic and Policy Analysis Directorate, Agriculture and Agri-Food Canada.

Young, M, P. C. Abbott and S. Leetma (2001). *Export Competition: Issues and Options in the Agricultural Negotiations*. Commissioned Paper No. 15. St. Paul, Minn.: International Agricultural Trade Research Consortium.

Yunez-Naude, A. (1998). Small-Scale Corn and Livestock Mexican Farmers. *In* R. M. A. Loyns, K. Meilke, R. D. Knutson, eds., *Economic Harmonization in the Canadian-U.S.-Mexican Grain/Livestock Sector*. Altona, Manitoba: Texas A.&M University, University of Guelph and El Colegio de Mexico

Yunez-Naude, A. (2002). Mexico's Basic-Crops Subsector: Structure and Competition Under Free Trade. *In* R. M. A. Loyns, K. Meilke, R. D. Knutson, and A. Yunez-Naude, eds, *Structural Change as a Source of Trade Disputes under NAFTA.* Altona, Manitoba: Texas A.&M University, University of Guelph and El Colegio de Mexico.

Zahniser, S. and J. Link (2002). *The Effects of the North American Free Trade Agreement on Agriculture and the Rural Economy*. Agriculture and Trade Report No. WR-02-1. Washington, D.C.: USDA Economic Research Service.

Zahniser, S., R. A. Hoppe, J. Johnson and D. Banker (2002). Structural Change in an Era of Increased Openness: A Background Paper on the Structure of U.S. Agriculture. *In* R. M. A. Loyns, K. Meilke, R. D. Knutson, and A. Yunez-Naude, eds, *Structural Change as a Source of Trade Disputes under NAFTA.* Altona, Manitoba: Texas A.&M University, University of Guelph and El Colegio de Mexico.

Zahniser, S. (personal communication). Stephen Zahinser, USDA, Economic Research Service, telephone interview, August 20, 2002.