Economic Valuation and Trade-Related Issues

Prepared by Scott Vaughan, Carnegie Endowment for International Peace,
Washington, DC

for the Secretariat of the Commission
for Environmental Cooperation of North America

As part of the Article 13 initative on
Maize and Biodiversity: the Effects of Transgenic Maize in Mexico

This paper reflects only the views of the author and not necessarily those of the Secretariat of the Commission for Environmental Cooperation, the governments of Canada, Mexico and the United States, or the CEC Advisory Group on Maize and Biodiversity: the Effects of Transgenic Maize in Mexico.

A. Economic Valuation

1. State of Knowledge

In recent years, an extensive body of literature has emerged estimating the economic value of the environment and biodiversity-related services and amenities (Constanza *et al.* 1997, Freeman 1993, Loomis 1992, Pearce and Turner 1992, Aylward and Barbier 1992, Munasinghe 1993, World Bank 1997). The goal of economic valuation—which finds some of its roots in cost-benefit analysis—is to impute a market value for environment-related services and amenities. Economic valuation is a used, often at the project-assessment level, because market prices either do not exist or are difficult to measure. In the past decade, advances in valuation have increased the kind of environmental costs and benefits that can be monetized. In general, valuation involves quantifying or monetizing human preferences for environmental services and amenities.

An extensive body of literature exists of valuation studies, usually applied at the local or regional level, to estimate values of forests, coastal and marine areas, protected areas, species, plant genetic resources, greenbelt areas and a whole range of other environmental media. Estimates at the global level by Constanza *et al*. (1997) found that the total annual value of the world's ecosystem functions is US$36 trillion. This estimate has sparked a lively debate in the field about methodologies, underlying data and ways in which different parts of valuation estimates are added up. While economists debate methods, data aggregation and techniques, there is universal agreement that biodiversity has an important value tthat is grossly underestimated or ignored in markets. Hence, the question for valuation is whether it affects policy choices.

Valuation has arisen from cost-benefit analysis (CBA) work, often applied at the project level. There, CBA has revealed the costs and benefits of different projects—for example, proposed roads or dams or reforestation projects—and has led, as part of an environmental impact assessment approach, to design modification or radical changes to a proposed project. Valuation extends CBA techniques in several ways (Bishop 1999). The most significant is its focus in the biodiversity context on indirect and intangible non-market values. Assumptions about indirect and intangible non-market values are controversial, in part because of incomplete scientific understanding of biodiversity functions and relationships.

Policy Links

Given that the most important part of biodiversity valuation involves non-market values, it should not be surprising that valuation exercises rarely lead to any kind of "yes-no" policy matrix or options. However, valuation generally can help redress what is commonly referred to as the "internalization of environmental externalities," whereby values are monetized in such as way so as to show that market prices, as currently constituted, fail to tell the ecological truth about environment-related costs and benefits. Valuation can also help policy-makers understand and value traditional farming practices intended to conserve the diversity of maize land races, and find supporting public policies for such efforts. Bellon, in observing small farmer actions in Mexico in which the value of maize land races is inferred through practices, forwards a series of conservation strategies and policies, drawing largely upon these inferred values (Bellon 2001).

In attempting to correct pricing failures, valuation can also form a bridge to various incentive and market-based approaches to biodiversity conservation (Grig-Gran 2000). There are then a range of policy tools that can partially (or fully) redress pricing failures, including environmental charges and user fees. In practice, these are almost never used because of lack of political will or citizen acceptance of higher taxes. Blunter instruments can also arise from valuation exercises. If, for instance, open markets can lead to the loss of diversity of maize land races that have exhibited high values, then various trade measures, like important constraints, can be used. Moreover, valuation may also be used to monetize damages associated with loss, which can in turn be used as one basis for liability or other claims.

Three general approaches to economic valuation are: (a) estimates of averted behavior; (b) hedonic pricing estimates, using changes in real estate-type prices as a proxy; and (c) contingent valuation, based on willingness-to-pay (WTP) type questionnaires. There are various strengths and weaknesses with different techniques that have been described in the literature (Carson 2002, Dixon and Sherman 1990). More generally, however, such approaches attempt to measure the total economic value (TEV), measured as:

TEV = Direct Use Value + Indirect Use Value + Option Value + Existence Value (Georgiou *et al.* 1997)

It has been recognized for some time that basing TEV on adding up different components in this way is problematic (Hearse 1996), for several reasons. Relative weightings between different categories are neither symmetrical nor sequential. There may well be some overlap in categories, for example, between indirect use value and option values, which could lead to some double counting. At the same time, it is worth noting briefly some of the considerations of these different categories and their general relation to how one might begin evaluating maize.

Direct Use Values are those derived from the direct use of environmental services and amenities, through some kind of measurable and reasonably transparent revenue. In the case of maize, for example, this would include farm income derived directly from maize varieties (both farmgate and informal revenues).

Of far greater importance to direct use value estimates is the present value that genetic materials derived from land races contribute to enhanced crop output or quality through current plant breeders programs. There is significant value from improved or expanded farm output, derived from genetic material inputs, contributing to greater food security or providing resistance to the risk of crop failure. Approximately one-half of the total increase in agricultural productivity in the 20th century is directly attributed to "artificial selection, recombination and intra-specific gene transfer procedures" (Woodruff and Gall 1992). Most modern crops benefit from genetic materials incorporated from related wild species, or from more primitive genetic stocks still used and maintained by communities that practice traditional agricultural (Secretariat of the Convention of Biological Diversity 1996). For maize, one study estimates that in the United States, between 1930 and 1980, genetic material inputs contributed to an 89-percent yield gain of 103 kg/ha/yr in commercial stocks, and a 71-percent yield gain in single-cross hybrids (Duvick 1984).

Indirect Use Values measure different ecological functions associated with the environment and biodiversity. For example, narrowing the variety of a given species may affect other species and ecosystem functions more generally. These changes can include various

synergistic effects, such as altering adjacent habitats, reducing ecological services like nutrient storing in soils, the maintenance of watersheds, changes to migratory areas, or carbon storage functions.

Option and Existence Values involve measuring in some way an individual's "willingness to pay" (WTP)—often with no direct relationship to the service or amenity—for the preservation of that service or amenity. Indirect uses and option values include the value of genetic materials in future plant breeders programs; the value of maize varieties in supporting various ecosystem services; the value of indigenous and traditional knowledge associated with traditional varieties (land races); and the value that individuals place simply in knowing that land races exist.

Methods to estimate these values revolve around an individual's WTP to obtain a desired good or services—and "willingness to accept" (WTA)—the amount of money needed to induce someone to do without the desired good or services—to measure preference satisfaction.[1]

Valuation exercises of the general approach described above can be greatly enhanced by referring to research that examines farmer behavior generally, including field research that explains choices of small-scale farmers in Mexico and elsewhere in maintaining on-farm diversity as a strategy to conserve crop genetic resources (Bellon and Brush 1994). For example, Bellon argues that the diversity of maize land races maintained by farming households in Mexico reflects a strategy to conserve crop genetic diversity, which in turn provides an accurate or real world estimation of the value farmers attach to this crop diversity (Bellon 2001). Field studies have looked at different reasons why small-scale farms in Mexico grow more than one crop variety, and the implications of crop varieties on value. Among the factors examined include differing perceptions of yield, price and consumption risk (Carter and Wiebe 1990), uncertainty or hedging related to crop experimentation and learning (Tsur *et al.* 1990), the persistence of incomplete or missing markets (de Janvery *et al.* 1991), the absence of external fertlizer inputs or markets (McGuirk and Mundlak 1991), and jointly produced crop outputs (Renkow and Traxler 1994). One of the interesting observations of farmer behavior in the face of incomplete or missing markets such as described above is that farmers allocate land among varieties "according to the shadow value of [varieties of maize] which are determined by household production processes and utility parameters (Smale *et al.* 1999a)."

2. Areas of Disagreement

There is consensus that economic valuation is useful in measuring human preferences, as noted. However, it does not attempt to measure in any way what some might describe as the "intrinsic value" of the environment. While some would voice discord that valuation may end up "commodifying" the environment, that is not its goal. Rather, it has a much more limited scope: to impute or infer the price of human preference—the demand curve—for environmental services and amenities (Georgiou *et al.* 1997).

Valuation represents what the National Academy of Sciences calls one "particular perspective" about biodiversity, as opposed to *the* perspective of how society values the environment (Commission on Life Sciences 1999). The proxy for gauging human

[1] The *Commission of Life Sciences* (2000) describes this relationship as WTP representing the buyer's best offer, and WTA representing the seller's best reservation price (that is, the price at which the seller will hold rather than selling).

preferences is money: valuation estimates the price that biodiversity would yield *provided that a market exists for that service.* As noted, since biodiversity services extend well beyond direct use values—that is, measuring the contribution that germplasm makes to crop productivity)—to include numerous non-use values, most valuation entails estimating biodiversity services that are never exchanged in the marketplace.

Despite consensus about the scope of valuation, considerable methodological challenges remain about valuation in general. In the former area, there are numerous methodological problems. Among the critiques of different WTP techniques—notably contingent valuation questionnaire-type approaches—is that results may be skewed towards individuals with higher incomes, and answers may miss potential impacts that are not revealed until the future. Different techniques have been used to discount present and future benefits, while more recent criticism has focused on shortcomings of discounting.

Among the particular challenges of estimating direct use and option values of land races is estimating the present and future contribution of germplasm to plant breeding programs. According to IPGRI, estimating the value of crop genetic resources derived from *ex situ* crops remains, "exceedingly difficult," largely because such resources have multiple and indirect economic functions (International Plant Genetic Resources Institute 2002a). One way of estimating the value of germplasm from land races is to track breeders' demand for germplasm, as well as its intended use, thereby creating a proxy demand curve for germplasm materials in a more immediate manner than WTP estimates.[2]

3. Unresolved Issues

The predominance of indirect values points to at least key challenges in any valuation exercise, including the valuation of land races. The first is the issue of complexity. Valuation studies by definition draw upon information from the natural sciences. Despite remarkable advances in scientific knowledge, gaps in the scientific understanding of biodiversity functions and ecosystems linkages persist. In short, since our scientific knowledge of biodiversity services and amenities is "incomplete" (Dietz and Stern 1998), so too will be the economic valuation of such services.

The complexity of scientific linkages is especially relevant when considering maize. Changes in the genetic traits of maize have accelerated with the growth of hybrid varieties at the global level. It remains complex to isolate the different sources and consequences of germplasm diffusion,[3] and then estimate the value of these changes relative to some proxy value, for instance, pure *Zea mays* or teosinte varieties.

---

[2] IPGRI notes that for large national collections, a combination of database records and requestor surveys can provide essential information. The next step would be more detailed investigation of how such germplasm has been utilized through a focused survey of requestors, such as those implemented through the IPGRI Project *"Linking Conservation and Use."* For smaller banks, records may not be fully assembled or digitized. Studies of this type generate important information about where the value of conserved resources lies, for example, in generating new scientific knowledge that contributes indirectly to technical change or in generating more direct production benefits through contributing to the release of improved varieties. (See International Plant Genetic Resources Institute, CGIAR Systemwide Information Network for Genetic Resources 2002).

[3] Germplasm diffusion take place through a number of osurces, including through formal maize programs under the CGIAR umbrella; diffusion of commercial seed sales and the growing importance of hybrid seeds; and diffusion brought about at the household level, and of course, possible changes arising from the outcrossing of maize with biotechnology-derived characteristics (the topic of the Article 13 analysis).

The second unresolved issue, as noted above, is the importance of non-market values associated with land races. These non-market values often reflect public, as opposed to private, goods. Like other public goods, most remain under-priced, or altogether external to market signals. The common approach, once values are revealed, is to internalize them in market prices.[4]

4. Priority Topics for Research

The first priority of research would be to do a complete literature review of valuation exercises and field research, such as described briefly above, of land races from Mexico, in particular, from the Oaxaca region. This should also draw upon work undertaken outside Mexico, and involve other crops or biological services from which lessons can be extrapolated for the study of maize.

A second research priority—given that while existing valuation exercises are extensive, they may be of limited relevance in terms of the Article 13 work—would be to undertake a valuation assessment on the ground, in Oaxaca. Such a review could entail estimating the TEV of land races, in a manner(s) to be determined.

As noted above, there are different approaches to estimating TEV, including using various WTP studies complemented by results of field studies following farmer behavior. The intended result of this work is to quantify the costs and benefits of conserving traditional maize varieties. As noted above, the introduction of transgenic corn is hardly the sole factor that has affected, and is affecting traditional maize varieties. The genetic diversity of seeds in Mexico has been affected by centuries of farmer-conducted seed management and variety choices (Smale *et al.* 1999b). One approach to such a study would revolve around consideration of the threat to land races. Identifying potential risks at the outset—this note makes no assumptions about their likelihood—builds upon standardized economic valuation techniques, in which the value of benefits and costs related to proposed changes to an environmental or biodiversity service or amenity are weighed.

Several risks to land races may arise if a transgene spreads to them (J. Carpenter *et al.* 2002). One entails the unintentional diffusion of the transgene in a way that affects the integrity of ancestral forebears, *Zea mays* or teosinte or land races. Such a transgene spread could directly or indirectly affect farmgate revenues or, more importantly, put at risk the contribution that genetic derivatives of teosinte extracted and used by plant breeders to enhance crop productivity, reduce stress tolerance, bolster pest resistance, as well as contribute to the storing of genetic material for future breeding needs.[5]

These direct and indirect use values are likely to be increased further because of the geographic uniqueness of teosinte (see map, Appendix 1) to Mexico, as well as to other Meso-American countries. An important assumption in economic valuation of biodiversity

---

[4] One of the most intuitively obvious ways of doing this is estimating indirect damages associated with environmental degradation. For instance, valuation is commonly used to quantify the costs of industrialized farm production by way of soil erosion, nutrient run-off, or health-related costs of pesticide residues in fruit or vegetables. The distribution of these costs is quite different. For example, farmers will bear some costs of soil erosion through lower crop yields and associated losses in land or freshwater productivity. However, most costs are passed along to the public in a way that is unpriced, and external to the market price of farm produce.

[5] Native maize diversity is used by plant breeders to increase the quality and productivity of maize crops worldwide. The Mexico-based International Center for Maize and Wheat Improvement (CIMMYT) also holds the world's most important *ex situ* collection of maize seeds.

generally is that uniqueness and scarcity are significant determinants of total economic value (Commission on Life Sciences 1999).

A second possible risk to consider involves the outcrossing of transgenes with wild and/or land races, with the outcrossing resulting in the formation of weed-like (or harder-to-control) conditions. Economic costs associated with such an occurrence include the impacts on non-maize crop output, or on other species of flora and fauna that become stressed because of such an outcrossing.

A third risk involves the costs arising from the introduction of corn transgenes on rural communities and, in particular, indigenous and traditional knowledge. It has long been established that mega-diverse areas are also geographic areas with rich and diverse cultural values and traditions. The UN Convention on Biological Diversity, in Article 8(j), recognizes this link thus:

> Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.[6]

This sentiment is echoed in a CEC working paper (2001), which observes that "[a]bove all, biodiversity in North America may be most valued for its cultural importance…."(Hanson *et al.* 2001). This may be especially true when estimating the value of land races in Mexico. Maize has been developed over thousands of years by indigenous farmers in Mexico. Indeed, several studies confirm the presence of dented corn in funerary urns of Zapotecan origin. Today, between two and three million small-scale farmers in Mexico, representing over 40 different languages or cultural traditions, are involved in the production of maize. More important than the historical role that maize plays is its presence within living mythologies of rural communities, which harbor as central motifs references to corn production and consumption as symbols of natural and mystical cycles (Nadal 1999).

---

[6] As part of the Article 8(j) work program of the Convention on Biodiversity dealing with traditional knowledge, Governments and Contracting Parties have undertaken:

- to establish mechanisms to ensure the effective participation of indigenous and local communities in decision-making and policy planning;
- to respect, preserve and maintain traditional knowledge relevant to the conservation and sustainable use of biological diversity;
- to promote its wider application with the approval and involvement of the indigenous and local communities concerned; and
- to encourage the equitable sharing of the benefits arising from the utilization of such traditional knowledge.

<http://www.biodiv.org/programmes/socio-eco/traditional/>.

B. Trade-Related Issues

This section is intended as a general introduction to some international trade and trade-related obligations relevant to maize and transgenic maize. It is not intended to be exhaustive, nor does the overview weigh or interpret such rules. Three general points are worth noting. First, there has never been a formal WTO or NAFTA dispute involving transgenic crops. Therefore, consideration of potential WTO rule coverage is for discussion purposes only. Second, the Biosafety Protocol of the Convention on Biological Diversity has not yet entered into force. Third, the work of the Codex Alimentarius working groups is ongoing (only applies to food safety isues not environmental issues).

Before describing some of these provisions generally, it is useful to examine generally international trade in maize and transgenic corn. According to the International Maize and Wheat Improvement Center (CIMMYT), the United States is the world's largest maize producer and exporter. Approximately 94 percent of current total maize exports from the United States are bound for Latin America in general, and Mexico and Colombia in particular (Meng and Ekboir 2001). This coincides with overall trends in agri-food trade: the US accounts for approximately 75 percent of total Mexican agricultural imports, followed by Canada with about 7 percent.

The following summarizes trends of the leading three maize exporters over the past decade.

Table 1 – Exports Maize from Three Leading Maize Exporters (thousand metric tonnes)

	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01
US	41,766	33,148	58,645	52,500	46,633	37,697	51,886	46,500	49,500
Argentina	4,779	4,230	6,046	6,700	10,210	12,756	7,849	8,800	9,500
China	12,623	11,769	1,413	250	3,892	6,173	3,340	9,000	6,000

Source: IMWIM, from United States Department of Agriculture, 2001

The following summarizes trends in maize imports of the three NAFTA countries over the past decade.

Table 2 – NAFTA Country Imports of Maize (thousand metric tonnes)

	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01
Mexico	396	1,691	3,166	6,400	3,141	4,376	5,615	4,600	5,000
US	166	519	245	385	285	126	388	325	325
Canada	1,190	585	1,108	650	874	1,148	903	800	500

Source: IMWIM, from USDA, 2001

It is anticipated that total imports of maize into Mexico from the United States will increase substantially following 1 January 2003, at which point disciplines of the North American Free Trade Agreement (NAFTA) related to the reduction of domestic price support programs for maize—as well as wheat, rice, barley, potatoes, diary products and other agricultural commodities in Mexico—come into effect (*The New York Times* 2002a).

Before briefly noting some relevant NAFTA and other disciplines, it is useful to refer to trade in commercial seed of corn/maize. According to the International Seed Federation, the commercial world seed market is approximately US$30 billion (International Seed Federation 2002), representing a dramatic increase since the 1970s. In 2000, total sales in

maize/corn seeds worldwide is US$530 million. The estimated value of the commercial market for seed and planting materials in Mexico, for all crops, is $350 million.

1. NAFTA

NAFTA entered into effect on 1 January 1994, and comprises a trade liberalization agreement among Canada, Mexico and the United States. There are several key provisions in that accord that affects trade in maize. These revolve primarily around liberalization and market access commitments affecting trade in agricultural goods generally. (Other disciplines covering the differentiation of maize or transgenic corn through labeling, patent protection or risk assessment are described under the WTO section immediately below.)

The main agricultural liberalization features of the NAFTA related to maize include:

- When NAFTA went into effect, Mexico converted its import-licensing regime to a transitional tariff-rate quota for corn imports from the United States (and Canada). The tariff-rate quota will be in effect until approximately 2009.
- For US corn, the initial duty-free quota into the Mexican market was 2.5 million metric tons of corn in 1994. This amount grows at a 3-percent annual compounded rate over the 15-year transition period. The quota for 1998 was 2,813,772 tons.
- US exports to Mexico in excess of the quota are assessed a tariff (based on the "tariffication" of Mexico's import license) initially equal to $206 per metric ton, but not less than 215 percent. Over the first six years of the agreement, an aggregate 24 percent of this over-quota tariff is being eliminated, with the remainder to be phased out over the rest of the 15-year transition period. For 1998, the over-quota tariff is $165 per metric ton, but not less than 172 percent.
- NAFTA established a separate tariff-rate quota for Mexico's corn imports from Canada. Canada gained duty-free access for an initial quota of 1,000 metric tons of corn. The annual growth rates for this quota amount, the initial level of the over-quota tariff, and the over-quota tariff phase-out are the same as those set for the United States.
- From the beginning of the implementation period, however, these quotas were waived by Mexico. Thus no US exports of corn were subject to any duties (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 seven million tons (USDA FAS 1996). The actual corn imports in 1996 (5.9 million metric tons), moreover, were 64 percent higher than the tariff-free quota established for 2007 (Nadal 1999). Starting in June 2001, Mexico temporarily imposed minor tariffs on over-quota imports of one percent on yellow corn and three 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.

2. World Trade Organization

Generally, NAFTA obligations complement those set out in the WTO Uruguay Round, which, in turn, build upon obligations set out under the 1947 General Agreement on Tariffs

and Trade (GATT). Among the main rights and obligations of the GATT are most-favored nation (mfn) under GATT Article I; national treatment and non-discrimination, in GATT Article III; the prohibition of the use of quotas and other trade barriers (GATT Article XI); and general exceptions to to trade rules, under GATT Article XX (Jackson 1994).

Through various negotiating rounds, the scope of the WTO now extends to a wide range of disciplines. Specifically, the Uruguay Round introduced new disciplines covering trade in agriculture, trade in services, and trade-related intellectual property rights. In addition, work in new areas, including environment, investment, competition policy, have increased the scope of the trade agenda away from disciplines applied only at the border, to what has been called "deeper integration" behind the border (Trebilcock 2002). As the mandate of the WTO broadens, there has been growing interest, and criticism from civil society generally, around WTO governance, transaprency and democracy-related issues (Esty 2002), (Howse 2000), (Petersmann 1998), (Wirth 1997). There are two areas of particular relevance to the Article 13 report analysis.

In the past decade, there has been extensive literature exploring the relationship between trade and environmental policies, broadly defined. Of these issues, perhaps the most relevant to the current CEC Article 13 report is the relationship between domestic environmental, agriculture, health, safety and sanitary regulations applied in Mexico to condition the access of transgenic, and obligations under the WTO and NAFTA (Esty 1994, Jackson 1993, Nordstrom and Vaughan 1999). The legal compatibility issues between environment-related and trade rules are far-reaching, and—most importantly—speculative. No WTO or NAFTA panel has addressed the issue of genetically modified foods, or import barriers or other measures covering corn or maize. Moreover, there has never been a formal clash between WTO rules and any environmental labeling measures, or any measures undertaken under a multilateral environmental agreeemnt.

Although not exhaustive, some trade-environment issues that merit analysis in the Article 13 report include:

- What is the relationship advanced notification procedures under the Biosafety Protocol (below) and the WTO and NAFTA? (While NAFTA sets out provisions allowing Multilateral Environmental Agreements to, in essence, trump trade laws in the event of an inconsistency, the clause refers only to the Montreal Progocol, the Basel Convention and CITES. Moreover, it requires that all three NAFTA Parties belong to the MEA in question, a situation that is not relevant to the current ratification status of the Protocol (Houseman 1994).
- To what extent would a prohibition on the importation of transgenic maize into Mexico for planting or other purposes be compatible with general obligations of the GATT and WTO? For example, would differentiated import restrictions between milled and non-milled transgenic maize face the same or different treatment under WTO rules? Several WTO cases have examined the scope of GATT Article XX exceptions, and these may provide some guidance in this regard[7].

[7] It is important to note that WTO Dispute Settlement is not based on precedence. In principle, previous cases are not intended to act as precedence for subsequent ones. Moreover, the WTO Secretariat is unable to provide any guidance on actions that are compatible. It is only through a formal WTO dispute procedure that cases are decided. Recent cases that may be of interest include EU- Measures Concerning Meat and Meat Products, "Beef Hormone," brought by the US and Canada, WT/DS48/; US- Shrimp-Turtle, brought by India, Malaysia, Pakistan, Thailand and the Philippines, WT/DS58; France: Prohibition on the Import of Asbestos, brought by Canada, WT/DS135.

- How would a WTO likely approach the use of trade restrictions, for example restrictions on the import of some or all genetically-modified organisms, with those restrictions based on scientific evidence, in the event that a WTO Member – for sake of argument the United States – challenged this action? It is impossible to answer this question, since each WTO case is unique. Moreover, no formal cases have arisen in this regard. However, it may be worth noting that, in terms of the scientific basis of the restriction, Article 2.2 of the WTO Agreement on Sanitary and Phytosanitary Measures (SPS) states, inter alia, that each SPS measure "be based on scientific principles and is not maintained without sufficient scientific evidence." However, the agreement also notes that measures that conform to relevant international standards are also deemed to conform to these SPS obligations. The Agreement on Technical Barriers to Trade (TBT) likewise refers to the relevance of international standards, noting that domestic standards that differ from international ones cannot "constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail or a disguised restriction on international trade." (TBT, preamble.) The issue of trade panels arbitrating non-uniform risk assessment has generated an enormous amount of attention from legal and other scholars, as well as from the WTO Appellate Body in its findings in the "Beef Hormones" EU-US cases. The decision notes in part:

> "We do not believe that a risk assessment has come to a monolithic conclusion that coincides with the scientific conclusion or view implicit in the SPS measure. The risk assessment could set out both the prevailing view representing the "mainstream" of scientific opinion, as well as the opinions of scientists taking a divergent view…In most cases, responsible and representative governments tend to base their legislative and administrative measures on "mainstream" scientific opinion. In other cases, equally responsible and representative governments may act in good faith on the basis of what, at the given time, may be a divergent opinion coming from qualifed and respected soources. By itself, this does not signal the absence of a reasonable relationship between the SPS measure and the risk assessment…"(WTO Appellate Body report, 1998).

In examining these and other issues, it is important to note—by way of background information—some of the main obligations under the WTO, in addition to the core provisions noted above concerns MFN, non-discrimination, prohibition on the use of quotas, and general exceptions.

Agreement on Agriculture: An extensive body of literature exists explaining different obligations under the WTO Agreement on Agriculture. It is generally recognized that this Agreement represents the most important accomplishment of the Uruguay Round, which came into effect in 1995. There are numerous disciplines contained in the Agreement. These include:

- market-access commitments, including switching various non-tariff measures to their tariff "equivalents" and agreeing in principle to enhance the transparency of tariff quotas;
- establishing tariff schedules for agricultural goods;
- introducing some disciplines for domestic support schemes; and
- introducing some disciplines covering export subsidies.

Although the Uruguay Round did introduce disciplines covering agricultural trade, its biggest source of criticism remains the persistence of trade distortions. For example, the pervasive practice of "dirty tariffication" before the conclusion of the Round led to actual tariff levels for many agricultural goods higher today than in 1993. In addition, many

countries used high ceiling bindings and tariff rate quotas, leading to further trade distortions. Incidents of contingent trade protection—anti-dumping, safeguards and countervailing measures—have affected trade in agriculture. However, of these, the persistence of domestic farm support and subsidy schemes remains the largest source of market and trade distortions. Statistics by FAO suggest that since the Uruguay Round was introduced, farm subsidies have actually increased to well over US$300 billion per year in the late 1990s.

The OECD, World Bank, WTO and CEC have undertaken analyses of the environmental impacts of subsides and other trade restrictions in the agricultural sector. Developing countries, which are most affected by the price-wedge effects that subsidies exert on domestic versus world prices, have consistently expressed opposition to such measures and, in particular, to the impediments that subsidies create for market access.

In 2002, the US Farm Bill—which will provide US$180 billion in farm support to US famers over ten years—has raised the concern of many, including small-scale farmers from Mexico who remain frozen out of world markets (*The New York Times* 2002b). Similarly, the EU has just completed renegotiating the Common Agricultural Policy, with annual spending—at roughly US$40 billion per year—unchanged.

(It is worth noting that the US Trade Representative has tabled a proposal to substantially reduce or eliminate tariffs, non-tariff barriers and other support schemes, in the WTO, or through regional or bilateral initiatives.[8])

Several studies, including some sponsored by the CEC (Nadal 1999, Runge 1999, Nadal 2002, Gallagher and Ackerman 2001), have examined both the environmental effects of agricultural and maize liberalization, while the WTO Secretariat (W/67) estimates various environmental costs of these distortions and concludes that they exert significant negative effects on habitats and species.

The agricultural sector is the focus of ongoing negotiations in the WTO, under the "built-in" agenda. Currently, the WTO is in Phase Two negotiations, with a deadline of March 2003 (World Trade Organization 2002a).

Trade-Related Patents, Intellectual Property Rights and Geographic Appellation: The biotechnology industry in the United States has tripled in size since 1992, from revenues of US$8 billion to $27.6 billion in 2001. As of mid-2000, approximately 1,400 companies comprised the US biotechnology sector and together they had a market capitalization of US$225 billion. Spending on research and development worldwide exceeds US$15 billion per year (Biotechnology Industry Association 2002), and this breadth of activity is reflected in patents issued. Growth in US patents in the biotechnology sector has outpaced average sector growth, measured by capitalization or revenues. According to the US Patent Office, approximately 1,500 patents issued in 1985 in the biotechnology sector. By 2000, that number had exceeded 14,000. The largest increases to date in patents occurred in the 1995–2000 period, when patents increased by almost 350 percent.

An ongoing area of discussion in the WTO is the relationship between the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS), the patenting of genetically modified organisms in general, and the institutional relationship between the TRIPS

[8] The United States proposal, unveiled in July 2002, includes eliminating all export subsidies in five years; reducing average allowed farm tariffs from 62 to 15 percent; reducing the ceiling on trade-distorting subsidies by over $100 billion through setting a cap of no more than five percent of total agricultural production.

Council and the Convention on Biodviersity.[9] Considerable attention remains focused on whether Article 27.3(b) of the TRIPS Agreement, which sets out exceptions whereby the public sector can exclude plants and animals from patentability for health, plant safety or environmental reasons, and allows the use of s*ui generis* systems in their place, is sufficiently flexible to protect plant varieties.

A more recent area of interest involves the provisions of TRIPS Article 22 covering "Geographic Indications." The appellation of geographic origin is commonly used for wines and cheeses. Article 22 covers "indications which identify a good as originating in the territory of a member, if a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographic origin." There has been interest among some labeling and certification groups to use geographic indications to differentiate land races originating, for example, in Oaxaca from other corn varieties.

Agreement on Technical Barriers to Trade (TBT)—This agreement includes disciplines covering national technical (mandatory) regulations, voluntary standards, rules to ensure the non-discriminatory treatment of mandatory and voluntary labels and product marking, and (in Annex Three) a Code of Good Practice for the adoption and use of standards used in labeling and other schemes. One of the longest-standing areas of discussion under trade and environment in the Committee on Trade and Environment (and its predecessor, the GATT) entails disciplines for environmental labeling and certification to ensure they do not impede unnecessarily market access. Broad exceptions are contained in the Agreement—similar to those contained in GATT Article XX—which allows a member to adopt national measures for environment-related objectives.

A particularly contentious issue between the US and the EU involves how a product label would potentially differentiate goods containing genetically modified organisms from those that do not. The suggestion that such a label is under consideration has prompted strong responses from the agri-food, hybrid seed and other industries, stressing, in particular, that WTO (and Codex) disciplines be clarified and strengthened to ensure that such labels do not affect market access (see Appendix 2). Of interest is what WTO agreement provisions should cover any possible GMO-related label. Some have noted that the provisions of the TBT Agreement are of particular relevance, because of their disciplines related explicitly to labeling (Stilwell and Van Dyke 1999). It is worth noting that both the TBT and Agreement on Sanitary and Phytosanitary Measures have received notifications pertaining to genetically modified Agricultural and Food Products from the United States, Mexico, Canada as well as other member countries.[10]

---

[9] The WTO Doha Ministerial declaration of November 2001 set out in Paragraph 19 the following work plan: "We instruct the Council for TRIPS, in pursuing its work programme including under the review of Article 27.3(b), the review of the implementation of the TRIPS Agreement under Article 71.1 and the work foreseen pursuant to paragraph 12 of this declaration, to examine, *inter alia,* the relationship between the TRIPS Agreement and the Convention on Biological Diversity, the protection of traditional knowledge and folklore, and other relevant new developments raised by members pursuant to Article 71.1. In undertaking this work, the TRIPS Council shall be guided by the objectives and principles set out in Articles 7 and 8 of the TRIPS Agreement and shall take fully into account the development dimension." <www.wto.org>.

[10] In 2000, there were a total of 12 notifications related to genetically modified agricultural and food products submitted under the SPS Agreement, and 8 notifications under the TBT Agreement. Examples include TBT 99.0330/Canada, "Foods Derived from Gene Technology;" SPSN/MEX/97 (Mexico), "Organisms manipulated by genetic engineering;" and SPS/N/USA/157, "Animal/Human Drugs, Bio. Products." From the WTO Committee on Technical Barriers to Trade, "Genetically Modified Agricultural and Food Products." Submission by the United States, G/TBT/W/115/Add.1 (18 October 2000).

According to the WTO Secretariat, a number of member countries submitted notification under the TBT Agreement covering the labeling of genetically modied foods (there were over 10 TBT notifications covering GMOs in 2001) (WTO (2002), Environmental Data-Base).

Agreement on the Application of Sanitary Phytosanitary Measures: The SPS Agreement disciplines apply to national sanitary and phytosanitary measures, potentially including those relating to certain food safety issues arising from genetically modified products. Like the TBT agreements in the WTO and NAFTA, the SPS Agreement allows countries to adopt SPS standards higher than those established under relevant international standards (such as those of the Codex Alimentarius or International Plant Protection Convention). However, an important qualification is that such standards need to be based on a "scientific justification" (Article 3), and that standards are based on a science-based assessment of risks to "human, animal or plant life or health, taking into account risk assessment techniques developed by the relevant international organizations" (SPS 5(1)).

3. Codex Alimentarius Commission

The Commission, created in the 1960s by FAO and WHO, develops food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Program (Codex Alimentarius 2002). Areas of work of direct relevance to this note include the Codex Ad Hoc Intergovernmental Task Force on Foods derived from Biotechnology (which focus on food safety, the Cartagena Protocol focuses on environmental issues). At the third meeting of the task force, held in Japan in March 2002, issues under discussion included safety and nutritional aspects of GMO foods; procedures for risk analysis and risk management of GMO foods (with proposed language broadly intended to yield safety levels comparable with those outlined in the WTO SPS Agreement); procedures related to the traceability of GMOs in food; and discussion of Draft Guidelines for Food Safety Assessments.

A second area of Codex work of relevance to the CEC analysis concerns food labeling. The most recent meeting of this task force was held in Canada in May 2002. Among the areas of work include labeling information for the production of organic foods, and labeling information for GMO foods.

4. The Biosafety Protocol of the Convention on Biological Diversity

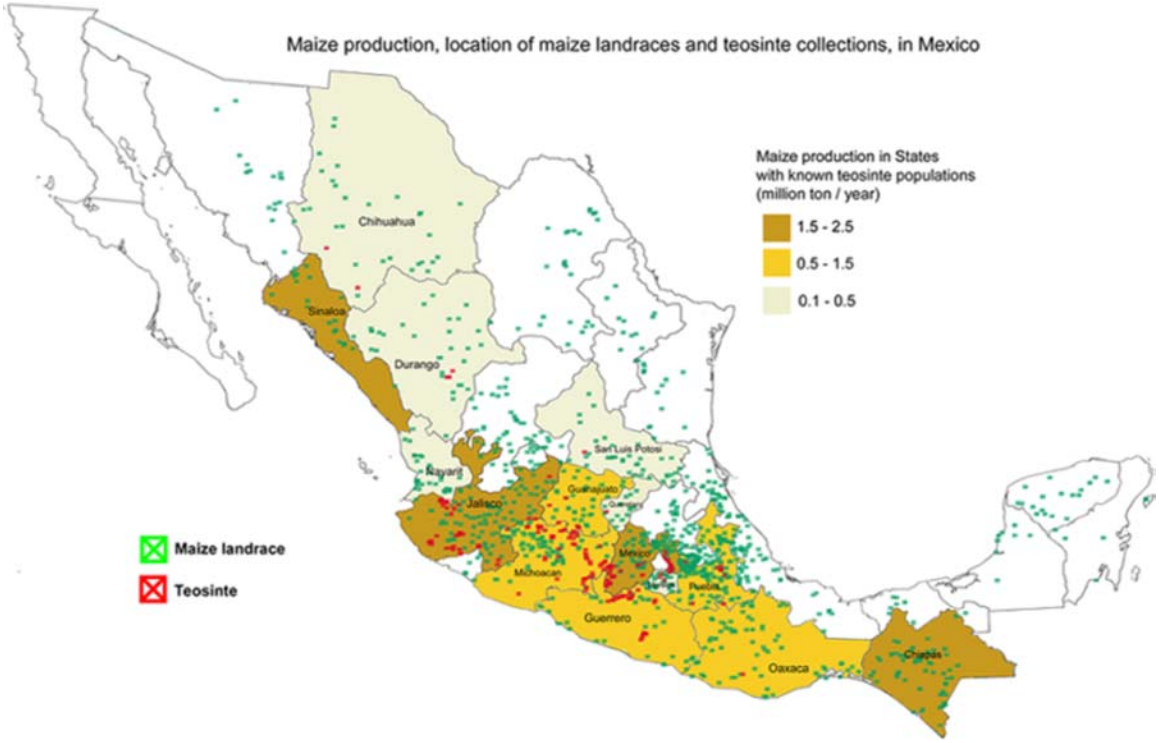
The Cartagena Protocol on Biosafety to the UN Convention on Biological Diversity was concluded in January 2000. It was established to ensure the safe transfer, handling and use of Living Modified Organism (LMOs) that may—in the absence of such standards—adversely affect biodiversity. (The Protocol does not use the term "GMO.") The main operational instrument of the Protocol is the Advance Informed Agreement (AIA). This compels exporters of LMOs to notify and seek consent from the intended country of import, prior to the transfer of an LMO. Among the procedures of the AIA is the requirement that the importing country acknowledge receipt of the notification within 90 days, after which time a risk assessment of the proposed import is to be undertaken. (Annex II of the Protocol sets out in detail procedures for risk assessment. These procedures generally go beyond risk assessment provisions identified in the WTO SPS Agreement. Moreover, unlike that agreement, the Protocol contains a description of risk management.)

After 270 days of receipt of the notification, the proposed country of import can approve the LMO import as is, or with modification or conditions; reject and prohibit the LMO transfer; request additional information about the LMO transfer; or extend the deadline.

Negotiations leading to the adoption of the Protocol were deeply contentious. Three issues in particular were particularly divisive:

- First, the scope of LMOs that would be covered under the provisions of the Protocol, dealing with possible environmental effects.
- Second, the relationship between risk assessment provisions set out, for example, in the WTO SPS Agreement (above) and the reference to precaution in the Biosafety Protocol. (Interpretation of the precautionary principle in its own right, as well as its interpretation to set conditions on the access to goods that could pose serious environmental risk, remain sources of considerable controversy which is too lengthy to discuss here.
- Third, the relationship between the Protocol and WTO rules. While the preamble to the Protocol notes that it and the WTO are to be "mutually supportive," the reference to provisions in the Protocol not changing "rights or obligations of existing international agreements" in the text has been regarded by some as suggesting that WTO rights, in particular, those contained in the SPS, TBT and TRIPS Agreements, are not affected by the Protocol.

Appendix 1


Maize production, location of maize landraces and teosinte collections, in Mexico
Maize production in States with known teosinte populations (million ton / year)
1.5 - 2.5
0.5 - 1.5
0.1 - 0.5
Chihuahua
Sinaloa
Durango
Nayarit
Jalisco
San Luis Potosí
Guanajuato
Querétaro
México
Morelos
Puebla
Michoacán
Guerrero
Oaxaca
Chiapas
Maize landrace
Teosinte

Appendix 2

April 29, 2002

The Honorable Robert B. Zoellick
United States Trade Representative
600 17th Street, N.W.
Washington, DC 20508

Dear Ambassador Zoellick:

The undersigned organizations, representing agriculture, food and biotechnology provider interests, support your efforts to formulate a global strategy to increase awareness and acceptance of agricultural biotechnology. We support this initiative and are writing to emphasize that promotion of science-based labeling policies is an essential element of any global strategy related to continued availability and marketability of food and agriculture biotechnology. Specifically, we believe that the US government must capitalize on upcoming meetings in key fora, such as the Codex Alimentarius Commission and the World Trade Organization (WTO), to promote science-based labeling policies.

Many countries around the world have recently adopted mandatory biotech labeling policies for foods derived through biotechnology that are not related to health or safety. Although these labels are often explained as providing consumer information or enhancing consumer acceptance of biotech foods, the actual impact has been just the opposite. Because biotech labels are often perceived as warnings to consumers, manufacturers are reluctant to market labeled products. To avoid having to label products and ensure compliance with these labeling schemes, manufacturers have reformulated products or sourced non-biotech ingredients for exported goods. In many cases, this has meant sourcing agricultural commodities from outside the United States. The result of the proliferation of mandatory process-based labeling policies, has therefore, been less market access for biotech products, reduced access for US agricultural products and less consumer choice, awareness and acceptance of this promising technology.

Given these developments, it is critical that the US government maintain and strengthen its long-held strategy of promoting science-based labeling polices that are consistent with US domestic regulation. Any shift away from defending science-based policies could have a damaging effect on exports of agricultural commodities by accelerating a growing trend away from the use of biotech ingredients in exported food products. In addition, any perceived shift in US support internationally for science-based labeling could increase pressure for mandatory process-based labeling policies domestically and potentially undermine arguments in future WTO challenges of trade restrictive labeling regimes abroad.

We believe that the Administration must redouble efforts to ensure that international standard-setting bodies adopt science-based policies and offer alternative methods to inform consumers about foods derived from biotechnology. In particular, the US government should build upon progress made at last year's meeting of the Codex

Committee on Food Labeling and work to strengthen alliances with developing and like-minded countries in preparation for its May 6-10 meeting where an international standard for biotech labeling will be debated. A science-based Codex standard could serve as a model for many countries that are looking for regulatory solutions for labeling of foods from modern biotechnology. A model regulation based on sound science will be especially useful to those countries that lack the sophisticated regulatory and compliance systems to enforce detection-based mandatory labeling policies or to police unenforceable systems to label foods with no detectable residue of modification.

In the long term, we believe the Administration should seek opportunities to build alliances and promote labeling policies that are consistent with existing disciplines in the WTO. For example, in the WTO, discussions on labeling are already a part of the work program of the Committee on Technical Barriers to Trade (TBT) and were mandated in the Committee on Trade and Environment in Doha. These meetings are an important opportunity to advance labeling policies that are consistent with TBT disciplines and engage in a dialogue with countries on alternative methods of providing information to consumers that would be more compatible with open markets and free trade. Finally, USTR may wish to consider working groups or standing committees on labeling and other technical regulations while negotiating during bilateral and regional free trade agreements.

Countries with regulatory systems for approvals and labeling of biotech products based on science are often those with the highest consumer acceptance of biotechnology. We firmly believe that the US government's outreach on biotechnology must include this fundamental approach.

Thank you for your time and consideration.

Sincerely,

American Bakers Association
American Farm Bureau Federation
American Feed Industry Association
American Frozen Foods Institute
American Meat Institute
America Seed Trade Association
American Soybean Association
Animal Health Institute
Archer Daniels Midland
Biotechnology Industry Organization
Bunge North America, Inc.
Central Soya Company
Corn Refiners Association
CropLife America
Food Distributors International
Grocery Manufacturers of America
Institute of Shortening and Edible Oils
National Association of Wheat Growers
National Corn Growers Association
National Cotton Council
National Fisheries Institute
National Food Processors Association
National Grain and Feed Association
National Oilseed Processors Association
North American Millers' Association
Pet Food Institute
Rice Millers' Association
Snack Food Association
US Dairy Export Council
US Grains Council
US Rice Producers' Group
Wheat Export Trade Education Committee
World Perspectives, Inc.

References

Aylward, B.A. and E.B. Barbier, 1992. What is biodiversity worth to a developing country? Capturing the pharmaceutical value of species information. *Discussion Papers—Environmental Economics Programme* DP 92-05, IIED *Environmental Economics* ISSN 1357924X, 18pp.

Bellon, M.R. 2001. Demand and supply of crop intraspecific diversity on farms: Towards a policy framework for on-farm conservation. <www.cimmyt.org>.

Bellon, M.R. and S.B. Brush. 1994. Keepers of maize in Chiapas, Mexico, *Economic Botany* 48: 196–209.

Biotechnology Industry Association. 2002. *Biotechnology industry statistics*. Washington, DC. Accessed Oct 2002 at <www.bio.org/er/statistics.asp>.

Bishop, J. 1999. *Valuing forests.* Working paper. International Institute for Environment and Development, London.

Carpenter, J. *et al.* 2002. *Comparative environmental impacts of biotechnology-derived and traditional soybeans, corn and cotton crops*. Council for Agricultural Science and Technology for the United Soybean Board. <http://www.talksoy.com/pdfs/Environmental%20Impact%20Study%20%20English.pdf>.

Carson, R. 2002. *Contingent valuation: A comprehensive bibliography and history.* Edward Elgar Publishers.

Carter, M.R. and K.D. Wiebe. 1990. Farmer's valuation and conservation of crop genetic resources. *Genetic Resources and Crop Evolution* 45: 139–150.

Codex Alimentarius. 2002. Welcome page. Rome, Italy. Accessed October 2002 at <http://www.codexalimentarius.net>.

Commission on Life Sciences. 1999. *Perspectives on biodiversity: Committee on Noneconomic and Economic Values of Biodiversity,* Washington, DC: National Academy Press.

Constanza, R. *et al.* 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253–260.

de Janvery, A.M. Fafchamps and E. Sadoulet (1991), Peasant household behavior with missing markets: Some paradoxes explained. *Economic Journal* 101: 1400–1417.

Dietz, T and P. Stern. 1998. Science, value and biodiversity. *Bioscience* 48: 441–444.

Dixon, J.A. and P.B. Sherman. 1990. *Economics of protected areas*. Island Press.

Duvick, D. 1984. Genetic contributions to yield gains of US hybrid maize, 1930 to 1980. In: W. Fehr (ed.), *Genetic contributions to yield gains of five major crop plants*. Madison: Crop Science Society of America, Special Publication 7, pp.15–47

Esty, D.C. 1994. *Greening the GATT: Trade, environment and the future*. Institute for International Economics, Washington, DC.

Esty, D.C. 2002. The World Trade Organization's legitimacy crisis. *World Trade Review* 1/1: 7–22.

Fafchamps, M. 1980. Cash crop production, food price volatility and rural market integration, *American Journal of Agricultural Economics* 74:90–99.

Freeman, A.M. 1993. *The measurement of environmental and resource values—theory and methods.* Washington, DC: Resources for the Future.

Gallagher, K., F. Ackerman, and L. Ney. 2001. *Environmental reviews of trade agreements: Assessing the North American experience.* Global Development and Environment Institute, Tufts University.

Georgiou, S. et al. 1997. Economic values and the environment in the developing world. Cheltenham, UK: Edward Elgar Publishing.

Grig-Gran, M. 2000. *Fiscal incentives for biodiversity conservation.* WWF International and International Institute for Environment and Development.

Hanson, A. *et al.* 2001. *Securing the continent's biological wealth: Towards effective biodiversity conservation in North America.* Montreal: CEC Working Paper.

Hearse, R. 1996. *Environmental appraisal of environmental goods and services.* London, UK: International Institute for Environment and Development.

Housman, R. 1994. *Reconciling trade and the environment: Lessons from the North American Free Trade Agreement.* Geneva: UNEP Environment and Trade Series.

Howse, R. 2000. Democracy, science and free trade: Risk regulation on trial at the World Trade Organization. *Michigan Law Review* 98/7, June.

International Plant Genetic Resources Institute. 2002a. *Economic analysis of crop genetic resource conservation.* Maccarese, Italy. Accessed Oct 2002 at <http://www.ipgri.cgiar.org/system/page.asp?theme=4>.

International Plant Genetic Resources Institute. 2002b. *System-wide genetic resource program*. Maccarese, Italy. Accessed Oct 2002 at <http://www.ipgri.cgiar.org/programmes/sgrp/homesinger.htm>.

International Seed Federation. 2002. *Seed Statistics.* Nyon, CH. Accessed Oct 2002 at <http://www.worldseed.org/statistics.html#dom%20com%20mark>.

Jackson, J.H. 1993. World trade rules: Congruence or conflict? In: Durwood Zaelke *et al.* 1993. *Trade and the environment: Law, economics and policy*. Washington, DC.

Jackson, J.H. 1994. *The world trade and the law of the GATT,* New York: Babbs-Merrill.

Loomis, J.B. 1992. The evolution of a more rigorous approach to benefit transfer: benefit transfer function, *Water Resources Research* 28(3).

McGuirk, A.M. and Y. Mundlak. 1991. *Incentives and constraints in the transformation of Punjab agriculture.* IFPRI Research Report 87, Washington, DC.

Meng, E. and J. Ekboir. 2001. *Current and future trends in maize production*. International Center for Maize and Wheat Improvement. <http://www.cimmyt.org/Research/Economics/map/facts_trends/maizeft9900/pdfs/maizeft9900_Part3.pdf>.

Munasinghe, M. 1993. *Environmental economics and natural resource management in developing countries.* World Bank and Committee of International Development Institutions on the Environment.

Nadal, A. 1999. Maize in Mexico: Some environmental implications of the North American Free Trade Agreement, in *Assessing Environmental Effects of NAFTA*, Montreal: CEC.

Nadal, A. 2000. *The environmental and social impacts of economic liberalization on corn production in Mexico.* I-113. Gland, Switzerland and Oxford, UK: WWF International and Oxfam GB.

Nadal, A. 2002. *Zea Mays* corn in NAFTA, eight years after. Paper presented at the CEC meeting, 'Assessing the Environmental Effects of Trade,' January 17th and 18th, 2002. Montreal, Canada.

The New York Times. 2002a. Mexico fears migrant deaths will increase with despair. 20 October.

The New York Times. 2002b. Editorial, 1 December.

Nordsrom, H. and Vaughan, S. 1999. *Trade and environment*. Geneva: World Trade Organization.

Pearce, D. 1990. *An economic approach to saving the tropical forests.* LEEC Paper DP 90-06, London: IIED.

Pearce, D.W., D. Moran and E. Fripp. 1992. *The economic value of biological and cultural diversity*. London: Center for Social and Economic Research on the Global Environment.

Pearce, D.W. and R.K. Turner 1992. *The use of benefits estimates in environmental decision-making.* Paris: OECD.

Perrings, C. (ed.) 1995. The economic value of biodiversity. In: Heywood, V.H. 1995. *Global biodiversity assessment*. UNEP, Cambridge University Press, UK.

Petersmann, E.U. 1998. Trade policy as a constitutional problem. In: *The World Trading System: Critical perspectives on the world economy*. R. Howse, ed., 1998.

Renkow, M. and G. Traxler. 1994. Incomplete adoption of modern cereal varieties: The role of grain-fodder tradeoffs. University of California, Davis, Ph.D. dissertation. Cited in: Bellon, M.R. 2001. *Demand and supply of crop intraspecific diversity on farms.* International Maize and Wheat Improvement Center, CIMMYT.

Runge, R.F. 1999. Feedlot production of cattle in the United States and Canada: Some environmental implications of the North American Free Trade Agreement, in *Assessing Environmental Effects of NAFTA.* Montreal: CEC.

Secretariat of the Convention of Biological Diversity. 1996. *Valuation of biodiversity*. Geneva.

Smale, M. *et al.* 1999a. *Farmer management of maize diversity in the central valleys of Mexico.* CIMMYT.

Smale, M., M. Bellon, J.A. Aguirre Gómez. 1999b. *The private and public characteristics of maize land races and the area allocation decisions of farmers in a center of crop diversity*. <www.cimmyt.org>.

Stilwell, M. and B. Van Dyke. 1999. *An activist's handbook on genetically modified organisms and the WTO.* Center for International Environmental Law and Consumer's Choice Council <http://www.consumerscouncil.org/>.

Trebilcock, M.J. 2002. *Trade liberalization and regulatory diversity*. Forthcoming, University of Toronto Press.

Tsur, Y., M. Sternberg and E. Hochman. 1990. Dynamic modeling of innovation process adoption and learning. *Oxford Economic Papers* 42: 336–355.

United States Trade Representative (USTR). 1997. *Study on the operation and effect of the NAFTA.* Washington, DC: USTR.

USDA, Foreign Agriculture Service (FAS). 1996. *Mexican tariff rate quotas*. Attaché report from American Embassy, Mexico City. October 11. Online at <http://www.fas.usda.gov/scripsw/attacherep/display_gedes_report.asp?Rep_ID=10007259 >.

Wirth, D. 1997. International trade agreements: Vehicles for regulatory reform? In: *University of Chicago Legal Forum* Vol. 1997.

Woodruff, D.S. and G. Gall. 1992. Genetics and conservation. *Agriculture, Ecosystems and Environment* 42: 53–73

World Bank. 1997. *Expanding the measure of wealth.* Washington, DC.

World Trade Organization. 1998. Appellate body report on EC measures concerning meat and meat products (hormones), WT/DS26/Ab/R, January.

World Trade Organization. 2002a. *Agricultural negotiations: Backgrounder.* Geneva. Accessed Oct 2002 at <http://www.wto.org/english/tratop_e/agric_e/negs_bkgrnd00_contents_e.htm>.

World Trade Organization. 2002b. *Environmental Data-Base*. WT/CTE/EDB/1.

Zahniser, S. and J. Link. 2002. *Effects of North American Free Trade Agreement on agriculture and the rural economy*. Agriculture and Trade Report No. WR5021. Washington, DC: USDA Economic Research Service.