Exploring the Critical Linkages Between Agriculture, Trade and Environment: A Look at Decoupled US Agricultural Subsidies*

Mark Ritchie and Gigi DiGiacomo**

Introduction

This paper explores one of the most important current economic debates -- the interactions of domestic food and agriculture programs, agricultural trade policy, and the environment.

Agriculture is the economic sector where there is the greatest amount of government intervention in most countries, including the United States. Agricultural programs of all kinds, including those which are often referred to as subsidies, are based on a rich history of local political and economic goals, resource availability and social beliefs that vary by region and nation.

Increasingly, however, agricultural subsidy programs and their relationship to trade and the environment are emerging as a critical international interest. Two recent global events, the 1995 Uruguay Round of the General Agreement on Tariffs and Trade (GATT UR) and the 1992 United Nations Conference on Environment and Development (UNCED), have not only focused international attention on these three sectors, but have also pioneered steps toward the study of the relationships between agriculture and trade and between agriculture and the environment.

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** Mark Ritchie is President of the Institute for Agriculture and Trade Policy (IATP), 2015 1st Ave. S., Minneapolis, Minnesota 55404. (612) 870-0453. Fax: (612) 870-4846. Email: iatp@iatp.org.
Gigi DiGiacomo conducts freelance agricultural research and is a former IATP Program Associate, 11655 Ridgemount Ave. W., Minnetonka, MN 55305. (612) 545-8634. Fax: (612) 591-7654. Email: digia002@tc.umn.edu.

These important first steps lay a useful foundation for the study of each of the relationships between agriculture and trade and between agriculture and the environment – but fail to take account of how the three interact together. The purpose of this paper is threefold. First, is the review of existing methodologies and indicators used to study partial linkages between agriculture, trade and the environment. Second, is the development of a framework that can be used to consider how agricultural policy, trade policy and the environment interact together and affect one another. Third, is the examination of the framework through an informal case study.

Part one of this paper reviews literature relating to agriculture, trade, and the environment -- including a detailed summary of the conceptual framework developed by the Organization for Economic Cooperation and Development (OECD) for analyzing agricultural policy and farm production impacts on the environment. Framework modifications are suggested to make possible the analysis of subsidy-related linkages between trade, agriculture and the environment.

Next, in part two, US farm subsidies are reviewed and then narrowed to a focus on income subsidies, called decoupled income supports. The decision to focus on one type of US farm subsidy was made after a preliminary effort indicated that such an approach could, in fact, be the basis for establishing a methodology for the multi-dimensional analysis of the agriculture, trade and environmental linkages that is eventually needed.

In part three, through an informal case study, the paper explores in detail the agriculture, trade and environmental links of decoupled agricultural income subsidies using the modified OECD framework.

In the final part, conclusions are summarized from the three prior sections of the paper and suggestions are offered for the future analysis of agriculture, trade and environmental linkages.

Part One: Review of Trade, Agriculture and Environment Literature

There is a growing body of literature on the interactions between trade and agriculture, agriculture and the environment and on trade and the environment. However, the question of how the three issues -- trade, agriculture and the environment, interact remains largely unexplored.

Trade and Agriculture

Most of the literature relating trade and agriculture has been limited to the concept of comparative advantage that accrues to nations based on their resource endowments – including, labor, natural resources and capital. Partial equilibrium trade models rooted in the theory of comparative advantage, are used to measure the gains from trade acquired by agricultural producers, consumers, their governments and societies as a whole. These models allow for the theoretical examination of the affects of agricultural policy changes on trade flows.[1]

As negotiations over the Canada-US Trade Agreement (CUSTA) were launched, analysts attempted to measure or quantify national agricultural subsidies for use in empirical trade studies. These measures were called "subsidy equivalents."[2] CUSTA negotiators recognized that the agricultural sector, unlike other economic sectors, could not be "liberalized" through tariff reduction alone due to the complex system of supports that existed to maintain, among other things, food supplies, price stability and export sales. This problem, as the negotiators saw it, became even more complicated in the GATT UR, where agricultural programs and objectives differed across more than 120 member countries.

Government subsidies in agriculture became one of the primary focuses of the GATT UR – requiring the creation of a new subsidy measure that could "provide GATT negotiators

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[1] See Houck for an excellent review of the Partial Equilibrium Trade model and the affects of agricultural policy changes on nations' gains from trade.

[2] The subsidy equivalents were categorized as "Producer Subsidy Equivalents" or PSEs and as "Consumer Subsidy Equivalents" or CSEs.

[with] suitable targets which [could] be negotiated downward much like tariff rates on manufactured items" (USDA, 1988, p. v). Analysts eventually developed an aggregate measure of direct agricultural subsidies, called the Aggregate Measure of Support (AMS). The AMS, like the CUSTA subsidy equivalents, categorized agricultural policies "by certain characteristics that broadly identify how policies affect prices, production decisions and therefore trade" (USDA, 1988, p. v).

Although the AMS begins to provide a foundation of indicators that can be used in empirical models to study agricultural trade flows and the gains from trade, clearly missing from both the traditional theoretical and empirical analysis are indicators to allow a study of the relationship between these subsidy equivalents and the environment.

Agriculture and the Environment

Recently there has been a flood of studies on agricultural subsidies and environmental linkages that primarily focus on the idea of "green payments" or direct payments to promote environmental conservation and sustainable land stewardship. Few studies, with the exception of those by the OECD, have considered the full range of agricultural policy implications for the environment.

Following the sustainable agricultural development goals laid out at UNCED, the UN Commission on Sustainable Development requested that nations develop agricultural indicators to measure progress in reaching sustainable development. Responding to this request, the OECD has begun to develop a set of "agri-environmental" indicators as well as a comprehensive framework for assessing and ultimately internalizing the environmental costs associated with agriculture. A preliminary set of indicators was released in 1997 – but have not yet been tested. The draft framework, however, is complete.

Following is a review of the OECD framework that will be applied, in a modified form, in this paper.

The OECD framework, called the Driving Force-State-Response (DSR) framework, is based on the concept of causality and can be used to analyze the links between agricultural policy, production and the environment. The DSR framework begins with the following series of three questions that must be answered to analyze the link and direction of causality between agriculture and the environment:

1. What is causing environmental conditions in agriculture to change (driving force)?

2. What effect is this having on the state or condition of the environment in agriculture (state)?

3. What actions are being taken to respond to changes in the state of the environment in agriculture (response)?

OECD defines "**driving forces**" in question (1) as: "natural environmental processes and factors," including weather and geological conditions; biophysical inputs and outputs at the farm level, such as chemicals, energy and water inputs and resources; and economic and societal driving forces, such as reactions to government policy, changing consumer attitudes toward agriculture and the environment, population growth and changes in technology and farm financial structures.

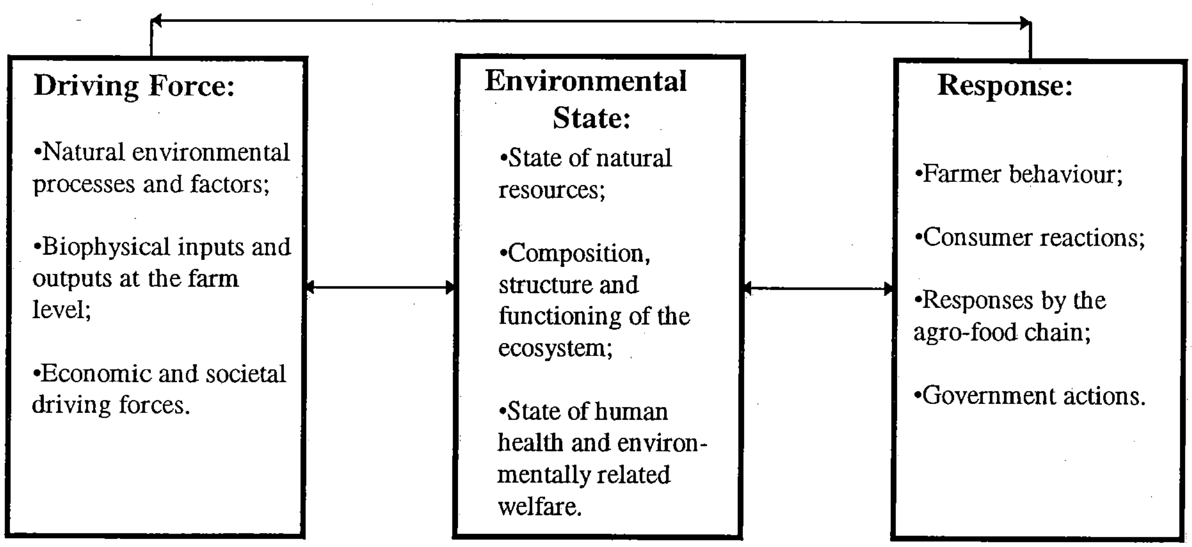
In question (2), the "**state,**" or "condition of the environment" as defined by OECD, includes the chemical and biological condition of natural resources, such as soil, water and air; the composition, structure and functioning of the ecosystem that are affected by agricultural production, including biodiversity and natural habitats; and the state of human health and environmentally related welfare, such as food safety and risks associated with chemical handling and applications.

Lastly, the OECD describes "**responses**" as including "farmer behavior" -- changes in input use, farm management practices; consumer reactions that include preferences for high-value, locally-grown and organic foods; responses by the agro-food chain that include technological innovation and voluntary adoption of better food safety and quality standards; and government actions that create regulatory requirements, and economic instruments -- such as price and income subsidies, other agricultural policies and research and development.

Chart (1) depicts a simplified DSR framework as described above.

Chart (1)

OECD Driving Force-State-Response Framework



Two way causality is represented by the multi-directional arrows in Chart (1). Two-way causality allows for "feedback," both positive and negative, between the environmental state and the response. Parris describes this as the agriculture sector's ability to both affect and be affected by the environment. For example, some agricultural cropping policies may affect the environmental state by creating soil erosion, while, an environmental state, such as climate change, may affect the agricultural sector's cropping and growing conditions.

The OECD calls the DSR framework a "working tool" and recognizes that its components may need modification. While the overall framework is appropriate for its intended use, a few simple modifications make it more applicable to domestic and cross-border analysis of the agriculture, trade and environment linkages.

One general modification is the inclusion of trade, in terms of both international rulemaking and the physical movement of goods, into the DSR framework as a "driving force" characteristic. It is not realistic to ignore the critical international economic and political forces that increasingly shape national agricultural policy, production decisions, and environmental resources as the trade and agriculture literature points out. The GATT UR Agreement on Agriculture, for instance, was written specifically to bring domestic agricultural support policies under trade disciplines. Therefore, as national markets become increasingly integrated through international trade rulemaking and communication technology, so do national environmental resources and environmental "states" that are tied to agricultural production. Additionally, in many OECD countries, like Canada, the United States, and the European Union, governments are required to prepare Environmental Impact Statements of agricultural policy changes, including those that result from new multi-lateral trade pacts (Parris). Therefore, the inclusion of trade policy and trade flows is necessary in any conceptual framework of the linkages between agriculture and the environment. Furthermore, incorporating international trade rules and patterns of exchange into the "driving force" framework formally and necessarily links trade, agriculture and the environment.

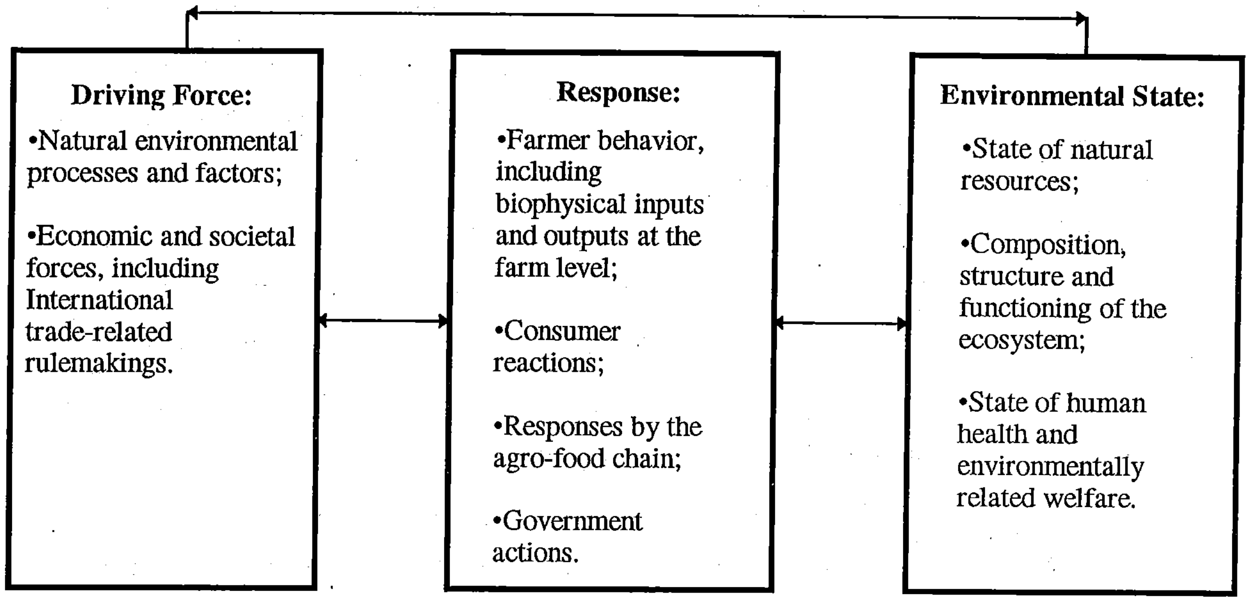
Another simple framework modification that is necessary for an analysis of the US agriculture sector, involves the re-characterization of US government policy as a secondary "driving force." The OECD framework characterizes government agricultural policy, including subsidies, as a "response." This effectively limits government policy to the product of an induced innovation process – whereby the policy arises in response to the existence of some environmental externality. This is only one possible characterization of government policy. Harold and Runge clearly note that subsidies "often arise from political demands in absence of demonstrable externalities ... Therefore, an externality may imply the need for a subsidy, but the subsidy need not imply the existence of an externality" (p. 140). In other words, by the nature of policymaking alone, government policies that are established to meet some economic or social need affect the environment and therefore may be considered a "driving force" instead of as a "response."

For example, the US price support system, created in 1938 and modified thereafter, relied on the calculation of base acres which have had the effect of encouraging farmers that participate in commodity programs to monocrop -- or to plant the same crops, such as corn, year after year, on the same acreage. Cochrane and Runge explain that "'corn base' [was, in the past,] literally an entitlement to receive government payments, which if corn [was] not planted, erode[d] over time unless otherwise guaranteed" (p.65). This policy was the driving force that induced farmers to monocrop. The continuous planting of corn on base acreage significantly altered the "state" of the environment throughout the Midwestern states directly through the loss of biodiversity and soil quality and indirectly through water quality deterioration due to tillage practices and the increased applications of chemical fertilizers, herbicides and pesticide inputs. In this case, therefore, government policy must be viewed as a political driving force that, in part, led to a production response and an undesirable environmental state.

The following modified DSR framework will be applied in this paper to an informal case study that explores the subsidy link between agriculture, trade and the environment. The modified framework includes trade and government policy as a driving force, while visually reordering the environmental state and the response to make clearer the causal relationship between the two as exists in the US agricultural policy example above. The arrows have been preserved to signify the fact that two-way causality can occur between all of the factors described.

Chart (2)

Modified DSR Framework



This modified DSR framework shows how complex the link between agriculture, trade and the environment is, depending on the time frame examined.

Trade and the Environment

Recent trade and environment research focuses on the question of how to account for environmental costs when measuring economic gains from trade. Conventional trade and welfare models treat environmental damage as an externality and therefore exclude it from analysis. Failure to internalize environmental damage in trade welfare models has biased the economic gains from trade – usually by overstating the gains for an exporter with a traditionally competitive economic advantage.

Anderson has developed a trade model to internalize environmental costs. Runge describes how internalizing environmental costs give a more realistic picture of trade earnings and other economic benefits. In his example, Runge depicts a small agricultural importing nation that foregoes domestic production of some agricultural good and instead imports the more economically competitive agricultural products from foreign suppliers. Runge notes that the imports act as "substitutes" for environmental degradation, such as soil erosion, that would have taken place had the importing country produced the agricultural goods domestically. Therefore, by internalizing environmental degradation associated with agricultural production, the importer's gains from trade increase due to improvements in societal welfare resulting from the foregone soil erosion. Conversely, the exporter's traditional gains from trade are diminished because of the costs associated with the soil erosion that took place to produce the exported agricultural good. In this example, the economic welfare losses that would typically accrue to the domestic producers of the traded product in the importing country may be offset by the environmental gains from trade so that overall, the importing country's welfare improves. These gains depend on the price and demand elasticities associated with the traded product and the environment, however, the implications of such a simple analysis are clear: without internalization of environmental costs associated with agricultural production and trade, it will be impossible to measure the full and true economic affect of changes in trade patterns.

Anderson's welfare analysis addresses another issue, one which surfaced during the GATT UR – the idea that indirect agricultural subsidies amass to producers and agribusinesses in countries that permit the production of agricultural goods with relatively low conservation standards. In the absence of an internationally-recognized methodology to internalize environmental costs, countries that produce crops, for example, without conservation measures, have lower production costs than farmers in a country which is either directly or indirectly taxed for environmental degradation. During the GATT UR negotiations this subsidization problem was labeled "eco-dumping" and raised serious, mostly unresolved questions about environmental harmonization, internalization of environmental costs, and the measurement of "gains" from trade.

These ideas raise important issues for countries that seek to maintain and establish agricultural programs, whether they be direct agricultural subsidies such as income supports or conservation payments, or indirect subsidies, such as the continued treatment of environmental costs, like soil erosion, as externalities.

Anderson's model, when applied to agriculture, theoretically comes the closest to measuring the relationships between agriculture, trade flows and the environment, but forces the analysis into a trade context. While less rigorous, the framework developed by the OECD can, with a few modifications to include trade, offer a more detailed and less restrictive look at the linkages between agriculture, trade and the environment and therefore will be used in this paper.

Part Two: US Agriculture Programs -- A Review of "Farm" Subsidies

There are hundreds of US programs designed primarily to impact the economic conditions of either the agricultural goods producers (farmers and ranchers) or agribusiness (suppliers of farming inputs and investors) or buyers of farm products (consumers). In the popular press, any and all of these programs are often mistakenly called "farm subsidies" or "subsidies."

Subsidies, as described by Webster, are "a grant of money, as from a government to a private enterprise." Similarly, agriculture subsidies, are most commonly described by agricultural economists as "incentive payments that are designed to reflect the marginal cost of engaging in a subsidized practice" (Knutson, Penn, and Boehm). The GATT UR, however, references what are considered subsidies in the AMS which it defines as "the annual level of support, expressed in monetary terms, provided for an agricultural product in favor of the producers of the basic agricultural product or non-product-specific support provided in favor of agricultural producers in general."[3]

[3] See Stone for a detailed review of GATT UR subsidy definitions and conditions.

While there are subtle and not so subtle differences between these subsidy definitions, what is common among all of them is the idea of government action that consciously raises or lowers prices, income and profit at some point in a production chain.

Chart (3) is a partial listing of direct US agricultural subsidy programs and examples. Excluded from the list are environmental externalities or indirect agricultural subsidies, as described in the review on the trade and environment literature.

Chart (3)

US Direct Agricultural Subsidies

1. Programs that directly raise producers' income without directly altering crop input and output prices or supply. The best example of this is the decoupled income support policy.

2. Programs that lower the cost of raw materials to agri-input firms, resulting in profits or a rate of return on investment (ROI) that is artificially higher than it would be otherwise. For example, low government fixed prices for natural gas or petroleum subsidize fertilizer firms.

3. Programs that lower the price for agri-inputs sold to farmers and ranchers, allowing the agri-input firms to make above average returns through increased sales. Exemption of certain farm inputs from taxes or direct farm income subsidies could fall into this category.

4. Programs that lower the costs of inputs to farmers that are supplied directly by government agencies thereby increasing input use. For example, low, fixed prices for irrigation water provided by publicly financed authorities.

5. Programs that lower the prices that crop and livestock buyers pay farmers for their output, thereby lowering farmer/rancher ROI and raising agri-business ROI. Deficiency payments, another type of income support, and acreage reduction programs have had this effect.

6. Programs which raise the prices that buyers must pay farmers:
Price support and stabilization programs, like the Commodity Credit Corporation non-recourse loan program, are an example of this type of subsidy.

7. Programs that lower the operating costs of processors and exporters. The Export Enhancement Program (EEP) and Market Promotion Program (MPP) are examples of this type of policy.

8. Programs that lower costs to consumers, such as the Food Stamp and WIC (Women, Infant and Children) programs.

Part Three: Applying the Modified DSR Framework to Decoupled Agricultural Income Supports

Informal case studies are an important way to explore conceptually the modified DSR framework and to study the critical subsidy linkages between agriculture, trade and the environment. Recognizing the difficulty of such a comprehensive analysis, this study focuses on the effects of the GATT UR agricultural rules on the recent US agricultural policy decision to implement decoupled direct income payments, and their potential affect on farm management and soil quality across the United States.

Although there are literally hundreds of farm policies and programs that could (and should) be analyzed, the decoupled direct income payment policy was chosen because it has been, by far, the most important and most controversial recent US agricultural policy instrument.

Decoupled income supports have been debated among domestic US agricultural policymakers since 1985 but were not enacted until 1996 following a shift in farm sector ideology and the completion of the GATT UR. They remain controversial in the United States because of the somewhat conflicting goals pursued by different members of the domestic economy. The US GATT UR negotiators believe that direct income supports "decoupled" from production controls allow governments to achieve political and economic goals without distorting production levels, prices and hence trade patterns. Many conservationists, however, feel that any type of income payment should be tied directly to mandatory environmental protection rules -- these are called "green payments." Meanwhile, US farmers, while favoring more planting flexibility, argue that direct income payments will not solve the long-term economic problems resulting from increased market price volatility following changes in international trade rules and the GATT-mandated removal of supply controls.

Soil quality, as measured by soil erosion, compaction and input rates,[4] was chosen as an agri-environmental indicator for the informal case study. The decision to use soil quality was made for several reasons. First, changes in soil quality are closely tied to changes in farm production. Soil compaction can lead to sheet erosion and lower plant growth by reducing root penetration. Chemicals, such as fertilizers, pesticides and herbicides, decrease the amount of organic matter in the soil and hence crop yields. The second reason for choosing soil quality as an agri-environmental indicator is because it has broad implications that stretch beyond farm fields. It is the compaction and topsoil erosion that results in most of the pesticides and nutrient run-off into our surface water and which just may be the nation's most serious threat to stream and river ecology, not to mention drinking water and wildlife habitat.

Of course, ecological impacts cannot, by definition, be properly isolated. For instance, scientific research shows that soil erosion is created by a combination of farm management practices, topography, rainfall, wind and forestry activities. But for the sake of exploring the modified DSR framework through an informal, conceptual case study, this oversimplification is necessary.

Chart (4) depicts the framework used in this example, outlining the impact of GATT UR trade rules on US farm subsidies, the income subsidy affect on farm input decisions, and the affect of farmers' decisions on soil quality.

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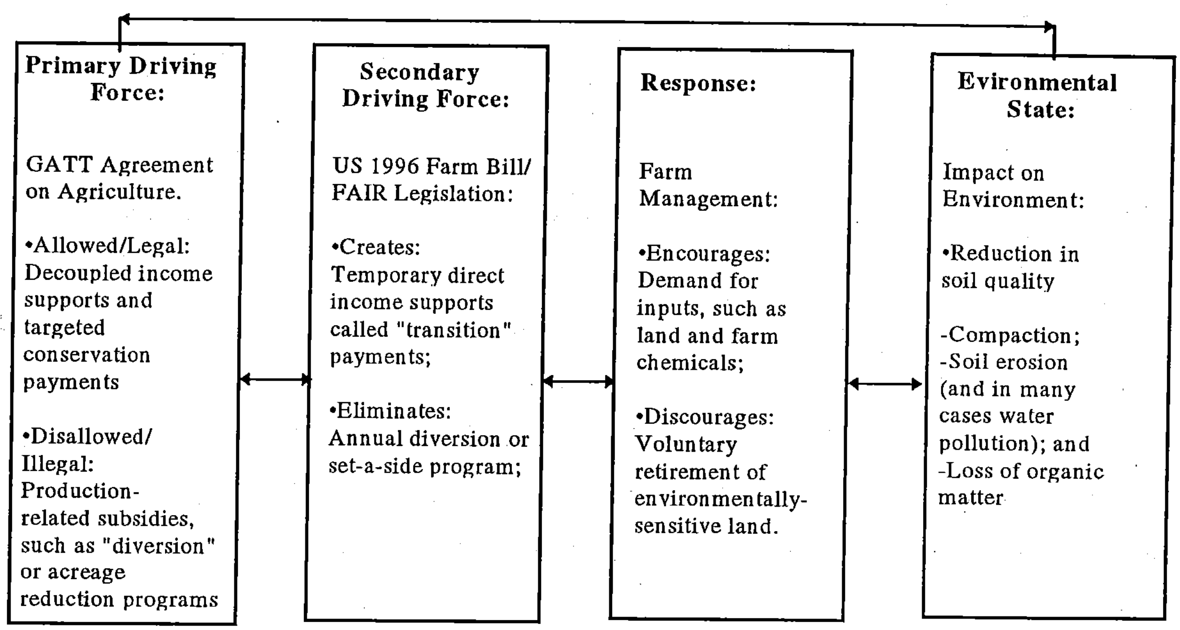
[4] Inputs include both variable and fixed inputs: pesticides, herbicides and fertilizer, machinery and land.

Chart (4)

Applied Framework



Primary Driving Force: Impact of GATT UR Rules on US Farm Policy Choice

Trade rules may be considered a "primary driving force" since they increasingly guide domestic agricultural policies. The GATT UR "Agreement on Agriculture," for example, directs domestic commodity programs, including subsidies, and farm-related conservation programs by defining allowable national agricultural subsidies in the AMS – some of which are considered trade-distorting and others which are considered non-trade-distorting.

Under the agreement, any form of government support or subsidy that directly affects or "distorts" production and trade are considered unallowable and must be phased out over specified time periods. Price supports, acreage reduction or land diversion programs, and direct export subsidies are examples of these unallowable subsidies.

There are a few exceptions to these international trade rules. They include direct, decoupled income payments and payments made to producers under environmental programs, so long as the programs have "no, or at most minimal trade distorting effects and, even then, only insofar as the payments are limited to the extra costs or loss of income occasioned by complying with the government program" (GATT, Annex 2, 12 (i), 12 (ii); Stone, p. 31).

Secondary Driving Force: US Agricultural Policy Guides Production Decisions

US agricultural policy has become a secondary driving force in the overall framework. In accordance with GATT UR rules and a range of other political and economic ideologies that existed in the United States during debate over 1996 farm policies, the US government implemented a host of policy changes under the 1996 Federal Agriculture Improvement Act (FAIR), including decoupled farm subsidies called "transition payments."

Under this system, direct income support in the form of declining payments are made to producers based on their production histories, while land set-aside and other forms of supply management requirements have been eliminated.

Farmers' Response to Decoupled Income Programs

The decoupling of support from production decisions and supply control and the direct payment of income subsidies may create two environmentally important producer responses that both affect soil quality:

1. Increased variable and fixed input use; and
2. The return of marginal or environmentally sensitive land to production.

First, farmers may respond to decoupled direct income supports by increasing input use. Inputs may include: land; machinery; farm chemicals such as fertilizers, herbicides and pesticides; and human capital, such as new cropping and tillage knowledge.

Conceptually, direct income supports should not induce demand for inputs because they do not affect the market price for farmers' output or the retail price of inputs – the two components that traditionally drive farm input decisions. Informal industry evidence, however, indicates that the high crop prices of 1996 combined with the implementation of direct income supports, led to increased fixed input use that same year. Although there have not yet been any studies to separate the effects of the two factors, it appears that income support may have been significant factor contributing to this increase in input demand. Ray contends that producers will treat the direct income payment as an increase in purchasing power – using it to buy new fixed inputs. He states that while the "economics" of increased input demand resulting from the income support may be "questionable ... there is no doubt, however, that many farmers who would benefit from a cash cushion in years ahead will decide to use that money as down payments to buy land, farm equipment, etc..." (p.92). This effect is illustrated in Graph (2) of the Appendix and leads to what Cochrane (1993) and Peterson refer to as the "capitalization" of income into land values. Income is allocated toward more fixed inputs, such as new land, which through the process of competitive bidding, pushes up fixed input prices.

As income is capitalized into land values, acreage prices for all farmland will increase – encouraging producers to make use of marginal lands that may be enrolled in conservation programs, such as the Conservation Reserve Program (CRP) or previous annual set-aside land under the Acreage Reduction Program (ARP). According to USDA data, for example, in the 1995/96 crop year, before the US annual Acreage Reduction Program (ARP) was eliminated under WTO and FAIR rules, farmers set aside 6.1 million acres of wheat and 7.7 million acres of corn (USDA, May 1997). USDA projected planting estimates as of April 1997 indicated that producers would return all of the set aside acres and more – most likely from the Conservation Reserve Program -- to production.

Voluntary environmental programs, such as the Conservation Reserve Program (CRP) which has been called the "main [US] environmental subsidy," are unlikely to divert these previously set aside land from production (Runge, p.148). CRP aims to retire sensitive lands for up to ten years, but producers were given the option under the 1996 FAIR legislation to terminate their CRP contracts early. In 1996 and 1997, for example, farmers withdrew land from the voluntary Conservation Reserve Program (CRP)[5] to plant more corn, wheat and soybean crops in the face of historically-high crop prices. Ray contends that in the future most "land likely to enter and leave production is in the CRP [Conservation Reserve Program]" (p.94).

Furthermore, it is not unreasonable to assume that producers will also increase the marginal and aggregate volume of other fixed and variable inputs, such as fertilizers, that are applied to previously-farmed land and new land brought back into production from either the CRP or ARP programs. An increase in the volume of farm inputs following the return of CRP and ARP land to production is a reasonable assumption and an event that has been highly anticipated by farm chemical and other farm implement dealers.

Although income supports could be applied to other types of inputs, such as human capital through education of alternative, sustainable farming practices, US research and extension institutions have been slow to respond with this type of encouragement.

Instead producers are pushed to increase inputs, whether it be in the form of machinery replacement or fertilizers, to achieve maximum production yields -- so long as the marginal cost of the total amount of new inputs is less than or equal to the market price of the additional crops and livestock produced (Peterson). Should farmers treat the income subsidy as an increase in purchasing power, as asserted by Ray, then producers may respond as if an input subsidy had been afforded. Cochrane (1993) explains the rationale behind farmers' drive to increase input use in his Theory of the Treadmill:

[5] The CRP historically offered 10-year contracts to producers who idled crop land for conservation purposes. However, under the 1996 FAIR legislation, producers were offered early-out options from

"The aggressive, innovative farmer is on the treadmill with regard to the adoption of new and improved technologies on his farm. As he rushes to adopt a new and improved technology when it first becomes available, he at first reaps a[n economic] gain. But as others after him run to adopt the technology, the treadmill speeds up and grinds out an increased supply of the product. The increased supply of the product drives the price of the product down to where the early adopter and his fellow adopters are back in a no-profit situation. Farm technological advance in a free market situation forces the participants to run on a treadmill" (p.429).

In this situation, which describes the rapid expansion of farm size in the United States between 1950 - present time, only the "early-bird" producer who is the first to adopt the new technology, or other inputs, reduces unit costs until the input prices either rise or the increased supply of final farm products expands and lowers market prices for the final commodity. This is illustrated in Graph (1) of the Appendix.

Based on limited empirical evidence and the above theoretical ideas, it is plausible that direct income supports have become the equivalent of input subsidies and thus encourage farmers to increase their fixed and variable inputs, such as marginal land and farm chemicals.

Increased Input Applications Affect the Environmental State

The return of marginal or environmentally sensitive land to production, combined with increased farm chemical input use and pre-existing resource factors, can be expected to have a dramatic impact on the state of the environment, most notably on soil quality.

Soils are the result of physical, chemical and biological processes which are all influenced by climate change and farm management practices over time. The cultivation

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existing and future CRP contracts.

of soils for cropping has a significant effect on the state of the environment, varying by the type of inputs applied and the farming methods used.

Chemical fertilizers and manure that are added to the soil, for instance, changes soil chemistry and can lead to fluctuations in acidity and the composition of soil solutions. Fertilizer applications and other soil amendments will increase soil nutrient levels, however at diminishing marginal rates as is illustrated in Graph (3) of the Appendix. Once optimal fertilizer levels have been surpassed, soil quality begins to decline rapidly due to nutrient over-loading. Overloading, coupled with topsoil erosion that results from the cropping of highly erodible land and intensive tillage, can cause ground and surface water contamination on the farm or thousands of miles away.

Furthermore, plowing and disking that result for increased machinery, disturb the soil structure directly and indirectly as heavy machinery compacts particles, reduces microbial communities, pore space and water and nutrient infiltration rates (thereby encouraging run-off). (USDA, 1991).

The deterioration of soil quality that results from increased variable and fixed input use per acre reduces soil productivity and increases water and chemical run-off, respectively, that can eventually affect drinking water and animal habitat.

Of course, quantitative analysis will be required to determine the optimal levels of input use and to perform a more rigorous study of the relationship between soil quality, input use and decoupled income subsidies. This is left to future analysis, once more data on direct income subsidies and soil quality indicators becomes available.

Part Four: Conclusions and Future Agenda

A methodology and corresponding set of indicators that take account of the linkages between agriculture, trade and the environment are needed to assist agricultural policymakers at the domestic and international level. Currently, there does not exist either a methodology or a set of indicators that can be used to asses all three factors together.

An existing framework methodology, developed by the OECD, was modified in this paper to enable the study of the agriculture, trade and environment interactions and was applied to an informal case study.

Based on the informal case study, the modified OECD framework reviewed in this paper appears to be a useful first step in analyzing the links between direct and indirect agricultural subsidies, trade and the environment. It provides a simple look at the causal relationship between the three sectors described, allowing policymakers to identify and consider the effects of trade and agricultural policy and environmental resources on one another.

Furthermore, the example considered in part three of the paper shows how international trade rules directly affect domestic agricultural policy by forcing the provision of direct decoupled agricultural income subsidies, which in turn can lead to increased input use and environmental degradation if left unbalanced or undirected toward positive alternatives as is shown in Graph (4) of the Appendix. Although it is theoretically possible to completely decouple income support from production decisions, the example illustrates otherwise. Additionally, it exposes the impossibility of "decoupling" domestic agricultural subsidies from their links to trade policy, requiring the incorporation of these factors into any analysis of the affect of farm policy and management on the environment.

Future Research

The future development of agricultural, trade and conservation-related subsidies will require careful consideration of their linkages to trade and to one another. The modified OECD framework should be further studied.

If appropriate, and following the availability of indicator data, the modified OECD framework will be used to build empirical models that can be applied to quantitative case studies of the links between trade, the environment. The agricultural subsidies detailed in Chart (3) in the second section of this paper could be used in such an analysis. However, key agreements made during the Uruguay Round negotiations that affect domestic farm programs should be the main focus of future analysis, in addition to new developments that have resulted from recent WTO dispute panel settlements.

These future studies will help to analyze the future impact of trade rules on domestic farm policies paying particular attention to the interaction of these policies, the environment and trade policies and physical trade patterns.

Sources

Anderson, Kym. "The Standard Welfare Economics of Policies Affecting Trade and the Environment." The Greening of World Trade Issues. University of Michigan Press. 1992.

Bhagwati, Jagdish. "Trade and the Environment: Exploring the Critical Linkages." Agriculture, Trade and the Environment. Westview Press. 1996.

Cochrane, Willard W. The Development of American Agriculture. 1993.

Cochrane, Willard W. and C. Ford Runge. Reforming Farm Policy: Toward a National Agenda. Iowa State University Press. 1992.

General Agreement on Tariffs and Trade. Uruguay Round "Agreement on Agriculture." 1995.

Harold and C. Ford Runge. "Environmental Impacts of Agricultural and Forestry Subsidies." Subsidies and Environment: Exploring the Linkages. OECD. 1996.

Houck, James. P. Elements of Agricultural Trade Policies. Waveland Press, Inc. 1992.

Knutson, Ronald D., J.B. Penn and William T. Boehm. Agricultural and Food Policy, Third Edition. Prentice-Hall Inc. 1995.

Miranowski, John A. "How Do Agricultural Policies and Practices Affect the Environment in the United States?" Agriculture, the Environment and Trade: Conflict or Cooperation? International Policy Council on Agriculture and Trade. 1993.

OECD. Environmental Indicators for Agriculture. Paris. 1997.

Parris, Kevin. "Agriculture and the Environment: Developing a Set of Indicators for Use in Agricultural Policy Analysis." OECD. September 19, 1994.

Ray, Daryll E. "The FAIR Act: What Does It All Mean?" Increasing Understanding of Public Concerns and Policies. Farm Foundation. January 1997.

Runge, C. Ford. Freer Trade, Protected Environment: Balancing Trade Liberalization and Environmental Interests. Council on Foreign Relations. 1994.

Seitz, Wesley D., Gerald C. Nelson, and Harold G. Halcrow. Economics of Resources, Agriculture and Food. McGraw-Hill, Inc. 1994.

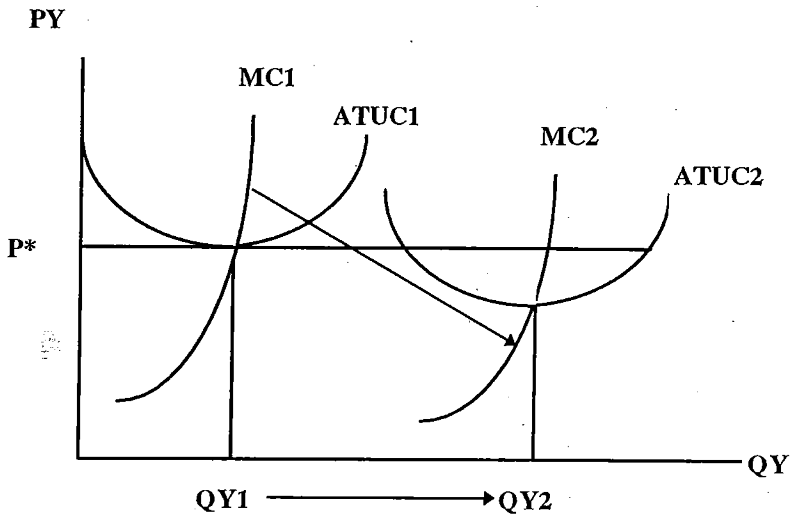
Stone, Christopher D. "The Maladies in Global Fisheries: Are Trade Laws Part of the Treatment?" *GETS-GISPRI Collaboration on Trade and the Environment.* New York City, New York. June 26-27, 1997.

USDA. Agriculture and the Environment: The 1991 Yearbook of Agriculture. 1991.

USDA, Economic Research Service. "Agriculture in the Uruguay Round: Analyses of Government Support." December 1988.

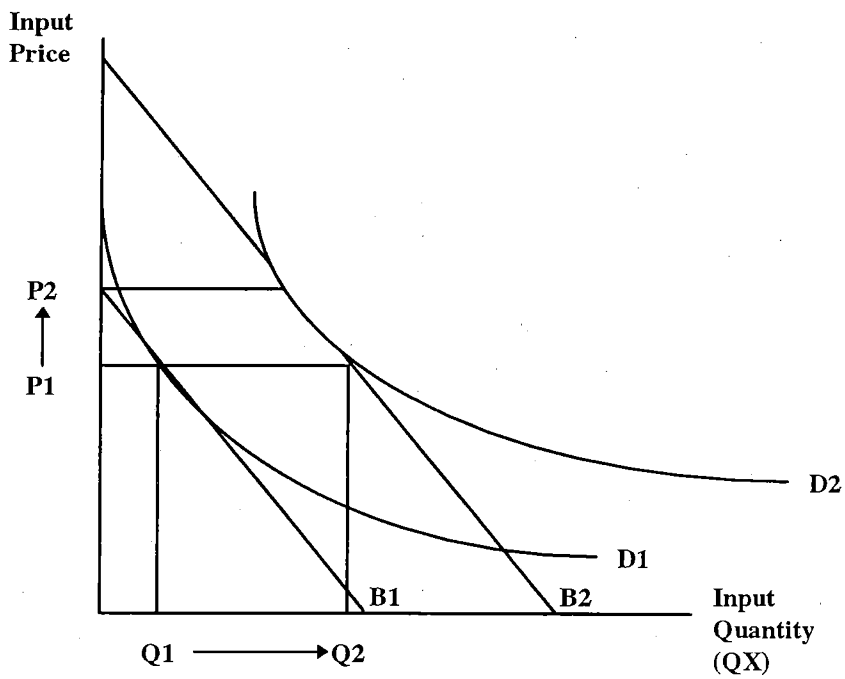
Appendix

Graph(1)
Conventional Derived Demand for Inputs



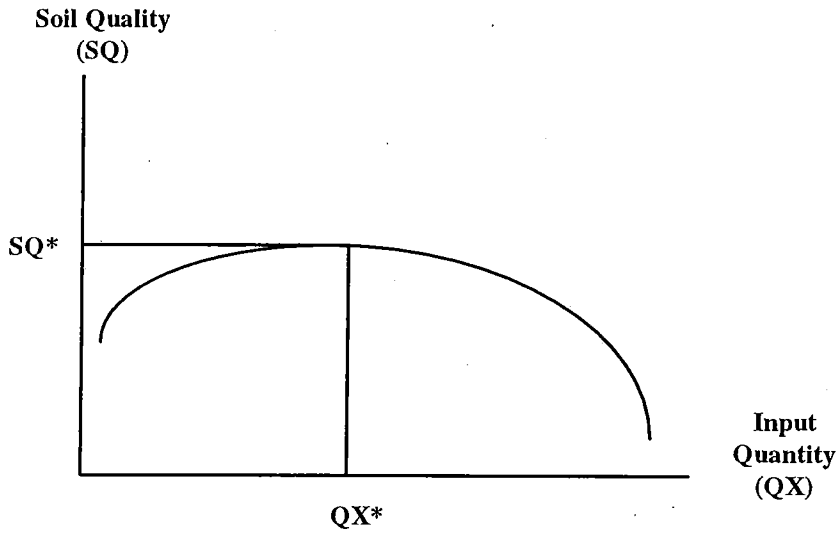
Conventional economic theory states that producers will only increase their demand for inputs in response to an increase in the output price of the final commodity, PY, or a reduction in their marginal and total costs, MC and ATUC, respectively. This assumes that producers are operating at their equilibrium or at efficient levels as shown by QY1. In order for MC and ATUC to fall, either fixed or variable input prices must be reduced from, for example, MC1 and ATUC1 to MC2 and ATUC2. This derived demand for inputs results in an increase in input use equal to the difference between QY1 and QY2.

Graph (2)
Decoupled Income Support Increases
Producer Purchasing Power and Demand for Inputs



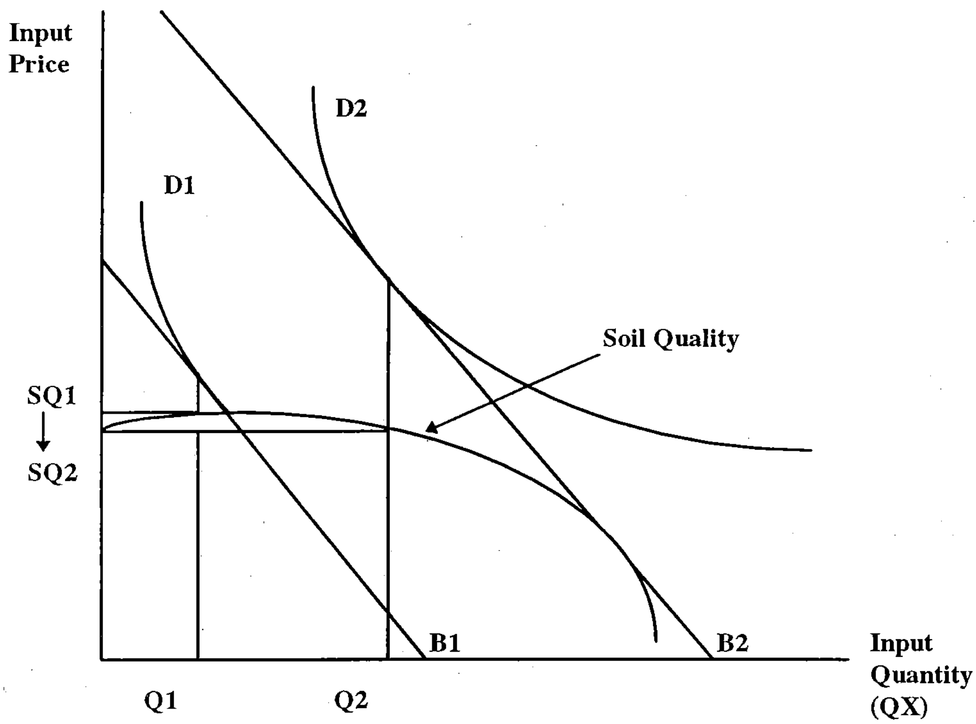
In Graph (2), farm producers treat direct income supports as an increase in purchasing power, as suggested by Ray, and much like consumers increase their demand for goods; inputs. It is possible for this to occur if producers are not initially operating at efficiency prior to the introduction of the income support. The income support effectively shifts the producers' budget line out from B1 to B2. Consequently, the demand curve shifts out to the right from D1 to D2, so that the input quantity demanded increases from Q1 to Q2. Prices respond to the increased demand by shifting upward.

Graph (3)
Relationship Between Input Use and Soil Quality Levels



Graph (3) depicts the relationship between soil quality and input use. The introduction of inputs may improve or have little affect on soil quality initially, up to the optimal level of SQ* when QX* inputs are applied. However, once inputs, such as fertilizer or marginal lands, are introduced beyond QX*, soil quality begins to deteriorate at either a decreasing or increasing rate, depending on soil quality elasticities. In the graph above, soil quality is represented as highly elastic – it decreases at an increasing rate when inputs are added beyond the optimal level QX*.

Graph (4)
Affect of Decoupled Income Support on Soil Quality



Overlaying Graph (2) onto Graph (3) illustrates how the introduction of an income support, without other conservation measures taken, can encourage producers to apply inputs beyond optimal levels, thereby reducing soil quality from SQ1 to SQ2.