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ENVIRONMENTAL AND AGRICULTURAL POLICY LINKAGES IN THE EUROPEAN COMMUNITY: THE NITRATE PROBLEM AND CAP REFORM

by

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SUMMARY

Two aspects of the trade/environmental interface are examined in this paper. First, the effect of domestic policy reform ("Mac Sharry Plan") on the European Community's level of fertilizer use and on the level of manure from livestock production are analyzed. A goal is to determine the compatibility of trade and/or production policy reform with the pursuit of environmental objectives. A second aspect is an examination of the effect of environmental policy measures on agricultural production and trade. Examined policies include provisions of the EC Nitrate Directive (especially regarding livestock density restrictions) and a hypothetical tax on nitrogen fertilizer use. The effect of these environmental policies are traced through to world markets and to U.S. agriculture.

CAP reform implies significant reductions in the delivery of nitrates to the soil. In particular, nitrogen fertilizer use is reduced because of large crop output price reductions and the land setaside program. Nitrogen deliveries from livestock manure are less affected. Total nitrate deliveries are reduced to about the same magnitude implied by the adaption of an ad valorem tax on nitrogen fertilizer use in the range of 50 percent. If the Nitrate Directive is imposed on top of CAP reform, total nitrate deliveries are reduced by about the same amount as a 75 percent ad valorem tax.

A tax on nitrogen fertilizer use has generally small effects on agricultural production and trade. EC exports of "other coarse grains" (primarily barley) are the most affected -- perhaps reduced as much as 30 percent. As a consequence, the United States could experience perhaps a 2 to 5 percent rise in its coarse grain exports. The Nitrate Directive primarily affects EC production of pigs, sheep, and poultry. Although the Directive has practically no effect on crop supply, demand for feedgrains is significantly diminished. Gains to the United States implied by decreased EC net exports of grains predicted under terms of CAP reform are reduced by about 2.7 mmt if the Nitrate Directive is implemented.

ENVIRONMENTAL AND AGRICULTURAL POLICY LINKAGES IN THE EUROPEAN COMMUNITY: THE NITRATE PROBLEM AND CAP REFORM

Until recently there has not been strong interest in the relationship between environmental and agricultural policies in the European Community (EC). Environmental policies have been typically in the domain of national and provincial governments, reflecting the local, particularized character of environmental problems in the past. Agricultural policies, on the other hand, have emphasized common EC-wide concerns of food security, rural development, preservation of rural character, and responsiveness to the demands of rural-based interest groups, especially farmers.

There is now an increasing recognition of agriculture's contribution to environmental degradation (Agra Europe, 1991; Vocke, 1991). One of the chief concerns is the effect of nitrate accumulation on water quality. Nitrates from livestock manure and chemical fertilizers are leached from the soil and lead to the contamination of potable water supplies in several highly populated areas of the EC and to the eutrophication of EC inland and coastal waters. The problem is considered sufficiently serious and trans-national in character that it must be dealt with on an EC-wide basis.

In this paper, two aspects of the trade/environmental interface will be examined. First, the effect of domestic policy reform on the EC's level of fertilizer use and on the level of manure from livestock production will be examined. Specific policy implications of the "Mac Sharry Plan" for EC agriculture and the environment will be examined. A goal is to examine the compatibility of trade and/or production policy reform with the pursuit of environmental objectives. A second aspect is an examination of the effect of environmental policy measures on agricultural production and trade. Examined policies include provisions of the EC Nitrate Directive (especially regarding livestock density restrictions) and a hypothetical tax on nitrogen fertilizer use. The effect of these environmental policies can be traced through to world markets and to U.S. agriculture.

Nitrate Pollution in the EC

Nitrate pollution has been identified as a major problem in the EC. Many policymakers are now concerned about the effect of animal manures and fertilizer use on water quality. In many areas of the EC, public water supplies cannot meet the EC standard for potable water of 50 milligrams (mg) of nitrate per litre. Vocke (1991) has identified areas where the problem is particularly severe: The Netherlands, low lying parts of Belgium and France (especially Brittany), southern Britain, Denmark, much of Germany (especially Lower Saxony and former East Germany), and northern Italy. Vocke argues that the major threat to water supplies for human consumption stems from the widespread introduction of intensive livestock production under confined conditions in the 1960's and the rapid growth subsequently. Health risks are associated with methemoglobinemia or "blue baby" syndrome. This dangerous condition is caused by oxygen starvation in bottle-fed infants. There are also fears that high concentrations of nitrates contribute to the incidence of stomach cancer, although the connection is unproven.

Nitrate pollution has also contributed to the eutrophication of EC inland and coastal waters. Nitrates from animal manures and nitrogen fertilizer applied to crops are responsible for this problem. The leached nitrates promote the growth of algae, whose decay depletes oxygen levels, especially in marine waters. (Phosphates are considered more of a problem than nitrates for fresh water eutrophication.)

EC agricultural policies have contributed to the nitrate problem. The EC's Common Agricultural Policy (CAP) has encouraged the growth of livestock and crop production through guaranteed high domestic prices, exceeding world levels and divorced from world price trends and disturbances. High returns from agricultural activities have been capitalized into land prices that have in turn favored intensive, land-saving livestock and cropping technologies. These technologies have been largely responsible for excess deliveries of nitrates to the environment.

Although environmental problems extend throughout the whole of the EC, environmental damage from nitrate pollution is more of a localized problem, concentrated especially in the areas listed above. Leaching risks are considered the most serious during periods of high rainfall, low evaporation, and low crop nitrogen demands: that is, usually during the fall. Optimal policy measures would ideally be targeted to those areas where the problems are the most serious and would take account of seasonality influences. Also complicating remedial policy measures is the dynamic nature of nitrate pollution: it can take up to 40 years for nitrates to travel from the soil to groundwater. Travel time is largely a function of intervening rock layers (Hanley, 1990).

<u>Potential Policy Responses</u>

Potential policy options can be categorized into three areas: reduction in nitrogen fertilizer applications, reduction in animal manure applications, and better management of nitrate applications (Hanley, 1990). One way to reduce fertilizer applications is through taxing their use. Hanley reports, however, that most estimates of fertilizer demand show it to be inelastic, implying that high tax rates would be needed to achieve sizeable reductions. Also, the localized nature of the nitrate problem would imply differentiated tax rates, although transactions costs could be high. A uniform tax would be simpler administratively, although potentially unfair. A headage tax on livestock producers could be used to internalize costs of manure disposal. Other solutions could be based on tradeable nitrogen quotas, or lump-sum compensation of producers subject to the nitrogen/headage taxes.

Increased regulation of land use is another possibility. Regulations covering land in vulnerable zones could be used to control detrimental management schemes and to encourage the adaption of other schemes. Regulations could be enacted to limit nitrogen applications in the fall and/or encourage the planting of fall cover crops. Regulations could limit the application of manure during periods of heavy rainfall and low crop growth. Policies could encourage the construction of manure storage facilities, the transport of manure to other areas, and/or the reduction of concentrations of livestock. Laws could restrict the large-scale ploughing of pasture land.

Although not primarily directed at environmental problems, CAP reform (the "MacSharry Plan") could promote lower net deliveries of nitrates to the environment. An aim of the program is to move away from supporting markets and toward supporting landholders (Agra Europe, 1991). Reduction of producer prices of cereals of 30 percent would translate into lower land prices, thereby encouraging more extensive agricultural techniques that use less yield-enhancing fertilizer. Although cattle prices would be reduced by only 15 percent, decreased profitability could lead to fewer head and consequently less manure, all else constant.[1] The land set-aside provisions (the idling of 15 percent of arable land on holdings above 20 hectares) could be useful in switching from arable crop production to grasslands or woodlands in vulnerable areas. Although Hanley (1990) reports that most environmental research does not predict significant nitrate abatement from policies oriented toward outputs, the effect on nitrate deliveries of the Mac Sharry Plan deserves attention because of the magnitude of the proposed changes.

The Nitrate Directive

The EC Nitrate Directive was passed by the Council of Environmental Ministers on 14 June 1991. Its intent is to limit nitrate levels in potable water to less than 50 mg per litre. It is not part of the Mac Sharry Plan and many of its details have

[1]Lower grain prices imply lower feed costs, possibly offsetting the effect of lower cattle prices.

yet to be worked out (Leuck, 1993).

The Directive requires EC member countries to designate "vulnerable" zones where water standards are not being met. The countries are to develop "codes of good practice" that are mandatory in vulnerable zones and voluntary, elsewhere. Implementation of the Directive is to take place over an eight year time frame. One known limitation is that the application of livestock manure can be no more than 170 kg per hectare at the end of the eight year period. A further restriction, although not clearly spelled out, is that the application of manure must be consistent with good agricultural practice in relation to use of nitrogen by crop, the amount of nitrogen from chemical fertilizers and other sources, and the amount already in the soil. The application rate may, therefore, be less than the prescribed maximum.

SWOPSIM Modeling Structure

The model chosen for this analysis is the SWOPSIM model developed at the Economic Research Service (ERS) to analyze the implications of worldwide agricultural trade liberalization (Roningen and Dixit, 1989). This section describes the modeling framework and discusses how it was modified to analyze the EC nitrate problem.

The SWOPSIM model is characterized by an economic specification that includes constant elasticity supply and demand equations and summary policy measures. For each region i and each commodity j, demand and supply functions are modeled as follows:

$$D_{ij}=D_{ij}(CP_{ij},CP_{im},X_{il}) \qquad (1)$$

$$X_{ij}=X_{ij}(PP_{ij},PP_{im},CP_{im}) \qquad (2)$$

where CP_{ij} and PP_{ij} are domestic incentive prices facing consumers and producers, respectively, of commodity j in country i. CP_{im} and PP_{im} are consumer and producer prices of commodities closely related to commodity j in either consumption or production, respectively. CP_{im} in the demand function accounts for substitution possibilities in consumption. CP_{im} in the supply function accounts for the use of commodity m as an intermediate input in the production of commodity j. PP_{im} in the supply function represents substitution possibilities for the producer. X_{il} in the demand function accounts for the derived demand for the product as an intermediate input for the production of X_{il}. X_{il} is typically a livestock product which enters into demand functions for feed. Trade is the difference between domestic supply and demand:

$$T_{ij}=X_{ij}-D_{ij} \tag{3}$$

Domestic incentive prices depend on the level of consumer and producer support (modeled in terms of consumer and producer price wedges CSW_{ij} and PSW_{ij}), and on world prices denominated in local currency:

$$CP_{ij}=CSW_{ij}+F(E_i*WP_j) \tag{4}$$

$$PP_{ij}=PSW_{ij}+G(E_i*WP_j) \tag{5}$$

where E_i is the exchange rate of i with respect to the U.S. dollar, and WP_j is the world reference price of j measured in U.S. dollars. Function relationships F( ) and G( ) allow a specification of world to domestic prices to be less than or equal to 1. If equal to 1, then 100 percent of a world price change is transmitted domestically. A value less than 1 indicates that the government intervenes to cushion domestic producers and/or consumers from experiencing the full change. These coefficients are referred to as price transmission elasticities. World markets clear when net trade of a commodity across all regions sums to zero:

$$\sum_{i=1}^{n} T_{ij}=\sum_{i=1}^{n} X_{ij}-\sum_{i=1}^{n} D_{ij}=0 \tag{6}$$

The model covers 22 agricultural commodities and includes 11 countries/regions. Livestock commodities include beef and veal, pork, mutton and lamb, poultry meat, poultry eggs, milk, butter, cheese, and milk powder. The crops include wheat, corn, other coarse grains (barley, rye, oats, sorghum, millet, mixed grains), rice, soybeans, other oilseeds, cotton, sugar, and tobacco. Processed commodities include soybean meal and oil, and other oilseeds meal and oil. The countries modeled are the United States, Canada, the European Community, Other Western Europe, Japan, Australia, New Zealand, developing exporters (Brazil, Argentina, Indonesia, Thailand, Malaysia, Philippines), newly industrialized Asia (South Korea, Taiwan, other East Asia), former centrally planned economies (Eastern Europe, former Soviet Union, China), developing importers, and the rest of the world.

Incorporation of EC Nitrogen Fertilizer Sector: Demand

The SWOPSIM model does not explicitly include a fertilizer sector. Researchers at the Australian Bureau of Agricultural and Resource Economics (ABARE) used a SWOPSIM-based model to examine the effect of a nitrogen fertilizer tax in the EC (Gunasekera et al., 1992). They calculated an output tax equivalent of the fertilizer tax. They used estimates of nitrogen fertilizer use provided by the SPEL modeling group in Germany (1989) in calculating their output taxes. Their comparative static experiment consisted in introducing the tax as an adjustment to the producer subsidy wedge on EC agricultural commodities (equation 5). Their results will be compared to those of this study later.

As an alternative to the ABARE specification, this study explicitly incorporates an EC nitrogen fertilizer sector. The primary advantage is that the effect of policy changes on fertilizer use and the delivery to the soil of nitrates from fertilizer can be tracked. The structure is similar to the way feedgrain demand is modeled in SWOPSIM. The quantity supplied of crops using fertilizer enter into the fertilizer demand equation and are exponentially weighted by their proportion of total nitrogen fertilizer use. The share coefficients are calculated from the SPEL data referred to above and are shown in Table 1.

An EC-wide own-price elasticity of demand for fertilizer is based on a study by Burrell (1989). Burrell reports that most estimates of fertilizer demand in individual EC countries show an inelastic price response. For the United Kingdom, Burrell's estimate ranges between -0.4 and -0.6. For this study, an elasticity value equal to the average (-0.5) is used in the fertilizer demand equation.

As in SWOPSIM's feedgrain specification, the share data, along with other model parameters, can be used to calculate a fertilizer cross price elasticity for each of the crops that use fertilizer. This relationship is based on the symmetry restriction on production functions implied by neoclassical microeconomic production theory.[2] The explicit SWOPSIM equation used to calculate the elasticity is as follows:

[2]See, for example, chapter 8 of Intriligator (1971) -- specifically equation 8.3.22.

Table 1 -- Calculation of Fertilizer Price Elasticities For Crop Supply

Input Data

Input	Consumer Price (ecu/mt)	Consumption by ST86 Crops (1000 mt)
Nitrogen Fertilizer	567.20	5249

Output Data and Elasticities

Commodity	Fertilizer Share	Producer Price (ecu/mt)	Production (1000 mt)	Own-price Supply Elasticity	Fertilizer Price Elasticity
Wheat	.385	188	72138	.52	-.04
Corn	.084	186	25482	.61	-.03
Other Coarse Grain	.335	163	57742	.57	-.06
Rice	.006	341	1971	.40	-.01
Soybeans	.013	431	1084	.40	-.03
Other Oilseeds	.091	468	7655	.71	-.05
Sugarbeets	.070	370	13423	.17	-.01

Source: Input data and Fertilizer Share: SPEL Group (1989); Producer Price, Production, and Own-Price Supply Elasticities: Sullivan, Wainio, and Roningen (1989); Fertilizer Price Elasticity: Calculated.

$$\textit{Fertilizer cross-price elasticity} = \textit{fertilizer share} \quad (7)$$

$$*\frac{\textit{total fertilizer expenditure}}{\textit{crop production value}} * \textit{own-price supply elasticity}$$

Table 1 shows the necessary data to calculate the cross-price elasticity. The cross-price elasticity itself is shown in the last column of the second block of data.

Incorporation of EC Nitrogen Fertilizer Sector: Supply

Except for the work of McCorriston and Sheldon (1989), there has been little work on the modeling of fertilizer supply. Their approach stressed an imperfectly competitive market structure for the fertilizer sector. The ABARE study, on the other hand, implicitly assumed perfectly elastic supply. This specification is consistent with a competitive industry in an open economy where it has little or no effect on world prices of fertilizers.

This study provides two alternatives for modeling supply. Both assume a competitive market structure. In the first, the small open economy specification is used, assuming an infinite supply elasticity. Although the modeling of the EC fertilizer industry is not a goal, this research seeks to provide an alternative to the simple open economy specification. A simple alternative is to specify a closed economy framework that allows the EC fertilizer industry to be affected by the tax. It is assumed, therefore, that the output of the fertilizer industry is described by an upward sloping supply curve. The supply elasticity is assumed to equal unity.

Description of Scenarios

Two sets of policy changes are examined. The first set encompasses EC CAP reform referred to as the "Mac Sharry Plan." The second set of policy changes are meant to achieve environmental objectives. There are two specific scenarios. The first is the adaption of the EC Nitrate Directive. The modeling emphasizes the effects of the Directive on livestock densities. The second deals with the imposition of a hypothetical tax on the use of nitrogen fertilizers. This scenario corresponds closely to the scenarios examined by ABARE.

Mac Sharry Plan

There have been several versions of the Mac Sharry Plan. The version used in this analysis is the one planned for implementation over three years starting in 1993/94. The specific features modeled are as follows:

- o Price supports are reduced:
  - grains intervention prices cut 30 percent
  - oilseed support prices cut 50 percent
  - beef intervention price cut 15 percent
  - commodities not covered include cotton, rice, and sugar

- o Compensation for price reductions made through direct payments:
  - 45 ecu/mt for grains
  - 152 ecu/mt for oilseeds

- o Payment based on historic yields/herd size and require current production

- o Larger farmers required to set aside 15 percent of arable crop base

Unlike the U.S. program, the EC setaside is not commodity specific and small farmers are exempt. Estimates of how much land will be setaside and how specific crop acreage will be affected must be exogenously incorporated into the model. For this study, estimates made by the European Branch of the Agriculture and Trade Analysis Division (ATAD) of ERS were used. These estimates of individual commodity land area reductions are as follows -- wheat: -7 percent; corn: -9 percent; other coarse grains: -12 percent; soybeans and other oilseeds: -12 percent.

The Mac Sharry Plan scenario is modeled as a unilateral EC policy change, that is, no other country is assumed to change its agricultural policies either in conjunction with the EC or as a result of the EC change. One important modeling detail is that the price transmission elasticities from the SWOPSIM model are kept fixed at pre-liberalized levels. (Actually this is true for all scenarios.) These elasticities are documented by Sullivan (1990) and are shown in Table 2.[3] As can be seen, the EC elasticities tend to be small, thereby indicating the great degree to which the EC insulates itself from world price disturbances. Another implication is that EC policy changes affecting trade will have magnified effects on world prices because the EC and other like protectionist countries will not absorb the world price shocks caused by the EC policy change.

An unresolved question in the Mac Sharry Plan is what effect the direct payments meant to compensate producers for support price reductions will have on production. In terms of U.S. policy discussions, the issue is the degree to which the direct payments are "decoupled" from production decisions. The two extremes are

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[3]Price transmission elasticities for regions not shown in the table are equal to 0.5 for all commodities.

Table 2 -- Price Transmission Elasticities

Commodity	European Community	United States	Canada	Other Western Europe	Japan	Australia	New Zealand
Beef	.10	.65	.60	.10	.10	.90	.50
Pork	.60	1.00	.50	.25	.50	.75	.80
Mutton/ Lamb	.10	.90	.60	.60	.40	.90	.50
Poultry	.60	1.00	.30	.25	.80	.75	.80
Wheat	.15	1.00	.85	.15	.40	.80	.70
Corn	.25	1.00	.95	.20	.75	.90	.75
Other Coarse Grains	.10	1.00	.95	.25	.75	.90	.75
Rice	0	.80	.75	.65	.05	.50	-
Soybeans	.30	1.00	1.00	1.00	.70	1.00	1.00
Other Oilseeds	.30	1.00	1.00	1.00	.70	1.00	1.00
Sugar	.10	.20	.30	.10	.10	.70	.50

"-" = Not Applicable
Source: Sullivan (1990).

examined in this report: full decoupling and zero decoupling.[4]

EC Nitrate Directive

Many of the provisions of the EC Nitrate Directive have yet to be worked out. However, Leuck (1993) has examined the likely effects of the Directive on livestock supplies in individual EC countries. His analysis implies the following percentage changes in EC livestock supplies: beef: -4.8 percent; pork: -11.7; mutton/lamb: -.9 percent; poultry: -10.1 percent; eggs: -10.1 percent; and dairy: -7.8 percent. Because the Directive will be implemented along with EC CAP reform, this scenario will be run assuming that the changes described above (Mac Sharry Plan scenario) are occurring simultaneously.

Nitrogen Fertilizer Tax

Although it is not planned, the EC could choose to impose a tax on the use of nitrogen fertilizer as a way to reduce the delivery of nitrates to the soil. As mentioned previously, ABARE researchers have already used a SWOPSIM-based model to examine the implications of a 50 percent and 75 percent ad valorem nitrogen fertilizer tax. This report uses these same percentage taxes in simulation analysis.[5] Results will be compared to those of the other scenarios and to those of ABARE.

The scenarios above are identified by letter labels from "A" to "H". Table 3 shows the listing.

Effect of Policy Changes on Production, Trade, and Prices

Detailed modeling results for the change in EC production and trade, world prices, and U.S. trade for all SWOPSIM commodities are reported in appendix tables 1-4. Tables 4-7 report changes in EC production and trade, and world prices for the grains, oilseeds, and sugar. Most discussion will focus on results in these tables.

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[4]The decoupling issue has also been examined by Abler and Shortle (1992) in their analysis of the environmental consequences of the Mac Sharry Plan. The decoupling assumptions they make have significant implications for the results. As will be seen later, their results in both instances imply greater reductions in EC agricultural production than what might seem realistic.

[5]The previous section discusses the modeling differences between the ABARE and the present approaches.

Table 3 -- Description of Scenarios

MacSharry Scenarios		
Scenario A	-	Income support assumed coupled to production
Scenario B	-	Income support assumed decoupled to production
MacSharry Scenarios with Livestock Density Restrictions (Nitrate Directive)		
Scenario C	-	Income support assumed coupled to production
Scenario D	-	Income support assumed decoupled to production
Fertilizer Tax Scenarios: 50 percent tax		
Scenario E	-	Fertilizer supply elasticity set to one
Scenario F	-	Fertilizer supply elasticity set to infinity
Fertilizer Tax Scenarios: 75 percent tax		
Scenario G	-	Fertilizer supply elasticity set to one
Scenario H	-	Fertilizer supply elasticity set to infinity

Production

The largest grain reductions result from the Mac Sharry scenarios (table 4). The assumption regarding the decoupling of the direct income support plays an important role in the magnitude of the reductions. Aggregate crop production is reduced by 9 percent under the assumption of coupled policies, and almost 15 percent

Table 4
Changes in EC Production and Trade, and World Prices: MacSharry Proposal

Percent Change

Scenario A: Income Support Assumed Coupled to Production

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-7.79	-55.08		8.24
Corn	-10.94		241.62	4.03
Other Coarse Grains	-10.43	-170.75		11.07
Rice	.07		-32.64	.86
Soybeans	-15.58		1.16	1.31
Other Oilseeds	-22.06		97.13	8.20
Sugar	.14	.78		.38

Scenario B: Income Support Assumed Decoupled from Production

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-12.64	-76.79		12.08
Corn	-17.61		295.97	6.51
Other Coarse Grains	-16.55	-210.91		15.37
Rice	.12		-32.75	1.25
Soybeans	-28.31		1.97	1.85
Other Oilseeds	-39.48		173.75	14.29
Sugar	.81	4.33		.03

Table 5
Changes in EC Production and Trade, and World Prices: Nitrate Directive

Percent Change

Scenario C: Income Support Assumed Coupled to Production

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-7.81	-44.21		7.50
Corn	-10.85		170.28	5.52
Other Coarse Grains	-10.46	-124.86		10.08
Rice	.07		-32.69	.74
Soybeans	-15.60		.92	.78
Other Oilseeds	-22.08		96.88	7.65
Sugar	.14	.78		.36

Scenario D: Income Support Assumed Decoupled from Production

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-12.66	-66.03		11.33
Corn	-17.49		225.82	8.01
Other Coarse Grains	-16.58	-166.07		14.37
Rice	.12		-32.80	1.14
Soybeans	-28.34		1.74	1.33
Other Oilseeds	-39.51		173.53	13.73
Sugar	.81	4.33		.01

Table 6
Changes in EC Production and Trade, and World Prices: Fertilizer Tax Scenarios

Percent Change

Scenario E (50 Percent Fertilizer Tax and Fertilizer Supply Elasticity = 1)

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-1.18	-5.97		.86
Corn	-.89		10.60	.38
Other Coarse Grains	-1.76	-16.43		1.11
Rice	-.30		2.25	.11
Soybeans	-.90		.06	.09
Other Oilseeds	-1.46		6.42	.57
Sugar	-.30	-1.58		.32

Scenario G (75 Percent Fertilizer Tax and Fertilizer Supply Elasticity = 1)

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-1.70	-8.59		1.24
Corn	-1.28		15.25	.54
Other Coarse Grains	-2.53	-23.59		1.59
Rice	-.43		3.24	.15
Soybeans	-1.29		.09	.14
Other Oilseeds	-2.10		9.22	.82
Sugar	-.43	-2.28		.46

Table 7
Changes in EC Production and Trade, and World Prices: Fertilizer Tax Scenarios

Percent Change

Scenario F (50 Percent Fertilizer Tax)

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-1.59	-8.06		1.17
Corn	-1.21		14.31	.51
Other Coarse Grains	-2.38	-22.15		1.50
Rice	-.40		3.04	.14
Soybeans	-1.21		.09	.13
Other Oilseeds	-1.97		8.66	.77
Sugar	-.40	-2.14		.43

Scenario H (75 Percent Fertilizer Tax)

Commodities	Change in EC Production	Change in EC Exports	Change in EC Imports	Change in World Price
Wheat	-2.19	-11.09		1.61
Corn	-1.66		19.70	.70
Other Coarse Grains	-3.27	-30.43		2.06
Rice	-.56		4.19	.20
Soybeans	-1.67		.12	.17
Other Oilseeds	-2.71		11.90	1.06
Sugar	-.56	-2.95		.59

under decoupling.[6] [7] The largest contribution to the supply reduction comes from the EC setaside. Setasides alone cause an 8.2 percent aggregate crop volume reduction.

The primary effect of the Nitrate Directive is on livestock production. The Directive implies the following percentage point reductions from the Mac Sharry scenarios -- beef: 3 percent, pork: 10 percent; mutton/lamb: 1 percent; poultry meat: 9 percent; eggs: 8 percent; and dairy: less than 1 percent (appendix table 1).

The imposition of taxes on fertilizer use imply modest reductions in EC crop production (tables 6 and 7). A 50 percent ad valorem tax reduces crop production between 1.26 and 1.70 percent, depending on the value of the fertilizer supply elasticity.[8] Similarly, a 75 percent tax reduces crop production between 1.81 and 2.33 percent.

Figure 1 shows a comparison of results with those of the ABARE study. Because the ABARE study implicitly assumes an infinite fertilizer supply elasticity, results from scenarios F (50 percent tax) and H (75 percent tax) are shown. As is evident from the figure, the ABARE study implies smaller crop production reduction than this study. The 50 percent tax reduces aggregate crop production 0.85 percent (compared to 1.70 percent), and the 75 percent tax reduces it 1.28 percent (compared to 2.33 percent).

As an experiment, the ABARE producer subsidy wedge changes (from their Table 3) used to model the fertilizer tax were inserted into the ERS SWOPSIM model. The 50 percent tax implied a reduction in aggregate crop production of 0.97 percent, and the 75 percent tax implied a 1.49 percent reduction. These results are much closer to the ABARE results than to those of this study,

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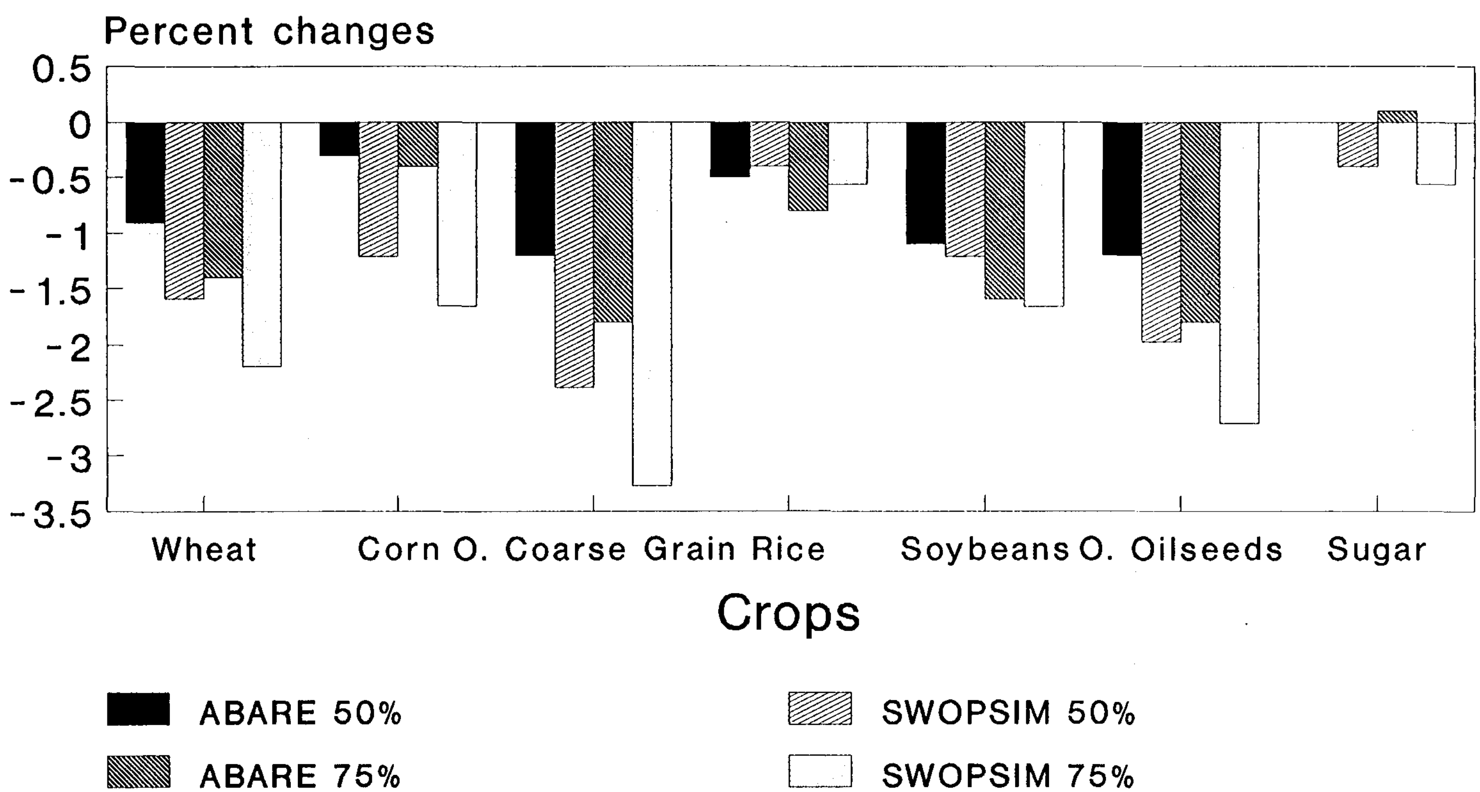
[6]Weights used to calculate aggregate crop volume changes are based on the volume proportion of each crop to the total: wheat -- .405, corn -- .141, other coarse grains -- .318, rice -- .007, soybeans -- .005, other oilseeds -- .042, and sugar -- .082.

[7]Comparable scenarios run by Abler and Shortle (1992)indicate between a 78 and 97 percent reduction in grain production assuming 0.33 to 0.67 decoupling of policies. These reductions seem rather extreme. It is unlikely that such reductions would be permitted in the EC as a consequence of CAP reform.

[8]If the fertilizer supply elasticity is a finite positive number, then the incidence of the tax is shared with the EC fertilizer industry. As a consequence, the price of nitrogen fertilizer does not rise by the full amount of the tax, and the negative effect on crop production is less.

Figure 1
Comparison with ABARE Results
Reductions in Crop Production



implying that the modeling of the EC fertilizer industry (that is, the incorporation of fertilizer demand and supply relationships) can have a significant effect on the modeling results.

Trade and World Prices

As with production, the largest trade and world price effects come from the Mac Sharry Plan scenarios (table 4). The reduction in production due to setasides and price decreases, and the expansion of consumption due to price reductions imply large trade effects. Net wheat exports decrease between 55 to 76 percent, depending on the degree of decoupling assumed. Net corn imports increase dramatically, between 240 to 300 percent from a small base of over 2,000 thousand metric tons. The EC changes from a net exporter of other coarse grains to a net importer: a change relative to base of -170 to -210 percent. The world price of wheat increases 8 to 12 percent; the price of corn increases between 4 and 8 percent; and the price of other coarse grains, between 11 and 15 percent.

The reduction in livestock supply implied by the Nitrate Directive reduces the demand for feedgrains (table 5). Net wheat exports in scenarios C and D are about 10 percentage points less than in the corresponding scenarios A and B. Net corn imports are about 70 percentage points less; and the changes in net exports of other coarse grains are about 45 percentage points less.

Fertilizer taxes imply smaller but not insignificant reductions in EC net exports. Net wheat exports decrease between 6 and 11 percent; net corn imports increase between 10 and 20 percent; and other coarse grain exports decrease between 16 and 30 percent. World price increases are small: less than 2 percent in most cases. These results are larger than those obtained by ABARE. As in this study, their largest adjustment came in other coarse grains net exports: a 10 to 16 percent reduction. They show a much more modest increase in corn imports: between 1 and 3 percent. Only in rice imports do they show a larger increase in imports: between 4 and 6 percent compared to 2 and 4 percent in this study.

Effect on U.S. Agricultural Trade

Appendix Table 4 shows the effect of the policy changes on U.S. agricultural trade. The Mac Sharry Plan would imply increases in wheat exports between 1 and 4 percent, in corn exports between 4 and 10 percent, and in coarse grain exports between 18 and 36 percent. These increases could be significantly reduced as a consequence of the Nitrate Directive, however. The United States is primarily affected as EC feedgrain demand is reduced through smaller livestock inventories resulting from the Directive.

Modeling results imply that wheat exports could be 0.4 mmt (or 1.5 percent) less; corn exports, 1.4 mmt (or 3.3 percent) less; and other coarse grain exports, 0.9 mmt (or 9 percent) less.

The EC fertilizer tax scenarios imply very little for the United States. The only significant effect might be on other coarse grain exports, which could increase in the 2 to 5 percent range.

Effect of Policy Changes on the EC Nitrate Balance

Policies affecting EC agricultural output or input use are also likely to significantly affect the delivery of nitrates to the soil. The task is to obtain a quantitative assessment of the policy changes described in the modeling scenarios on nitrate deliveries. At this time it is not possible to relate the policy changes to actual improvement in water quality or some other environmental objective. Part of the problem, as alluded to previously, is the dynamic aspect of the accumulation of nitrates over time. Another problem lies in the aggregate EC-wide modeling approach. An examination of changes in the aggregate EC nitrate balance masks problems in specific regions within the EC. A better and feasible approach, but also more costly, would involve the construction of regionally focused components of the SWOPSIM model that would tie in to the other country/regions in the model.

This report adapts the methodology of Koopmans (1987) who used IIASA's Basic Linked System to examine the delivery to the soil of nitrates and other nutrients.[9] Koopmans' study used coefficients to calculate nitrogen from various livestock manures and the amounts of nitrogen retained in crops and grassland. He obtained the livestock coefficients from the Netherlands Ministry of Agriculture and the crop coefficients from the Dutch food table and personal interviews. As Koopmans admits, the approach is probably only minimally satisfactory given that coefficients for the Netherlands are applied to the EC as a whole. This weakness implies that less significance should be attached to nitrate levels shown in this report and more significance attached to a comparison among scenarios of changes in nitrate deliveries. Future, more disaggregated, analysis would require greater precision in tracking nitrate deliveries.

Table 8 shows the calculation of the base EC nitrogen balance against which the scenarios can be compared. The first block shows nitrogen from livestock manure. Animal numbers are from the Food and Agriculture Organization (FAO). In the modeling

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[9]It is difficult to directly compare Koopmans' results with those of this study. The modeling structures are very different, and Koopmans used a 1980 base period for model initialization.

Table 8 -- Base EC Nitrogen Balance

Nitrogen From Livestock Manure

Livestock	No. of Head (1000)	Nitrogen Manure Coeff. (kg/year/animal)	Nitrogen Delivery (1000 mt)
Cattle	83,581	64	5,349
Pigs	95,707	13	1,244
Sheep	83,111	20	1,662
Poultry	794,000	.48	381
Total	-	-	8,636

Fertilizer Application and Nitrogen Stored in Crops

Crop	Nitrogen Fertilizer Use (1000 mt)	Production (1000 mt)	Nitrogen Percentage Coefficient	Nitrogen Stored in Crop (1000 mt)
Wheat	2,021	71,688	.019	1,362
Straw	-	-	-	680
Corn	441	24,974	.015	375
Other Coarse Grain	1,758	56,288	.015	844
Rice	31	1,275	.013	17
Soybeans	68	903	.006	5
Other Oilseeds	478	7,462	.006	45
Sugarbeets	367	14,415	-	-
Other	85	-	-	-
Non-ST86 Crops	4,651	-	-	-
Total	9,900	-	-	3,328

Nitrogen in Grassland

Area (1000 ha)	Grass Coeff. (mt/ha)	Nitrogen Coeff.	Nitrogen in Grass (1000 mt)
56,163	6.0663	.03	10,221

'-' = either not available or not applicable

Table 9 -- EC Nitrogen Balance

1,000 Metric Tons

Base Scenario:

Scenarios	Fertilizer Application (+)	Livestock Manure (+)	Nitrogen in Crops (-)	Nitrogen in Grass (-)	Net Delivery
Base	9,900	8,636	3,328	10,221	4,987

Mac Sharry and Nitrate Directive Scenarios:

Scen. A	9,551	8,824	3,032	10,971	4,372
Scen. B	9,308	8,535	2,851	10,971	4,021
Scen. C	9,551	8,506	3,032	10,971	4,054
Scen. D	9,308	8,227	2,851	10,971	3,713

Fertilizer Tax Scenarios:

Scen. E	9,111	8,636	3,285	10,221	4,241
Scen. F	8,862	8,636	3,270	10,221	4,007
Scen. G	8,801	8,636	3,266	10,221	3,950
Scen. H	8,524	8,636	3,248	10,221	3,691

scenarios, the percentage changes of meat production (e.g. beef, pork, lamb) from the base are used to calculate new levels of nitrogen delivery.

The next block shows nitrogen fertilizer applied to crops and nitrogen stored in crops. The source of the fertilizer data for the SWOPSIM crops is the SPEL group (1989). FAO reports total nitrogen fertilizer use for the EC in 1986 at 9,900 thousand metric tons. The difference between this amount and the total for SWOPSIM crops is attributed to Non-SWOPSIM crops. Because these crops are not modeled, this amount is assumed not to change in any of the scenarios. The nitrogen percentage coefficient available for the SWOPSIM crops except sugarbeets is used to calculate the nitrogen stored in the crops. Although straw is not part of the model, it is calculated as a percentage of wheat production. Because coefficients are not available for the Non-SWOPSIM crops, there is no accounting for how much nitrogen is stored in these crops.[10]

The last block shows the nitrogen in grass from EC pasture land. Permanent pasture land in hectares from FAO is multiplied by the grass coefficient to calculate the grass tonnage. This amount is multiplied by the nitrogen storage coefficient to calculate the nitrogen stored in the grass.[11] Although pasture land is not tracked in SWOPSIM, there will be increases in pasture land resulting from the land setaside portion of the Mac Sharry Plan. These land use changes have been estimated by ERS and have been described in the previous section.

Results

The largest reductions in nitrogen fertilizer consumption come from the fertilizer tax scenarios (table 9). The 50 percent tax reduces consumption between 8 and 10.5 percent. The 75 percent

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[10]Because there is no modeling of reduced fertilizer use by Non-SWOPSIM crops, the reductions in nitrate deliveries described below are understated.

[11]Koopmans used a grass coefficient equal to 8 mt/ha in his work. He dutifully notes the weaknesses of applying this coefficient to all of the EC, but justifies its use as an average for the EC excluding Greece, Spain, and Portugal. In attempting to work back from his nitrogen in grass value of 7,562 thousand metric tons, total pasture land was calculated to be 31,567 thousand hectares for his 1980 base. FAO reports pasture land for 1980 for the EC-9 at 41,629 thousand hectares. Because of the discrepancy, this report adjusted the grass coefficient downward by the percentage of the difference in pasture area. This coefficient is applied to the EC-12 in this report.

tax reduces it between 11 and 14 percent. Fertilizer use declines under the Mac Sharry Plan between 3.5 and 6 percent. Because the Nitrate Directive does not affect crop supply (at least as it is modeled), it has no effect on fertilizer use.

Nitrogen deliveries from livestock manure are reduced most under the Nitrate Directive (between 1.5 and 4.7 percent). Better comparisons of the Nitrate Directive scenarios are the Mac Sharry scenarios. There, the percentage reductions are both about 3.5 percent. Most of the reduction comes from pigs, sheep, and poultry, about 195 thousand metric tons. The reduction from cattle is only about 115 thousand metric tons.

Assumptions regarding the decoupling are important in evaluating the environmental effects of CAP reform. If predicted output levels differ as a result of decoupling, then so will nitrogen fertilizer use. Scenarios A and C both show greater use of fertilizer (243 thousand metric tons) compared to scenarios B and D, respectively (table 9). Scenario A shows an increase in nitrogen from livestock manure rather than a decrease. The increase results from the assumption that the direct payments made to grain producers are fully coupled to production. The grain price reductions, therefore, do not greatly reduce grain supply, but they do expand livestock supply due to less expensive feed. Beef supply increases 0.9 percent in scenario A while it decreases by 7.1 percent in scenario B (which assumes decoupling). The manure from the additional cattle accounts for 97 percent of difference of deliveries of nitrogen from manure between scenarios A and B.

Nitrogen retained in crops is a direct function of crop supply. Nitrogen in grass is a function of the EC land setaside. It is assumed that idled land is converted into grass pasture land. The Mac Sharry Plan setaside increases nitrogen retained in grasses by about 750 thousand metric tons.

Conclusions

There is increasing overlap in environmental and agricultural policies. In the EC, policies dealing with nitrates and water quality (such as the Nitrate Directive) will likely affect agricultural production and trade patterns. Likewise, policies dealing with agricultural restructuring (like CAP reform) will affect the rate of delivery of nitrates to the environment. This paper has attempted to estimate the magnitude of these effects.

CAP reform implies significant reductions in the delivery of nitrates to the soil. In particular, nitrogen fertilizer use is reduced because of large crop output price reductions and the land setaside program. Nitrogen deliveries from livestock manure are less affected. Total nitrate deliveries are reduced to about the same magnitude implied by the adaption of an ad valorem tax on nitrogen fertilizer use in the range of 50 percent. If the Nitrate Directive is imposed on top of CAP reform, total nitrate deliveries are reduced by about the same amount as a 75 percent ad valorem tax.

A tax on nitrogen fertilizer use has generally small effects on agricultural production and trade. EC net exports of "other coarse grains" (primarily barley) are the most affected -- perhaps reduced as much as 30 percent. As a consequence, the United States could experience perhaps a 2 to 5 percent rise in its coarse grain exports. The Nitrate Directive primarily affects EC production of pigs, sheep, and poultry. Although the Directive has practically no effect on crop supply, demand for feedgrains is significantly diminished. Gains to the United States under CAP reform are reduced by about 2.7 mmt if the Nitrate Directive is implemented.

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Appendix Table 1

Modeling Results -- World Price Changes

Percentage Change

WDPRICE%

	-- MacSharry--		--Nitrate Directive --		---- Fertilizer Tax ----			
ST86-WD	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	SCEN G	SCEN H
BF	2.50	7.26	5.02	9.71	.06	.08	.08	.10
PK	-3.30	-3.44	1.58	1.50	.08	.11	.12	.15
ML	-1.11	-.17	.42	1.34	.04	.06	.06	.08
PM	.28	3.36	3.88	6.80	.10	.14	.14	.19
PE	-1.08	2.80	3.93	7.60	.07	.09	.10	.13
DM	.00	.00	.00	.00	.00	.00	.00	.00
DB	3.84	5.73	5.94	7.86	-.06	-.08	-.09	-.11
DC	-.37	-.53	3.17	3.06	.01	.01	.01	.02
DP	-2.05	1.72	1.41	5.31	.03	.04	.04	.06
WH	8.24	12.08	7.50	11.33	.86	1.17	1.24	1.61
CN	4.03	6.51	5.52	8.01	.38	.51	.54	.70
CG	11.07	15.37	10.08	14.37	1.11	1.50	1.59	2.06
RI	.86	1.25	.74	1.14	.11	.14	.15	.20
SB	1.31	1.85	.78	1.33	.09	.13	.14	.17
SM	1.49	.69	-2.01	-2.67	.07	.09	.10	.13
SO	1.04	3.11	3.85	5.87	.10	.13	.14	.18
OS	8.20	14.29	7.65	13.73	.57	.77	.82	1.06
OM	4.10	4.54	-1.50	-.95	.25	.34	.36	.47
OO	4.26	7.94	5.35	9.03	.31	.41	.44	.57
CT	.93	1.42	.81	1.31	.08	.11	.12	.15
SU	.38	.03	.36	.01	.32	.43	.46	.59
TB	.05	.07	.04	.06	.00	.01	.01	.01

Appendix Table 2
Modeling Results -- EC Supply Changes

Percentage Change

SUPPLY% EC

ST86-WD	-- MacSharry--		--Nitrate Directive --		---- Fertilizer Tax ----			
	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	SCEN G	SCEN H
BF	.92	-7.14	-2.31	-10.11	-.00	-.00	-.00	-.00
PK	7.20	8.86	-3.33	-1.82	.01	.02	.02	.02
ML	2.50	2.32	.81	.64	-.00	-.00	-.00	-.01
PM	6.01	-.99	-3.64	-9.98	.01	.02	.02	.03
PE	4.43	-1.53	-4.13	-9.54	.01	.02	.02	.03
DM	.14	-.04	-.43	-.62	.00	.00	.00	.00
DB	.16	-1.12	-.49	-1.77	.00	.00	.00	-.00
DC	.24	.76	-.75	-.25	.00	.00	.00	.00
DP	.31	-1.84	-.92	-3.06	.00	-.00	-.00	-.00
WH	-7.79	-12.64	-7.81	-12.66	-1.18	-1.59	-1.70	-2.19
CN	-10.94	-17.61	-10.85	-17.49	-.89	-1.21	-1.28	-1.66
CG	-10.43	-16.55	-10.46	-16.58	-1.76	-2.38	-2.53	-3.27
RI	.07	.12	.07	.12	-.30	-.40	-.43	-.56
SB	-15.58	-28.31	-15.60	-28.34	-.90	-1.21	-1.29	-1.67
SM	.15	.09	-.16	-.20	.01	.01	.01	.01
SO	.15	.09	-.16	-.20	.01	.01	.01	.01
OS	-22.06	-39.48	-22.08	-39.51	-1.46	-1.97	-2.10	-2.71
OM	.02	.01	-.03	-.04	.00	.00	.00	.00
OO	.02	.01	-.03	-.04	.00	.00	.00	.00
CT	.07	.10	.06	.09	.01	.01	.01	.01
SU	.14	.81	.14	.81	-.30	-.40	-.43	-.56
TB	.01	.01	.00	.01	.00	.00	.00	.00

Appendix Table 3

Modeling Results -- EC Net Agricultural Trade Changes

Percentage Change

NTRADE% EC

	-- MacSharry--		--Nitrate Directive --		---- Fertilizer Tax ----			
ST86-WD	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	SCEN G	SCEN H
BF	-48.55	-137.25	-86.63	-172.48	-.05	-.07	-.08	-.10
PK	581.33	684.00	-59.84	34.52	1.72	2.33	2.48	3.20
ML	-15.98	-14.88	-7.61	-6.54	.03	.04	.04	.06
PM	36.19	-79.68	-127.75	-232.54	.55	.74	.79	1.02
PE	170.24	-139.16	-276.51	-558.13	1.00	1.35	1.44	1.86
DM	.02	.00	-.00	-.00	-.00	.00	-.00	.00
DB	-16.25	-30.29	-23.29	-37.33	-.01	-.01	-.01	-.02
DC	4.50	14.08	-13.39	-4.11	-.00	-.01	-.01	-.01
DP	3.34	-15.76	-7.61	-26.60	-.01	-.01	-.01	-.01
WH	-55.08	-76.79	-44.21	-66.03	-5.97	-8.06	-8.59	-11.09
CN	241.62	295.97	170.28	225.82	10.60	14.31	15.25	19.70
CG	-170.75	-210.91	-124.86	-166.07	-16.43	-22.15	-23.59	-30.43
RI	-32.64	-32.75	-32.69	-32.80	2.25	3.04	3.24	4.19
SB	1.16	1.97	.92	1.74	.06	.09	.09	.12
SM	5.82	.87	-8.78	-13.40	.03	.04	.05	.06
SO	-.01	-.21	-.34	-.53	-.01	-.01	-.01	-.01
OS	97.13	173.75	96.88	173.53	6.42	8.66	9.22	11.90
OM	1.82	-2.90	-9.00	-13.46	-.09	-.12	-.13	-.16
OO	-2.97	-5.26	-3.35	-5.64	-.21	-.29	-.31	-.39
CT	-.32	-.48	-.28	-.45	-.03	-.04	-.04	-.05
SU	.78	4.33	.78	4.33	-1.58	-2.14	-2.28	-2.95
TB	-.03	-.05	-.03	-.04	-.00	-.00	-.00	-.01

Appendix Table 4
Modeling Results -- U.S. Net Agricultural Trade Changes

Percentage Change

NTRADE% US

ST86-WD	-- MacSharry--		--Nitrate Directive --		---- Fertilizer Tax ----			
	SCEN A	SCEN B	SCEN C	SCEN D	SCEN E	SCEN F	SCEN G	SCEN H
BF	-19.48	-60.53	-39.28	-79.01	.15	.20	.22	.28
PK	85.19	100.37	-5.18	9.11	.56	.75	.80	1.03
ML	14.80	10.50	7.00	2.95	.47	.63	.67	.87
PM	-11.15	51.84	75.05	132.86	.59	.79	.84	1.08
PE	-92.95	58.22	129.68	267.39	-1.22	-1.65	-1.75	-2.27
DM	.01	-.01	.01	-.01	-.01	.00	-.01	-.01
DB	4.00	12.53	5.20	13.62	-.16	-.22	-.23	-.30
DC	2.26	5.52	-5.63	-2.50	.07	.09	.10	.13
DP	-.05	1.03	.09	1.15	-.01	-.02	-.02	-.02
WH	2.74	3.42	1.23	1.93	.31	.41	.44	.57
CN	8.32	9.61	4.60	5.94	.36	.49	.52	.68
CG	31.09	36.61	18.68	24.39	2.79	3.76	4.00	5.17
RI	.20	.28	.17	.26	.02	.03	.03	.04
SB	.73	1.21	.44	.93	.04	.06	.06	.08
SM	5.32	2.19	-5.78	-8.70	.06	.09	.09	.12
SO	-.06	-.79	-1.34	-2.02	-.05	-.07	-.08	-.10
OS	40.02	74.01	41.66	75.59	2.49	3.36	3.57	4.61
OM	-81.12	-16.82	144.78	203.68	-1.51	-2.03	-2.16	-2.79
OO	-.75	-.83	.22	.09	-.04	-.05	-.06	-.07
CT	-.20	-.31	-.07	-.19	-.00	-.00	-.00	-.01
SU	.77	1.20	.82	1.25	.06	.08	.08	.10
TB	-1.83	-2.54	-.93	-1.67	-.12	-.16	-.17	-.22

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