Curbing Nitrogen Runoff: Effects on Production & Trade

As U.S. policy makers seek to minimize adverse effects on the environment from agricultural operations, their decisions will have impacts on agricultural trade and on other aspects of the agricultural economy. Since alternative policy tools may be used to achieve environmental goals, information on potential trade and other effects of specific policy instruments can be useful for decision makers, who face trade-offs among consumer, producer, taxpayer, and environmental interests.

Most studies of trade and environment linkages have focused on the manufacturing sector, where environmental policies have shown little direct influence on trade. This may be because the cost of compliance with environmental regulation is a relatively small fraction of the total cost of production and has little price impact, or because limitations in measuring the stringency and enforcement of environmental regulation hinders accurate estimation of production cost, price, and trade effects. Such studies often use pollution abatement costs as a measure of the cost of environmental regulation, but if such costs are underreported (due either to lack of reporting or to lack of implementation of abatement technologies), they may not reflect the true effect of environmental regulation on trade or other areas of the economy.

Sales abroad are an important component of market returns for a number of commodity producers. Research on agricultural trade shows varying effects of environmental regulations and policies. If domestic environmental policies have relatively little effect on production costs, agricultural trade effects would be expected to be small as well. Some studies show that specific environmental policies may have significant trade effects and large increases in production costs. For example, agricultural chemical use restrictions in the U.S. and the European Union (EU) may significantly affect trade by reducing production, which can dramatically increase production costs per unit of output while also shrinking exports.

Likewise, a ban on methyl bromide use as a soil fumigant in the U.S. may boost U.S. imports of specific vegetables from Mexico (*AO* August 1999). Implementation of the EU's Nitrate Directive (which limits nitrogen applications to the soil) would have considerable effects on EU net trade of livestock, livestock products, grains, and oilseeds, according to one study by USDA's Economic Research Service (ERS).

This article focuses on a specific policy goal—an environmental goal of reducing nitrogen releases that result from agricultural operations. Excess nitrogen released into waterways promotes growth of microscopic organisms that use up dissolved oxygen, leaving insufficient oxygen in the water for other forms of aquatic life, such as fish. Excess nitrogen is a key issue in strategies to address the hypoxic zone in the Gulf of Mexico (*AO* November 1999), and in the Environmental Protection Agency's development of regional water quality nutrient criteria under the Clean Water Action Plan.

A goal of 10-percent reduction in nitrogen releases from agriculture is used here to illustrate the effects of a small change in nitrogen releases on production and trade. To reduce nitrogen releases by 10 percent, four alternative generic policy approaches are evaluated:

- a "green payment" which producers receive from the government to compensate for lower returns resulting from lower crop yields caused by reduced fertilizer use;
- regulation to reduce per-acre nitrogen use;
- a tax on nitrogen fertilizer; and
- buffer strips and other land retirement to intercept field runoff and reduce nitrogen fertilizer use.

Economic and environmental effects of alternative environmental policies were analyzed using the U.S. Regional Agricultural Sector Model (USMP) developed by USDA's Economic Research Service. With its linkage to the Erosion/Productivity Impact Calculator (EPIC), USMP can estimate how changes in environmental or other policies affect U.S. production, demand, trade, input use, environmental indicators, and world prices. Environmental indicators include soil erosion and erosion damages, and releases of nitrogen, phosphorus, and other chemicals. USMP includes 44 agricultural commodities and processed products, 23 inputs, and is disaggregated into 45 regions within the U.S.

Policies for Reducing U.S. Agricultural Nitrogen Releases Would Affect Market Prices and Farm-Sector Receipts

Indicator	Base[1]	Nitrogen-release reduction policy: Green payments	Regulation	Nitrogen tax	Land retirement/ buffer strip
		Percent change from base			
U.S. wheat market example					
Production (million metric tons)	67.3	-0.7	-2.3	-3.1	-4.0
Consumption (million metric tons)	34.0	-0.1	-0.3	-0.4	-0.5
Trade volume (million metric tons)	37.4	-1.0	-3.4	-4.5	-5.8
Market price ($/metric ton)	152.5	1.1	3.6	4.8	6.2
Farm sector gains/losses[2]					
All producers, net cash receipts ($ billion)	63.3	5.9	3.1	-0.2	4.9
Crop ($ billion)	37.7	10.1	5.6	0.3	8.2
Livestock ($ billion)	25.7	-0.4	-1.2	-1.6	-2.0
Consumer surplus ($ billion)[3]	422.1	-0.1	-0.3	-0.4	-0.7
Environmental effects[2]					
Erosion damage ($ billion)	1.8	1.2	0.5	-0.5	-2.4
Total soil erosion (million met tons)	1,820.8	1.3	0.4	0	-2.8

Policies are to reduce nitrogen releases by 10 percent. Numbers are rounded.
1. Analysis for 2001, using ERS February 1998 baseline projections. 2. Policies applied to all cropland except fruits and vegetables. 3. Consumer surplus is the amount of money consumers would be willing to pay for goods (e.g., food) in excess of what they are required to pay (i.e., market prices). Thus, the surplus shrinks as prices rise.

Economic Research Service, USDA

The first three approaches require a reduction in nitrogen use nationally by a little under 20 percent to achieve a 10-percent reduction in nitrogen releases. The green payment policy would require payments of about 2.5 times the price of nitrogen fertilizer to attain this reduction, and the tax on nitrogen fertilizer would have to approach 75 percent. For the regulation scenario, a lowering of per-acre nitrogen fertilizer applications was simulated. For the land retirement/buffer strip scenario, two-thirds of the 10-percent reduction in nitrogen release was assumed to come from the interception of runoff by buffers and about one-third from the decrease in acreage planted.

Which Scenario Produces Strongest Market Effects?

Economic and environmental effects of the four alternative environmental policy types were analyzed using the U.S. Regional Agricultural Sector Model. The analysis covers policy effects on most major agricultural commodities. In terms of commodity market effects on grains, wheat is generally representative of most grains in the analysis. Results show that in all four scenarios, wheat production declines from reduced acreage or reduced nitrogen fertilizer, or both. Export volume decreases under all scenarios but drops the most in the land retirement alternative. A land retirement policy reduces wheat acreage and production the most, with correspondingly greater price-boosting effects and consumption and export reductions.

Wheat exports and other indicators are affected least under the green payment scenario. Green payments, if not tied to acreage reduction, encourage acreage expansion, which partially offsets the production-depressing effects of reduced fertilizer use. Hence, the resulting consumption, price, and trade effects of this policy are the most modest of the four alternatives.

A regulatory policy that restricts per-acre nitrogen use has greater market effects, in general, than a green payment. Cultivated acreage increases slightly under the regulatory policy, countering some production contraction from reduced fertilizer use per acre, but acreage increases less than under the green payment policy. Wheat prices rise and exports slip more than under the green payment alternative.

Under a nitrogen tax, cultivated wheat acreage declines, reinforcing the production-depressing effect of reduced nitrogen use. Market prices rise, second only to the land retirement alternative. Consumption and exports fall, second only to the land retirement alternative.

The effects of these policy alternatives on soybeans, which fix nitrogen and receive much less nitrogen fertilizer than grains, are markedly different from the effects on wheat. Soybean production, consumption, and exports generally increase as some grain producers switch to soybeans, with lower prices under all four scenarios except the land retirement alternative.

Comparing Overall Effects of Policy Alternatives

From a farm-sector perspective, the four policy alternatives produce varying effects on consumers, crop producers, and livestock producers. Since prices rise proportionately more than production falls, crop producers' net cash receipts rise and livestock producers' receipts decline because of higher feed costs.

Under a green payment scenario, crop producers as a group gain from higher market prices as fertilizer use and production fall, and in addition, receive $2.9 billion in government payments for reduced fertilizer use. Consumers and livestock producers lose as crop prices rise, but this effect is relatively small compared with the other three scenarios.

The regulation scenario brings higher net cash receipts to crop producers, but the effect is less than under a green payment scenario since the regulation alternative provides no government payments. Consumers and livestock producers fare worse under a regulatory scenario than under a green payment scenario because production is lower in the regulatory alternative, pushing up prices and adding to food and feed costs.

Curbing Agricultural Nitrogen Releases Through Green Payments Ranks First in Benefits to Consumers and Producers

	Benefits for:				
		Producers			Soil erosion
Policy	Consumers	Crop	Livestock	Taxpayers	reduction
			Rank		
Green payments	1	1	1	4	4
Regulation	2	3	2	2	3
Nitrogen tax	3	4	3	1	2
Land retirement/ buffer strips	4	2	4	3	1

Economic Research Service, USDA

Under the tax scenario, crop producers receive the benefits of higher prices for their commodities, but they must pay a tax on every pound of fertilizer used (total tax charges are almost $3.3 billion). Crop producers gain only slightly under this scenario, while consumers and livestock producers fare worse than under the regulatory scenario—again because of higher food and feed costs.

A land retirement policy to reduce nitrogen losses yields the greatest crop producer benefits, aside from the green payment policy, and the worst downside effects—higher food and feed costs—on consumers and livestock producers. Moreover, costs to taxpayers are estimated at around $1.6 billion—lower than the public outlays for green payments.

While nitrogen losses are the focus of the simulated policies, reducing soil erosion is an aim of USDA conservation efforts as well. The policies modeled to reduce nitrogen releases also have ancillary, or secondary, effects on soil erosion—some adverse and some desirable. As greater acreage is planted under the green payment and regulatory policies, soil erosion and erosion damages rise. Conversely, soil erosion and/or erosion damage decline under the tax policy and the land retirement policy, both of which encourage contraction in cultivated acres. The land retirement/buffer strip scenario yielded the greatest decrease in soil erosion and erosion damage costs.

No Simple Formula

The choice of domestic policy instruments to achieve an environmental goal has trade and other economic and environmental implications, generating trade-offs among various concerns. Policies that lower production also lower exports. Given an objective of reducing agricultural nitrogen releases, policies aimed directly at reducing nitrogen use have lesser trade and other market effects than a policy of land retirement.

Among the three input-targeted policies, a green payment policy achieves the environmental goal with the least market-price escalation. A green payment approach also generates the smallest consumer costs and the greatest producer benefits, but it also involves the greatest government cost and results in the largest increase in soil erosion.

In contrast, a land retirement policy to achieve the same nitrogen loss reduction has export-reducing effects almost six times that of a green payment policy, with the largest costs to consumers. Producer benefits in the land retirement scenario are second only to green payments, and the reduction in soil erosion is the greatest of any scenario.

In selecting environmental policies to mitigate the impacts of agricultural production, trade-offs arise between and within economic interests and environmental goals. A policy choice to achieve one environmental objective may exacerbate (or ameliorate) another environmental problem. The choice of policies affects agricultural trade and other farm-sector economic indicators. No one policy will satisfy all stakeholders. **AO**

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