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Innovations in Nonpoint Source Pollution Policy—European Perspectives

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Agriculture is an important source of nutrient loading—nitrogen and phosphorus—into surface and groundwater in Europe. Phosphorus is the most common cause of eutrophication in fresh waters, such as rivers and lakes, while nitrogen loading promotes eutrophication of coastal waters. Several valuation studies show that Europeans value clean water and agricultural landscapes, which often exhibit high historical and cultural values as well as biodiversity. Traditional emphasis of the European agri-environmental policies has been on landscapes and biodiversity.

Over time the role of agriculture in water pollution has been recognized. Indeed, agriculture contributes generally 50-80% of the total nitrogen and phosphorus loading to Europe's fresh waters. The same holds true for sea waters. For example, in the Baltic Sea catchment area, nonpoint source loading represents 71% of nitrogen and 44 % of phosphorus loads. No wonder the need to develop policies to reduce nonpoint source nutrient loads has emerged.

By the gradual increase of the number of its member states, the European Union (EU) has become the key European player in environmental and agricultural policies targeting nutrient loads from point and nonpoint sources. The key means of the EU environmental policies are the legally binding environmental directives, such as the Water Framework Directive, Marine Strategy Directive, Urban Waste Water Treatment Directive, and Nitrates Directive. Member states are required to implement the directives within their jurisdiction and choose the most appropriate means to do so. Furthermore, member states are allowed to impose stricter policies than directives require if they want to do so.

The *Common Agricultural Policy* (CAP) provides the basis for agricultural nonpoint source policies. CAP consists of partly decoupled farm income support with environmental conditionality, so called environmental cross-compliance, and voluntary agri-environmental policies in member states. While in most member states voluntary agri-environmental policies focus more on biodiversity and landscapes, Denmark, Finland, and Sweden have developed ambitious voluntary nonpoint source policies.

Agri-environmental policies in the EU and the United States differ in some respects. While agri-environmental policy in the EU primarily addresses positive environmental externalities, such as landscape features and biodiversity, the emphasis in the United States is more on the reduction of negative externalities. As regards policies targeting negative environmental effects, the EU focuses more on negative environmental effects brought on by intensification of farm input use—fertilizer, manure, and pesticide—whereas extensification-related effects—cultivation of erosion-prone and other environmentally sensitive land— are addressed in the United States. Third, agri-environmental payments in the United States are mostly targeted towards environmental performance, such as those based on the environmental benefit index. However, in the EU, they are based on the adoption of environmentally friendly cultivation practices (Baylis et al., 2008). Finally, there are also differences as regards environmental regulatory approaches between these two regions.

Keeping the key role of the EU in mind, we review both past experience and current policy initiatives for nonpoint source pollution. We start with the features of the CAP.

Past Policy Experiences Addressing Agricultural Nutrient Pollution

EU's CAP policy addresses nutrient pollution from agriculture via three channels: farm income support policies coupled with environmental cross-compliance, environmental regulations, and agri-environmental payments.

Agricultural Policy Reforms, Decoupled Income Support, and the Development of Environmental Conditionality

Since the 1992 MacSharry CAP reform, there has been a gradual shift from production, trade, and environmentally distortive coupled support payments towards more decoupled income support payments to EU farmers and increased environmental conditionality of general agricultural support payments as well as increased use of specific agri-environmental payments. The CAP reform has increased the coherence of agricultural policies with overall water policies in the EU. While direct measurement of loads is missing, a decline in nutrient surpluses for EU15 from 1990 to 2009 is evident (Table 1). This has reduced the overall nutrient loading pressure on watercourses.

Environmental Regulations

The 1991 EU *Nitrates Directive* forces EU member states to reduce the nitrate loading from agriculture to groundwater and surface water. Member states need to assign areas that are vulnerable to nitrate leaching—Nitrate Vulnerable Zones (NVZ). These are areas where surface water and groundwater contain nitrate concentrations that may exceed 50 mg. per liter if preventative action is not taken. In 2007, 40% of the area of the EU27 was designated under NVZs and 10 member countries have designated their whole national territory as an NVZ.

Within NVZs mandatory measures are established regarding sufficient manure storage capacity, timing and location of manure application, and maximum application limits of 170 kg N/ha. Effectiveness of the Nitrates Directive in reducing nitrate loading has varied among member states. The EU-wide report on the implementation of the Nitrates Directive found that the gross nitrogen balance at the EU15 level in 2000—55 kg/ha—had decreased by 16% compared to 1990, with the range from 37 kg/ha in Italy to 226 kg/ha in the Netherlands. However, a number of challenges remain in the implementation of the Nitrates Directive. Most notably, several member states have failed to comply with requirements related to manure storage capacity, manure application limits, and manure application periods. Oenema et al. (2009) estimated that the costs of reducing nitrogen surplus through balanced fertilization in the context of the Nitrates Directive in the EU27 is € 4 per kg N surplus, which is € 25 per ha.

Table 1: Nitrogen and Phosphorus Balances in the EU15 from 1990 to 2009 (OECD 2013)

Years	Average N-balance, thousand tonnes of N	Average P-balance, thousand tonnes of P	Average N-balance, kg/ha	Average P-balance, kg/ha
1990-92	9 966	1 399	109	14
1998-2000	8 529	812	93	9
2007-09	6 567	239	65	3

Experience from Fertilizer Taxes

Before their joining to the EU, Austria, Finland, and Sweden generated experience from using fertilizer taxes for fiscal purposes. Rougoor et al. (2001) analyzed the impacts of fertilizer taxes on fertilizer use in these three countries. Tax burdens varied between 10% and 72% of the fertilizer price. The price elasticity of fertilizer varied between countries and years from -0.1 to -0.5. Administrative costs of these taxes were low, representing, on average, about 0.75% of the tax revenues.

Unfortunately, the reviewed experience does not provide extensive evidence of the effectiveness of fertilizer taxes in reducing nonpoint source pollution. Calculations based on the Finnish data show that tax rates on nitrogen fertilizer need to be high to have an effect on nitrogen fertilizer use and nitrogen runoff. With a 15% tax rate the use of nitrogen would decrease only 4-5% and nitrogen runoff by 4-5%, while a 100% tax rate would decrease use by 22-34% and nitrogen runoff by 28-32%. A 15% tax rate reduces farm income by € 15/ha and 100% tax rate by € 85/ha.

Tax on Nutrient Surplus

The Dutch approach to the Nitrates Directive was to implement the Mineral Accounting System (MINAS). MINAS combined farm-level nutrient accounting with a tax on nutrient surplus. The accounting was based on a farm gate balance approach in which nutrient outputs in animal products and crops leaving the farm were reduced from nutrient inputs entering the farm in chemical fertilizer, feed, and organic and livestock manure. Some nutrient losses were allowed so that there was a levy-free surplus and only the surplus above that level was taxed on a per kg N and per kg P basis. Standards related to levy-free surpluses were progressively lowered between 1998 and 2003. For example, the P standard for arable crops was lowered from 40 kg/ha to 20 kg/ha, while the N standard was lowered from 175 to 100 kg/ha on clay soils (Wright and Mallia, 2008).

Despite the perceived advantages of a nutrient surplus tax over a uniform manure application standard or uniform fertilizer tax rate, the MINAS system failed and was replaced in 2006. Wright and Mallia (2008) examined reasons for this failure. First, the Dutch government thought that with the implementation of MINAS it was possible to avoid strict, and possibly costly, manure application standards mandated by the Nitrates Directive. However, the EU Commission was unsatisfied with the system and considered it insufficient to protect groundwater from nutrient pollution and took legal action against the Dutch government. Indeed, in 2003, the European Court of Justice ruled that the Dutch government had failed to fulfill obligations of the Nitrates Directive. Second, the MINAS was considered unfair towards intensive pig and poultry farms with very little arable land for the application of manure produced on the farms. These farmers had to bear the cost of transporting manure off the farms to crop farms. Moreover, the surplus levies were considered extremely high representing 5 to 10 times the price of nitrogen fertilizer and 50 times the price of phosphorus fertilizer.

Ondersteijn et al. (2002) assessed the impact of MINAS on individual farms by using detailed financial and nutrient bookkeeping data of 194 farms distributed over five different farm types and covering the years from 1997 through 1999. Their study shows, among other issues, that farm-specific nutrient surplus taxes can vary a lot, ranging from € 179/ha for arable farms to € 404/ha for mixed dairy and intensive livestock producers. On average, these taxes would reduce gross margin by 8%.

Agri-environmental Payments

Agri-environmental measures were introduced in 1992 for all EU member states as an “accompanying measure” to the Common Agricultural Policy reform. For the EU27 the total expenditure in agri-environmental measures from 2007 to 2009 was about € 6 billion annually, around 7% of the total agricultural support. Agri-environmental measures are designed to encourage farmers to protect and enhance the environment on their farmland. Farmers receive payments in return for carrying out agri-environmental measures that involve more than the application of usual good farming practice or environmental cross-compliance. Farmers sign a contract with the administration and are paid for the additional cost of implementing the measures and for income losses, for example, due to reduced production which the practices entail.

Practice based payments have been a dominant means in the EU agri-environmental programs and they have been successful in regards to voluntary participation by farmers. Agri-environmental programs covered 22% of the utilized agricultural area of the EU27 in 2009. However, several studies have indicated that their environmental performance has been poor and thus, they may not provide value for the money invested by European taxpayers. Hence, there has been an increasing interest in performance based payments—also called results based or outcome-based payments. In Europe many experimental projects have utilized performance-based payments over the last decade, and calls for a stronger connection between agri-environmental payments and environmental outcomes are growing (Burton and Schwarz, 2013).

Agri-environmental measures can be designed and implemented at national, regional, or local levels so that they can be tailored to the particular farming systems and environmental conditions, both of which vary greatly throughout the EU. An obvious drawback in the EU system is the fact that crop area payments and some other instruments promote increasing farm land expansion and regional concentration of livestock production. While this further increases the need for spatial targeting and tailoring of the agri-environmental measures, it also may contribute to partial failures of national voluntary programs. Finland provides a striking example.

Lankoski and Ollikainen (2013) find that the Finnish agri-environmental program has failed to achieve its water protection-related goals, which was a 30% reduction of both nitrogen and phosphorus loading from 1995 to 2007: nitrogen loads from agriculture have even increased by 14% and phosphorus loads have decreased only 4%. Their counterfactual analysis helps to trace the mechanisms behind this failure. First, the CAP has modified the incentives provided by the Finnish agri-environmental program. Crop area payments and the current single farm payment invite new land in cultivation. Second, relative prices have favored land allocation towards more fertilizer-intensive land use forms, thus leading to increased use of nitrogen. Third, environmental support is also an area-based payment. Due to the fact that payment levels over-compensates farmer’s compliance costs, it further invites more cultivated land to agriculture and keeps low productivity lands in cultivation. Thus, due to overcompensation the policy instrument works against its water protection aims.

Novel Practices and New Policy Approaches

Europe is increasingly aware of the need to find more efficient ways to reduce nonpoint source loads. The search is going on for instruments that could provide stronger and more flexible incentives for reducing nutrient runoff. Interestingly, water quality trading in nutrients has not received similar attention as in the United States, although some proposals and studies have been made. Instead, active research and pilot projects have been conducted regarding environmental auctions. Also alternative manure handling systems have been under scrutiny and practice.

Conservation Auctions

A pilot auction on applying gypsum to reduce phosphorus runoff in the Nurmijärvi area in Southern Finland was carried out in 2010 (Iho et al., 2011). The pilot was based on an environmental benefit index describing the expected phosphorus runoff reduction based on three factors: soil phosphorus levels, field parcel slope, and location of the field parcel with respect to ditches or surface water. Application of gypsum was used as a measure to reduce phosphorus loading and farmers were asked to offer their field parcels with associated bids to spread gypsum in the fields. According to Finnish studies, four tons per ha of a gypsum amendment decreases particulate phosphorus runoff by 57% and dissolved reactive phosphorus runoff by 29%. The pilot auction was successful as it enrolled the parcels providing the highest environmental benefits—reductions in dissolved and particulate phosphorus runoff—from among the parcels for which bids were submitted. The key factor that separated the enrolled targets from rejected ones was soil P-status: it was four times higher for accepted bids. What is more, the auction format attracted some of the most environmentally sensitive parcels in the area. This was shown by a comparison to data on P-status in the whole study area.

Novel Manure Management Technologies

It is well-established that manure application is often excessive at both farm and regional levels and is one of the major causes of nutrient loads. Manure contains, from an agronomic viewpoint, too much phosphorus in relation to nitrogen and thus leads to a very high soil phosphorus content. Moreover, manure is very expensive to transport. Much work has been done in separating liquid manure into phosphorus-rich solid fractions and nitrogen-rich liquid fractions. This facilitates field application of nitrogen in optimal amounts per ha even in the presence of tight P-standards in environmental regulations and provides a relatively cheap option to transport phosphorus from nutrient-surplus regions to deficit regions, that is from areas dominated by livestock to crop production regions. Transportation of manure from surplus regions to deficit regions reduces the need for mineral phosphorus fertilizer by 30-50%. Total nitrogen runoff can decrease by 10%, total phosphorus runoff by 6%, and dissolved phosphorus runoff by 13% (Luostarinen et al., 2011).

Greening of CAP Support

Political agreement has been achieved on the CAP 2014-2020. In this reform so called "greening" has been introduced to the Pillar 1 payments, that is single farm payments, and 30% of the farmers' direct payments are now focused on the environment. Under the Commission's proposals, 30% of Pillar 1 national envelopes were to be used to fund three environmental measures as follows: (i) crop diversification—at least three different crops; (ii) maintain 95% of the area of permanent grassland on the farm as declared in 2014; and (iii) 7% of the farm must be managed as ecological focus areas, examples of which include landscape features, fallow land, and buffer strips.

No assessment of the potential impacts of these measures on water quality has been conducted, but some preliminary critique has been provided that the overall environmental value added by the reform may be small. We would like to mention one possibility, however. The greening of CAP supports may increase crop rotation with legumes as biological fixers of nitrogen. This reduces the need for mineral fertilizers and some preliminary estimates indicate that this would reduce nitrogen runoff on average by 2-4 kg/hectare per year over the crop rotation length.

Way forward

Due to historical and cultural reasons, landscape and biodiversity conservation have had the dominant role in the European agri-environmental policies with the exception of Nordic countries. This state of affairs is now changing. Nonpoint source pollution policies receive increasing attention throughout Europe. More efficient and targeted policies and policy instruments are both under research and underway in practice.

A dominant feature of the European policies is the interplay between EU-wide and voluntary national policies. The CAP policy creates a framework for member states' voluntary programs and sometimes may even work against CAP's specific goals. This stresses the need for careful designing of more ambitious national water policies in the member states. We find Europe has still much to do in coordinating various policies and developing more efficient instruments suited well for the European environment.

At the moment, much of the innovative work on more efficient policies is being made in the member states. But there is a long road to a nutrient-smart agriculture sector, which recycles nutrients and uses them efficiently in production so that nutrient loads are considerably lowered.

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