frontiers | Frontiers in Sustainable Food Systems

TYPE Perspective
PUBLISHED 07 July 2023
DOI 10.3389/fsufs.2023.1205510

OPEN ACCESS

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RECEIVED 18 April 2023
ACCEPTED 26 June 2023
PUBLISHED 07 July 2023

CITATION
Secchi S (2023) What decades of policies aimed at agricultural water pollution can teach us about agricultural climate change mitigation: a US perspective.
Front. Sustain. Food Syst. 7:1205510.
doi: 10.3389/fsufs.2023.1205510

What decades of policies aimed at agricultural water pollution can teach us about agricultural climate change mitigation: a US perspective

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The Inflation Reduction Act has catalyzed resources for climate change mitigation in several sectors of the US economy, including agriculture. As these activities ramp up, a clear delineation of the US approach to agricultural climate mitigation is emerging. Practices and policy frameworks are similar to those used to address water quality concerns from agriculture, which started in the 1970s. In fact, some of the programs being deployed to address climate change are the same. In both cases, policies rely on a voluntary approach and subsidies, and focus on practices not outcomes. The experience of agricultural water quality programs can provide useful insights on the effectiveness of the approach being used in agricultural climate change mitigation. Voluntary practices have generally been ineffective in improving water quality. More comprehensive policies, or at least better targeted ones, and more system-based analytical capacity are needed.

KEYWORDS

agricultural water quality policy, agricultural climate mitigation policy, US federal policy, crop production, livestock production

Introduction

The passage of the Inflation Reduction Act (IRA) has catalyzed resources for climate change mitigation activities in the United States in several sectors of the economy including agriculture for the first time. The US Department of Agriculture (USDA) also recently awarded over $3 billion to Partnerships for Climate Smart Commodities. As these activities ramp up, a clear delineation of the US policy approach to agricultural climate change mitigation is emerging. The policies rely on a voluntary approach and focus on soil organic carbon or methane emissions only rather than on overall carbon budgets or systemwide assessments. They also lack consistent baselines. Direct subsidies are largely directed to annual crop production practices, such as tillage and cover crops, and for livestock the focus is on anaerobic biodigesters, end-of-pipe treatments which ignore upstream emissions.

This policy framework is remarkably similar to that used to address water quality concerns from agriculture. In fact, some of the programs being re-purposed and deployed to address climate change are the same. Thus, the experience of agricultural water quality policies provides useful insights on the effectiveness of the approach being used to address agricultural Greenhouse Gas (GHG) emissions.

I focus here on water pollution caused by nutrients, nitrogen and phosphorus, because it is a national-level problem with commensurate impacts largely being managed by federal programs and regulations. Though climate change is a global problem, the structure of the Paris agreement means that in the US it is primarily addressed at the federal level. Therefore, it is appropriate to compare national policies. It is also important to note that there are strong connections between water and climate when it comes to nitrogen: nitrous oxide from livestock is a potent GHG, and the production of nitrogen fertilizer via the Haber-Bosch process generates carbon emissions, for example (Fowler et al., 2013). Despite these linkages, however, there has been no attempt to synchronize policies or consider synergies and overlaps with unintended consequences.

Agriculture is the biggest source of nutrient pollution in freshwater systems in the United States (Stets et al., 2020) and it contributes a disproportionately high level of GHGs, over 10% of US emissions compared to <1% of the Gross Domestic Product and about 1% of employment (Gierlinger and Krausmann, 2012; USEPA, 2022; Kassel et al., 2023). Therefore, federal policies to address both types of agricultural-generated pollution have significant consequences on human and ecosystem health. Agriculture is a sector generally treated differently from all other industries because the historically diffused nature of the pollution it generates has made the application of the "polluter pays" principle less common (OECD, 1972; Stevens, 1993). I first discuss the legal frameworks forming the basis of the policies for water pollution and GHG emissions. I then focus on policy aspects critical to both: baselines and policy goals, choice of activities included, and metrics and monitoring. I conclude considering some actionable proposals to improve climate mitigation policies.

The legal framework

The United States does not have a specific law to address agricultural water pollution, which is driven by two federal statutes: the Clean Water Act (CWA) and the farm bill (Monke et al., 2013; Johnson and Monke, 2018). The farm bill provides different types of subsidies for conservation activities, with a historic focus on erosion that expanded to a broader set of environmental concerns, including water quality, in the 1970s. The bill also includes subsidies for commodities, whose production generates pollution. For example, a recent study found that nearly half a million acres of Iowa cropland is in the 2 year floodplain, and these flood-prone fields are mostly used for corn production (Yildirim and Demir, 2022). The subsidized crop insurance program, which is the main delivery mechanism for commodity subsidies, causes moral hazard: farmers plant crops such as corn in areas where they would not do so if crop insurance were not subsidized (Wu et al., 2020).

Thus, the bill's provisions both create incentives to pollute and then to address the pollution generated from agriculture. Since agricultural pollution is considered a non-point source, it is excluded from the purview of the CWA, with two exceptions: Confined Animal Feeding Operations (CAFOs), technically point sources, and Total Maximum Daily Loads (TMDLs), ambient standards theoretically including agricultural pollution. In practice, both these policies are ineffective. Court decisions in 2005 and 2011 resulted in a system in which CAFOs do not have a "duty to apply" for a permit as any other point source, even if the operation "proposes to discharge" (Copeland, 2016). The TMDL process allocates the pollution load across all sources, including agriculture, and includes plans for how to reduce the load to meet intended uses of the lake or stream, but there are no enforceable consequences for the farm sector. The backstop for not meeting the reduction in pollution would *de facto* be to increase the stringency of the allocation for point sources—a highly controversial and possibly ineffective approach that EPA has so far not implemented (Copeland, 2014; Van Cleve, 2021). In practice, therefore, the US approach to agricultural water pollution is based on subsidies and a voluntary approach.

While the CWA regulates pollution from point sources, there is no comparable legislation for GHG emissions for any sources in the US. President Obama attempted to use the Clean Air Act to regulate GHG emissions from stationary sources with the Clean Power Plan, and initially the Supreme Court largely upheld the structure of the plan. The Trump administration, however, repealed the Plan, and in 2022 the Supreme Court struck it down, even though the Biden administration had decided not to pursue the Obama approach (Lazarus, 2023), and instead took a legislative approach with the IRA, which has been hailed as the first major climate legislation in the US. The act largely focuses on the use of subsidies to promote the adoption of renewable technologies and their production in the US. The agricultural title of the bill includes increased subsidies for pre-existing farm bill conservation programs (Leggett and Ramseur, 2022). Besides the IRA, another recent USDA program has recently funded several "climate smart" partnerships for over $3 billion (USDA, 2022), financed through the Commodity Credit Corporation (CCC) whose borrowing is authorized in the farm bill (Stubbs, 2019).

For both forms of pollution there are voluntary mitigation markets that co-exist with the federal subsidy system. In the case of water quality, these trading schemes are rare, largely TMDL-driven and face substantial regulatory and institutional challenges that have impacted their effectiveness (Liu and Brouwer, 2023). Carbon offsets in the US, on the other hand, are generally voluntary, with the notable exceptions of the Regional Greenhouse Gas Initiative (RGGI) states and California, which have cap-and-trade programs that allow limited agricultural offsets (Murray, 2015). The California offset program has been criticized for lack of additionality, inflated baselines and perverse incentives (Akrawi, 2019; Haya et al., 2020). These issues could be amplified if offset markets became more widespread.

Both water pollution and GHG emissions are caused by a wide set of activities in crop and livestock production, which means that there are several ways to reduce pollution. Some of these activities simultaneously cause both problems, such as the use of nitrogen fertilizer and manure from livestock. In both cases, commodity subsidies cause more production of the pollution-generating goods than there would have been in a market equilibrium. The current policy set-up thus makes it harder to use one important environmental policy tool: the reduction in production of the pollution-causing good[1] (Goulder and Parry, 2008). Besides the farm bill subsidies, the other policy that has been an indirect subsidy for commodity crop production is the 2008 second Renewable Fuel Standard (RFS2), which creates additional demand for corn in particular. There is widespread consensus in the literature that the RFS2 has contributed to worsening in water quality. The effects of the mandate on GHG emissions are heavily contested (Hoekman and Broch, 2018), but recent evidence suggests that the land use change effects negate the benefits of a renewable fuel whose production is heavily dependent on fossil fuels (Lark et al., 2022).

Since direct and indirect subsidies act counter to one of the main pollution reduction channels for both agricultural water pollution and GHG emissions, the other available ones, change in input mix/practices and end-of-pipe treatments, have to be deployed at higher levels than would be optimal to address the pollution if all tools were available (Goulder and Parry, 2008).

The choice of baseline and goals

The CWA mandates that waterbodies should meet their intended uses, but there are no national water quality standards. Instead, the states are left to determine their own criteria. The National Strategy on the Development of Regional Nutrient Criteria asserted that states would have to develop criteria by 2003 or the EPA would act as the backstop (USEPA, 1998). As of 2023, however, 26 states still do not have criteria in place and no states have a complete set of criteria (USEPA, 2023), and EPA has no plans to step in. As discussed above, TMDLs offer a baseline for reduction where they are in place, but the enforcement of the load allocation is doubtful. Another issue is that states can put off the listing of water bodies as impaired, thereby stalling the development of TMDLs. In such a case, following the constructive submission doctrine, EPA can take over, but the process is rarely used (Kirk, 2019). Therefore, in practice, in many parts of the US there are no national, state or watershed-specific baselines that can be enforced to ensure that water pollution from agriculture is addressed. A critical tool to assess the effectiveness of agricultural water quality efforts is missing. A good example of the ineffectiveness of the approach is the TMDL for Lake Erie, where water quality problems came to national attention in 2014 when Toledo's drinking water supply became contaminated by microcystins associated with a harmful algal bloom. The state of Ohio had to be sued to implement a TMDL, after positive results of years of voluntary programs never materialized. The draft TMDL does not include a target for dissolved reactive phosphorus, which is driving the algal blooms, does not allocate a portion of the load (and therefore its reduction) to CAFOs, and does not have an implementation plan with deadlines (Environmental Law Policy Center, 2023).

The situation regarding climate mitigation is similar. The IRA does not incorporate any baselines to measure progress against. There are several modeling efforts that have projected the impact of the legislation, including levels of uncertainty (Mahajan and Orvis, 2021; Jenkins et al., 2022), but the statute itself does not include mechanisms to ensure a certain level of GHG reductions is achieved. A key difference between water and climate is that the CWA provides a more direct backstop to address water quality issues, though its effectiveness is uncertain. The Clean Air Act's authority to address climate change, on the other hand, is highly contested in the courts.

The choice of activities

As noted above, there is no dedicated program to address water pollution from agriculture. The conservation subsidy programs in the farm bill address a wide variety of environmental concerns and only a portion of them is focused on water quality specifically. For example, the largest land retirement policy, the Conservation Reserve Program (CRP), enrolls land on the basis of a complex Environmental Benefit Index whose structure has changed through time (Hellerstein, 2017). In the last sign-up, a maximum of 100 out of 445 points was water quality-related (USDA FSA, 2023). In fact, since 2003 the EBI has also included points for carbon sequestration (up to 10). Other programs such as the Environmental Quality Incentive Program (EQIP), which provides a cost-share for conservation activities on working lands, are practice-based, so there is no water quality outcome associated with them. The Conservation Stewardship Program (CSP), the other large working land conservation policy, is performance-based, and uses models to determine the outcomes, but it is not a water-quality focused program: farms are enrolled on the basis of state-level priority resource concerns, which vary by ranking pool or farm type (Stubbs, 2019). Water quality is just one of a large set of priority concerns (National Sustainable Agriculture Coalition, 2020). To complicate matters, it is well established that conservation programs in the US are dual goal, that is, they have been devised to address environmental concerns but also provide income support to farmers (Batie, 1999; Secchi et al., 2008), and this reduces their environmental effectiveness. Further, as I noted above, other non-environmentally focused programs such as the crop insurance subsidies and the ethanol mandate worsen water quality. The federal government does not systematically assess these effects in any way.

Current efforts to address climate change in agriculture appear to be following the same approach. The IRA and Climate Smart partnership funding is focused on existing programs and activities, particularly conservation tillage and cover crops, which can be subsidized through EQIP, with the goal of increasing Soil Organic Carbon. No till in particular is a controversial choice because its effectiveness in sequestering carbon is heavily debated in the agronomic literature (Powlson et al., 2014; Cai et al., 2022), and it depends on the continuous use of the practice. However, in reality tillage is largely a rotational activity (Claassen et al., 2018), so its carbon sequestration benefits are highly speculative. Further,

1 Reductions in production may not be necessary if there are efficiency gains. In their absence, the three ways in which pollution can be reduced are reductions in production, changes in the input mix and end of pipe treatment (Goulder and Parry, 2008).

farmers already use various no till or conservation tillage methods so its additionality is unclear. In addition, a recent report from an environmental non-profit found that some conservation activities funded by EQIP actually worsened climate change (Schechinger, 2022), but there are no plans for a systematic attempt to measure agricultural carbon budgets and overall reductions in emissions because of the extra funding. The lack of plans to assess the effectiveness of both sets of policies is troubling, particularly in light of their complex interactions at various spatial and temporal scales and high reliance on public funding.

The choice of metrics and monitoring

Conservation programs with water quality effects are often practice-based, that is, the effect on the environment is assumed and USDA uses indicators such as acres of land retired to report on the policy. Sometimes, expenditure is used as a metric, which is very problematic since higher land costs, for example, mean that the same budget retires less land from production. When performance or outcome metrics are used, as in the case of the CSP, the effects are estimated using models rather than actual measurements due to the expense and complexity that would be associated with that approach. The modeling approach is also used at the landscape and national level to measure the benefits of the programs. Specifically, the ongoing Conservation Effects Assessment Project (CEAP), has various components that simulate the benefits of federally funded conservation programs. Since the project does not consider changes to the structure of agriculture, including the environmental costs of the commodity title of the farm bill (Northey, 2020), its utility for planning and policy-making is limited. For example, the steady rise in the number of CAFOs and their increase in size is not accounted for in the analysis, though it means that more manure is concentrated in certain areas and is treated as a waste product and not as a valuable fertilizer (Burkholder et al., 2007; Glibert, 2020). At the same time, there is no consistent monitoring of water quality at the national levels. States report to EPA their impaired waters, but the process is arbitrary, in part because it is based on limited data (National Research Council, 2001).

As a result, agriculture is the biggest source of pollution in American streams and lakes (Evans et al., 2019), and, though historical evidence is hard to interpret because of data availability issues, it is clear that the current policy approach has not been effective at reducing agricultural water quality problems (Capel et al., 2018; Paudel and Crago, 2021). In fact, experts have argued that the voluntary, practice-based approach has failed not because of lack of funding but by design, as it lacks the capacity to link conservation activities to changes in outcomes (Stephenson et al., 2022). This missing policy feedback loop—which is critical in adaptive management—means that lack of progress has not been able to trigger any substantive policy changes. An illuminating example of this dynamics can be seen in the Des Moines-Raccoon River watershed. At the confluence of the two rivers, the biggest drinking water provider in Iowa, the Des Moines Water Works, determines which source to use depending on its levels of pollution. A TMDL for the Raccoon was developed in 2008 and a Master plan in 2011 (Agren Inc., 2011). However, in 2021 the Waterworks started planning the building of wells because the water in both river was still heavily polluted and—because of climate change—flow in summer could be dangerously low (Payne, 2021). A year before, farmers in the Raccoon watershed had refused 80% of the conservation funds available to reduce nutrient pollution (Cullen, 2020). This illustrates and the limits of the voluntary approach—even in the presence of a TMDL, and the lack of adaptive management in water quality policy.

Problems of metrics and monitoring are likely to be as prevalent in agricultural climate mitigation. The focus on SOC is controversial in agricultural systems that are heavily dependent on fossil fuels. Similarly, in the case of biodigesters, there is no systemic attempt to understand their overall impact on GHG emissions even though there is evidence the digesters capacity to actually reduce GHG emissions is questionable as they increase the amount of methane produced and associated leaks (Rotz et al., 2016; Vergote et al., 2019). If operations using biodigesters expand, so would actual leaks (Grubert, 2020). If subsidies for biodigesters were to increase the number of CAFOs, this problem would be even worse. As of now, there is no evidence biodigester-driven expansion is occurring, but experts are concerned about it (Smith, 2022).

Discussion

Political realities are driving very ineffective and inefficient systems. It is clear that agricultural exceptionalism (Luna, 1999; Schneider, 2009) is alive and well in US environmental policy. Since the approach being used for agricultural climate mitigation is the same as agricultural water quality policies, the problems that have plagued the latter, from lack of coordination and clear benchmarks to reliance on practices, subsidies and voluntary adoption, will likely beset the former. Historically, environmental policies in the agricultural sector have always also had income support goals (Cochrane, 1979). Given that agricultural climate mitigation is using the same approaches, it is apparent that it also has dual goals. This needs to be acknowledged in the research community, which will play a critical role in analyzing the effects of the policies given the lack of assessment mechanisms at the government level.

The lack of baselines and the reliance on practice-based metrics will make policy assessment very complicated. There is no attempt on the part of the federal government to use system-wide assessment for both cropland activities and livestock operations and no consideration of the interplay between GHG reductions and other environmental objectives, even though analyses of the biofuel mandate have made clear that there are considerable trade-offs between water quality, habitat and GHG emission reductions in agriculture (Lark et al., 2022). Without the analytical capacity to understand system-level effects through time, policy benefits could be overestimated, causing delays in more comprehensive policy solutions. This has certainly been the case for agricultural water quality programs.

While the political economy of agriculture may limit the range of policy tools that can be used to address various forms of pollution, USDA should restrict the use of subsidies to practices that have been proven to be effective, are additional and provide benefits as close to permanent ones as possible, following the scientific literature. The focus should move away from SOC, which has limited potential (Schlesinger, 2022), and to overall GHG emission impacts, with consideration of co-benefits and impacts on other pollutants. USDA should also use its analytical capacity to monitor and assess the programs using system-wide approaches. The research community also has a critical role to play in helping ensure that more realistic assessments of the current policy models are available. Analyses should include system-wide studies and modeling of alternative production systems, including changes in diets as suggested by the EAT-Lancet project, for example (Willett et al., 2019; Coleman et al., 2021).

Author contributions

SS conceived the paper and its design, wrote the manuscript, read, and approved the submitted version.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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