doi:10.2489/jswc.68.3.74A

FEATURE

Additionality in agricultural conservation payment programs

Roger Claassen, Eric Duquette, and John Horowitz

A large number of both state and federal agricultural policies are designed to pay farmers and ranchers to undertake conservation practices that have off-farm environmental benefits or long-run farm-productivity payoffs. These supported actions can include implementing a nutrient management plan, installing stream-side or field-edge buffers, adopting no-till, or retiring cropland to grass or tree cover. Payments can take the form of cost-sharing for explicit costs incurred by the farmer, specified payment amounts meant to capture the cost of transitioning to the new practices, or lost income, particularly when land is taken out of production. In fiscal year 2012, USDA spent nearly US$5.5 billion through voluntary payment programs to support the adoption of conservation practices.

What are taxpayers getting for their money? The answer entails, in part, knowing whether practices that receive conservation payments would have been pursued without those payments. Additionality is a measure of the extent to which conservation payments are necessary for practice adoption for those farmers who receive payments. Practices supported by payments are additional if they would not have been adopted without the payment, or, from an environmental standpoint, if the environmental benefits would not have been realized without the payment. Practices that would have been adopted even if the farmer had not received a payment are not additional, and no environmental gain can be attributed to the payments that support them.

The additionality issue also arises in situations where farmer payments come from private sources rather than from the government, such as what occurs with water quality trading or proposed greenhouse gas offset markets. In most of these markets, regulated companies seek to reduce the cost of pollution abatement by purchasing offsets or credits from farmers or ranchers who can reduce emissions at a lower cost. In a nutrient trading market, for example, a regulated company could buy credits from farmers who agree to adopt specific practices that reduce nutrient runoff, while maintaining their own nutrient emissions at a higher level than would otherwise be permitted. A trading program is effective only if the practices supported through credit purchases are additional. If practices are not additional, point sources will increase emissions with no accompanying decrease in agricultural emissions, and the overall goals for pollution abatement and environmental quality would not be met. While the number of actual water quality trading programs is small and the number of trades to date is modest, interest in trading and market-based conservation payments is high and may grow as states begin implementing rules designed to achieve total maximum daily loads for specific water bodies.

In this paper, we briefly describe the causes of nonadditionality (i.e., when payments are not needed for conservation practice adoption, at least on some farms), discuss some policy options for increasing additionality in conservation programs, and address some of the challenges that policy makers may face in attempting to increase additionality. We then report preliminary estimates of additionality achieved for a limited number of widely used practices that are supported by USDA's Environmental Quality Incentives Program (EQIP), the Conservation Reserve Program (CRP) continuous sign-up, and many state conservation payment programs (table 1).

It is important to keep in mind that conservation payments are designed to satisfy multiple policy goals and that achieving additional environmental benefits may be only one among multiple priorities. For instance, some (but not all) payments in the Conservation Security Program (2004 to 2008) and the Conservation Stewardship program (2009 to present) are designed to reward farmers

Roger Claassen and **Eric Duquette** are agricultural economists with the USDA Economic Research Service, Washington, DC. **John Horowitz** is an economist with the US Department of the Treasury, Washington, DC.

Table 1

Conservation practice groups, programs payments, surveys, and adoption and payment rates.

Practice group	Practices	Programs	ARMS surveys	Percent adopting	Percent paid
Buffer practices	Field-edge filter strips, grassed waterways, field borders, riparian buffers	EQIP, CRP, other	Wheat, 2009	13.7	5.3
			Corn, 2010	25.3	6.8
			Overall	22.2	6.3
Soil conservation structures	Terraces, grade stabilization structures, and water and sediment basins	EQIP, other	Wheat, 2009	20.1	7.3
			Corn, 2010	9.9	3.0
			Overall	12.8	4.2
Conservation tillage	No-till, strip till, mulch till, ridge till	EQIP, other	Corn, 2010	43.2	3.5
			Barley, 2011	55.5	8.2
			Sorghum, 2011	52.9	0.7
			Overall	43.7	3.5
Nutrient and manure management plan	Comprehensive nutrient management, manure management	EQIP, other	Wheat, 2009	4	1.5
			Corn, 2010	9.6	3.2
			Barley, 2011	20.7	9.4
			Sorghum, 2011	1.9	0.2
			Overall	8	2.7

Notes: EQIP = Environmental Quality Incentives Program. CRP = Conservation Reserve Program. ARMS = Agricultural Resources Management Survey.

for on-going stewardship. In EQIP, some payments support practices that producers must adopt to comply with regulation; because producers were required to adopt these practices whether they received a payment or not, the payments do not lead to additional environmental gain.

SOME NONADDITIONALITY IS INEVITABLE

Program administrators may unintentionally provide payments for practices that would have been adopted without payments because it is difficult to predict whether or when a specific farm might adopt the conservation practice in question. The risk of nonadditionality is highest for conservation practices that boost farm profits or provide other benefits to farmers and landowners (e.g., enhanced wildlife populations for hunting or viewing) since these practices are more likely to be adopted without payment. Predicting adoption is difficult, in general, because on-farm net benefits can vary across practices and, for any given practice, across farms and over time.

For conservation management practices, profit can increase because these practices often reduce input use and input costs. A nutrient management plan that specifies reduced fertilizer use, for example, will also reduce fertilizer costs. Whether profit is increased depends on how crop yields or other outputs are affected. In the nutrient management example, reduced fertilizer use may reduce crop yields and revenue. Moreover, any given practice may yield positive on-farm net benefits for some farms (where adoption is likely even without a payment) but not others (where adoption is not likely without a payment). Farmers differ in their expectation of on-farm benefits based on differences in soils, climate, crop or livestock enterprises, and their underlying propensity to innovate. Conservation tillage, for example, can reduce labor, fuel, and machinery costs, but may also delay planting and reduce yields when springtime weather is wet and cool.

Unlike management practices, many conservation structural practices are expensive to install and may yield on-farm benefits that are small or occur only in the distant future. For most (but not all) farms, the present value of on-farm benefits will not be positive. These practices are more likely to be additional because they are less likely to be adopted without payments. Additionality is likely, for example, with field-edge filter strips, riparian buffers, and grassed waterways, which we refer to collectively as "buffer practices." Because these practices are designed to capture nutrients and sediment before leaving the farm, many of the benefits associated with them occur downstream and would not be captured by the farmer or landowner. The cost of taking land out of production and establishing vegetation can also be high, further discouraging adoption. Nonetheless, buffers may provide some on-farm benefits, such as enhancing wildlife populations for hunting or viewing. So there may be some farmers who expect positive on-farm benefits from the adoption of these practices. Some farms have indeed adopted buffers without payments (table 1).

More importantly, farmer expectations about on-farm benefits from a given practice can change over time, particularly for conservation management practices. This suggests that if past practices are known by program administrators, they may not be a good proxy for what the farm would do in the future in the absence of a payment. Farmers who have not yet adopted a practice may change their view of its merits once it has been adopted successfully by others or as the technology evolves and improves. In the conservation tillage example, the development of glyphosate tolerant crop varieties may have made it easier for producers to control weeds without tillage, removing an important barrier to conservation tillage, particularly no-till.

Payments to future adopters are difficult to avoid, however, because it is difficult to predict whether or when a given farmer will adopt a specific conservation practice. If payments support practices that would have been adopted without payments at some time in the future, additionality is limited. The environmental gain that can be attributed to the payment is the benefit that accrues before adoption would have happened without the payment. For farms that would have adopted in the near future additionality will be quite limited. Nonetheless, payments that support early adoption of a conservation practice, if successfully applied, may have the indirect benefit of encouraging other producers to adopt the practice.

POLICY OPTIONS FOR INCREASING ADDITIONALITY

Because program managers cannot identify additional practices with certainty, they cannot avoid the risk of paying for nonadditional practices. These programs can still be worthwhile because program payments may procure sufficiently large social benefits from the additional practices, even if the payments for nonadditional practices yield no new benefits. Tighter program eligibility rules, enhanced practice requirements, and use of benefit-cost indices are three program design elements that could be used to improve additionality.

For some practices, farm-specific eligibility rules can increase additionality. In most conservation programs, for example, only those practices that have not been previously used are eligible for payments. For practices that can be easily observed, are unlikely to have positive on-farm benefits, and are difficult or expensive to remove, these rules can encourage additionality. Practices funded through the EQIP that are likely to meet these criteria include a range of structural and vegetative practices, including terraces and grade stabilization structures. Where these practices have not yet been adopted, it is unlikely that they will be adopted without a payment. Where one of these practices is already in place, it is also unlikely that the practice will be removed. For practices that are more difficult to observe and easier to remove, limiting payments to newly adopted practices may create an unintended incentive for farmers to alter practice use in ways that enhance their chances of receiving future conservation payments. If offered a payment for the adoption of no-till methods, some farmers may be tempted to till land that had been in no-till production to become eligible for the payment. To the extent that this type of incentive is created, the risk of nonadditionality can be high.

Requiring producers to undertake a suite of conservation practices, rather than a single practice, can also increase additionality. For example, farmers wanting to receive credit for changes in their nitrogen application regime could also be required to adopt no-till as part of their contract.

Where no-till is well adapted and broadly used, it may even be reasonable to require no-till without increasing the contract payment. The greater the requirements for receiving conservation payments, the less likely it is that the farmer would have pursued that suite of practices without payment, making the practices more likely to be additional. Requiring multiple practices, however, could discourage participation on the part of some producers who may be willing, for example, to change their nitrogen application regime but are unwilling to adopt no-till. These unintended consequences could reduce the overall gain in additional environmental benefit sought by requiring program participants to adopt the suite of practices.

Finally, conservation program benefit-cost indices could be adjusted to reflect the likelihood of nonadditionality. Benefit-cost indices are used to rank applications for acceptance in all major USDA conservation programs and have been shown to be effective in increasing environmental benefits as long as supported practices are additional (Feather et al. 1999). To account for potential nonadditionality, benefit points could be deducted for practices that are relatively unlikely to be additional. Conservation program applications that propose practices that provide additionality would be more likely to be funded, and payment support would be more likely to be directed toward practices that yield additional environmental gain. Because all the environmental benefits and costs of each practice that could be used to address a given problem are considered, this approach recognizes that practices which are more likely to be additional may also be less beneficial (at least in terms of addressing a specific resource concern) or more expensive than practices that are less likely to be additional. The practice that is less likely to be additional may still be the most cost-effective alternative.

MEASURING ADDITIONALITY IN CURRENT CONSERVATION PROGRAMS

Supported practices are additional to the extent that they would not have been adopted without payment support. Once a payment has been received and the required changes in farming practices have been made, however, it is no longer possible to observe what the farmer would have done without the payment. We estimate what farmers who received payments (payment farms) would have done without the payment by looking at practice use in a group of farmers who did not receive payments (nonpayment farms) but who are very similar to or "match" the payment farm.

The theory behind statistical matching can be understood by analogy to a controlled experiment. In controlled experiments, individuals are assigned randomly to "treatment" and "nontreatment" groups to minimize the possibility of systematic differences between groups and ensure that differences in outcome, on average, reveal the effect of the treatment. In policy evaluation studies, however, researchers are seldom able to randomly assign the treatment, which, in our case, means receiving a conservation payment. However, if similar farms are likely, on average, to make similar decisions about production and practice adoption, matching methods can be used to define an appropriate comparison group for each payment farm (Caliendo and Kopeing 2008). Thus, for each payment farm, we identify a group of very similar or matched nonpayment farms. Although matching is done on a farm-by-farm basis, we stress that comparisons are valid only when averaged across a large number of payment farms.

Under Propensity Score Matching, the analyst first estimates the propensity (probability) that an individual farm will receive a payment supporting the adoption of a practice. We conducted four regressions, based on the four practice categories defined in table 1. Data on practice use and payments are from the crop-specific, field-level portion of the Agricultural Resources Management Survey for 2009 (wheat [*Triticum* L.]), 2010 (corn [*Zea mays* L.]), and 2011 (barley [*Hordeum vulgare* L.] and sorghum). Different surveys were used with different practice groups depending on the practice and program participation questions in any given year (table 1). Respondents were asked which practices were in use on the surveyed field, when they were first installed or used, whether a payment was received in conjunction with the practice, and what program the payment came from. The program choices were the (1) EQIP, (2) Conservation Security Program/ Conservation Stewardship Program, (3) Conservation Reserve Program continuous signup, or (4) other federal, state, and local programs. Farms that received Conservation Security program (CSP; 2004 to 2008) or Conservation Stewardship Program (CStP; 2009 to present) were excluded because (1) a portion of these payments supported stewardship (ongoing conservation efforts) rather additional conservation and (2) enhancement payments—a large part of Conservation Security Program—supported changes to existing practices and, therefore, are not well matched to Agricultural Resources Management Survey questions which are based on full adoption of standard conservation practices. The probability of a farmer receiving a payment for practice adoption was modeled as a function of the field, farm, farmer, and program characteristics believed to influence the farmer's receipt of a practice adoption payment (table 2).

Next, we match payment and nonpayment farms. Rather than defining a small group of farms to serve as a comparison group for each nonpayment farm, we assign a weight to each nonpayment farm that is proportional to the distance between the payment and nonpayment farms in terms of the propensity score. Relatively large weights are assigned to nonpayment farms that "look like" the farm that did receive a payment. These are farms that might have received a payment but did not, presumably for a random reason that is not correlated with the likelihood of adopting the practice. Each nonpayment farm is assigned a weight for each payment farm.

We measure the effect of conservation payments on practice adoption as the average difference in the probability of conservation practice adoption with a payment (=1, given the payment) and without the payment, which is estimated as the average adoption rate for nonpayment farms using the appropriate set of weights. If the weighted average adoption rate among nonpayment farms is 0.25, for example, our estimate of additionality is 0.75. Our data allow us to match based on current levels of practice adoption (from 2009 to 2011) for the nonpayment farms. Some of the nonpayments farms that have not adopted a given practice may adopt

it, without payment, in the future. In our example, if the weighted average adoption rate among nonpayment farms rises to 0.30 at some future time, estimated additionality at that time would be 0.70. Of course, early adoption does yield benefits, as already noted. While we acknowledge that this is an issue, accounting for future adoption is well beyond the capability of our current data.

Finally, our data do not identify producers who may have received management practice payments but dropped the practice once payments ended. EQIP, for example, provides management practice payments for three years, after which the payments end and the producer is free to continue using the practice or drop it. While we have no information on the number of farmers who may have dropped practices, payments for these practices would not provide additional environmental gain. This is not an issue for structural or vegetative practices where producers who receive cost-sharing are required to maintain the practices for their full useful life.

Table 2

Data for Propensity Score Models.

Category	Variable	Description
Field	Productivity	National Commodity Crop Productivity Indicator, unit interval
	Erodibility	Highly erodible field (0 or 1)
	Wetland	Wetland in field (0 or 1)
Farm	Size	Log(total farm acreage)
	Manure	Manure applied to field (0 or 1)
Farmer	Occupation	Primarily farming (0 or 1)
	Age	Years
	Education	College degrees (0 or 1)
	Land tenure	Owns field (0 or 1)
Programs	EQIP payments	Total US$ ac^{-1} in county
		Total US$ ac^{-1} in adjacent counties
	CRP payments	Total US$ ac^{-1} in county (buffer equation only)
		Total US$ ac^{-1} in adjacent counties (buffer equation only)
Other	Population density	1,000 people per acre
	Fixed effect for state	One variable for each state, =1 for observations with state, =0 otherwise
	Local practice adoption rate	Unit interval

Notes: EQIP = Environmental Quality Incentives Program. CRP = Conservation Reserve Program.

Table 3

Additionality in adoption of common conservation practices.

Practice	Unit	Payment farms	Nonpayment farms		Additionality in adoption
			Matched	Unmatched	
Soil conservation structures	Adoption rate	1	0.21	0.09	0.78*
Buffer practices	Adoption rate	1	0.22	0.15	0.78*
Conservation tillage	Adoption rate	1	0.46	0.42	0.54*
Nutrient management plan	Adoption rate	1	0.18	0.05	0.83*

*Significantly different from zero with $p < 0.01$

**Significant with $p < 0.05$

ADDITIONALITY ESTIMATES

Adoption results are shown in table 3. We find high levels of additionality for buffer practices (0.78) and soil conservation structures (0.78). These figures mean that roughly 80% of the farmers that received payment would not have installed buffers or soil conservation structures without the payment. Our results may reflect the likelihood that these practices offer limited on-farm benefits, at least in the short run, and are expensive to install. In the long run, soil conservation structures can protect the underlying productivity of the land, and buffers can provide landscape amenities, including wildlife habitat and hunting opportunities. For many farms however, the present value of expected on-farm benefits that occur far in the future may not exceed adoption costs. Our findings are generally consistent with those of Mezzatesta et al. (forthcoming), who find high levels of additionality (above 80%) for acreage in the state of Ohio devoted to filter strips and cover crops.

Our estimate of additionality in conservation tillage (0.54) is considerably lower than for either category of structural or vegetative practices. Under favorable conditions, conservation tillage can reduce the cost of labor, fuel, and machinery without a reduction in crop yields; although, the transition to conservation tillage may require upgrading some equipment (e.g., a planter or grain drill that can handle heavier residue) and may involve learning new techniques for weed and pest control. Because conservation tillage can be profitable, at least on some farms, lower additionality in conservation tillage is not surprising. Our estimate, however, is much higher than that of Mezzatesta et al. (forthcoming), who find that less than 25% of conservation tillage adopted with payment support is additional. The difference in estimates may indicate that conservation tillage is better adapted in the portion of Ohio studied by Mezzatesta et al. (forthcoming) (82% overall adoption rate) than in the 26 states included in our study (44% overall adoption rate).

Finally, our estimate of additionality for nutrient management plans (0.83) is very high. The estimate is based on survey questions that ask producers whether they have written plans for nutrient and/or manure management and whether they have received payments in conjunction with these plans. The real question, of course, is whether written plans, supported by conservation payments, are leading to better nutrient management. While we do not know exactly what practices are

included in individual nutrient management plans, we investigate the effect of nutrient management payments on several common practices. We match farms based on the probability of receiving a payment for a nutrient management plan and then compare payment farms to matched nonpayment farms in terms of nitrogen fertilizer application rates. Our measure of additionality is the average difference in the nitrogen application rate for the payment farm and the matched nonpayment farms when both are expressed as a percentage difference from the overall mean for the crop (nitrogen application rates are expressed as a percentage difference from the crop-specific mean to facilitate cross-crop comparisons). Focusing only on corn producers, we consider the timing of nitrogen fertilizer applications. Here, our measure of additionality is the average difference in the proportion of nitrogen applied in (1) fall and (2) after planting by the payment farms and the matched nonpayment farms.

Nutrient application rate and timing results are shown in table 4. Our estimates show that nitrogen application rates are roughly the same for farms that have received nutrient management payments and farms that have not received payments. In terms of timing, corn producers receiving nutrient management payments are likely to apply significantly less nitrogen fertilizer in the fall than matched nonpayment farms. While the matched nonpayment farms apply 12.9% of total nitrogen fertilizer in the fall (on average), we estimate that payment farms apply only 1.2% of total nitrogen in the fall. So, nutrient management payments appear to largely eliminate fall application of nitrogen. For postplanting application, we estimate that payment farms apply 38.1% of nitrogen after planting, while matched nonpayment farms apply 24.8% after planting. The difference of 13.3%, however, is not a precise estimate and is not statistically different from zero.

Table 4

Additional estimates for nutrient management practices.

Practice	Unit	Payment farms	Nonpayment farms		Additionality in rate/timing
			Matched	Unmatched	
Nitrogen application rate	Percent difference from crop mean	−12	−14.4	−3	2.3
Fall nitrogen application	Percent nitrogen applied in fall	1.2	12.9	14.4	−11.6**
Postplant nitrogen application	Percent nitrogen applied after planting	38.1	24.8	23.4	13.3

*Significantly different from zero with $p < 0.01$

**Significant with $p < 0.05$

POLICY IMPLICATIONS

Additionality is and will continue to be an issue for US conservation payment programs. So long as farmer intentions with respect to conservation practice adoption are not known with certainty, there is likely to be some level of nonadditionality in practices supported by conservation payments. To the extent that policy makers seek to maximize environmental gain per dollar of program expenditure, however, additionality is critical. Payments for nonadditional practices use limited budget resources without returning any environmental gain.

While still preliminary, our estimates conform to expectations in the sense that additionality is higher for practices that are unlikely to provide positive on-farm benefits to producers and landowners. They also comport with those of Mezzatesta et al. (forthcoming) to the extent that our practice groups can be compared to the practices they consider. Differences with respect to nonadditionality in conservation tillage, however, may indicate regional differences in the level of additionality for specific practices. More research is needed to understand how additionality for specific practices may vary across regions.

In the case of nutrient management, our results are somewhat ambiguous. We estimate that additionality is high in terms of having a written plan and for fall application of nitrogen in corn production. Our findings on fall application probably reflect the fact that very few, if any, nutrient management plans call for fall application of nitrogen for corn. We also estimate that there is little or no additionality in terms of nitrogen fertilizer application rates and after-planting nitrogen application in corn—practices that are often included in nutrient management plans. This result could reflect the fact that our data do not include the individual practices required by nutrient management plans. Some plans may focus on other nutrient management practices, such as soil testing, fertilizer or manure application methods, and the use of nitrogen inhibitors. Data on specific nutrient management practices could improve additionality estimates.

Finally, managing nonadditionality may be a balancing act. The best response to the risk of nonadditionality may depend on the environmental benefits and costs of available alternatives. If our estimate of additionality in conservation tillage is correct, for example, it implies that a substantial share of the payments made in support of conservation tillage is not delivering environmental benefits. Nonetheless, conservation tillage could still be the most cost-effective way to address some resource concerns. To slow soil erosion, especially on land that is not highly erodible, changes in tillage may still be less costly per ton of erosion reduction than structural practices which are more likely to be additional but also more expensive.

DISCLAIMER

The views expressed in this article are those of the authors and do not necessarily reflect the views of the Economic Research Service, USDA, or the US Department of the Treasury.

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