WRI POLICY NOTE
ENVIRONMENTAL MARKETS: REVERSE AUCTIONS No. 3
WORLD RESOURCES INSTITUTE

Paying for Environmental Performance: Using Reverse Auctions to Allocate Funding for Conservation

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SUZIE GREENHALGH, JENNY GUILING, MINDY SELMAN, AND JONATHAN ST JOHN

Can reverse auctions be used to achieve cost-effective improvements in environmental quality?

Recommendation: Apply reverse auction concepts where there is a constrained or limited budget for agricultural best management practices (BMPs) or for easements that improve environmental quality. This will ensure cost-effective improvements are purchased by agricultural conservation programs or environmental trading programs.

Because demand for funding in conservation programs has historically exceeded the available funds, allocating funding in a way that achieves the greatest environmental outcomes is essential. Reverse auctions are one way to efficiently allocate funding. Two recent reverse auctions conducted in Pennsylvania, designed to fund best management practices that reduced phosphorus (P) pollution, demonstrate the effectiveness of reverse auctions. This note explains how reverse auctions can be used to maximize environmentally desirable outcomes, and outlines the findings and lessons learned from the Conestoga Reverse Auction Project within Pennsylvania's Susquehanna River Watershed that are relevant for the wider adoption of reverse auctions.

What is a Reverse Auction?

Reverse auctions, like standard auctions, are competitive bidding systems. In a reverse auction sellers compete to supply buyers with a specified good or service, enabling buyers to locate the most competitive sellers. Unlike standard auctions in which multiple buyers compete to *buy* goods from a single seller, in reverse auctions, multiple sellers compete to *sell* goods to a single buyer. The effect is that in a reverse auction sellers bid prices *down* while in a standard auction buyers bid prices *up*. In markets with multiple sellers and a single buyer, reverse auctions can help to efficiently allocate a limited budget.

In a reverse auction whose goal is to purchase environmental goods or services, bids are specified in terms of cost per environmental outcome achieved (e.g., cost per pound of P reduced) and are then ranked from lowest to highest, allowing the administrators of the auction to determine which bids are most competitive. The very nature of reverse auctions makes them cost-effective as they allow auction administrators to identify and purchase the lowest cost environmental outcomes.

The cut-off price for the accepted bids in a reverse auction can be based on the price that exhausts a given budget, or based on distinct and marked changes (or break-points) in bids submitted to the auction (see Box 1). Choosing an appropriate cut-off price depends on the objectives or funding constraints of the agency or organization administering the auction.

Break-points may be appropriate where the agency or organization wish to limit the price paid per environmental outcome or there are no time restrictions for when funding needs to be spent.[1] Exhausting the budget may be appropriate where the funding expires within a specified timeframe. Us-

BOX 1 Example of Reverse Auction Break-Points for Hypothetical P Reductions

Farmer Bid ($'000)	Cumulative Auction Bids ($'000)	Pounds P Reduced (1000 lbs)	P Bid Price ($/lb P)
60	60	28	2.14
100	160	45	2.22
9	169	0.9	10.00
10	179	0.8	12.50
20	199	1.5	13.33

- Assuming a program funding budget of $180,000, the cut-off price to exhaust the budget would be $12.50/lb P
- Using a bid price break-point, the cut-off price would be $2.22/lb P
- Using a P reduction break-point, the cut-off price would be $2.22/lb P

ing break-points will most likely result in more cost-effective environmental outcomes for a given budget, however it may take longer to allocate the funds if subsequent auctions need to be held—increasing the transaction costs of allocating the funds.

Where can Reverse Auctions for Conservation Be Used?

Reverse auctions are well suited for allocating funding in both conservation programs and environmental trading markets, such as water quality or greenhouse gas markets. In both cases, a single buyer with a limited budget (e.g., a government agency) purchases environmental goods and services from many potential sellers (e.g., farmers).

In many conservation programs, government agencies pay farmers to implement BMPs for environmental improvements or to retire sensitive or marginal lands. Government conservation programs include federal programs such as the U.S. Department of Agriculture (USDA) Farm Bill programs or state government initiatives that promote BMPs like the Pennsylvania Department of Environmental Protection's Growing Greener Program. These programs, which have limited budgets, could improve the environmental outcomes they achieve by using reverse auctions to identify those farmers who can provide the greatest environmental improvements for the lowest price. For example, this might include farmers who can reduce the amount of phosphorus or nitrogen delivered to a specific point in a watershed, such as the mouth of a river or a lake, from their farm at the lowest cost.

Recognizing the benefits of this approach, in July 2006 the USDA piloted a reverse auction in the Wetlands Reserve Program to reduce the acquisition costs of wetland easements.[2] The enrollment applications were prioritized according to an environmental benefits index determined by dividing the landowner bid by an environmental self-assessment score.

In environmental trading markets, reverse auctions can be used by individual credit aggregators[3] or credit banks to purchase environmental credits.[4] Credit banks, for instance, can stimulate a trading market by providing the initial set of credits for sale. With a limited budget to purchase these initial credits, a reverse auction enables the bank to purchase the most cost-effective credits available. These credits are later sold to a third party (e.g., any source with a regulated discharge or emission level).

Reverse auctions allow conservation programs, aggregators, and credit banks to identify and purchase the most cost-effective environmental improvements for their specified budget. Generally speaking, the more quantitative the estimation of these environmental outcomes, the more likely the auction will identify the most cost-effective outcomes.[5]

The Conestoga Reverse Auction

Two reverse auctions were conducted in Pennsylvania's Conestoga Watershed to demonstrate the effectiveness of using reverse auctions to allocate funding for environmental improvement. The Conestoga watershed is impaired by high levels of P, with one of the main contributors being the agricultural sector. The purpose of these reverse auctions was to pay farmers to implement BMPs that reduced P losses to local waterways. The reverse auction project awarded approximately $486,000 to farmers to implement BMPs that were estimated to result in over 92,000 pounds (lbs) of P reductions (see Box 2 for the implementation details of these auctions).[6]

One of the more interesting results of the reverse auctions was the variation in bids[7] received from farmers to reduce agricultural P losses to waterways in the watershed (see Box 2 and Table 1). This reflects the differing efficiency at which specific BMPs reduce P losses, the different location of specific BMPs within the watershed, and different costs of implementing or installing specific BMPs; and illustrates the importance of considering both the environmental outcomes (in this case, the P reductions) associated with a BMP and the price of the

TABLE 1 **Summary of the Conestoga Reverse Auction Results**

Auction	Funds Allocated (Funds Budgeted)	No. Bids Accepted (Received)	Range of P Bid Prices Received $/lb P	P Reduced, lbs (P Reduced, lbs P/mi²/yr)	Average Bid Price, $/lb P[3]
Auction 1[1]	~$39,000 ($90,000)	6 (8)[2]	$8.87 - $103.06	~3,800 lbs P (~1 lbs P/mi²/yr)	$10.32
Auction 2	~$447,000 ($450,000)	13 (23)	$2.36 - $157.49	~88,300 lbs P (~18 lbs P/mi²/yr)	$5.06

Notes:
1. The first auction did not exhaust the allocated funding budget as participation was low.
2. Two bids were rejected—one because the total bid price was higher than the standard EQIP pricing (see Box 2) and the other because the farmer decided not to implement the BMP and withdrew from the auction.
3. The average bid price was calculated as (total funds allocated in auction)/(total P reduction achieved by successful bids).

BMP before allocating funding. Results from the Conestoga Watershed reverse auctions are useful in this context, because they reveal:

- The price the farmer is willing to accept for implementing a BMP or for retiring land that improves environmental quality.[8]
- The cost-effectiveness of each BMP, which is reflected in the individual farmer's bid price (see Figure 1).
- The environmental outcome (e.g., lbs of P reduced) each bid achieves (see Figure 2).

The budget for the Conestoga Watershed Reverse Auction expired on a specific date, so bids were accepted in order of cost-effectiveness until the budget was exhausted. For the second auction, 13 bids were accepted and the auction cut-off price was $54.33/lb P (see Figure 1). Accepting bids based on the lowest cost reductions (i.e., in terms of $/lb P reduced) ensured that the most cost-effective reductions submitted to the auction were purchased. However, if there had been no time restriction for allocating the funds and/or the goal of the auctions was to further maximize the reduction in P losses achieved for the given budget, break-points could have been used to determine the auction cut-off price.

What Was Learned in the Conestoga Reverse Auction?

Reverse auctions are being increasingly considered as a funding allocation tool in a number of conservation programs and trading programs throughout the United States. In the Conestoga Watershed, the concept of using reverse auctions to allocate conservation funding was new to the stakeholders, thereby providing some useful lessons for the implementation of reverse auctions in other contexts and locations. These include:

- Invest the time to carefully explain the aims of a reverse auction to all stakeholders (i.e., farmers, technicians, etc). For example, explain what commodity or environmental outcome is being purchased.
- Invest the time to streamline the initial auction rules and process to reduce confusion and any potential lack of participation because of perceived or real over-complication.
- Invest the time to identify appropriate methods to calculate the environmental outcomes achieved through implementing BMPs, and the cost of implementing BMPs.
- Ensure that any tools used to implement the reverse auction, such as tools to estimate the environmental improvements associated with BMPs, are user-friendly.
- Clearly define the rules of the auction to all stakeholders beforehand to reduce any confusion about how the auction will be implemented.

FIGURE 1 Variation in Farmer Bid Price (Second Auction)

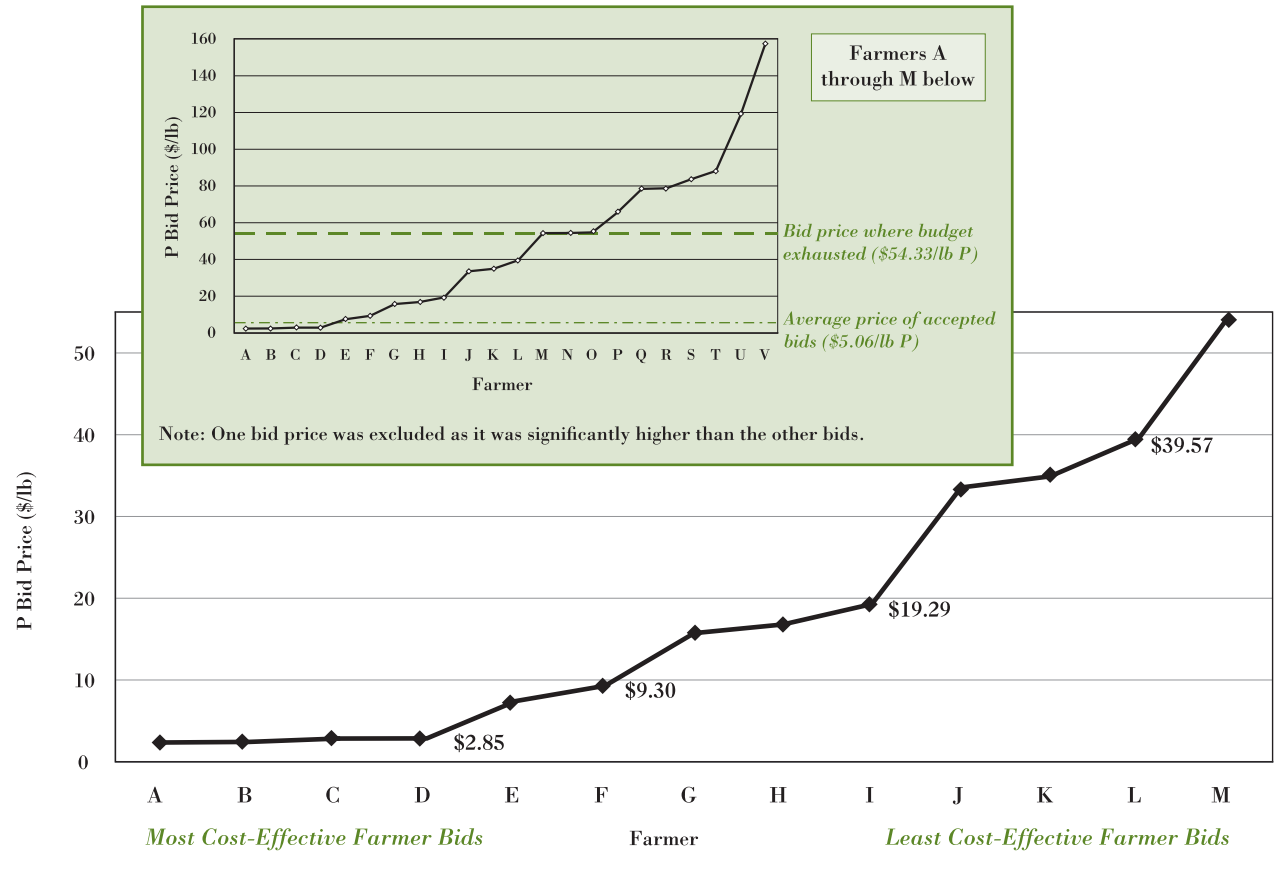
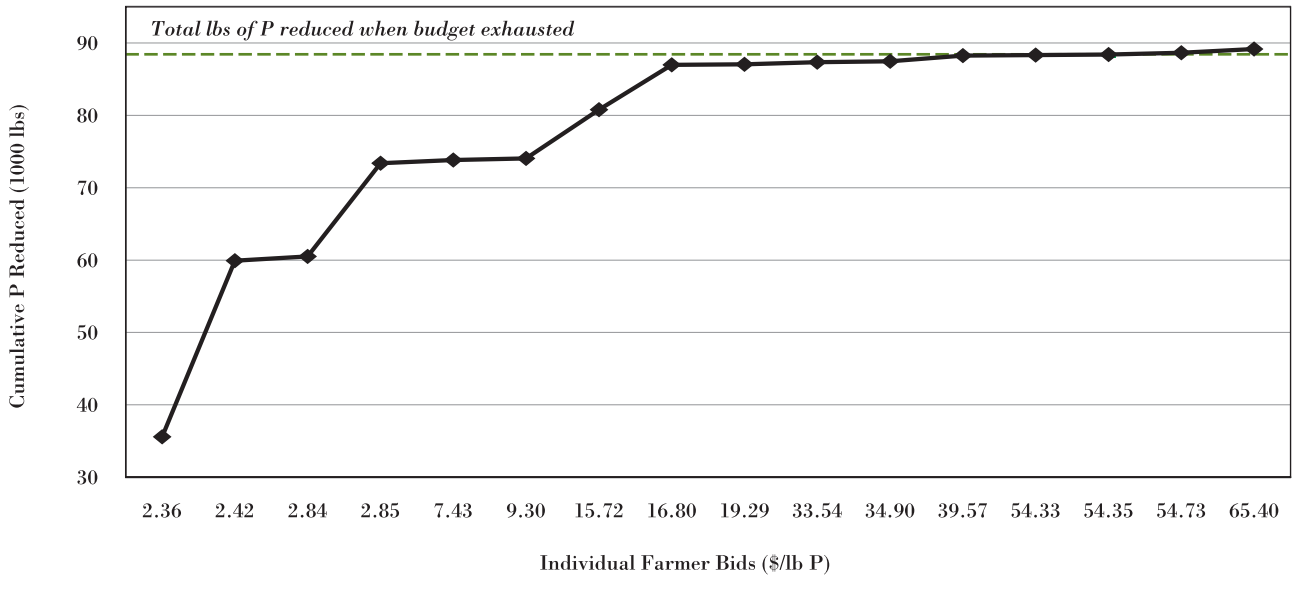


FIGURE 2 Cost-effectiveness of Bids (Second Auction)



BOX 2 Details of the Conestoga Reverse Auction Project

Between 2004 and 2006, the Conestoga Reverse Auction project team[§] received USDA Conservation Innovation Grant funds to conduct two reverse auctions with farmers in the Conestoga Watershed in Lancaster County, Pennsylvania. These auctions paid farmers to implement BMPs that reduced P losses to local waterways.

The total budget for the two auctions was $490,000. The first auction was conducted in June 2005 and the second auction between October 2005 and February 2006. The reverse auction concept was tested in the first auction with modifications made to the format of the second auction to streamline the auction process.

Technicians from the Lancaster County Conservation District worked closely with farmers in the watershed to estimate the P reductions associated with the BMPs the farmers were interested in implementing. Phosphorus reductions were estimated using a version of WRI's NutrientNet tool (See the supplementary WRI Policy Note Environmental Markets No. 4, Paying for Environmental Performance: Estimating the Environmental Outcomes of Agricultural Best Management Practices for more details on how to quantitatively estimate the environmental performance of agricultural BMPs and visit http://conestoga.nutrientnet.org to see the reverse auction on-line tool). In the first auction, farmers entered their bids to implement specific BMPs based on USDA Environmental Quality Incentive Program (EQIP) standard BMP costs and cost-share amounts, while in the second auction farmers bid the price they were willing to accept to implement a BMP (which could exceed the EQIP BMP implementation costs). The bids were then ranked within NutrientNet based on the cost of each P reduction (i.e., $/lb of P reduced). Based on this ranking, it was possible to determine the cut-off price where the auction budget was exhausted. Any bid lower than the cut-off price was successful and funded.

[§] Project Team: Pennsylvania Environmental Council, WRI, Lancaster County Conservation District, Natsource LLC and The Conservation Fund

BMPs Implemented	Lifespan of BMP (yrs)	Sum of Farmer's Bids	Pounds Reduced (lifespan)	Price per Pound ($/lb P)
Successful Bids				
Stacking Pad, Nutrient Management Plan	15	$84,000	35,576	$2.36
Stacking Pad, Nutrient Management Plan	15	$143,000	24,350	$2.42
Grassed Waterway	10	$144,679	590	$2.84
Waste Storage Facility	15	$181,451	12,886	$2.85
Underground Outlet in Heavy Use Area	10	$184,635	428	$7.43
Contour Stripcropping	5	$186,635	215	$9.30
Stacking Pad, Nutrient Management Plan	15	$292,635	6,742	$15.72
Stacking Pad, Animal Composting	15	$396,775	6,198	$16.80
Streambank Stabilization, Crossing	20	$398,275	78	$19.29
Terraces, Tile Drains	10	$407,739	282	$33.54
Terraces, Tile Drain Repair	10	$412,239	129	$34.90
Stacking Pad, Animal Composting	15	$443,290	785	$39.57
Grassed Waterway	10	$446,990	68	$54.33
Unsuccessful Bids				
Grassed Waterway	10	$452,116	94	$54.35
Grassed Waterway	10	$465,500	245	$54.73
Animal Composting	15	$498,012	497	$65.40
No-Till	3	$499,512	19	$78.39
Grassed Waterway	10	$505,312	74	$78.76
Animal Composting	15	$528,841	281	$83.66
Grassed Waterway	10	$533,616	54	$88.18
Waste Storage Facility, Heavy Use Area Protection	15, 10	$635,606	859	$118.70
Grassed Waterway, Rock Chute Outlet, Tile Drain	10	$646,106	67	$157.49

About the Authors

Suzie Greenhalgh is a senior economist at the World Resources Institute. Ph: 202-729-7786. Email: suzieg@wri.org

Jenny Guiling is a research analyst at the World Resources Institute. Ph: 202-729-7714. Email: jguiling@wri.org

Mindy Selman is a senior associate at the World Resources Institute. Ph: 202-729-7644. Email: mselman@wri.org

Jonathan St. John is an associate at the World Resources Institute. Ph: 202-729-7646. Email: jstjohn@wri.org

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Notes

1. When break-points are used and the budget is not exhausted any remaining funds can be transferred to a later auction.
2. Auction results were finalized just before the publication of this policy note. The reverse auction enrolled 3,500 acres into the program and reduced easement acquisition costs by 14% ($820,000). (News Release: http://www.nrcs.usda.gov/news/releases/2006/reverseauctionpilotresults.html).
3. Credit aggregators are third parties that bundle small credit lots into larger credit portfolios that are then sold into a trading market.
4. Any improvements in environmental quality are converted to environmental credits based on the rules of the relevant trading program.
5. See the supplementary WRI Policy Notes Environmental Markets No. 1, Paying for Environmental Performance: Investing in Farmers and the Environment, and Environmental Markets No. 4, Paying for Environmental Performance: Estimating the Environmental Outcomes of Agricultural Best Management Practices, for a broader discussion on quantitative estimates of environmental outcomes.
6. For comparison, the annual Chesapeake Bay Model reduction allocation for the Pennsylvania portion of the Susquehanna Watershed is ~26 lbs P/mi^2/yr, and the second Conestoga reverse auction achieved ~18 lbs P/mi^2/yr (see Table 1; 2002 current nutrient loading Chesapeake Bay Model query database—http://www.chesapeakebay.net/data/index.htm; Cap load allocation—http://www.chesapeakebay.net/pubs/waterqualitycriteria/nutrient_goals_by_state.pdf).
7. Each farmer bid represents the price a farmer was willing to accept to implement or install a specific BMP. In general, the structural livestock BMPs proved to be the more cost-effective BMPs to install or implement.
8. Farmers may submit bids that are higher than their implementation or installation costs for the BMP. However, in sealed bid auctions (where participants only know their bid and not the bids of others) farmers who submit substantially inflated bids run the risk of their bids being unsuccessful. Programs may also stipulate a maximum dollar amount they are prepared to pay for an environmental outcome. The USDA Wetland Reserve Program reverse auction, for instance, used a maximum per acre value paid.

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