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Agricultural Water Quality BMPs: A Standardized Approach to Financial Analysis

Abstract
Addressing water quality issues continues to emerge as a challenge to be faced by agricultural interests across the Cornbelt. Agricultural Extension has a role to play in assisting farmers in complying with water quality regulations and adoption of Best Management Practices (BMP) to address water quality impacts. Despite the clear importance of financial information in BMP decision-making, often, published cost assessments are rare and lack transparency. This article provides a framework for Extension personnel who provide water quality BMP cost assessments while also highlighting financial information necessary for creating Extension publications that have transparent and dynamic financial assessments.

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Introduction

A key environmental indicator of sustainability in agricultural landscapes is water quality, which is deteriorating throughout the U.S. Cornbelt. This is largely due to nutrient and sediment loading in surface waters driven by agricultural land use (Christianson & Tyndall, 2011). Compliance with water quality regulations will be one of the major policy challenges faced by agricultural interests in this region for some time to come (Jordan et al., 2011). More broadly speaking, farmers are also expected to be stewards of our collective natural resource base in the U.S. (Harrison, 2002). Assisting farmers in complying with water quality regulations or enacting voluntary measures on farms in order to proactively address water quality impacts will continue to be an important and growing role for Extension.

Within the U.S. Cornbelt, 95% of agricultural land is privately owned by hundreds of thousands of different individuals (USDA NASS, 2002). Therefore the regional capacity to prevent and/or mitigate water quality impacts while also addressing other environmental issues of concern (e.g., diminished biodiversity) will largely be dependent on environmentally focused management by many farmers across the region (Swinton, 2008). Specifically, the adoption of effective non-point source Best Management Practices (BMPs) will be paramount to ensuring measurable improvements in water quality and other conservation goals. BMPs referred to in this article are conservation or production practices used singularly or in combination that effectively and practically prevent or mitigate non-point source pollution (e.g., nutrient and sediment runoff) that results from row-crop agriculture.

Water quality oriented BMPs commonly used in row-crop landscapes are either cultural or structural in nature (Ritter& Shirmohammaddi, 2001). Cultural BMPs are characterized by in-field practices that often minimize or prevent erosion or nutrient transport at the field level, such as conservation tillage or nutrient management. Structural BMPs are typically land-based installations designed to capture, buffer, or otherwise treat sediment or nutrients before reaching water. Structural BMPs involve various kinds of natural or artificial structures that are placed within or at field-edges and often featuring perennial vegetation and/or landform engineering that is generally considered permanent (or quasi-permanent). Examples of structural BMPs commonly used in the Cornbelt region are vegetative filter strips, terraces, constructed/restored wetlands, and riparian buffers. The focus of this article is on structural BMPs. Table 1 summarizes five different structural water quality BMPs that are increasingly used in this region.

Table 1.

Examples of Structural Surface Water Quality BMPs Used in the U.S. Cornbelt

Best Management Practice (NRCS practice standard code)	**General use of the BMP: For the most part this information comes directly from NRCS practice standard information.**	**Basic Cost Parameters: Varies considerably from site to site and depends on initial conditions, hydrology, soil, crop, practice design, and management characteristics.**
Vegetative Filter Strip (Practice Code 393)	Reduce suspended solids and associated contaminants in runoff. Reduce dissolved contaminant loadings in runoff. Reduce suspended solids and associated contaminants in irrigation tailwater.	Site preparation; seed mix (usually 1-2 different species); planting; mowing. Opportunity costs in the form of foregone land rent or crop revenue.
Multi-Purpose Prairie Strip (New practice; no practice standard)	Reduce sheet and rill erosion. Reduce suspended solids and associated contaminants in runoff. Restore riparian plant communities. Reduce erosion by reducing slope length. Reduce excess sediment, nutrients (N & P).	Site preparation; seed mix (high diversity); planting; mowing and/or periodic burning. Opportunity costs in the form of foregone land rent or crop revenue.
Contour Buffer Strip (Practice Code 332)	Reduce sheet and rill erosion. Reduce transport of sediment and other water-borne contaminants downslope Increase water infiltration	Site preparation; seed mix (usually 1-2 different species); planting; mowing. Opportunity costs in the form of foregone land rent or crop revenue.

Riparian Buffer (Practice Code 391)	Restore riparian plant communities. Reduce excess sediment, organic material, nutrients (N & P), and pesticides in surface runoff. Increase carbon storage.	Site preparation; seed mix (high diversity; multi-species: woody, grasses); planting; mowing and/or periodic burning. Opportunity costs in the form of foregone land rent or crop revenue.
Terrace (Practice Code 600)	Reduce erosion by reducing slope length. Retain runoff for moisture conservation.	Site preparation (including earth moving and planting bed prep); seed mix (usually 1-2 different species); planting; mowing. Opportunity costs in the form of foregone land rent or crop revenue.
Note: Information included is general use characteristics of each BMP as designated by the Natural Resource Conservation Service (NRCS) and basic cost parameters.		

As typically noted in Extension materials regarding farmer use of BMPs (e.g., Brown, Boone, Nokes, & Ward, 1991), before farmers choose one or several BMPs to implement, they should consider a balance between three factors: 1) the bio-physical effectiveness of the BMP in performing its intended field-level task; 2) the compatibility of the practice relative to the current operation in terms of equipment and time/labor availability, etc.; and 3) the financial feasibility of the BMP relative to farmer willingness to pay and/or alternative management options.

The main purpose of this article is to focus on how Extension personnel can more systematically assess the financial aspects of BMP implementation. Farmers who are interested in using BMPs should be given transparent financial information in order to weigh potential costs and benefits of a BMP option. Extension personnel need to be able to provide consistent, transparent, and updateable farm-level financial information regarding the technologies they are in effect "extending" to users.

Despite the clear importance of financial information in BMP decision-making, for many specific BMPs, published cost assessments are rare, and those that are available often lack transparency. Critical information that is often lacking includes a full presentation of cost parameters, the timing of typical cost events, and the discount rate used, as well as the reason for the selected rate and, often most critically, the choice/value of opportunity costs accounted for (Afari-Sefa, Yiridoe, Gordon, & Hebb, 2008; Christianson, 2011).

The purpose of this article is two-fold: 1) provide an analytical framework to Extension personnel who are, or will be, providing water quality BMP cost assessments as part of their Extension programming; 2) highlight the key financial information to provide in Extension publications so as to make such financial assessments more transparent and dynamic, and ultimately more effective in guiding BMP adoption among landowners.

Discounted Cash-Flow Analysis: The Basics

BMPs involve upfront "base capital," annual and periodic costs and may involve payments (or revenues) over time. Analyzing such cash-flows requires a discounted cash-flow framework. That is, all future costs/revenues are discounted to the present time (present value) so as to appropriately account for the time-value of capital (money). Discounted Cash-Flow (DCF) assessments generally involve fairly straightforward computations, which can be found in textbooks and Extension materials (e.g., Hofstrand, 2012). Additionally, there are many decision support tools available to landowners and analysts to conduct DCF analysis (e.g., Straka & Bullard, 2009).

For farm-level DCF cost analysis there are typically two key computational tasks: 1) calculating total present value costs of the BMP over the relevant planning horizon and 2) translating the total present value cost to an equal annual cost basis.

For reference, the Discounted Cash Flow computational structure is as follows:

$$\text{Present Value Costs} = \text{PVC} = \sum_{t=0}^{n} Total\ Costs\ \frac{1}{(1+r)^t} \quad [1]$$

Where total costs represent all costs associated with establishing and managing a BMP over a designated period of time; r represents the discount rate; and t represents the analytical time frame. Note, as discussed below, there may be payments involved in the use of BMPs. When this is the case, such payments represent a cash inflow rather than outflow. Equation 1 is simply modified to represent total "benefit"; present value costs are subtracted from present value benefits (net present value). The calculated total present value cost for a BMP is then annualized by converting into an equal annual cost basis (EAC) by applying a capital recovery factor (CRF):

$$\text{CFR} = \sum_{t=0}^{n} Total\ Costs\ \frac{1}{(1+r)^t} \quad [3]$$

$$\text{EAC} = \text{PVC} * \text{CRF} \quad [2]$$

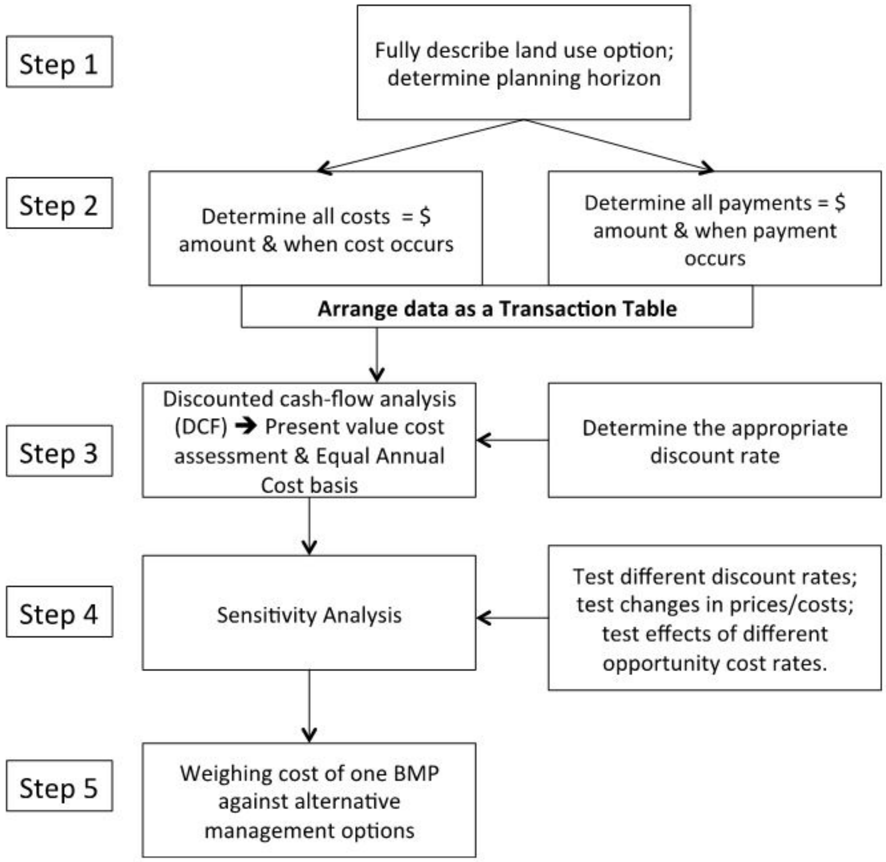
The EAC format allows farmers to consider BMP costs essentially on the same annual basis that they consider other farm-level production costs (Jacobson, 2003).

It is important for Extension personnel to note that the decision criteria for a *cost-only* analysis is conceptually different from a DCF assessment geared towards analyzing revenue bearing investments. In the case of a cost-only assessment, the main decision criterion is based on a landowner's willingness to accept a cost usually relative to current or alternative management options. Profit-oriented land-use options typically have different decision criteria (e.g., if the NPV of a land-use option ≥ 0 it is "financially viable"; Internal Rate of Return should be ≥ 0; etc.).

Analytical Framework for BMP Cost Assessment

A particular challenge for Extension personnel is obtaining a consistent analytical structure for BMPs so that a dependable and easily updateable body of work can be developed. Textbooks and other general DCF overviews typically won't outline specific analytical details and parameters unique to BMPs that allow such assessments to be transparent, adaptable, and comparable across similar BMPs and/or regions. For the sake of consistency, we recommend that a financial assessment regarding a BMP should (at least) include the five steps outlined in Figure 1 below.

Figure 1.
A Generalized, Five-Step Approach to the Financial Analysis of a Non-Point Source Water Quality BMP



5)

Note: Adapted from Elevitch & Wilkinson, 2000

Step One

In the context of planning, the first step is to develop a full physical description of the BMP, the land-use extent (e.g., where on the farm a BMP will do the most good and why), the environmental goals associated with its use, and determine a logical analysis ("planning") horizon. These actions are important because they establish scale and application parameters and characterize management. The analysis horizon should be based on fairly concrete criteria (e.g., the expected lifespan of a BMP). There may be a policy or contract parameter involved which defines a planning horizon (e.g., length of a USDA Conservation Reserve Program contract).

Step Two

The second critical step involves creating a realistic step-by-step outline of BMP implementation/management actions. All activities that carry an expense, in the form of direct expenditures and/or foregone revenue (opportunity costs), must be accounted for, as well as any market or government payments that may be associated with the use of a BMP. Dollar amounts and the timing of payment events are critical to this outline. With regard to the timing of events, one needs to be aware of when activities are likely to occur (e.g., annually and/or periodic as well as beginning vs. end of the year). For greater precision within a year (e.g., late spring reseeding), the discount exponent ("t" in Equation 1) could be set to n/12.

There are four main cost categories that farmers should consider in the use of most structural BMPs: 1) site preparation costs (e.g., any required soil excavation, prepping land for planting vegetative material); 2) establishment costs which would include any land formation, vegetative stock and planting/equipment installation; 3) annual and periodic management costs which might involve structure maintenance as well as relevant overhead costs; and 4) relevant annual opportunity costs associated with any productive land being used for the BMP.

For structural BMPs, average costs of most construction, establishment, and management activities can be found in regularly published custom rate surveys (e.g., see Edwards, 2012). Analysts should keep in mind that data from these surveys often represent lower bound costs (e.g., financial data may reflect economies of scale efficiencies not always in effect or reported prices may reflect one-time volume discounts and so on) (Beaton, Dhuyvetter, & Kastens, 2003); therefore scaling factors may be needed to better represent on-the-ground cost outcomes. For example Beaton et al. (2003) describe a "Relative Custom Rate Ratio" that can be used to adjust the reported cost of machinery operations in Kansas. Analysts can also conduct local/regional "transaction evidence" surveys (e.g., calling a small sample of local service providers who do the relevant type of work and inquiring about rates). Many Extension offices and the NRCS publish lists of regional vendors/technical service providers (TSP) who can provide customized cost information. Opportunity costs are discussed in detail below.

In some cases there may be government program payments involved with the use of various BMPs. Such payments are typically in the form of establishment cost-share and/or annual land rent and other assorted incentives. Common USDA programs that support a wide variety of structural water quality BMPs include: the Environmental Quality Incentive Program (EQIP), a working lands program that cost-shares BMP establishment, and the Conservation Reserve Program (CRP). a land retirement program that will cost-share BMP establishment and pay annual rent and other incentives. Information regarding these and other programs is available through county-level NRCS offices (Gerlach, 2009; Murdock, 2010).

There may also be revenues that involve person-to-person type payments (e.g., hunting leases in the case of BMPs that enhance game habitat). Other BMP-related revenue may be associated with emerging markets for environmental services (e.g., nutrient trading and/or carbon credits, wetland banking, environmental auctions; Smith, Nejadhashemi, & Leatherman, 2009) or commodities such as biomass (e.g., Wen, Ignosh, Parrish, Stowe, & Jones, 2009). In these cases, environmental market prices to use in the analysis are generally determined locally at the project/program scale (e.g., Smith et al., 2009). Analysts should inquire locally. For emerging commodities like biomass, prices can often be obtained via regional clearing-houses (e.g., The Minnesota Biomass Exchange: https://www.mbioex.com/). When revenues are a primary feature in the use of a BMP, the landowner would best be served by a Net Present Value assessment and concomitant decision-criteria (James, Swinton, & Thelen, 2010).

To better enhance the transparency and updateability of a BMP analysis, the outline of all costs and payments is ideally presented as a transaction table that visually organizes and articulates the general details and timing of the activities, per unit costs, and cost information citations (see Table 2 below for an example).

Table 2.

Example Transaction Table, Presenting Costs Associated with Planting Contour Prairie Strips Planted After Soybean

	Steps as per mgt	Cost Activities/	Year cost incurred (assumed to be early	Range of costs	Mean price	Source of price

Cost type	plan	items	spring)	(units)	(ac)	information
Site Preparation	1	Tillage	0	$6 to $30/ acre	$18.00	Edwards (2012)
	2a	Herbicide	0	$40 to $80/gal	$15.00	—
	2b	Herbicide application	0	$20 to $85/ acre	$53.00	Edwards (2012)
Establishment	1	Seed	0	Variable	$137.00	Prairie Seeds Farm (2011)
	2	Seed drilling	0	$10 to $48/ acre	$15.00	Edwards (2012)
	3	Cultipacking	0	$5 to $30/ acre	$17.50	Edwards (2012)
Management	1a	Mowing	3 x in yr 1; annually 2-15 thereafter	$5 to $55/ acre	$30.00	Edwards (2012)
	1b	Burning	Yrs 2-6; every 2 yrs thereafter	$30 to $100/hour	$36.00	Gee & Biermacher (2007)
	2	General operating costs	Annual	1-3% of upfront costs	—	--
Opportunity cost	1	Land rent	Annual	Variable	$80 - $525	Edwards et al. (2012)
Note: Costs presented in 2012 dollars. Data from Tyndall et al. (unpublished).						

Step Three

The third step involves discounted cash-flow procedures; for this, determination of the discount rate is necessary. Recommended Federal discount rates for water quality projects are published by the Natural Resource Conservation Service and represent average market yields on Treasury securities. The 2013 Federal discount rate for water projects is 3.75% (USDA-NRCS 2013). Most analyses of these types are performed using "real" discount rates as opposed to nominal discount rates; that is, inflation is removed from the analysis and all cash-flows are treated as real throughout the analysis.

Step Four

After the DCF analysis is complete, analysts are encouraged to vary certain input costs to ascertain how sensitive total BMP cost is to future price changes (step four). Generally, DCF analysis aligns with "options theory," which assumes that efficient markets are unpredictable; therefore the value of current input costs are the best value indication of future costs for that same input (Keith, 1999). However, it is a good idea to examine the effects of even small changes in the costs associated with a given practice. Say, for example, opportunity costs are expected to rise at rates greater than inflation in the near term, what would this increase do to costs on an annual basis? Simple sensitivity analysis (for example, running the DCF with higher land costs) can allow some perspective on cost dynamics and give farmers a more robust understanding of the role of various inputs relative to the adoption of a BMP.

Step Five

Finally, with step five, the analytical goal of DCF is to calculate total present value cost (PVC) of a BMP and then express PVC on an equal annual expenditure basis (EAC). Once complete the baseline financial information from which to weigh a BMP adoption decision is presented.

BMPs: The Impact of Opportunity Costs

Opportunity costs associated with structural BMPs often represent the most significant cost component (based on some assessments upwards of 90% of the total long-term costs; Christianson, 2011) and can be the most complex aspect of BMP cost accounting. Opportunity costs associated with BMP usage are manifest in foregone net revenue or rental payments associated with land removed from production. While these costs are often calculated in the abstract, they are very real costs and are arguably the largest barrier to voluntary BMP adoption (Secchi, Tyndall, Schulte, & Asbjornsen, 2008).

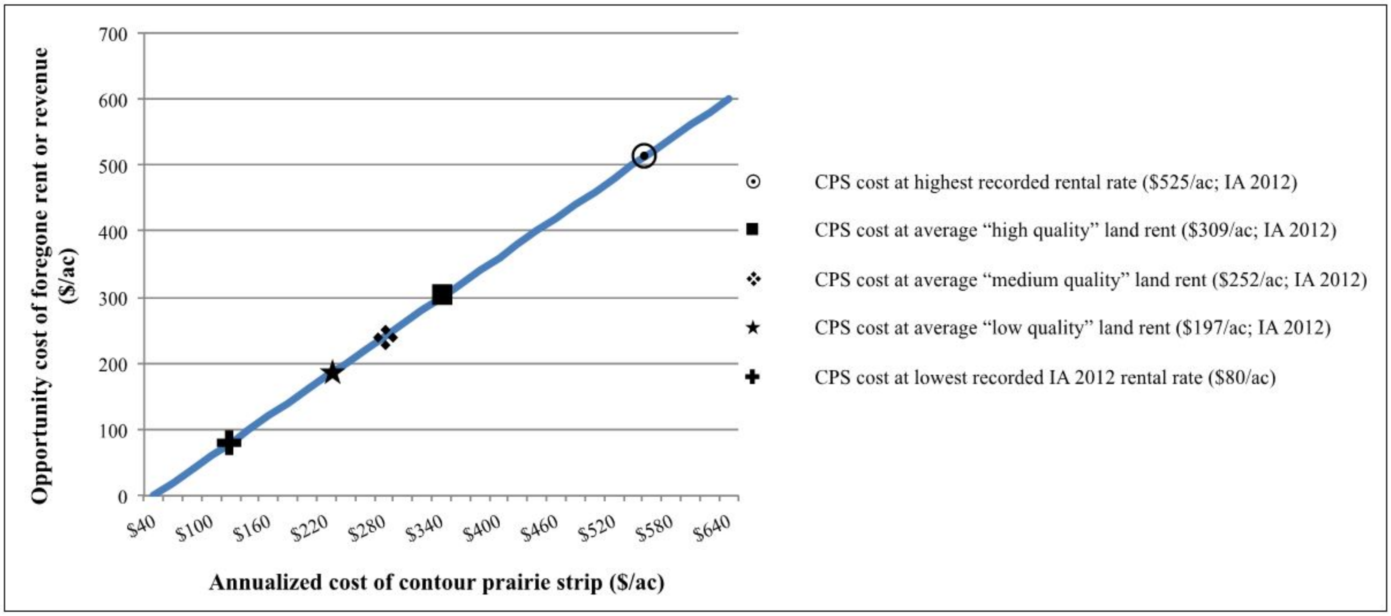
Accurately accounting for future opportunity costs of land use is challenging. Land rental rates or net crop revenue associated with a specific acre vary from year-to-year and across land quality. By and large, state or county-level average (fixed) rental rates are used as the proxy for the opportunity costs of land in BMP analysis (Gloy, Boehlje, Dobbins, Hurt, & Baker, 2011). This is largely because the rental rate proxy simplifies the analysis considerably and regional rental rates are fairly assessable to analysts (e.g., Edwards & Johanns, 2012; Ward, 2011). However, annual rental rates are a function of several static and dynamic factors such as (Edwards, 2011b): rental contract arrangements (e.g., fixed or flexible rate terms), trends in rental rates, average yields, and productivity classification of land in question such as the Corn Suitability Rating (CSR) or the USDA-NRCS's National Commodity Crop *Productivity Index* (NCCPI). Rental rates vary considerably based on land quality (e.g., 2012 Iowa rental payments ranged from $80 to $525 per acre) and show a degree of volatility from year-to-year. For example, in Iowa fixed rental rates in 2011 experienced a record high increase of 32.5% from the previous year (Duffy, 2012).

Opportunity cost associated with foregone net-revenue also varies by land quality and can be much higher than the land rental rate. Revenue on farmland is a function of many complex and often interacting factors. Land tenure, commodity prices, government payments and base acreages, cropland quality and yields, rotations, tillage, and rate of fertilization and other chemicals all interact to define potential revenue-based opportunity costs on productive land. Many of these variables (e.g., crop and input prices) are difficult if not impossible to predict with accuracy. The main point is that potential opportunity costs are significant and vary considerably across acres and measurement standards/proxy's.

To illustrate how the costs of structural water quality BMPs might scale according to various opportunity costs, an annualized cost curve (Figure 2) was created representing the use of contour prairie strips, a BMP described in Table 1. As would be expected, the annualized costs of the BMP generally increases/decreases linearly with annual opportunity cost.

Figure 2.

Annualized Costs of Contour Prairie Strips (CPS) Across a Range of Potential Opportunity Costs in Dollars per Acre



Note: Discount rate is 4%; costs presented in 2012 dollars. Data from Tyndall et al. (unpublished).

At the farm scale, cost-effectiveness of a particular BMP has two points of view. One is relative to "out-of-pocket" expenses to the landowner/farmer, and the other is in regard to any allocation of government program monies that incentivize private stewardship. The actual cost-effectiveness of BMPs to ameliorate water quality concerns depends on the capacity of the practice to biophysically perform as well as the total costs of utilization, with an emphasis on the role of potential opportunity costs (Christianson, 2011; Ribaudo, Heimlich, Claassen, & Peters, 2001). Thus the above commentary highlights the significance of private opportunity costs and their influence on farmer adoption and long-term management of structural BMPs. The second reason relates to the capacity of conservation programs to offset annual opportunity costs with annual rent-like payments. Access to such payments will likely be critical to the initial adoption of BMPs as well as their long-term management (Batie, 2009). Accurately understanding the role of potential opportunity costs associated with BMPs will better calibrate existing and/or emerging conservation programming.

Recommendations

Improving water quality will remain a large challenge throughout the U.S. Cornbelt and will require widespread adoption of BMPs. To this end it will be critical for Extension personnel tasked with providing critical decision-making information to be consistent with regards to assessing and presenting financial information. Financial cost information about BMPs is universally needed and yet is often lacking or presented in a way that limits its usability and updatability.

This article presents a generalized framework for BMP cost assessment and highlights key data—where it might be found and how it should be considered. If followed, the approach outlined here can help Extension personnel and other outreach professionals and land-use analysts to develop a structured body of cost assessments that will allow for greater transparency, broader and more specific applicability across land-use context, enhanced updatability, and, finally, broader recognition of the key role that financial information will play in the future of water quality improvement. Further research should also be conducted on the potential benefits provided to farmers for their adoption of BMPs and potential incentives available to those who wish to implement them.

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References

Afari-Sefa, V., Yiridoe, E. K., Gordon, R., & Hebb, D. (2008). Decision considerations and cost analysis of Beneficial Management Practice implementation in Thomas Brook Watershed, Nova Scotia. *Journal of International Farm Management* 4(3):1-32.

Batie, S. S. (2009). Green payments and the US Farm Bill: information and policy challenges. *Frontiers in Ecology and the Environment*, 7(7), 380-388.

Beaton, A.J., Dhuyvetter, K.C. & Kastens, T.L. (2003). Custom rates and the total cost to own and operate farm machinery in Kansas. Publication MF 2583. *Kansas State University Agricultural Experiment Station and Cooperative Extension Service*. Kansas State University, KS.

Brown, L., Boone, K., Nokes, S. & Ward, A. (1991). Agricultural Best Management Practices. Ohio Cooperative Extension Service. AEX-464-91.

Christianson, L. (2011). *Design and performance of denitrification bioreactors for agricultural drainage*. Iowa State University. Department of Agricultural Systems Bioengineering. PhD Dissertation, 2011.

Christianson, L., & Tyndall, J.C. (2011). Seeking a dialogue: a targeted technology for sustainable agricultural systems in the American Corn Belt. *Sustainability: Science, Practice, & Policy 7*(2):70-77.

Duffy, M. (2012). 2011 Farmland value survey. *Ag Decision Maker*. Iowa State University. File C2-70. January 2012. 5p.

Edwards, W., & Johanns, A.M. (2012) Cash rental rates for Iowa: 2012 survey. *Ag Decision Maker*. Iowa State University Extension. File C2-10. FM 1851 (Revised May 2012). 11p.

Edwards, W. (2011). Computing a cropland cash rental rate. *Ag Decision Maker*. File C2-20. FM 1801 (Revised) June 2011. 4p.

Elevitch, C. R., Wilkinson, K. M (2000) Economics of farm forestry: Financial evaluation for landowners. Agroforestry Guides for Pacific islands #7. Permanent Agricultural Resources, Holualoa, Hawaii, USA.

Gee, K., & Biermacher, J. (2007). Prescribed burning: what is the cost? *Nobel Foundation News and Views Research* (July 2007). Retrieved from: http://www.noble.org/ag/research/Articles/PrescribedBurning/index.html

Gerlach, J. D. (2009). The Conservation Reserve Program: A tool for public participation in biodiversity management and conservation. *Journal of Extension* [On-line], 47(5) Article 5TOT3. Available at: http://www.joe.org/joe/2009october/tt3.php

Gloy, B. A., Boehlje, M. D., Dobbins, C. L., Hurt, C. & Baker, T. G. (2011). Are economic fundamentals driving farmland values? *Choices*. 2nd Quarter 2011, 26(2).

Harrison, J. D. (2002). Managing for sustainable agriculture. *Journal of Extension* [On-line], 40(4) Article 4FEA5. Available at: http://www.joe.org/joe/2002august/a5.php

Hofstrand, D. (2012). Basics of capital budgeting. *AgMRC Renewable Energy and Climate Change Newsletter*.

James, L. K., Swinton, S. M., & Thelen, K. D. (2010). Profitability analysis of cellulosic energy crops compared with corn. *Agronomy Journal*, 102(2), 675-687.

Jacobson, M. (2003). Comparing values of timber production to agricultural crop production. Institute of Food and Agricultural Sciences, University of Florida. Florida Cooperative Extension Service. Document FOR 61. 7p.

Jordan, N. R., Schively-Slotterback, C., Cadieux, K. V., Mulla, D. J., Pitt, D. J., Schmidt-Olabisi, L., & Kim, J. (2011). TMDL implementation in agricultural landscapes: A communicative and systemic approach. *Environmental Management*. 48:1–12.

Keith, K. (1999). Optimal grain marketing: Balancing risks and revenue. National Grain and Feed Foundation. 36 p.

Murdock, J., Brzuszek, R. F., & Schauwecker, T. J. (2010). Self-Evaluation of a statewide conservation planning program: Perceptions of an Extension partner. *Journal of Extension* [On-line], 48(6) Article 6FEA3. Available at: http://www.joe.org/joe/2010december/a3.php

Ribaudo, M. O., Heimlich, R., Claassen, R., & Peters, M. (2001). Least-cost management of non point source pollution: source reduction versus interception strategies for controlling nitrogen loss in the Mississippi Basin. Ecological Economics, 37 (2001), pp. 183–197

Ritter, W. F., & Shirmohammaddi, A. (2001). Agricultural nonpoint source pollution: Watershed management and hydrology. Ch 10: *BMPs for non-point source pollution control*. CRC Press, 342 p.

Secchi, S., Tyndall, J. C., Schulte, L. A., & Asbjornsen. H. (2008). High crop prices and conservation: Raising the stakes. *Journal of Soil and Water Conservation* 63(3): 68-75.

Smith, C. M., Nejadhashemi, A. P., & Leatherman, J. C. (2009). Using a BMP Auction as a Tool for the Implementation of Conservation Practices. *Journal of Extension* [On-line], 47(4) Article 4FEA7. Available at: http://www.joe.org/joe/2009august/a7.php

Straka, T. J, & Bullard, S. H. (2009). FORVAL: Computer software package for agricultural and natural resources investment analysis. *Journal or Extension* [On-line], 47(2). Article 2TOT3. Available at: http://www.joe.org/joe/2009april/tt3.php

Swinton, S. M. (2008). Reimagining farms as managed ecosystems. *Choices*, 23(2), 28-31.

USDA Natural Resource Conservation Service (USDA NRCS) (2013) Rate for Federal Water Projects/ NRCS Economics. Retrieved from: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/econ/costs/?cid=nrcs143_009685

Ward, B. (2011). Western Ohio cropland values and cash rents 2011-12. Ohio State University Extension Fact Sheet. Agriculture, Environmental, and Development Economics. AEDE-RP-0136-11.

Wen, Z., Ignosh, J., Parrish, D., Stowe, J., & Jones, B. (2009). Identifying farmers' interest in growing switchgrass for bioenergy in southern Virginia. *Journal of Extension* [On-line], 47(5). Article 5RIB7. Available at: http://www.joe.org/joe/2009october/rb7.php