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CLEANEAST™ Comprehensive Environmental Assessment Tool for Livestock and Poultry Farms: Design, Utility, and Performance for Adoption of Sustainable Agri-Environmental Practices

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At the time of writing, **Paul R. Peterson**, MS, PE, now deceased, was a senior research environmental engineer in RTI's Air Quality Engineering Program.

Acknowledgments

This work honors the spirit and achievements of Paul R. Peterson, PE, who, prior to his passing, contributed to the Environmental Assessment Tool's design, developed the CLEANEAST Project's Ammonia Air Emission Mitigation Indicator tool, and was a valued expert advisor on the project. The CLEANEAST Project was a congressionally funded project administered through a cooperative agreement between the US Environmental Protection Agency and RTI International. We express our appreciation to sub-agreement partner North Carolina State University and subcontractor Agri-Waste Technology, Inc., for their valuable contributions. We particularly acknowledge the technical services to 429 farms performed by 57 Technical Assistance Professionals (or TAPs) who staffed eight subcontracted firms. We also extend our appreciation to the project's Advisory Committee on Science and Strategy for their valuable contributions.

Abstract

RTI's Environmental Assessment (EA) Tool enables livestock and poultry farmers to evaluate their operations for environmental challenges and identify practical ways to address those challenges.

Between 2007 and 2011, the Comprehensive Livestock Environmental Assessment and Nutrient Management Planning (CLEANEAST™) Project provided confidential, no-cost EAs and nutrient management planning (NMP) assistance to more than 400 livestock and poultry operations. During 2007 and 2008, RTI, our sub-agreement partner, North Carolina State University, and subcontractor, Agri-Waste Technology, Inc., designed the EA Tool, which contains over 400 questions in 12 topical areas. We pilot tested the EA Tool at two livestock operations before full-scale application.

We used the EA Tool at more than 290 livestock and poultry operations in 20 states east of the Mississippi River. In total, operators received 385 EA-related recommendations for improving on-farm, environmentally related practices. We used our results to inform both livestock and poultry sectors, as well as the US Department of Agriculture and US EPA, of nutrient management practices observed; to predict potential environmental releases from technologies and practices; to measure adoption rates of recommendations, technologies, and practices; to evaluate behavioral response to outreach; and to identify future needs for water and air quality program improvements and policy. The EA Tool remains in the public domain, and as interest grows in mitigating greenhouse gas emissions and adapting to climate variability, the EA Tool can be readily expanded to inform farmers about their emissions from manure management and guide them in obtaining carbon credits for mitigation measures.

Introduction

Animal agriculture in the United States is a major industry and represents important components of the national economy. In its 2012 National Pollutant Discharge Elimination System (NPDES) *Permit Writers' Manual for Concentrated Animal Feeding Operations* (CAFOs), the US Environmental Protection Agency (EPA) states:

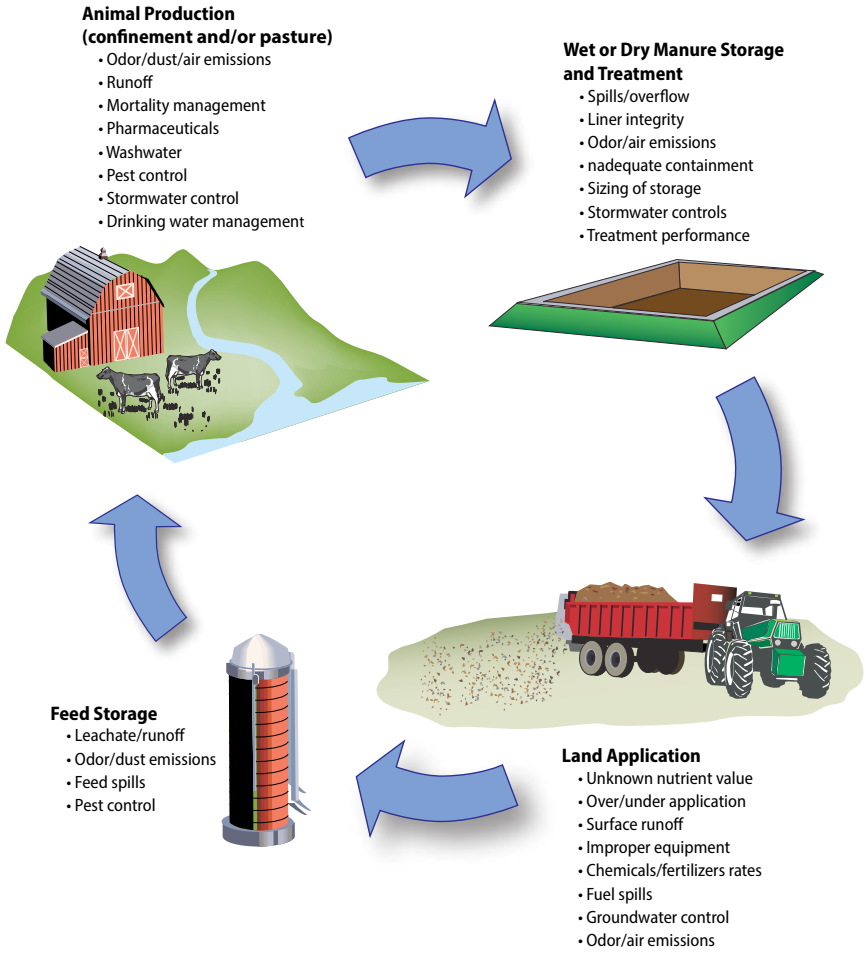
> [In 2007, the US Department of Agriculture (USDA) estimated] there [were] slightly more than one million farms with livestock in the United States. EPA estimates that about 212,000 of those farms are likely to be AFOs—operations where animals are kept and raised in confinement. Although the number of AFOs has declined since 2003, the total number of animals housed at AFOs has continued to grow because of expansion and consolidation in the industry. (EPA, 2012, 1-2)

Further, EPA estimated in 2003 that AFOs generate more than 500 million tons of manure per year (US EPA, 2012; USDA, c2007).

Concerns exist that current conventional manure management methods such as lagoons and sprayfields (Figure 1) can lead to discharges into nearby nutrient-sensitive waters and, in turn, can promote over-enrichment, eutrophication, fish kills, and other impacts to aquatic species. Land-based manure management systems are particularly vulnerable to flooding, and their failure can result in serious environmental impacts. As alternative technologies are conceived and demonstrated, the need exists to develop a protocol or methodology for evaluating those technologies in terms of performance, economic feasibility, and environmental benefits. An environmental assessment (EA) can aid livestock and poultry operators, policymakers, and regulators with their choices by (1) identifying pathways by which environmental releases from livestock and poultry operations potentially affect the environment and (2) gathering valuable information for input to other tools developed to quantify air and water quality benefits, ecosystem services values, and human health benefits.

In 2007, EPA awarded a cooperative agreement to RTI International and its sub-agreement partner, North Carolina State University, to design and conduct a project intended to improve water and air quality in the 27 states east of the Mississippi River. Our project team would effect this change by raising farmers' awareness of potential environmental impacts and recommending changes in farm practices to reduce environmental releases such as nitrogen and phosphorus.

Figure 1. Key components of animal feeding operations addressed through the CLEANEAST Project's technical services



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RTI coined the project name CLEANEAST for Comprehensive Livestock Environmental Assessment and Nutrient management plans for the eastern United States. Our charge from EPA was to develop and apply tools to perform environmental assessments (EAs) and also produce nutrient management plans (NMPs). Through our outreach strategy, we planned to recruit volunteer beef, dairy, swine, poultry, and other livestock operators to participate at no cost to the farmer with the promise of maintaining confidentiality.

The purpose of this report is to introduce RTI's CLEANEAST EA Tool and report on its performance. Information provided in this report originates from the RTI CLEANEAST Project final report, *Comprehensive Livestock Environmental Assessments and Nutrient Management Plans: Eastern United States* (Deerhake et al., 2012).

Goals

The CLEANEAST Project had four desired outputs. The first output was to recruit farm operators to voluntarily participate in the project. Although regulations existed requiring NMPs for CAFOs, it was clear that greater environmental benefits could be achieved by the larger livestock and poultry sector proactively and voluntarily adopting practices. The CLEANEAST Project was the opportunity to test the potential for voluntarism.

A second desired output was to perform site-specific EAs and prepare NMPs for livestock and poultry farms where operations might impact water bodies located in the states served by the CLEANEAST Project. Over the past decade, large-scale livestock production had increased significantly, and with that growth came more concentrated impacts to watersheds as nutrient loads from high-volume manure management had the potential to reach waters through management practices, such as land application, and failed treatment and storage units, such as lagoons holding liquid manure from water-flushed barn floors. Performing EAs and implementing NMPs would reduce impacts as farmers acted to mitigate environmental releases risks.

The third output desired was a database composed of nonconfidential information compiled from farm visits. Such a database would enable researchers to measure the benefits of voluntary participation and adoption of best management practices (BMPs) to mitigate or reduce adverse environmental impacts.

The fourth and final output was an expanded capacity for trained professionals capable of performing EAs and preparing NMPs for livestock and poultry operations potentially impacting water bodies. Access to trained professionals such as USDA Natural Resources Conservation Service (NRCS)-registered Technical Service Providers (TSPs) was spotty in some regions where the number of livestock operations may not support a viable consulting business. Further, training had focused on NMP development for CAFOs. EPA desired to test the viability and benefits of an environmental assessment, but without TSPs trained to perform the assessments, there was no avenue to increase farmer awareness and encourage farmers to adopt environmentally beneficial practices.

In addition to outputs, the CLEANEAST Project had three desired long-term outcomes: (1) mitigation of adverse water and air impacts from livestock and poultry operations by implementing CLEANEAST-recommended BMPs; (2) an increase in the number of partially or fully restored water bodies that had become impaired due to nutrient runoff; and (3) an increase in farmers' knowledge of environmental impacts and methods so they can understand how to mitigate adverse impacts from their livestock and poultry operations.

Other Similar Environmental Assessment Programs

Although comparable EA programs such as those in New York and Pennsylvania have existed in the past (New York State Soil and Water Conservation Committee, 2015; the Pennsylvania program no longer operates), we were unable to identify any peer-reviewed accounts of the two programs' tools, nor tools of any other comparable US programs. Our search for peer-reviewed literature about comparable tools designed for on-farm data collection did,

however, identify noteworthy programs in Canada, the European Union, and New Zealand. We found these tools to be significant and relevant in that they demonstrate the global community's interest in assessing the environmental impacts of livestock operations and in promoting practices to mitigate environmental risks.

Further, these tools and their evaluations provided valuable findings about farmers' motivations to participate in voluntary programs, the effectiveness of voluntary programs, and the design and use of informative performance indicators. These findings can be applied in future refinements of US farm evaluation products such as the CLEANEAST EA Tool.

For example, Smithers and Furman (2003) reported on the Nova Scotia, Canada, environmental farm plan (EFP) program and focused on the nature and reasons for program participation. However, their paper did not focus on the tools used by the program. They did note, however, that those voluntary survey respondents who acknowledged they only partially participated in the program chose to leave the program after the environmental appraisal of their farm's operation. Unlike the Nova Scotia EFP, the CLEANEAST Project was intended from the onset to provide the EA service as a one-time event and not sustain participation long-term.

Smithers and Furman also observed that a method's success seemed to be correlated with its compatibility with the recipient's listening and learning style. Thus, the design of a tool and the ability of the TSP to communicate the tool's contents are important factors for keeping farmers engaged and effecting change. The CLEANEAST Project did not attempt to characterize farm participants' listening and learning style; however, 168 of 385 EA recommendations (44 percent) were implemented at 47 of the farms with EA reports that received follow-up site visits within 2 years of a CLEANEAST EA (16 percent). Also, 90 percent of participants who responded to the satisfaction survey stated that they somewhat agreed or strongly agreed that participation in the CLEANEAST Project increased their awareness of environmental challenges their operation may face.

Atari and colleagues (2009) evaluated the same Nova Scotia EFP program from the perspective of which farmer traits and program attributes motivated voluntary participation. The EFP program followed steps similar to those for CLEANEAST in interfacing with and evaluating and reporting for both crop farmers and livestock operators; however, the article did not focus on the design of any tools developed for the program. Nor did the article address farmer survey respondents' opinions on the utility of any tools used or the influence of those tools in adopting BMPs. However, Atari et al.'s findings are valuable because they compare programs' influence on farmer behavior—a topic we plan to address in a separate manuscript.

Halberg, van der Werf, Basset-Mens, Dalgaard, and de Boer (2005) compared six tools for environmental assessment of livestock operations in the European Union. Halberg and colleagues analyzed the tools as methods of scoring farm performance based on an indicator(s). The comparison focused on the type and application of indicators designated for each tool, comparing indicators intended for national-scale policy development to indicators intended to improve farm-specific performance. Only two of the six tools (environmental management for agriculture [Lewis & Bardon, 1998] and DIALECTE [Solagro, 2000]) appeared to address manure use on-farm, and those tools did not include aspects associated with reducing nitrifying air emissions or reducing emissions linked to aquatic ecotoxicity. One of these two tools appeared to address water quality (as opposed to systems, such as natural biodiversity and soil quality).

In contrast, the CLEANEAST EA Tool was designed to collect information that is later entered into external tools (e.g., the CLEANEAST Nutrient Emission Reduction Performance Indicator) to estimate farm-specific performance, such as potential nitrogen loss via non-point-source runoff or via ammonia air emissions. Therefore, comparing the CLEANEAST EA Tool directly with those assessed

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in Halberg et al. (2005) is difficult. However, Halberg et al. did conclude that indicators linked to environmental objectives with a geographic target should be area-based (as opposed to globally focused indicators, which should be farm production-based), and the CLEANEAST Nutrient Emission Reduction Performance Indicator tool is based on farm area.

New Zealand has applied the concept of environmental whole farm management plans (aka environmental farm plans, or EFPs) since the mid-20th century. An EFP is "a documented time-bound set of environmental management objectives and actions particular to a farm property," which includes an on-farm assessment (Manderson, Mackay, & Palmer, 2007). Manderson and colleagues evaluated 20 different types of New Zealand EFPs. Although 10 of the 20 plans targeted lowland dairy (among other farming types such as pastoral hill country and high country), the authors reported that only two EFPs had a wide scope of agri-environmental issues comparable to the CLEANEAST EA Tool. They stated that only one plan targeted issues of erosion, water quality, water conservation, pests, and biodiversity. Unlike the EA Tool, which was designed for use in the eastern 27 US states, the authors describe the New Zealand EFPs as widespread and diverse to address regional authorities' goals.

Methods

In this section, we introduce service providers, describe the CLEANEAST EA Tool and its product (the EA Report), and explain how the EA was administered.

About the CLEANEAST Project Technical Assistance Professionals

RTI contracted 57 qualified Technical Assistance Professionals (TAPs) to provide technical services to 429 farm operators who volunteered to participate in the CLEANEAST Project. Each TAP participating in the CLEANEAST Project was a US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)-registered Technical Service Provider (TSP; USDA, c2014) with certifications and expertise specific to the state where the TAP's assigned farm was located. These TAPs performed the EAs and produced EA Reports for each farm participant.

CLEANEAST Environmental Assessment Tool Description

The EA assistance provided by the CLEANEAST Project consisted of the TAP performing an on-farm environmental review of the operation and preparing a report containing recommendations that could be implemented by the farm participant to address any identified environmental issues. Between 2007 and 2008, NRCS-registered TSPs at subcontractor Agri-Waste Technology, Inc., worked with RTI and North Carolina State University to create the following two tools to support performing an EA:

- the Farm Operation Introductory Profile Tool, completed by the farm participant (with support from the TAP if needed) to collect background information about the farm for the TAP before the scheduled visit
- the On-Site Environmental Assessment Tool, completed by the TAP during the on-farm visit to identify and evaluate any potential environmental issues.

In addition to these tools, we gave all TAPs a standardized EA Report template so that all EA Reports prepared for the CLEANEAST Project and delivered to the farm participant used a consistent format. An expert advisory committee composed of representatives from federal agencies, growers associations, academia, and nonprofit organizations provided valuable input on tool development. In addition, the EA Tool was pilot tested at two livestock operations.

The overall objectives of performing an EA are to help operators ensure that all pathways affecting water quality are considered and ensure that nutrient management practices to protect water quality do not adversely affect air quality and vice versa.

The EA has four primary features. First, the EA is a comprehensive assessment of nutrient-driven environmental challenges facing livestock and poultry operations. It contains more than 400 questions in 12 topical areas. Second, the EA is intended to promote practical recommendations for mitigating those

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environmental challenges. The EA's principal focus is to reduce nutrients in runoff, but it also provides an overview of air-related impacts.

Third, the Farm Information Profile developed in preparation for each EA contained information about general facility location, layout, and operation; overall appearance; feed and silage storage; animal types and numbers; and animal housing and manure and wastewater collection systems. The profile also identified any sheds, lots, pastures, and holding areas; manure and wastewater transfer systems; manure and wastewater storage and treatment methods (ponds, lagoons, and other structures); and types of crops planted. Finally, it was important to understand what the farmer considers to be potential impacts of the farm's design and operation on local waters, so we collected information on farm proximity to water bodies and artificial and natural conveyances to water bodies.

The EA Tool covered topics such as building and lot layout and management (including building ventilation and animal contact with water bodies); construction, operation, and maintenance of handling and storage facilities for manure, litter, and wastewater; and nutrient management, including existing management plans and manure land application practices. Conservation practices and land management and tillage practices were included in the tool to augment nutrient management interests with erosion control practices, particularly since phosphorus is frequently transported on soil particles. Mortality management information was also collected since such decision making is routine on farms, and carcass degradation can trigger a number of environmental concerns.

Water quality and quantity management was, of course, essential to evaluate given the mission of the CLEANEAST Project. Odor and air emissions are also a growing area of concern from both environmental and health perspectives. Technologies are emerging to control odor and air emissions as public awareness leads to negative publicity; however, we found training of field consultants is limited because few guidelines and regulations do not exist in many states.

The EA Tool was also designed to collect information on other environmental risks, including chemical storage and handling; aboveground storage tanks and piping; underground storage tanks and piping; and management of pesticides, pharmaceuticals, fertilizer, petroleum products, and other potentially hazardous materials. Finally, knowledge and evaluation of existing facility emergency management plans, recordkeeping, and sampling indicates the farm's preparedness and diligence, which can, in turn, lead to greater environmental protection.

How the CLEANEAST EA Tool Was Administered

To ensure consistent service across farms served, RTI developed a 10-step protocol (Figure 2), with responsibilities divided between RTI, the farmer, and the TAP. RTI evaluated farmers' applications and, if the farmer was selected for the project, arranged and facilitated TAP services using a customized confidential tracking database. RTI tracked farms from initial contact through TAP site visits, reporting, final farmer evaluation of services, and follow-up contacts to measure implementation of CLEANEAST recommendations. After RTI assigned TAPs to farms, TAPs were responsible for interacting with farmers both on- and off-farm, collecting farm information, performing the EA, and preparing a draft and final EA Report.

The EA was the most critical step of the protocol. It required the TAP to gather and record farm data accurately using the EA Tool and then to apply his or her knowledge, experience, and training to assess the farm's potential impacts and opportunities to mitigate environmental risks. TAPs then prepared an EA Report that was designed to both effectively inform the farmer about the EA and recommend practices to improve the farm's performance from an environmental perspective.

Upon acceptance into the CLEANEAST Project, participating farmers were expected to complete a Farm Operator Introductory Profile, an essential overview of the farm's layout and operations which set the stage for the TAP's EA. Farmers were also expected to review the TAP's draft EA and complete an evaluation survey after receiving the final EA Report.

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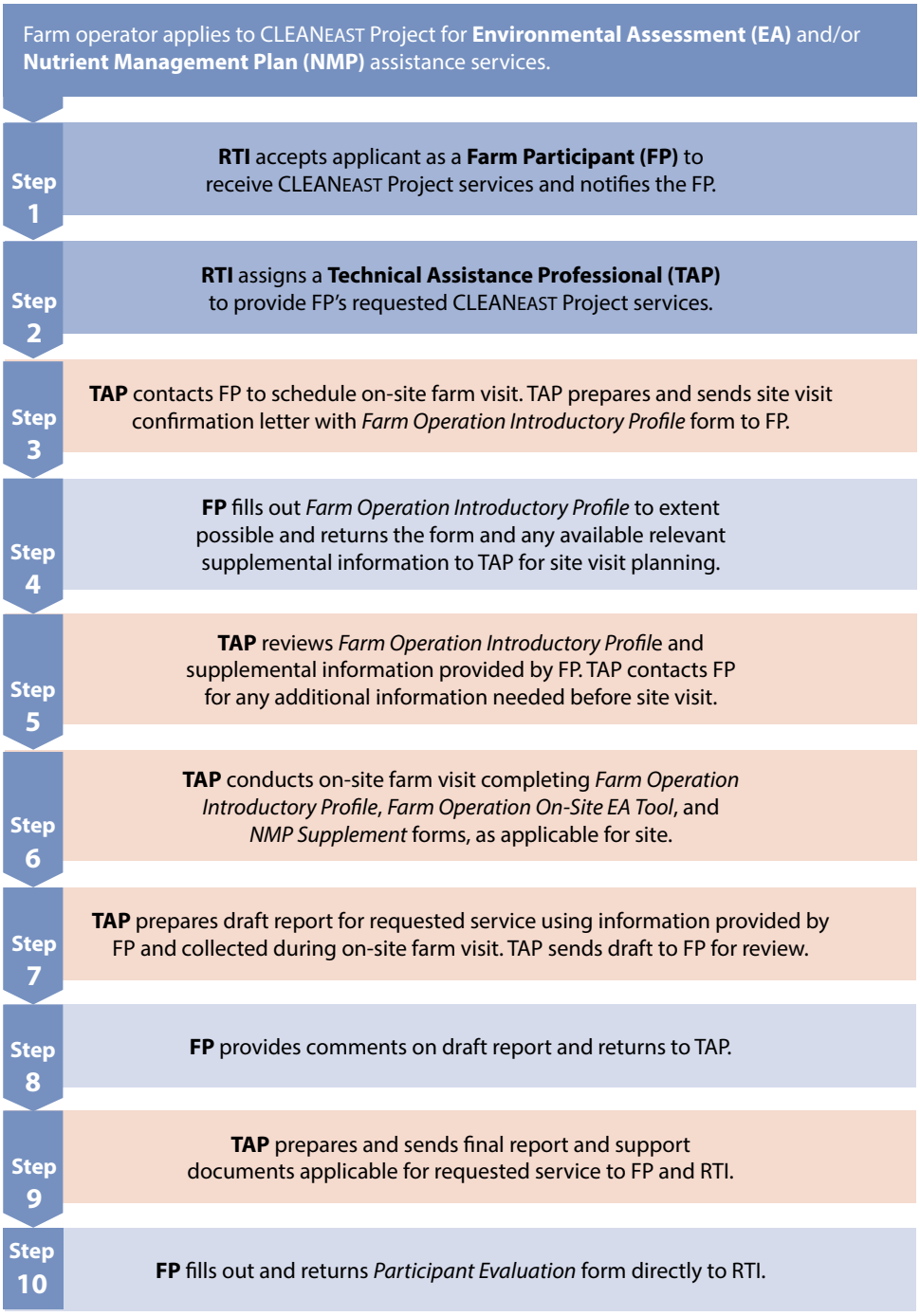
We found that the 10-step protocol enabled RTI to manage a large network of TAPs effectively, built trust with farm participants about our provision of standardized professional services, and ensured a common measure of progress. As a result, CLEANEAST services were successfully completed through EA Report delivery, and a negligible number of farmers withdrew from the project.

Figure 2. General CLEANEAST Project implementation steps for farm participant selected to receive technical services



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Results

In this section, we summarize the EA results, focusing on TAPs' recommendations and the degree of implementation documented at a sample of project farms.

A total of 297 EAs were performed, and respective EA Reports were delivered to farm participants. These reports contained numerous recommendations often pertaining to adopting BMPs (USDA, c2009). RTI performed follow-up site visits at 47 farms to gauge the level to which farmers adopted a total of 385 EA recommendations. Based on the analysis of discussions with these 47 farm participants in the follow-up site visits, approximately 44 percent (or 168) of the TAP EA recommendations were implemented by the time of the follow-up site visit (typically within 2 years of CLEANEAST service). Table 1 provides the list of the EA recommendations and implementation frequencies for the 47 farms. It is important to note that a BMP can be recommended more than once at a single farm operation (e.g., there may be more than one manure storage unit per farm).

Recommendations associated with "waste (manure) storage facilities" were most frequent, with 35 percent implemented by the time of follow-up contact. In contrast, "nutrient management modifications" was the second most frequent recommendation and resulted in 76 percent implementation. This contrast in adoption frequency can most likely be attributed to differences in the expense and time required to implement a large construction project such as a storage facility compared with smaller-scale, more affordable modifications associated with manure management.

As reported by Smithers and Furman (2003), volunteer participants in environmental farm planning programs may choose not to participate completely; they may enter a program with the intent of only partial participation, i.e., to achieve a smaller target. In the case of the CLEANEAST Project, this limited participation could be interpreted as farm participants' not adopting all TAP recommendations. A farm participant may enter a program to understand how their farm is performing relative to those of their peers or to receive an external evaluation to affirm or reject their own assessment about beneficial practices and investments.

Table 1. Technical Assistance Professionals' environmental assessment recommendations, ranked by implementation frequency at farms receiving follow-up site visits

NRCS BMP Code	Common practices recommended by CLEANEAST TAPs	Frequency recommended at farms receiving follow-up site visit	No. of BMPs implemented by farms (confirmed by follow-up site visit)	Percent implemented
412	Grassed Waterway	1	1	100
442	Irrigation System, Sprinkler	1	1	100
575	Animal Trails and Walkways	1	1	100
578	Stream Crossing	1	1	100
N/A	Develop Conservation Plan	1	1	100
N/A	Domestic Waste Management	1	1	100
590	Nutrient Management Modifications	37	28	76
N/A	Lot Runoff Control Measures	4	3	75
393	Filter Strip	3	2	67
629	Waste Treatment	3	2	67
N/A	Miscellaneous Repair	20	13	65
748	Recordkeeping	30	18	60

continued

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Table 1. Technical Assistance Professionals' environmental assessment recommendations, ranked by implementation frequency at farms receiving follow-up site visits *continued*

NRCS BMP Code	Common practices recommended by CLEANEAST TAPs	Frequency recommended at farms receiving follow-up site visit	No. of BMPs implemented by farms (confirmed by follow-up site visit)	Percent implemented
N/A	Export Manure	5	3	60
558	Roof Runoff Structure	11	6	55
316	Animal Mortality Facility	19	10	53
312	Improve Leachate Collection	10	5	50
342	Critical Area Planting	2	1	50
360	Waste Facility Closure	2	1	50
614	Watering Facility	2	1	50
317	Composting Facility	9	4	44
N/A	Trash Handling Alternative	9	4	44
472	Access Control/ Livestock Exclusion Area	26	11	42
359	Waste Treatment Lagoon	19	7	37
313	Waste (Manure) Storage Facility	84	29	35
587	Structure For Water Control	3	1	33
N/A	Clean-Up Spilled Feed	3	1	33
710	Secondary Containment (Fuel)	14	4	29
355	Well Water Testing	12	3	25
561	Heavy Use Area Protection	4	1	25
309	Agrichemical Handling Facility (O&M)	9	2	22
N/A	Calibrate Application Equipment	6	1	17
528	Prescribed Grazing	7	1	14
570	Stormwater Runoff Control	6	0	0
634	Waste Transfer	6	0	0
635	Vegetative Treatment Area	4	0	0
N/A	Develop Emergency Response Plan	4	0	0
380	Windbreak/Shelterbelt Establishment	3	0	0
449	Irrigation Water Management	1	0	0
468	Lined Waterway or Outlet	1	0	0
554	Drainage Water Management	1	0	0
TOTAL		**385**	**168**	**44**

NRCS = US Department of Agriculture (USDA) Natural Resources Conservation Service

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Discussion

In this section, we discuss the project's successes and challenges, and we describe lessons learned from structural, organizational, and technical perspectives.

Project Successes

The results of this project indicate that the application of a standardized environmental assessment tool for livestock and poultry farms can help facilitate voluntary behavioral change to reduce environmental risks on livestock and poultry farms. In this case, more than 400 farm operations in 20 eastern states volunteered and received CLEANEAST EA and NMP assistance, and a sample of 47 farms receiving EAs implemented 44 percent of their TAPs' recommendations within 2 years of CLEANEAST service.

We measured other indicators of project success in addition to the number and geographic coverage of farms participating in the project. For example, 72 percent of farm participants were in counties designated with a high-priority watershed CLEANEAST Project rating. To assess the impact of serving high-priority watersheds, we performed a case study using EA and NMP data collected from 104 CLEANEAST farms located in the Chesapeake Bay watershed. Our case study applied methods and assumptions reported in the 2011 EPA report *An Optimization Approach to Evaluate the Role of Ecosystem Services in Chesapeake Bay Restoration Strategies* (US EPA, 2011).

In our assessment, we assumed that the Chesapeake Bay watershed's CLEANEAST farm participants are representative of the total livestock and poultry farm population (55,600 farms) in the Bay watershed, and we also assumed each non-CLEANEAST farm achieved a comparable reduction in the level of nitrogen and phosphorus loss (e.g., runoff to surface waters) as we estimated for the CLEANEAST Chesapeake Bay watershed farm participants. Our case study results indicate that applying those reductions in nutrient losses to livestock and poultry operations watershed-wide would achieve 78 percent of the nitrogen reduction total maximum daily load (TMDL) goal and 39 percent of the phosphorus reduction TMDL goal for the entire watershed's agricultural sector (comprising 83,775 farms).

Additional observations pertaining to the CLEANEAST EA Tool's success are summarized below.

For example, we observed that using a voluntary approach for implementing a farm assistance program can be successful with key stakeholder support and a vote of confidence from the NRCS, regulatory, TSP, and growers' communities. Overall, a voluntary approach to increasing environmental awareness in farm operators and motivating them to request and implement nutrient management practices can succeed. For example, research by Kim, Gillespie, and Paudel (2005) determined that having contact with NRCS and Extension personnel positively affects BMP adoption. From 2008 to 2011, the RTI CLEANEAST Team, with the assistance of state government officials, local agents, sector representatives, and TAPs, were able to recruit more than 290 applicants for EAs.

Another observation was that tools developed by the RTI Team demonstrated their utility in the field, as well as in final analyses and reporting. The development of farm-level environmental impact evaluation tools is an outgrowth of intensification, increased potential for environmental pollution, and the implementation of sustainable agricultural practices (van der Werf & Petit, 2002). The CLEANEAST Farm Operation Introductory Profile and the Farm Operation On-Site Environmental Assessment Tool were designed to collect data on and evaluate livestock and poultry farm performance from an environmental impact perspective. These tools were posted on the CLEANEAST Project's website and were publicly available for download and use by farm operators and TSPs independent of the CLEANEAST Project. This provided an additional, free-of-charge benefit to both the farming and environmental communities. In addition, the tools enabled RTI to extract data into a confidential

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relational database to perform aggregated analysis of individual farm data collected by TAPs performing CLEANEAST Project. RTI used that database to generate aggregated, nonconfidential project results for public presentation.

Finally, we observed that farm participants were satisfied with CLEANEAST services overall. Approximately 37 percent of the 429 of the farm participants completed and returned the participant evaluation survey. Ninety percent of respondents strongly agreed or somewhat agreed that the process increased their awareness of environmental challenges their operation may face. Comparable results were found with a Canadian environmental farm planning program in which over 90 percent of respondents acknowledged that participation increased their awareness of farm-related environmental issues (Smithers & Furman, 2003). In addition, 93 percent of CLEANEAST farm participants who responded to the survey strongly agreed that the CLEANEAST TAP who assisted the farm provided a high-quality final work product (EA Report, NMP update, or new NMP).

As with any large, service-oriented project that serves many clients, some farm participants (2 percent of survey respondents) were not fully satisfied with the services they received from the CLEANEAST Project due to farm-specific reasons. In those cases, RTI made every effort to follow up with each farm participant to address expressed concerns.

Project Challenges

The successes of the CLEANEAST Project were achieved by extensive planning; the formation of a collaborative team of professionals who had the skills and expertise to perform the array of tasks needed to develop and implement the project; early solicitation of input from an expert advisory committee; and ultimately, recruitment of a large and diverse pool of farm participants. However, as the project work progressed, the CLEANEAST Project team identified occasional unexpected challenges that required adaptive management of certain project tasks.

For example, we observed that farm operators were more motivated to request NMPs over EAs (Deerhake et al., 2012). Although the EPA conceived of and included EAs in the scope of this cooperative agreement, the introduction of a new farm operation on-site EA tool and the absence of federal and state officials' public endorsement and promotion of EAs made it challenging to acquaint the larger farm community with the tool and persuade them to sign up for services. In addition, federal NPDES CAFO permit regulations (40 CFR 122) require large CAFO dischargers to have NMPs. Likewise, the USDA NRCS actively promotes nutrient management planning for livestock and poultry operations of all sizes through both its guidelines (USDA, 2009) and its Environmental Quality Incentives Program, which provides cost-share funds to address the growing need of environmental assistance for AFOs.

However, a noteworthy fraction of the farm participants seeking NMPs were willing to receive EAs after RTI familiarized the farm operator with its contents, explaining that the EA was broader than the traditional NMP and that it can increase an operator's understanding of environmental sensitivities. In some cases, farm operators were willing to receive EAs even though they did not need an NMP due to an exemption or exclusion from regulatory programs. This willingness is most likely attributed to one or more of the following factors:

- The Farm Operation On-Site Environmental Assessment Tool was endorsed and recommended by a trusted local official or TSP.
- The tool was recommended by a state official as a result of a negotiated enforcement action.
- The tool was provided free of charge and confidentially.
- The farm participant wanted to be more informed and demonstrate environmental stewardship in his or her community.
- In some respects, the tool assessed nutrient management in the same way as an NMP, with the additional benefit of informing the design and operational effectiveness of the farm from an overall environmental perspective.

Two of the CLEANEAST states (Pennsylvania and New York) had their own versions of EAs in place as state programs at the time of the project. In those states, it was more challenging to persuade farm operators to request EAs because their state's EA may have been structured somewhat differently, and states were reluctant to certify that the CLEANEAST EA could be equivalent to the state's EA.

Lessons Learned

Based on the successes achieved by the CLEANEAST Project and the challenges faced in its implementation (Deerhake et al., 2012), the project team compiled a set of lessons learned that can be applied to similar farm assistance projects. These lessons are grouped here by structural, organizational, and technical subcategories to evaluate and articulate the benefits and opportunities for improving specific project features.

Structural lessons learned. Structurally, the creation and provision of two basic services (EAs and NMPs) was manageable. Farm participants could request one or both services from the CLEANEAST Project. Since RTI trained all TAPs to provide both types of services, no issues arose on the availability of TAPs. Because EAs were a new form of service unfamiliar to farms (unless their state had a similar EA program), the project team spent more effort informing farm operators about EAs and their utility. As noted previously, although EPA conceived of producing more EAs than NMPs, NMP demand was greater due to post-2008 NPDES regulatory amendments. The creation of EAs caused some confusion in two states with comparable tools: Pennsylvania and New York. In both cases, RTI explored seeking state buy-in to accept CLEANEAST EAs as equivalent to their programs; however, equivalency was not achieved readily, and RTI determined it was not cost-effective to pursue an equivalency determination.

Another structural lesson learned was that delivering draft EA Reports to farm participants for their review often delayed finalizing reports. The CLEANEAST protocol was to deliver the draft EA Report or draft NMP to the farm participant for review and comment, and then revise and deliver a final EA Report or NMP. It was not uncommon that receiving farm participants' comments or approval was delayed. As a result, the time from acceptance into the CLEANEAST Project to the time of final product delivery was longer than anticipated. This situation can be improved by delivering the EA Report to the farm participant as a final document with the understanding that he or she can seek revisions upon request.

Farm participants could have benefited from one or more follow-up visits. For example, it would have been beneficial if TAPs could have scheduled a visit to review and explain how to apply the EA Report and NMP recommendations. Such visits could also reinforce the educational aspect of the project and serve as a reminder to farm participants about the practices they should or could implement.

Not tracking farms' implementation of TAP recommendations reduced the certainty of the project's benefits. Because, the project had a significant potential to contribute to restoration of nutrient-impaired watersheds. RTI was, however, able to contact a subset of farm participants receiving EAs to assess their degree of BMP adoption, but a more comprehensive effort to measure implementation would have been beneficial.

Organizational lessons learned. The CLEANEAST Project issued two Requests for Proposals for TAP subcontract support: (1) Northeast and Mid-Atlantic and (2) Southeast and Midwest. Once the subcontracts were awarded and rates were established for EA and NMP services based on animal category and farm size, RTI assigned a farm to one of the multiple subcontracted TAP firms based on several criteria, including demonstrated certification in the state of interest and provision of the best value to the project. Organizing the TAP subcontract competitions and issuing technical directives to each farm applicant based on predetermined criteria worked well for RTI given our business systems design.

The project served a relatively small number of farms in the eastern United States. If the project were implemented again and served a larger fraction, the potential for water quality improvement would increase.

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It is important to understand that the proximity of the farm population to nutrient-sensitive waters can be as important as the number of farms (and their livestock) served. Serving even a limited number of farms strategically located near impaired streams and water bodies could make a difference in water quality locally. Benefiting water quality on a larger scale, such as reducing the livestock industry's total nutrient load to the Chesapeake Bay, would require additional resources and the willingness of a significant percentage of the Bay watershed's total farm community to volunteer for NMPs and EAs.

Technical lessons learned. Technical evaluation of the project's performance and lessons learned was centered on the application of existing technical resources and the development of new technical tools to promote performance analysis at both the farm and project levels. We observed over the course of the CLEANEAST Project that NRCS-registered TSPs can benefit from additional training and technical guidance, particularly in areas not as commonly regulated, such air quality and mortality management, as well as new land application technologies and renewable energy technology such as anaerobic digestion.

For example, farm TSPs do not routinely address air quality issues. Based on our CLEANEAST Project team's air quality assessment experience, we see a clear need for (1) a tool to predict the benefits of best management practices (BMPs) for air quality, such as RTI's Ammonia Air Emissions Mitigation Indicator, and (2) expanded guidance and training for TSPs on use of BMPs to improve air quality. Although the NRCS does have a TSP certification for air quality management, we found limited evidence of CLEANEAST states promoting air quality–related projects.

Conclusions

RTI used its CLEANEAST EA Tool to assess the performance of 297 livestock and poultry farms in the eastern United States. This experience demonstrated that standardized tools such as the EA Tool can help facilitate voluntary farm behavioral change to reduce environmental risks from livestock and poultry farms. The EA Tool not only demonstrated its utility in the field but also provided a means of measuring program performance. Farm participants expressed satisfaction with CLEANEAST services overall, including the utility of the EA Tool, as it raised their awareness of their farm's potential environmental impacts.

Since on-farm EAs were unfamiliar to many farmers, it was necessary for the CLEANEAST Project Team to expend effort initially to inform farmers about the EA Tool. However, with continued outreach to the farming community and growing awareness about the potential environmental impacts of farms, EA Tool use can increase. Recommended improvements in administering the CLEANEAST EA Tool include investing more effort in EA Report delivery and review time with each farmer; follow-up visits to farms to gauge implementation of EA recommendations; and additional TSP training on EA Tool features such as farm air emission reduction practices and technologies.

As interest grows in seeking ways for livestock and poultry farms to mitigate greenhouse gas emissions and adapt to climate variability, the CLEANEAST EA Tool can be readily expanded to gather information that will educate farmers about their level of greenhouse gas emissions from manure storage and land application practices. The EA Tool could also guide farmers as they seek opportunities for gaining carbon credits for sequestration through vegetative planting such as windbreaks and installing energy-efficient technology. Finally, the EA Tool can be used to gather data on existing manure management technologies, so that farmers can (1) compare existing and emerging technologies and practices, (2) select new strategies that will reduce their carbon footprints and greenhouse gas emissions, and (3) increase nutrient utilization, which, in turn, will reduce consumption costs for chemical fertilizers.

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