PROJECT NO.

STAR-N6R14/4857

Finding and Adding Agricultural BMP Performance Studies to the Agricultural BMP Database

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2018

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WRF ISBN: 978-1-60573-366-1
WRF Project Number: STAR_N6R14/4857

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This publication was developed under Assistance Agreement number RD-83556701-0 awarded by the U.S. EPA. It has not been formally reviewed by EPA. The views expressed in this document are solely those of the grantee and EPA does not endorse any products or commercial services mentioned in this publication.

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Abstract and Benefits

Abstract:

The Agricultural Best Management Practice Database (AgBMPDB) was created as a central repository to provide scientifically based information on practices that reduce pollutant loading from agricultural sites. During the creation of the database, a substantial number of agricultural BMP research studies were entered, however, there is a significant amount of published, peer-reviewed literature suitable for entry that has not yet been included. This project involved entering peer-reviewed agricultural BMP studies from the Chesapeake Bay Watershed and Upper Midwest (Illinois, Minnesota, and Iowa) into the AgBMPDB.

This project tested how readily assessable other studies were for database entry, how well-known the database is among researchers, the willingness of research partners to allow their data to be shared in the database, and the level of time and effort to review, assemble, and input the data. The Center for Watershed Protection (Center) teamed with the University of Illinois and completed data entry spreadsheets for eight studies in the upper Midwest (Illinois, Minnesota, and Iowa) and eight studies in the Chesapeake Bay Watershed (Maryland, Pennsylvania, Virginia, and New York) in preparation for their addition to the AgBMPDB.

Benefits:

- Contributes to the growth of the Agricultural Best Management Practice Database (AgBMPDB).
- Provides federal, state, and local environmental agencies with quantitative information on the effectiveness of individual practices for addressing sediment and nutrients.
- Identifies studies in different regions that may help identify potential causes of regional and agricultural activity differences in BMP effectiveness.

Keywords: Agricultural BMP Database, agriculture, water quality, research studies, Midwest, Chesapeake Bay.

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Acronyms and Abbreviations

AgBMPDB	Agricultural Best Management Practice Database
BMP	Best Management Practice
CBP	Chesapeake Bay Program
Center	Center for Watershed Protection
QA/QC	Quality Assurance/Quality Control
WRF	The Water Research Foundation

Executive Summary

The AgBMPDB includes performance data and metadata that document the many field-based and practice-based variables that affect BMP performance. The long-term goal of the AgBMPDB is to provide agricultural advisors, planners, consultants, and producers with information that enables them to better select systems of BMPs for their operations and to support improvements in agricultural BMP design and implementation (WE&RF 2017). The AgBMPDB will also be useful for watershed assessments and planning efforts. The most recent version 2.0 release of the AgBMPDB continues to focus on row crops, particularly corn and soybeans. This project further tested the willingness of research partners to allow their data to be shared in the database and the level of time and effort to review, assemble and input the data.

The inclusion of more studies in the AgBMPDB will make the database more useful to planners, consultants, and producers. A significant amount of research has taken place in the Midwest and Chesapeake Bay regions, making them a good place to focus to increase the number of studies in the database. The Center for Watershed Protection (Center) and University of Illinois investigated data sources from a previous project with the Walton Family Foundation, as well as others that Dr. Christianson from the University of Illinois suggested based on his current and previous research for inclusion in the AgBMPDB. The goal was to obtain at least 12 studies that could be used to populate the database from the upper Midwest (Illinois, Minnesota, and Iowa). The Center also contacted researchers from the University of Maryland, Virginia Tech, and Penn State University, among others, with the goal of attaining at least 12 studies for populating the database from the Chesapeake Bay watershed (Maryland, Pennsylvania, and Virginia). A total of 102 studies were reviewed: 29 from the upper Midwest; 48 from the Chesapeake Bay watershed; and 25 either outside the study area, with unknown locations, or literature reviews covering multiple regions.

Data entry spreadsheets for the AgBMPDB were compiled for eight studies from the Chesapeake Bay watershed and eight studies from the upper Midwest. The original goal of this project was to identify and prepare data entry spreadsheets for 12 studies from the upper Midwest and 12 studies from the Chesapeake Bay watershed. However, many of the studies are complicated and required more time from senior staff than expected. In addition, some of the studies that were initially thought to be a good fit for the database were found to be missing key pieces of information as they were closely reviewed during data entry. As a result, more time was spent than anticipated on gathering studies, particularly in the Chesapeake Bay watershed, which had a more limited number of studies meeting the criteria for entry into the database described in Chapter 3.

CHAPTER 1

Introduction

The purpose of the Agricultural BMP Database (AgBMPDB) is to develop a centralized repository of agricultural BMP performance studies to provide scientifically based information on practices that reduce pollutant loading from agricultural sites. The AgBMPDB includes performance data and metadata that document the many field-based and practice-based variables that affect BMP performance. The long-term goal of the AgBMPDB is to provide agricultural advisors, planners, consultants and producers with information that enables them to better select systems of BMPs for their operations and to support improvements in agricultural BMP design and implementation (WE&RF 2017). The AgBMPDB will also be useful for watershed assessments and planning efforts. The most recent version 2.0 release of the AgBMPDB continues to focus on row crops, particularly corn and soybeans.

The value of the AgBMPDB will grow as it is further populated. Version 2.0 of the AgBMPDB provides useful information for quantitatively evaluating agricultural BMP performance; however, it is still relatively limited in terms of the number of studies available for use in rigorous statistical comparisons. There is a significant amount of published, peer-reviewed literature suitable for entry into the AgBMPDB that has not yet been entered. Continued support of the AgBMPDB effort by multiple producers beyond corn and soybean producers is needed to enable continued growth of the AgBMPDB and more refined data analysis. As the database continues to expand, it can be used to check the reasonableness of existing and on-going data collection compared to entered studies as well as recommendations provided by expert panels or agencies estimating agricultural BMP performance benefits. This project further tested the willingness of research partners to allow their data to be shared in the database and the level of time and effort to review, assemble and input the data. The inclusion of more studies in the AgBMPDB will make the database more useful to planners, consultants, and producers. To increase the number of studies in the database, this project focused on the Midwest and Chesapeake Bay regions where a significant amount of research has been conducted. The Center for Watershed Protection (Center) recently completed a review of science assessments from Illinois, Iowa and Minnesota for the Walton Family Foundation which included many references to peer-reviewed (and research farm reports) papers associated with the different types of agricultural conservation practices that were incorporated into their respective state nutrient reduction strategy (Christianson et al. 2018; Christianson et al. 2016). This work for the Walton Family Foundation was intended to highlight similarities between agricultural nutrient reduction or nutrient loss reduction strategies associated with nutrient reduction goals for the Gulf of Mexico for Iowa, Minnesota, and Illinois (IDALS et al. 2013; IEPA, and IDOA 2015; MPCA 2014). These strategies are in response to EPA's Gulf Hypoxia Action Plan which calls for the 12 states within the Mississippi River basin to produce a plan to reduce nutrients to the Gulf of Mexico by 45%. The three states included here have spent considerable time and effort and enlisted help from scientists and professionals in developing state-specific plans to reduce nutrients leaving their states. The Center and University of Illinois investigated these data sources as well as others that Dr. Christianson from the University of Illinois suggested based on his current and previous research for inclusion in the AgBMPDB with the goal of obtaining at least 12 studies that can be used to populate the database from the upper Midwest (Illinois, Minnesota and Iowa).

The Chesapeake Bay watershed is another area with a tremendous amount of agricultural BMP research and several studies have already populated the AgBMPDB. Urban and agricultural BMPs go through a peer-review process for determining BMP effectiveness to evaluate progress in meeting the Chesapeake

Bay TMDL. The Center has led several Chesapeake Bay Program (CBP) BMP Expert Panels and has established an excellent relationship with many of the researchers studying agricultural BMP effectiveness. Maryland, Pennsylvania, and Virginia were the primary states targeted because they compose the largest portion of the Chesapeake Bay watershed and are where the Center's research contacts are located. The Center contacted researchers from the University of Maryland, Virginia Tech, and Penn State University, among others, with the goal of attaining at least 12 studies for populating the database from the Chesapeake Bay watershed.

CHAPTER 2

Data Sources and Researchers Contacted

Prior to data collection, the Center contacted Jane Clary from Wright Water Engineers, Inc., the project coordinator of the AgBMPDB, to determine the best strategies to identify studies for inclusion in the database. She provided guidance on which studies to include that meet the requirements of the AgBMPDB as further described in Chapter 3. Ms. Clary also suggested that the Center refer to a table in the database called REFERENCES (V1 through 2013), which contains informal tracking information by Wright Water Engineers about the studies already included or excluded, as well as where they were found.

A total of 102 studies were reviewed: 29 from the upper Midwest; 48 from the Chesapeake Bay watershed; and 25 either outside the study area, with unknown locations, or literature reviews covering multiple regions. The upper Midwest studies were obtained based on University of Illinois collaborator familiarity with literature from work on the Iowa and Illinois Nutrient Reduction Strategies and the Center's previous work on cover crop effectiveness. The Chesapeake Bay watershed studies were obtained through a large effort to contact researchers in the region and were supplemented through a review of CBP Expert Panel reports, previously collected information from Wright Water Engineers, Inc., and an online search of peer-reviewed publications. These studies were reviewed as further described in Chapter 3 to identify those most appropriate for inclusion in the AgBMPDB.

2.1 Midwest Studies and Researchers Contacted

Dr. Reid Christianson was the primary researcher for the Walton Family Foundation project and was working for the Center at the time of the project. He has since taken a position as a Research Assistant Professor at the University of Illinois where he works with the agricultural research community in the region. Dr. Christianson identified studies based on his familiarity with literature from work on the Iowa and Illinois Nutrient (loss) Reduction Strategies and the Center's previous work on cover crop effectiveness, as well as his research contacts in the region.

2.2 Chesapeake Bay Data Sources and Researchers Contacted

Chesapeake Bay studies were obtained through a large effort to contact researchers and users on BMP research data in the region and were supplemented through a review of Chesapeake Bay Program Expert Panel reports, previously collected information from Wright Water Engineers, Inc., and an online search of peer-reviewed publications. All of the people contacted agreed with the need and value of the database but none of them knew it existed. Table 2-1 provides a summary of the researchers contacted within the Chesapeake Bay Watershed. The CBP Expert Panel Reports reviewed included:

- Recommendations of the Phase 6 Expert Panel to Define Removal Rates for Cover Crops (https://www.chesapeakebay.net/documents/Phase_6_CC_EP_Final_Report_12-16-2016-NEW_TEMPLATE_FINAL.pdf)

- Recommendations of the Phase 6 Expert Panel to Define Removal Rates for Conservation Tillage Practices (https://www.chesapeakebay.net/documents/CT_6.0_Conservation_Tillage_EP_Revised_Full_Report_12-14-16.2_FINAL_NEW_TEMPLATE.pdf)

- Recommendations of the Phase 6 Expert Panel to Define Removal Rates for Nutrient Management Practices (https://www.chesapeakebay.net/documents/Phase_6_NM_Panel_Report_11-28-2016_New_Template_FINAL.pdf)

Table 2-1. Researchers Contacted Within the Chesapeake Bay Watershed.

Researcher and Contact Information	Notes
Mark Dubin Agricultural Technology Coordinator Chesapeake Bay Agricultural Programs College of Agriculture & Natural Resources University of Maryland College Park, MD 20742-2315 mdubin06@umd.edu	Mr. Dubin, referred us to the studies cited in the Chesapeake Bay Program Expert Panel reports for crediting Agricultural BMPs.
Dr. Kenneth Staver Associate Research Scientist/Acting Center Director Wye Research and Education Center College of Agriculture and Natural Resources University of Maryland College Park, MD 20742-2315 kstaver@umd.edu (410) 827-6202 (phone)	He said that most of the research that is done at his location is for state agencies and is not published in peer reviewed journals. He emphasized the need for a national AgBMP database. He forwarded a couple of older papers, two of which had already been entered into the database. He mentioned the Chesapeake Bay Program Expert Panel reports for AgBMPs as a possible source.
Dr. Gary K. Felton Associate Professor Department of Environmental Science & Technology University of Maryland 1424 An. Sci./Agr. Engr. Bldg. College Park, MD 20742-2315 gfelton@umd.edu (301) 405-8039 (phone) (301) 314-9023 (fax)	He sent a 2009 Chesapeake Bay Program Report on BMP efficiency. He also mentioned the Chesapeake Bay Program Expert Panel reports for AgBMPs as a possible source. Suggested that I speak to Mark Dubin. He also said that he will look for studies when he returned to his office as he was traveling.
Dr. Gregory Evanylo Professor and Extension Specialist Department of Crop & Soil Environmental Sciences Virginia Tech 426 Smyth Hall 185 Ag Quad Lane Blacksburg, VA 24061 gevanylo@vt.edu (540) 231-9739 (phone) (540) 257-4647 (alternate phone)	He sent 17 published studies on agronomy with a focus on nutrient management for maximizing crop production.
Dr. Suzanne Dorsey Executive Director Harry R. Hughes Center for Agro-Ecology, Inc. College of Agriculture & Natural Resources University of Maryland 124 Wye Narrows Drive P.O. Box 169 Queenstown, MD 21658 sdorsey1@umd.edu (410) 827-8056 x129 (phone)	She had Josh Bollinger, Communications Coordinator contact us as they also have an interest in developing a database that summarizes BMP efficiencies for the Eastern Shore of MD. After conferring with him it was obvious that his effort is much more general. He did give us a couple of contacts with the University of Maryland and Department of Natural Resources to follow-up with.
Dr. Jonathan M. Duncan, M.P.A. Assistant Professor of Hydrology Department of Ecosystem Science & Management Pennsylvania State University 306 Forest Resources Building University Park, PA 16802 jmduncan@psu.edu (814) 865-7554 (phone)	After discussing the database and sending him background, he contacted several colleagues who were not aware of any studies that his school had participated in. He also referred me to Dr. Sarah McMillan from Purdue University who is coordinating an AgBMP database among several Land Grant Universities.

Researcher and Contact Information	Notes
Dr. Sara McMillan, P.E. Assistant Professor of Agricultural & Biological Engineering Department of Agricultural & Biological Engineering Purdue University 225 South University Street West Lafayette, IN 47907-2093 mcmill@purdue.edu (765) 496-0211 (phone)	She is very interested in collaborating but was traveling in March and agreed to follow-up with a call in April. Note the database she is working on is an AgBMP database that is focused on implementation not monitoring.
Jeremy Hanson Project Coordinator, Expert Panel BMP Assessment Virginia Tech 410 Severn Ave, Suite 112 Annapolis, MD 21403 jchanson@vt.edu hanson.jeremy@epa.gov (410) 267-5753 (phone: M, T, W, F) (443) 852-9092 (alternate phone: Th)	He coordinated the (Manure Treatment Technologies and Animal Waste Management Systems) AG BMP Panels which are more animal production centric. He doesn't have spreadsheets of all the literature for those panels, so the reports are the best resource for those citations. He also forwarded our request to Mark Dubin (Ag Tech Coordinator, Environmental Science and Technology, University of Maryland and Steven Dressing, Tetra Tech, former contractor to Chesapeake Bay Program Expert Panels.
Dr. Gene Yagow Former Senior Research Scientist Biological Systems Engineering Department Center for Watershed Studies Virginia Tech 306 Seitz Hall Blacksburg, VA 24061 eyagow@vt.edu (540) 231-2538 (phone)	Dr. Yagow noted that he is officially retired from Virginia Tech and is easing out of his former role with agricultural nonpoint source pollution. He suggested several additional contacts at Virginia Tech, including Saied Mostaghimi, Cully Hession, and Tess Thompson.
Dr. Saied Mostaghimi H.E. and Elizabeth F. Alphin Professor Director of Virginia Agricultural Experiment Station Associate Dean for Research College of Agriculture & Life Sciences Virginia Tech University 104D Hutcheson Hall Blacksburg, VA 24061 smostagh@vt.edu (540) 231-6336 (phone)	Dr. Mostaghimi responded that he did not have any data to contribute.
Josh Bollinger Communications Coordinator Harry R. Hughes Center for Agro-Ecology, Inc. College of Agriculture & Natural Resources University of Maryland joshboll@umd.edu (443) 239-1392 (phone)	Mr. Bollinger was not aware of any recent studies that would meet the requirements of the database. He referred us to Dr. Andrew Miller from the University of Maryland Baltimore County, Dr. Adel Shirmohammadi and Ms. Sarah Lane, from the Maryland Department of Natural Resources. Dr. Miller was not aware of any studies. Ms. Lane provided two studies described below.
Sarah Lane Innovative Technology Coordinator Chesapeake and Coastal Service Maryland Department of Natural Resources 580 Taylor Ave., E-2 Annapolis, MD 21401 (410) 260-8788 (phone) sarah.lane@maryland.gov	Ms. Lane provided two studies. One was a master's thesis focused on evaluation of floating treatment wetlands in stormwater retention ponds on poultry farms. The second was a manuscript currently in press focused on the treatment of agricultural runoff by a cascading system of stormwater containment basins.

CHAPTER 3

Study Review Process

The Water Research Foundation (WRF) has a high standard for original data sources to ensure only good data that follows QA/QC protocol can be entered into the AgBMPDB. For consideration of entry into the database, researchers need to demonstrate that the data collection followed a QA/QC procedure that can support the data quality and credibility. Only studies in peer-reviewed publications were considered for inclusion in the database as these were assumed to follow proper QA/QC procedures. The AgBMPDB utilizes data entry spreadsheets that identify required data necessary for the study to be included in the database. In order for a BMP monitoring study to be considered for inclusion in the database, several criteria must be met, including:

- The study must be for a BMP conducted in the field. Laboratory studies are not accepted.
- Required fields in data entry spreadsheets must be provided or explained if not applicable to the specific study. As a general rule, event mean concentrations (EMCs) are required for most studies, unless special considerations are identified (e.g., bacterial data may be taken as grab samples).
- Studies conducted by vendors or manufacturers of proprietary devices must meet certain requirements to ensure study results are independent and unbiased. These requirements are outlined in the Proprietary Device Policy (http://www.bmpdatabase.org/data-entry.html).

The Center coordinated with Wright Water Engineers, Inc. to ensure that the agricultural BMP study data entry spreadsheets from this project would be ready for use to upload into the AgBMPDB. Several additional criteria in addition to the general database criteria listed above were used when selecting studies to add to the database. These criteria include:

- The study is in fact a water quality study. Many of the reviewed studies focused on other benefits of agricultural BMPs, such as soil nutrient content and crop yield, but not the reduction of nutrients from agricultural runoff.
- The study is located within the three Midwest states (IA, MN, or IL) or three Chesapeake Bay states (PA, MD, VA) identified in the scope of work. Note that due to the difficulty in finding studies within PA, MD, and VA that met the criteria for inclusion, studies from NY and WV that were either in the Chesapeake Bay watershed or close to the watershed boundary were also reviewed.
- The study is not based on modeling, simulated rainfall, or lysimeter data. The intention of this project aligns with the AgBMPDB to obtain monitoring studies that are conducted under real world and not modeled or simulated conditions.
- The study is not already in the database. Wright Water Engineers, Inc. reviewed the list of studies the Center identified for addition to the database to help ensure that duplicate studies were not included.

Throughout the study identification and review process the Center documented: study citation; description of the research; quality of the original data from the researchers; decision of whether to add to the database; and if not selected for inclusion, the reason why. Studies that fail to meet the criteria described above were not selected for inclusion in the database. These studies and rationale for the

decision not to include are provided in Table 3-1. The studies identified for inclusion in the AgBMPDB are described in Chapter 4. Of the 29 studies reviewed from the upper Midwest, 11 were identified for inclusion in the database and of the 46 studies reviewed from the Chesapeake Bay watershed, nine were identified for inclusion. Note that data entry spreadsheets for eight studies from each of these regions were completed, as further described in Chapter 4. Appendix A contains a Microsoft Excel spreadsheet of all the reviewed studies and is available by request.

Table 3-1. Studies Not Selected for Inclusion.

Study	Title	Reason Not Selected for Inclusion
Acuña & Villamil 2014	Short-Term Effects of Cover Crops and Compaction on Soil Properties and Soybean Production in Illinois	Not a water quality study
Al-Kaisi, Yin, & Licht 2005	Soil Carbon and Nitrogen Changes as Influenced by Tillage and Cropping Systems in Some Iowa Soils	Not a water quality study
Andraski, Mueller, & Daniel 1985	Phosphorus Losses in Runoff as Affected by Tillage	Outside study area
Angle et al. 1984	Nutrient Losses in Runoff from Conventional and No-Till Corn Watersheds	Already included in database
Angle et al. 1993	Soil Nitrate Concentrations under Corn as Affected by Tillage, Manure, and Fertilizer Applications	Not a water quality study
Angle, Gross, & McIntosh 1989	Nitrate Concentrations in Percolate and Groundwater under Conventional and No-Till *Zea mays (L.)* Watersheds	Insufficient data
Ardón et al. 2010	The Water Quality Consequences of Restoring Wetland Hydrology to a Large Agricultural Watershed in the Southeastern Coastal Plain	Outside study area
Axt & Walbridge 1999	Phosphate Removal Capacity of Palustrine Forested Wetlands and Adjacent Uplands in Virginia	Not a peer-reviewed publication
Bamber et al. 2016	Importance of Soil Properties on Recommended Biosolids Management for Winter Wheat	Not a water quality study
Bamber et al. 2018	Rapid Estimation of Potentially Mineralizable N in Early Spring Following Fall Biosolids Applications to Winter Wheat	Not a water quality study
Barrow et al. 1997	Effects of Fe and Ca Additions to Dairy Wastewaters on Solids and Nutrient Removal by Sediments	Does not meet study design criteria
Basche et al. 2016	Soil Water Improvements with the Long-term Use of a Winter Rye Cover Crop	Not a water quality study
Benham et al. 2007	Surface Water Quality Impacts of Conservation Tillage Practices on Burley Tobacco Production Systems in Southwest Virginia	Does not meet study design criteria
Bowden et al. 2007	Mineralization and N Fertilizer Equivalent Value of Composts as Assessed by Tall Fescue (*Festuca arundinacea*)	Not a water quality study
Bundy, Andraski, & Powell 2001	Management Practice Effects on Phosphorus Losses in Runoff in Corn Production Systems	Outside study area

Study	Title	Reason Not Selected for Inclusion
Chichester 1977	Effects of Increased Fertilizer Rates on Nitrogen Content of Runoff and Percolate from Monolith Lysimeters	Does not meet study design criteria
Chinkuyu et al. 2002	Effects of Laying Hen Manure Application Rate on Water Quality	Does not meet study design criteria
Christianson et al. 2016	Ten Ways to Reduce Nitrogen Loads from Drained Cropland in the Midwest	Insufficient data
Clover 2005	Impact of Nitrogen Management on Corn Grain Yield and Nitrogen Loss on a Tile Drained Field	Not a peer-reviewed publication
Collins and Gillies 2014	Constructed Wetland Treatment of Nitrates: Removal Effectiveness and Cost Efficiency	Insufficient data
Cooke, Nehmelman, & Kalita 2002	Effect of Tile Depth on Nitrate Transport from Tile Drainage Systems	Not a peer-reviewed publication
Dabney, Delgado, & Reeves 2001	Using Winter Cover Crops to Improve Soil and Water Quality	Not a water quality study
Dean & Weil 2009	Brassica Cover Crops for Nitrogen Retention in the Mid-Atlantic Coastal Plain	Does not meet study design criteria
Denver et al. 2014	Nitrate Fate and Transport through Current and Former Depressional Wetlands in an Agricultural Landscape, Choptank Watershed, Maryland, United States	Not an agricultural BMP
Dinnes et al. 2002	Nitrogen Management Strategies to Reduce Nitrate Leaching in Tile-Drained Midwestern Soils	Not a water quality study
Dougherty et al. 2009	Nitrogen Values of Liquid Dairy Manure and Dry Broiler Litter as Affected by Preservation Treatment	Not a water quality study
Drinkwater, Wagoner, & Sarrantonio 1998	Legume-Based Cropping Systems Have Reduced Carbon and Nitrogen Losses	Not a water quality study
Evanylo & Alley 1997	Presidedress Soil Nitrogen Test for Corn in Virginia	Not a water quality study
Evanylo et al. 2008	Soil and Water Environmental Effects of Fertilizer-, Manure-, and Compost-Based Fertility Practices in an Organic Vegetable Cropping System	Does not meet study design criteria
Evanylo 1989	Rate and Timing of Nitrogen Fertilizer for White Potatoes in Virginia	Not a water quality study
Evanylo 1990	Dryland Corn Response to Tillage and Nitrogen Fertilization. I. Growth-Yield-N Relationships	Not a water quality study
Evanylo 1991	No-Till Corn Response to Nitrogen Rate and Timing in the Middle Atlantic Coastal Plain	Not a water quality study
Evanylo 2003	Effects of Biosolids Application Timing and Soil Texture on Nitrogen Availability for Corn	Not a water quality study
Feyereisen et al. 2006	Potential for a Rye Cover Crop to Reduce Nitrate Loss in Southwestern Minnesota	Does not meet study design criteria
Gilmour et al. 2003	Decomposition and Plant-Available Nitrogen in Biosolids: Laboratory Studies, Field Studies, and Computer Simulation	Not a water quality study

Study	Title	Reason Not Selected for Inclusion
Hall et al. 1993	Effects of Agricultural Nutrient Management on Nitrogen Fate and Transport in Lancaster County, Pennsylvania	Already included in database
Hansen et al. 2018	Contribution of Wetlands to Nitrate Removal at the Watershed Scale	Not an agricultural BMP
Jaynes et al. 2001	Nitrate Loss in Subsurface Drainage as Affected by Nitrogen Fertilizer Rate	Already included in database
Johnson et al. 2011	Effect of Dairy Manure Slurry Application in a No-Till System on Phosphorus Runoff	Does not meet study design criteria
Jordan et al. 2003	Nutrient and Sediment Removal by a Restored Wetland Receiving Agricultural Runoff	Not an agricultural BMP
Justes, Mary, & Nicolardot 1999	Comparing the Effectiveness of Radish Cover Crop, Oilseed Rape Volunteers, and Oilseed Rape Residues Incorporation for Reducing Nitrate Leaching	Outside study area
Kanwar et al. 1995	Clean Water - Clean Environment - 21st Century: Team Agriculture - Working to Protect Water Resources: Conference Proceedings: Volume II: Nutrients	Insufficient data
Kanwar et al. 2005	Corn-Soybean and Alternative Cropping Systems Effects on NO3-N Leaching Losses in Subsurface Drainage Water	Already included in database
Kibet et al. 2011	Phosphorus Runoff Losses from Subsurface-Applied Poultry Litter on Coastal Plain Soils	Does not meet study design criteria
Kleinman et al. 2004	Evaluation of Phosphorus Transport in Surface Runoff from Packed Soil Boxes	Does not meet study design criteria
Knox et al. 2008	Efficacy of Natural Wetlands to Retain Nutrient, Sediment, and Microbial Pollutants	Outside study area
Kuo & Sainju 1998	Nitrogen Mineralization and Availability of Mixed Leguminous and Non-Leguminous Cover Crop Residues in Soil	Outside study area
Kuo, Huang, & Bembenek 2001	Effect of Winter Cover Crops on Soil Nitrogen Availability, Corn Yield, and Nitrate Leaching	Outside study area
Langland et al. 1995	Hydrology and the Effects of Selected Agricultural Best-Management Practices in the Bald Eagle Creek Watershed, York County, Pennsylvania, Prior to and During Nutrient Management: Water-Quality Study for the Chesapeake Bay Program	Already included in database
Lawson et al. 2013	Nitrogen Contribution of Rye-Hairy Vetch Cover Crop Mixtures to Organically Grown Sweet Corn	Outside study area
Lee et al. 2016	Impacts of Watershed Characteristics and Crop Rotation on Winter Cover Crop Nitrate-Nitrogen Uptake Capacity within Agricultural Watersheds in the Chesapeake Bay Region	Does not meet study design criteria

Study	Title	Reason Not Selected for Inclusion
Lemus & White, 2017	Evaluation of Cover-Crop Mixes for Agronomic Performance and Forage Quality under Mississippi Conditions	Outside study area
Lietman et al. 1997	Evaluation of Agricultural Best Management Practices in the Conestoga River Headwaters, PA: Effects of Pipe-Outlet Terracing on Quality and Quantity of Surface Runoff and Ground Water in a Small Carbonate-Rock Basin Near Churchtown, PA, 1983-89	Already included in database
Lizotte et al. 2012	Mitigating Agrichemicals from an Artificial Runoff Event using a Managed Riverine Wetland	Outside study area
Lowman 2013	Evaluation of Floating Treatment Wetlands in Stormwater Retention Ponds on Poultry Farms to Reduce Nutrient Loading	Not a peer-reviewed publication
Lowrance et al. 1997	Water Quality Functions of Riparian Forest Buffers in Chesapeake Bay Watersheds	Not a water quality study
Mahimairaja et al. 1994	Losses and Transformation of Nitrogen during Composting of Poultry Manure with Different Amendments: An Incubation Experiment	Outside study area
McVay, Radcliffe, & Hargrove 1989	Winter Legume Effects on Soil Properties and Nitrogen Fertilizer Requirements	Outside study area
Meisinger et al. 1991	Effects of Cover Crops on Groundwater Quality	Does not meet study design criteria
Myers & Wagger 1996	Runoff and Sediment Loss from Three Tillage Systems under Simulated Rainfall	Outside study area
Owens 1987	Nitrate Leaching Losses from Monolith Lysimeters as Influenced by Nitrapyrin	Does not meet study design criteria
Park et al. 1994	BMP Impacts on Watershed Runoff, Sediment, and Nutrient Yields	Insufficient data
Peterjohn et al. 1986	The Effect of Riparian Forest on the Volume and Chemical Composition of Baseflow in an Agricultural Watershed	Already included in database
Pierson et al. 2001	Phosphorus and Ammonium Concentrations in Surface Runoff from Grasslands Fertilized with Broiler Litter	Outside study area
Puckett 2004	Hydrogeologic Controls on the Transport and Fate of Nitrate in Ground Water beneath the Riparian Buffer Zones: Results from Thirteen Studies across the United States	Outside study area
Randall & Vetsch 2005	Nitrate Losses in Subsurface Drainage from a Corn-Soybean Rotation as Affected by Fall and Spring Application and Nitrogen and Nitrapyrin	Already included in database
Randall et al. 1997	Nitrate Losses through Subsurface Tile Drainage in Conservation Reserve Program, Alfalfa, and Row Crop Systems	Already included in database

Study	Title	Reason Not Selected for Inclusion
Reinhardt et al. 2005	Phosphorus Retention in Small Constructed Wetlands Treating Agricultural Drainage Water	Outside study area
Sharpley & Kleinman 2003	Effect of Rainfall Simulator and Plot Scale on Overland Flow and Phosphorus Transport	Not a water quality study
Sherman, Van Horn, & Nordstedr 2000	Use of Flocculants in Dairy Wastewaters to Remove Phosphorus	Does not meet study design criteria
Shields & Pearce 2010	Control of Agricultural Nonpoint Source Pollution by Natural Wetland Management	Outside study area
Shipitalo et al. 2013	Effect of No-Till and Extended Rotation on Nutrient Losses in Surface Runoff	Outside study area
Snyder 1998	Impact of Riparian Forest Buffers on Agricultural Nonpoint Source Pollution	Already included in database
Sommer 2001	Effect of Composting on Nutrient Loss and Nitrogen Availability of Cattle Deep Litter	Outside study area
Spargo et al. 2006	Repeated Compost Application Effects on Phosphorus Runoff in the Virginia Piedmont	Does not meet study design criteria
Staver & Brinsfield 1998	Using Cereal Grain Winter Cover Crops to Reduce Groundwater Nitrate Contamination in the Mid-Atlantic Coastal Plain	Insufficient data
Vanotti & Hunt 1999	Solids and Nutrient Removal from Flushed Swine Manure using Polyacrylamides	Outside study area
Vaughan & Evanylo 1998	Corn Response to Cover Crop Species, Spring Desiccation Time, and Residue Management	Not a water quality study
Vaughan & Evanylo 1999	Soil Nitrogen Dynamics in Winter Cover Crop-Corn Systems	Not a water quality study
Verbree, Duiker, & Kleinman 2010	Runoff Losses of Sediment and Phosphorus from No-Till and Cultivated Soils Receiving Dairy Manure	Does not meet study design criteria
Weller, Baker, & Jordan 2011	Effects of Riparian Buffers on Nitrate Concentrations in Watershed Discharges: New Models and Management Implications	Does not meet study design criteria
Whigham, Chitterling, & Palmer 1988	Impacts of Freshwater Wetlands on Water Quality: A Landscape Perspective	Not an agricultural BMP

CHAPTER 4

Summary of Studies Identified for Addition to the Database

A total of 11 studies from the upper Midwest and nine studies from the Chesapeake Bay watershed were identified for inclusion in the AgBMPDB. Data entry spreadsheets were compiled for eight studies from the Chesapeake Bay watershed and eight studies from the upper Midwest. The original goal of this project was to identify and prepare data entry spreadsheets for 12 studies from the upper Midwest and 12 studies from the Chesapeake Bay watershed. However, many of the studies are complicated and required more time from senior staff than expected. In addition, some of the studies that were initially thought to be a good fit for the database were found to be missing key pieces of information as they were closely reviewed during data entry. As a result, more time was spent than anticipated on gathering studies, particularly in the Chesapeake Bay watershed, which had a more limited number of studies meeting the criteria for entry into the database described in Chapter 3.

For the eight studies in the upper Midwest and eight studies in the Chesapeake Bay watershed with completed data entry spreadsheets, test site numeric codes were assigned as Year + Organization ID + Study ID per the suggestion of Wright Water Engineers, Inc. The Center's ID is 008 and the University of Illinois' ID is 009. For example, a code of 2018008001 refers to the first study entered by the Center in 2018. The study sites were numbered sequentially in the order they were reviewed for completion of the data entry spreadsheets. Table 4-1 provides a summary of the study sites with completed data entry spreadsheets for inclusion in the AgBMPDB.

Table 4-1. Studies Identified for Inclusion with Completed Data Entry Spreadsheets.

Study	Test Site Code	Title	Midwest or Chesapeake Bay	BMP	Pollutant	Study Design
Jaynes et al. 2004	2018009001	Using the Late Spring Nitrate Test to Reduce Nitrate Loss within a Watershed	Midwest	Nutrient Management Plan	Nitrate	Paired Sites (Multiple Tests, With Control); Subwatershed Scale
Jaynes & Colvin 2006	2018009002	Corn Yield and Nitrate Loss in Subsurface Drainage from Midseason Nitrogen Fertilizer Application	Midwest	Nutrient Management Plan	Nitrate	Paired Sites (Multiple Tests, With Control); Plot Scale
Qi et al. 2011	2018009003	Nitrate-Nitrogen Losses through Subsurface Drainage under Various Agricultural Land Covers	Midwest	Cover Crop; Forage and Biomass Planting	Nitrate	Paired Sites (Multiple Tests, With Control); Plot Scale
Bakhsh et al. 2002	2018008001	Cropping System Effects on NO3-N Loss with Subsurface Drainage Water	Midwest	Conservation Tillage	Nitrate	Paired Sites (Multiple Tests, With Control); Plot Scale

Study	Test Site Code	Title	Midwest or Chesapeake Bay	BMP	Pollutant	Study Design
Kovacic et al. 2000	2018008002	Effectiveness of Constructed Wetlands in Reducing Nitrogen and Phosphorus Export from Agricultural Tile Drainage	Midwest	Constructed Wetlands	Nitrate, Ammonium Nitrogen, Organic Nitrogen, Total Nitrogen, Dissolved Phosphorus, Organic Phosphorus, Total Phosphorus, Dissolved Organic Carbon	Inflow – Outflow; Field Scale
Lawlor et al. 2011	2018008003	Comparison of Liquid Swine Manure and Aqua-Ammonia Nitrogen Application Timing on Subsurface Drainage Water Quality in Iowa	Midwest	Nutrient Management Plan	Nitrate	Paired Sites (Multiple Tests, No Control); Plot Scale
Rosen and Christianson 2017	2018008004	Performance of Denitrifying Bioreactors at Reducing Agricultural Nitrogen Pollution in a Humid Subtropical Coastal Plain Climate	Chesapeake Bay	Denitrifying Bioreactors	Nitrate, Ammonium, Total Nitrogen, Orthophosphate, Total Phosphorus	Inflow-Outflow; Farm Scale
Bock et al. 2018	2018008005	Performance of an Under-Loaded Denitrifying Bioreactor with Biochar Amendment	Chesapeake Bay	Denitrifying Bioreactor	Nitrate, Total Phosphorus	Inflow-Outflow; Field Scale
Hassanpour et al. 2017	2018008006	Seasonal Performance of Denitrifying Bioreactors in the Northeastern United States: Field Trials	Chesapeake Bay	Denitrifying Bioreactors	Nitrate, Dissolved Organic Carbon	Inflow-Outflow; Field Scale
Inamdar et al. 2001	2018008007	BMP Impacts on Sediment and Nutrient Yields from an Agricultural Watershed in the Coastal Plain Region	Chesapeake Bay	Overall Site (Multiple Practices)	Sediment, and Soluble and Particulate Forms of Nitrogen and Phosphorus	Before-After; Watershed Scale
Mendez et al. 1999	2018008008	Sediment and Nitrogen Transport in Grass Filter Strips	Chesapeake Bay	Grass Filter Strips	Total Suspended Sediment, Nitrate, Ammonium, Total Kjeldahl Nitrogen	Paired Sites (Multiple Tests, With Control); Plot Scale

Study	Test Site Code	Title	Midwest or Chesapeake Bay	BMP	Pollutant	Study Design
McFarland, 1995	2018008009	Ground-water Flow, Geochemistry, and Effects of Agricultural Practices on Nitrogen Transport at Study Sites in the Piedmont and Coastal Plain Physiographic Provinces, Patuxent River Basin, Maryland	Chesapeake Bay	Conservation Tillage, Contour Farming	Total Nitrogen	Other[1]
Helmers et al. 2012	2018008010	Water Table, Drainage, and Yield Response to Drainage Water Management in Southeast Iowa	Midwest	Drainage Water Management	Nitrate	Paired Sites (Multiple Tests, With Control); Plot Scale
Rekha et al. 2011	2018008011	Nitrate Leaching to Shallow Groundwater Systems from Agricultural Fields with Different Management Practices	Midwest	Conservation Tillage	Nitrate	Paired Sites (Multiple Tests, No Control); Plot Scale
Koerkle et al. 1997	2018008012	Surface-Water Quality Changes after 5 Years of Nutrient Management in the Little Conestoga Creek Headwaters, Pennsylvania, 1989-91	Chesapeake Bay	Nutrient Management	Nitrogen, Phosphorus, Suspended Sediment	Paired Sites (Multiple Tests, With Control); Small Watershed Scale
Koerkle et al. 1997	2018008013	Evaluation of Agricultural Best Management Practices in the Conestoga River Headwaters, Pennsylvania: Effects of Nutrient Management on Water Quality in the Little Conestoga Creek Headwaters, 1983-89.	Chesapeake Bay	Nutrient Management	Nitrogen, Phosphorus, Suspended Sediment	Paired Sites (Multiple Tests, With Control); Small Watershed Scale

[1]Experimental design was a six-year monitoring study based on changes in agricultural practices at the study sites to meet the changing needs of the farming operations. Note that this was a complex study that may be difficult to interpret through addition in the AgBMPDB.

Additional studies identified for inclusion in the AgBMPDB that do not have data entry spreadsheets due to time constraints mentioned are provided in Table 4-2.

Table 4-2. Studies Identified for Inclusion without Completed Data Entry Spreadsheets.

Study	Title	Midwest or Chesapeake Bay	BMP
Mitsch et al. 2005	Nitrate-Nitrogen Retention in Wetlands in the Mississippi River Basin	Midwest	Constructed Wetlands
Randall et al. 2003	Nitrate Losses in Subsurface Drainage from a Corn-Soybean Rotation as Affected by Time of Nitrogen Application and Use of Nitrapyrin	Midwest	Nutrient Management Plan
Tomer et al. 2010	Groundwater Nutrient Concentrations During Prairie Reconstruction on an Iowa landscape	Midwest	Land Use Change
Myers et al. In Press	Treatment of Agriculture Stormwater Runoff by a Cascading System of Stormwater Containment Basins	Chesapeake Bay	Water and Sediment Control Basin/Pond

CHAPTER 5

Conclusions and Recommendations

In addition to the initial data entry, this project further tested the willingness of research partners to allow their data to be shared in the database and the level of time and effort to review, assemble and input the data. Potential barriers identified for population of the AgBMPDB include the level of effort to complete data entry spreadsheets, difficulty in finding studies that meet the criteria for inclusion in the database, and limited knowledge of the database by researchers. All of the researchers contacted agreed with the need and value of the database, but none were aware that it existed.

The original goal of this project was to identify and prepare data entry spreadsheets for 12 studies from the upper Midwest and 12 studies from the Chesapeake Bay watershed. However, many of the studies are complicated and required more time from senior staff than expected. In addition, some of the studies that were initially thought to be a good fit for the database were found to be missing key pieces of information as they were closely reviewed during data entry. As a result, more time was spent than anticipated on gathering studies, particularly in the Chesapeake Bay watershed, which had a more limited number of studies meeting the criteria for entry into the database described in Chapter 3. Data entry spreadsheets required a minimum of three to four hours per study to read, interpret, and complete the spreadsheet.

A total of 82 studies were reviewed, but not selected for addition to the AgBMPDB. Twenty-five studies were either outside the upper Midwest and Chesapeake Bay watershed study areas for this project, had unknown locations, or were literature reviews covering multiple regions. Those that were located within the study areas were not identified for inclusion in the database due to the following reasons:

- 10 were already included in the database
- 17 did not meet the study design criteria. Many of the studies were based on modeling results and/or simulated rainfall, whereas the intention of this project was to obtain monitoring studies that were conducted under real world and not modeled or simulated conditions.
- Six had insufficient data. Many of these studies contained data in graphical format that would need to be interpreted instead of results provided in tabular format or directly included as part of the study narrative. Future contact of authors of these studies may yield information that could make the record complete and allow for the work to be included in the database.
- Four were not peer-reviewed publications and included a master's thesis and two conference proceedings papers.
- 21 were not water quality studies. Instead, the focus of these studies included soil nutrient properties and crop yield. A few literature review publications were also included in this category.
- Four were not based on agricultural BMPs. These studies were all based on natural wetlands as opposed to constructed wetlands.

Further promotion of the AgBMPDB among researchers across the country would be beneficial in order to promote their involvement in both identifying potential studies that could be added to the database and entering their own research results. A significant amount of time was required to read and interpret the studies as part of this project that could be eliminated if researchers were willing to complete data entry spreadsheets for their own study results. Demonstrating the value of the database to researchers will be a key component to their participation.

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