



United States
Department
of Agriculture

Technical
Bulletin
Number 1913

March 2005



Electronic Report from the Economic Research Service

www.ers.usda.gov

Technical Documentation of the Regional Manure Management Model for the Chesapeake Bay Watershed

Marcel Aillery, Noel Gollehon, and Vince Breneman

Abstract

The Regional Manure Management Model, developed for the ERS project on “Manure Management for Improved Water Quality,” is used to evaluate the cost and feasibility of manure land application as a manure management strategy at the regional level. This model is a nonlinear mathematical programming model of animal manure-nutrient production and distribution applied to the Chesapeake Bay watershed. The model is designed to assess regional costs of manure management, transport, and land application in the Chesapeake Bay watershed, given the existing structure of the animal industry and manure-storage technologies currently in use. Manure-nutrient production is allocated within the basin to minimize costs to the animal sector, subject to land availability and policy provisions. A defining feature of the modeling system involves the integration—within an optimization framework of spatial data from a Geographic Information System and farm-level data from the 1997 Agricultural Census—aggregated to the county level. The framework captures important spatial interactions involving animal concentrations and land available for manure spreading that can significantly affect manure land application costs faced by animal producers.

Keywords: Technical documentation, regional analysis, Chesapeake Bay, animal waste, manure management, nutrient management plan, manure land application, manure transport, cost minimization, optimization model.

Acknowledgments

We would like to thank Utpal Vasavada, Margriet Caswell, Marca Weinberg, and Marc Ribaldo for providing administrative support throughout development of the regional modeling analysis under the Manure and Water Quality Research Project. Valuable assistance in data development and document review was provided by Jean Agapoff, Shawn Bucholtz, Glenn Carpenter, Lee Christensen, Robert Johannson, Robert Kellogg, Daniel Meyer, Dave Moffitt, Jim Pease, and Arthur Stoecker. Finally, we appreciate the editorial assistance of Carol Jones, Sharon Lee, and Tom McDonald in preparation of the technical documentation, and we also thank Wynnice Pointer-Napper for the design and layout of the report.

Cover Photo: NASA - Goddard Space Flight Center Scientific Visualization Studio.

Contents

Summary .....	.iv
Introduction .....	.1
Overview of Modeling Framework .....	.4
Model Scope .....	.5
Model Spatial Scale .....	.6
Model Variables and Activities .....	.7
Model Data .....	.8
Manure-Nutrient Production and Use .....	.8
Technology Use and Input Costs .....	.11
Distance Functions for Manure Hauling .....	.14
Model Equation System .....	.21
Output Generation .....	.26
Conclusion and Future Extensions .....	.30
References .....	.32
Appendix .....	.34