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Field Handbook

Chapter 15

**Computer Software and
Models**

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651.1500 Introduction

The planning and design of an Agricultural Waste Management System (AWMS) requires an evaluation of alternative approaches in addressing an environmental concern. The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) uses computer software to speed and enhance this process. The software includes several nutrient assessment models and a component design program. This chapter of the Agricultural Waste Management Field Handbook (AWMFH) provides a brief description of available computer software and reference material.

651.1501 Planning software

Customer Service Toolkit (CST) is the primary conservation planning tool used by the NRCS, conservation districts, and technical service providers (TSP). CST is used for conservation planning and design, layout, and evaluation of approved conservation practices. With CST, the user can create and check in customer data to the National Conservation Planning Database (NCPDB) and also check out customer data from the NCPDB. In addition, the customer data is made available to the Performance Reporting System (PRS).

TSPs have an important role in the conservation planning process. With proper permissions, TSPs have access to the CST and NCPDB data via the Conservation Transaction Plug In Tool. Further information and guidance on the TSP certification process can be found at <http://techreg.usda.gov>.

Within the CST application resides a front-end ESRI® ArcGIS®¹ interface to geo-reference and digitize farming/ranching operations, fields, conservation practices, and other needed features. The ArcGIS application consists of a table of contents that contains the layers that may be displayed in the View. A menu bar and toolbars comprise the graphical user interface. Several pop-up menus are available using a right-mouse click to assist in planning.

¹ ESRI and ArcGIS are trademarks, registered trademarks, or service marks of ESRI in the United States, the European Community, or certain other jurisdictions.

651.1502 Animal waste management design software

Animal Waste Management (AWM) software is a planning and design tool, providing assistance with the calculations associated with manure management systems. Using estimated daily production of manure, bedding, and process water, it supports the design of lagoons, storage ponds, storage tanks, and stacking facilities. The procedures and calculations used in AWM are based on information from the AWMFH and use average monthly precipitation and evaporation data. The program also supports the design of anaerobic and aerobic lagoons with multiple cells and operated either alone or in combination with other manure storage facilities. Options for anaerobic lagoon design include the AWMFH procedure and Clyde Barth's Rational Method (Barth 1985). The program also allows the user to print preconfigured design and/or operation and maintenance reports. Customized reports can be generated by using design variables imbedded in the report templates. Since the release of Version 2.4, AWM has the added capability of evaluating existing storage structures.

AWM also includes Manure Master, a simplified tool used to estimate the amount of cropland that will be needed for the nutrients produced by an animal feeding operation. Manure Master computes a gross nutrient balance between the nitrogen, phosphorus, and potassium content in the manure and the quantity of these nutrients used by crops. This balance can be calculated based upon recommended fertilizer application rates when known or upon estimated plant nutrient content when recommended fertilizer application rates are not known. For nitrogen, the balance is calculated taking into account expected losses from leaching, denitrification, and volatilization. Manure Master does not track mass or concentration of nutrients for determining land application rates or for other utilization components; therefore, Manure Master is not a sufficient nutrient management tool for producing a nutrient plan that will comply with the criteria in NRCS National Conservation Practice Standard (CPS) Code 590, Nutrient Management.

651.1503 Site modeling software

The Soil-Plant-Air-Water (SPAW) Field and Pond Hydrology Model is a software tool developed by the USDA Agricultural Research Service (ARS) to perform a one-dimensional water budget on agricultural fields using daily values. It can evaluate AWM designs by examining in detail how runoff and other inputs affect the resulting pond volumes. While this tool is fairly complex, it is ideally suited for special studies and evaluations where daily values are preferred over average monthly values. The performance of wastewater storage systems are modeled by SPAW using a water budget in the vertical dimension to simulate runoff, infiltration, evapotranspiration, percolation, and the water content of the soil profile. Including manure and process water inputs along with periodic pumping data allows the program to estimate the effects of management upon a given storage system.

651.1504 Nutrient management software

Manure Management Planner^{® 2} (MMP) is a Windows^{®3}-based computer program, developed at Purdue University, used for development of nutrient management plans CPS Code 590 and Comprehensive Nutrient Management Plans (CNMPs) for crop and animal feeding operations. The user enters information about the operation's fields, crops, storage, animals, and application equipment. MMP streamlines the allocation process of both organic and inorganic nutrients (where, when, and how much) on a monthly basis for the length of the plan (1–10 years). This allocation process helps determine if the current operation has sufficient crop acreage, seasonal land availability, manure storage capacity, and application equipment to manage the manure produced in an environmentally responsible manner. MMP is also useful for identifying changes that may be needed for a nonsustainable operation to become sustainable and determining what changes may be needed to keep an operation sustainable if the operation expands.

Further information on MMP is available at <http://www.purdue.edu/mmp>. More information on the CNMP development process is available in the CNMP Field Handbook available at <http://directives.sc.egov.usda.gov/viewerFS.aspx?hid=25650>.

Base data for nutrient management planning is available from various locations and entities. To streamline this process and make it user friendly, the University of Missouri developed a data finder routine available to the public for download. Please note that the needed data can be pulled from other sources, as long as the data are authenticated.

- University of Missouri National Data Finder Web site located at http://www.nmplanner.missouri.edu/software/national_data.asp. The clipped download zip file contains the following base data:
 - Aerial photograph of the farm
 - Topographic map of the farm
 - Digitized soil survey layer for the farm

- Revised Universal Soil Loss Equation, Version 2 (RUSLE2) database that contains crop management zone, climate, and soils data required by RUSLE2 for the farm. The clipping feature automatically creates a RUSLE2 database for the farm's area that can be used with MMP.

The Geospatial Nutrient Tool (GNT), developed by the NRCS in cooperation with the University of Missouri, is the spatial front end for NRCS conservation planners and used prior to streaming data to MMP. Its primary purpose is to enable NRCS planners to download previously accomplished work contained in the CST software. GNT operates as a toolbar within the CST application and runs in the ArcGIS 9.x environment. NRCS planners can access a customer's folder, produce or modify maps, and push the data to MMP to expedite development of an NRCS CNMP document. GNT includes the National Setbacks Database to provide access to manure setback requirements for the states currently supported by MMP. More States will be added as the MMP rollout to States continues. The tool is used primarily by nutrient management planners. Further information on GNT is available at <http://www.wsi.nrcs.usda.gov/products/W2Q/nutr/nutrGNT.html>.

Conservation planners can also digitize operations that have not been digitized yet and also refine field features for farming operations that have already been digitized. Larger fields that are adequate for conservation planning purposes generally need to be divided into subfields for nutrient management planning purposes. In addition, there is a field setbacks tab that steps the user through various voluntary and regulatory setbacks regarding nutrient (generally manure) applications. These setbacks are important when determining "spreadable acres" for manure applications, and developing a farm nutrient balance.

TSPs and other private industry individuals currently do not have access to the GNT. However, with the landowner's permission and NRCS authorization, TSPs can be granted access to NRCS client information using the Conservation Transaction Plug In Tool and use the client data in their own software to make nutrient management and CNMP changes. Changes made can also be uploaded back to the NRCS CST for NRCS usage.

² MMP is copyrighted by the Purdue Research Foundation.

³ Microsoft, Encarta, MSN, and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

The National Setbacks Database was developed by the University of Missouri in cooperation with the NRCS. The software is Windows[®]-driven, offered free of charge, and available at <http://nmplanner.missouri.edu/software/setbacks.asp>. The site currently provides access to manure setback requirements by categories established by each individual State, e.g., regulatory, NRCS, and other State-setback options. At present, setback requirements are furnished for the 34 States currently supported by MMP. More States will be added as the MMP rollout to States continues. The tool is used primarily by nutrient management planners.

AFOPro^{® 4} is a standalone nutrient management planning tool with optional connections to geographic information systems (GIS) such as ESRI ArcMap[™] and ArcView[®], and the NRCS's AWM (ver. 2.0.2 or higher) engineering software⁵. The application allows the user to plan manure and commercial fertilizer allocation decisions in compliance with CPS Code 590, which requires the documentation of form, source, timing, method, and placement of nutrients. The design of the application is open, transparent, and flexible, enabling it to be adapted to specific State crop removals, nutrient risk ratings, and nitrogen accounting requirements. Additionally, the application uses modular Phosphorus Indices (PI), State-specific fertility recommendations and State-specific CNMP templates.

The Idaho OnePlan Nutrient Management Planner^{® 6} provides data and software to help growers develop a single conservation farm plan that can be pre-endorsed by interested agencies, streamlining and simplifying the regulatory process for animal feeding operations. Several States use OnePlan for CNMP creation and offer training on its use.

4 AFOPro is intellectually copyrighted by the University of South Carolina Research Foundation (USCRF# 00354).

5 ESRI, ArcMap, and ArcView are trademarks, registered trademarks, or service marks of ESRI in the United States, the European Community, or certain other jurisdictions.

6 OnePlan is copyrighted by the University of Idaho.

651.1505 Site assessment software

The Nitrate Leaching and Economic Analysis Package (NLEAP) is a field-scale computer model developed to provide a rapid and efficient method of determining potential nitrate leaching associated with agricultural practices at a given location. It combines basic information concerning on-farm management practices, soils, and climate and then translates the results into projected nitrogen budgets and nitrate leaching below the root zone and to groundwater supplies and estimates the potential offsite effects of leaching.

The screening procedure uses a simplified annual water and nitrogen budget and is designed to give only a general estimate of potential leaching of nitrate. The monthly budget analysis calculates leaching with consideration for the seasonal and monthly effects of precipitation, temperature, evapotranspiration, and farm management. The event-by-event analysis provides the best estimate of nitrate leaching. Its water and nitrogen budgets track the impacts of each precipitation, irrigation, fertilization, and tillage event on potential nitrate leaching. The event-based procedure is recommended for analysis of potential nitrate leaching to domestic water supply. NLEAP can be operated alone or in conjunction with a GIS system.

The Agricultural Policy/Environmental eXtender⁷ (APEX) model was developed by USDA Agricultural Research Service (ARS) and Texas A&M University for use in whole farm/small watershed management. The model was constructed to evaluate various land management strategies considering sustainability, erosion (wind, sheet, and channel), economics, water supply and quality, soil quality, plant competition, weather, and pests. Management capabilities include irrigation, drainage, furrow diking, buffer strips, terraces, waterways, fertilization, manure management, lagoons, reservoirs, crop rotation and selection, pesticide application, grazing, and tillage. Besides the farm management functions, APEX can be used in evaluating the effects of global climate/CO² changes; designing environmentally safe, and economical landfill sites; designing biomass production systems for energy; and other spin-off applications. The model operates on a

7 Blackland Research and Extension Center, Texas A&M University (<http://www.brc.tamus.edu>).

daily time step and is capable of simulating hundreds of years if necessary. Farms may be subdivided into fields, soil types, landscape positions, or any other desirable configuration. Currently, APEX is not directly integrated with a GIS.

The individual field simulation component of APEX is taken from the Erosion/Productivity Impact Calculator (EPIC) model, developed by the USDA ARS. The drainage area considered by EPIC is generally a field-sized area, up to 247 acres (100 ha), where weather, soils, and management systems are assumed to be homogeneous. The major components in EPIC are weather simulation, hydrology, erosion-sedimentation, nutrient cycling, pesticide fate, plant growth, soil temperature, tillage, economics, and plant environment control. Although EPIC operates on a daily time step, the optional Green and Ampt infiltration equation simulates rainfall excess rates at shorter time intervals (0.1 h). The model offers options for simulating several other processes including five potential evapo-transpiration (PET) equations, six erosion/sediment yield equations, and two peak runoff rate equations. EPIC can be used to compare management systems and their effects on nitrogen, phosphorus, pesticides and sediment. The management components that can be changed are crop rotations, tillage operations, irrigation scheduling, drainage, furrow diking, liming, grazing, tree pruning, thinning, and harvest, manure handling, and nutrient and pesticide application rates and timing.

The APEX model was developed to extend the EPIC model capabilities to whole farms and small watersheds. In addition to the EPIC functions, APEX has components for routing water, sediment, nutrients, and pesticides across complex landscapes and channel systems to the watershed outlet. APEX also has groundwater and reservoir components. A watershed can be subdivided as much as necessary to assure that each subarea is relatively homogeneous in terms of soil, land use, management, etc. The routing mechanisms provide for evaluation of interactions between subareas involving surface runoff, return flow, sediment deposition and degradation, nutrient transport, and groundwater flow. Water quality in terms of nitrogen (ammonium, nitrate, and organic), phosphorus (soluble and adsorbed/mineral and organic), and pesticides concentrations may be estimated for each subarea and at the watershed outlet. Commercial fertilizer or manure may be applied at any rate and depth on specified dates or automatically. The GLEAMS

pesticide model is used to estimate pesticide fate considering runoff, leaching, sediment transport and decay. Because of routing and subdividing there is no limit on watershed size. However, a practical limit may be about 965 square miles (2,500 km²) because of the detailed crop/management system of APEX. APEX has its own data bases for weather simulation, soils, crops, tillage, fertilizer, and pesticides.

The PI is a site vulnerability assessment tool to help determine the relative risk for offsite transport of phosphorus and manure. The PI is a useful tool for prioritizing fields for the application of animal manure or other organic by-products that contains phosphorus. It may also be used to identify fields on which more careful management of phosphorus may be necessary by assessing the various landforms and management practices for potential risk of phosphorus movement to water bodies. The ranking of PI identifies sites where the risk of phosphorus movement may be relatively higher than that of other sites. Corrective soil and water conservation practices and management techniques can then be used to reduce the potential for movement of phosphorus and reduce the concern for excessive phosphorus enrichment. Each State may modify the PI, based on local criteria.

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