Available online at www.sciencedirect.com
ScienceDirect
Computers and Electronics in Agriculture 57 (2007) 190–201
Computers and electronics in agriculture
www.elsevier.com/locate/compag

Review

# Integrated decision support system (DSS) for manure management: A review and perspective

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Received 23 June 2006; received in revised form 26 February 2007; accepted 8 March 2007

**Abstract**

For centuries, livestock manure has been utilized as a valuable soil amendment and fertilizer for crops. The continuing growth of the livestock industry in both developed and developing countries coupled with the implementation of rigorous environmental regulations and protocols are increasing the importance of appropriate manure management systems and practices. A systematic approach to manure management must involve the identification and evaluation of criteria that are necessary for the design and selection of optimal manure management systems. The purpose of such a decision-making process is to analyze the system parameters and to recommend site-specific and need-based parameters that result in an optimized manure management strategy. The objectives of this article were to identify manure management criteria, review some of the available decision support systems and to suggest ways for integrating systems components. Not surprisingly, environmental considerations have been found to top the list of manure management criteria. Most of the existing decision-support tools are based on very specific aspects, for example nutrient management. The need to develop whole-farm decision-support tools that address all the major components of manure management systems, such as manure collection, storage, treatment, and land application, has been identified. Integrated decision support systems (DSS) should play a major role in the identification of the most suitable manure management system for a given livestock operation.


*Keywords:* Decision support systems (DSS); Manure management; Design criteria

## Contents



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0168-1699/$ – see front matter 
doi:10.1016/j.compag.2007.03.006

## 1. Introduction

Manure has always been considered as a valuable input to the soil for crop production. In a broad sense, manure management relates to the appropriate use of animal manure according to each farm's capabilities and goals while enhancing soil quality, crop nutrition, and farm profits (Nowak et al., 1998). Manure management is defined as a decision-making process aiming to combine profitable agricultural production with minimal nutrient losses from manure, for the present and in the future (Brandjes et al., 1996). Appropriate manure management systems (MMS) are becoming increasingly important, firstly because of the increasing population of livestock animals and the growth of the livestock industry, and secondly as a result of the implementation of environmental regulations and protocols. Increasing environmental and sustainability concerns lengthen planning horizons and increase the number of decision variables that must be considered in management planning (Li et al., 1994). The selection of manure management and treatment options increasingly depends on environmental regulations for preventing pollution of land, water and air. For example, regulated reductions in ammonia emissions could influence the housing management, the storage and treatment of manure, and methods of land application (Westerman and Bicudo, 2005).

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1997 and became international law in 2005 (Boehm, 2005). Under this protocol, parties agreed to legally-binding greenhouse gas (GHG) emission reduction targets intended to reduce global GHG emissions to about 5% below 1990 levels during the first commitment period, which covers the years 2008–2012. In livestock production, manure management constitutes a potential area for reducing GHG emissions. Greenhouse gases are generated at all stages of manure management: collection, handling/storage, treatment, land application, etc. The use of an appropriate decision support system (DSS) could assist livestock operators in identifying MMS or components that have a positive impact on the reduction of GHG emissions.

A number of criteria determine the suitability of a given MMS components. The main purpose of the research on the systematic approach to manure management is to identify and assess the relative importance of such criteria, which are required for the design, evaluation, and selection processes of alternate MMS (Laguë et al., 2000). Decisions related to the design, selection, and operations of MMS are difficult and complex because of the heterogeneity of manure, options for managing in different forms with different end uses, cost factors, related soil and crop factors, etc. (Stonehouse, 1991). The objectives of this article were to: (1) identify the criteria required for the selection, design, and operation of livestock MMS, (2) review some of the available decision support systems (DSS) for manure management and (3) suggest ways for integrating different options and their components.

## 2. Criteria for DSS in manure management

Traditionally, manure has been directly recycled into soil-crop agricultural systems as an amendment and a fertilizer. However, an increasing number of constraints must now be considered when designing, selecting, and operating MMS. In order to appropriately bridge increased animal production and more demanding environmental laws and regulations, the Livestock-Environment and Development initiative is emphasizing a decision support tool (DST) on manure management to facilitate the identification, evaluation, and selection of manure management options for confined pig production in rapidly growing economies (LEAD-FAO, 2003). Design and operation of a MMS requires the simultaneous consideration of environmental and economic outcomes (Ogilvie et al., 2000). Magette et al. (2002) developed a list of '*Best Available Techniques*' for the Irish pig and poultry producers that meets integrated pollution prevention control (IPPC) regulations. Recommended techniques for the overall waste management mainly focused on environmental management systems (EMS) incorporating modifications on feed composition and manure handling from production facilities. Criteria used in formulating manure management guidelines for the Western Washington region of the USA included water quality, local support and application, and economic feasibility (Peterson, 1995).