

CORN MANAGEMENT SYSTEM FOR REDUCING GROUNDWATER CONTAMINATION

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Groundwater contamination is becoming an acute problem, especially in rural areas where farms and rural communities depend on groundwater for drinking. Recently, the agricultural community has become keenly aware of the impact that agricultural practices such as fertilizer and water applications can have on groundwater quality. Over-use of chemicals and water can increase the risk of groundwater contamination. Groundwater contamination by nitrate originating from inefficient fertility and irrigation management practices has become a prevalent issue. Since corn is a major crop in the high plains of Colorado, a crop management system was developed for irrigated corn to assist farmers in maintaining or increasing yield while minimizing the nitrate leaching potential. This system is an attempt to combine irrigation water management with fertilizer management into a single decision support package.

One of the main objectives of this model was to incorporate experience based (heuristic) knowledge together with procedural methods into a management system that simulates a human expert. Thus, the first task was to acquire knowledge from corn field experts and research. Knowledge acquisition was performed in a three-step process. First, information pertaining to the domain was compiled from current, available literature. Secondly, a broad questionnaire was sent to local domain experts regarding fertilizer management. The questionnaire was designed to highlight the factors considered when fertilizer recommendations are made and to clarify the relationships between these factors. This knowledge was used to: assess the knowledge from the literature, establish the scope and boundaries of the domain being represented, formulate some general rules, and delineate additional unresolved considerations. The third step involved direct interviews with experts familiar with the domain of interest. From the literature and heuristic knowledge, the methods used to drive the system were extracted.

The crop management system consists of an irrigation scheduler, a fertility scheduler, and a vadoze zone leaching model. Each model is independent and can be operated in a stand-alone environment. However, the models have been developed to operate together as an integrated system under the governance of a central control program.

The irrigation scheduler uses a traditional soil water mass balance approach and the concept of a critical soil water depletion level to trigger irrigation recommendations. The system operates in a real-time mode using daily weather data to estimate reference and crop evapotranspiration, and can forecast irrigation requirements one day in advance. Management allowable depletion levels can be selected for each crop growth stage. The stage of crop development, daily crop coefficient, and irrigation decision calculations can be estimated using either the season days or a growing degree day model. Reference evapotranspiration can be calculated using the Kimberly Penman, Jensen-Haise, or modified Hargreaves methods. Reference ET can also be directly input if it is calculated from a different source. The user can select the choice of units with which the model works and can calibrate the reference ET methods if site-specific calibration information exists. The irrigation scheduler has been developed to be used with any crop for which crop coefficients are available.

The fertility scheduler provides preseason nutrient recommendations for three nutrients, nitrogen, phosphorus, and potassium. It does not make recommendations for micronutrient. The fertility model has been designed as a preseason management tool, therefore it does not provide mid-season revisions which might be deemed necessary by monitoring the soil and crop conditions. The phosphorus and potassium recommendations are based upon an availability indices approach. The nitrogen recommendation is based upon three independent methods; the CSU soil test method, an inorganic nitrogen mass balance, and a crop use efficiency method. Each method is providing a recommendation independently of the other. If there is disagreement between the three methods a conflict resolution scheme is then used to resolve the discrepancies among the three decisions and obtain a single recommendation. The model schedules the nutrient recommendations for specific fertilizer materials in applications across the season.

The leaching model utilizes the management information produced by the irrigation scheduler and fertility scheduler to evaluate the potential impacts of the management strategy on nitrate leaching. The leaching model calculates the amount of water deep percolating and the nitrate available for leaching during a season. From this information it then calculates the potential amount of nitrate that will leach. The model provides an analysis of the nitrate leaching implications of the proposed management strategy. It uses a modified quadratic/plateau model to estimate the yield reduction that would be sustained if the amount of nitrogen fertilizer applied was reduced to minimize the leaching problem.

The software is written in ANSI C and has a complete screen-based windowing environment. The software requires two megabytes of hard disk memory and 640 kilobytes of random access memory. The system runs on an MS-DOS platform. Because of the size and complexity, the model requires a 286 or higher IBM compatible MS-DOS personal computer. The system is user friendly and easy to use. It has pull-down menus and is self explanatory.

This system has been developed to be used by any person who is involved in crop management decision support for irrigated corn. Potential users include farmers, agronomists, agricultural consultants, and extension personnel. By providing the agricultural community with a consultation tool that can be used to produce management strategies that minimize the potential for groundwater contamination, we hope to help minimize future water quality problems resulting from fertilizer use on irrigated corn.

Farmer acceptance of this crop management system will be largely based upon: 1) the ease with which it can be used, and 2) the quality of the management advice it provides. The system has been designed with usability and applicability specifically in mind. A fully interactive user interface environment has been developed to allow the user to easily utilize the systems potential.