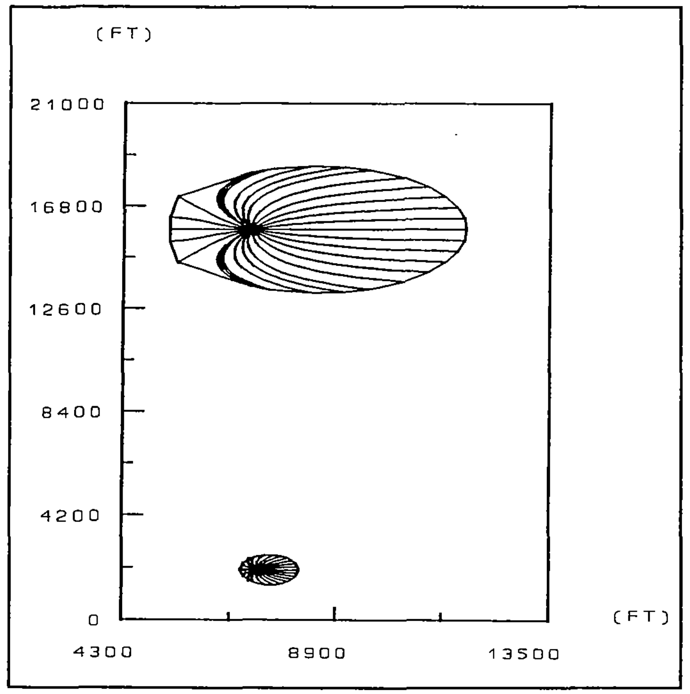

Figure 5. Sample Output from CANDI: Wellhead Protection Area Delineation Option.

In sprinkler irrigation, efficiency is a function of the uniformity coefficient, the fraction of area adequately irrigated, and soil characteristics. These variables are required as inputs. The sprinkler irrigation module estimates the soil storage efficiency. The module uses the approach of Hart and Reynolds (1965) to predict the total infiltrated depth of water for the prescribed combination of parameters. Ranjha et. al. (1992a and 1992b) showed how furrow and sprinkler irrigation system simulation can be linked with pesticide simulation to provide useful design charts.

Total infiltrated depth, soil data, crop data, and pesticide data are subsequently used as inputs for a module that emulates the simulation abilities of the widely-used Chemical Movement in Layered Soil, CMLS (Nofziger and Hornsby, 1986). This module calculates the relative amount of pesticide that reaches a prescribed depth after a period of time has elapsed. CANDI also delineates the capture zones for all wells within a study area. CANDI incorporates the Multiple Well Capture Zone module (MWCAP) for this purpose (USEPA, 1990). MWCAP provides efficient delineation of steady-state, time-related, and hybrid capture zones for wells in homogeneous aquifers. Knowing the capture zone of his well, the user might select different water/pesticide management schemes for inside the capture zone than for outside it.

CANDI's Input and Output

CANDI runs on an IBM PC or compatible with at least 512 K of RAM, hard and floopy disks. CANDI has a sophisticated user interface designed for people having minimal PC experience. CANDI presents output as full-screen enhanced graphics. Figures 2–5 show some CANDI outputs (see Aly and Peralta, 1993).

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CANDI: A Decision Support System for Management of Agricultural Pesticides with Irrigation

Richard C. Peralta and Alaa H. Aly

Authors are respectively, Professor and Graduate Student, Dept. of Biological and Irrigation Engineering, Utah State University, Logan, Utah 84322-4105.

The use of pesticides is an integral part of today's agriculture. Pesticides contribute significantly to improved crop productivity and to public health. Some pesticides, even in extremely low concentrations, can pose a risk to human health and to the environment. Applied to plants or soil, pesticides can leach to the groundwater or may be washed off by surface water. A portion of water that has fallen on the earth, either from precipitation or irrigation, infiltrates the soil through pore spaces. As water moves downward under the influence of gravity, it dissolves materials, including pesticides and other chemicals. Once this contaminated water reaches the groundwater aquifer, horizontal and vertical movement of the pesticide will occur.

Objective

The objective of this fact sheet is to describe a user-friendly Decision Support System, CANDI (Figure 1), that can aid managing agricultural pesticides and irrigation systems by considering their groundwater contamination potential (Aly and Peralta, 1993). The acronym CANDI stands for Chemicals AND Irrigation.

CANDI facilitates estimating the relative reduction of potential pesticide contamination of groundwater achievable by improved water/pesticide management. By comparing the potential contamination results of different water management schemes, best management systems (BMSs) can be selected. When BMSs are implemented, the likelihood of groundwater contamination is reduced. CANDI uses the concept of relative amount of pesticide. The relative amount is the fraction of the applied chemical that exists in the soil profile by the time the pesticide reaches groundwater.

CANDI Overview

In order to help the user estimate the effect of different management practices on the potential contamination of groundwater, CANDI can do the following:

1. For a particular irrigation system design, CANDI can predict which pesticide will yield the most acceptable relative amount of pesticide at a specific depth. In this case, the user must provide CANDI with the irrigation system efficiency, soil and crop data, weather information, pesticide application dates, and depth for

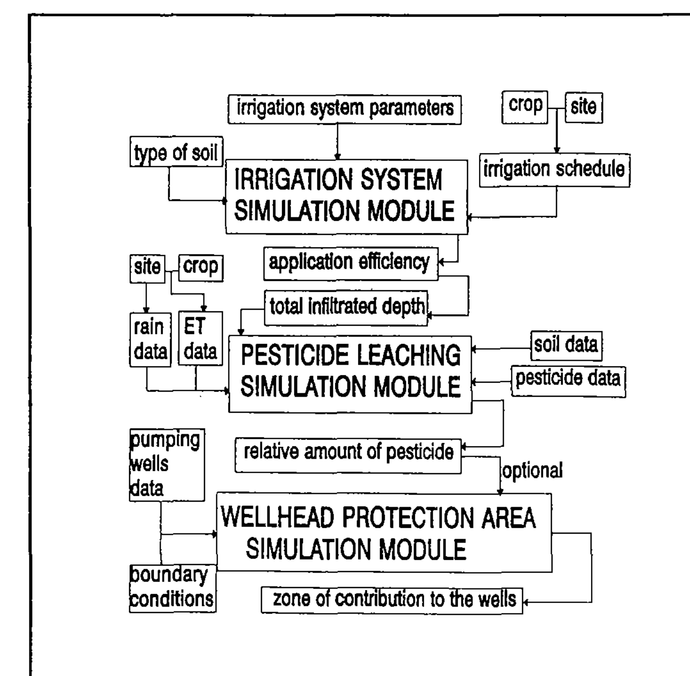

Figure 1. Flow Chart of CANDI.

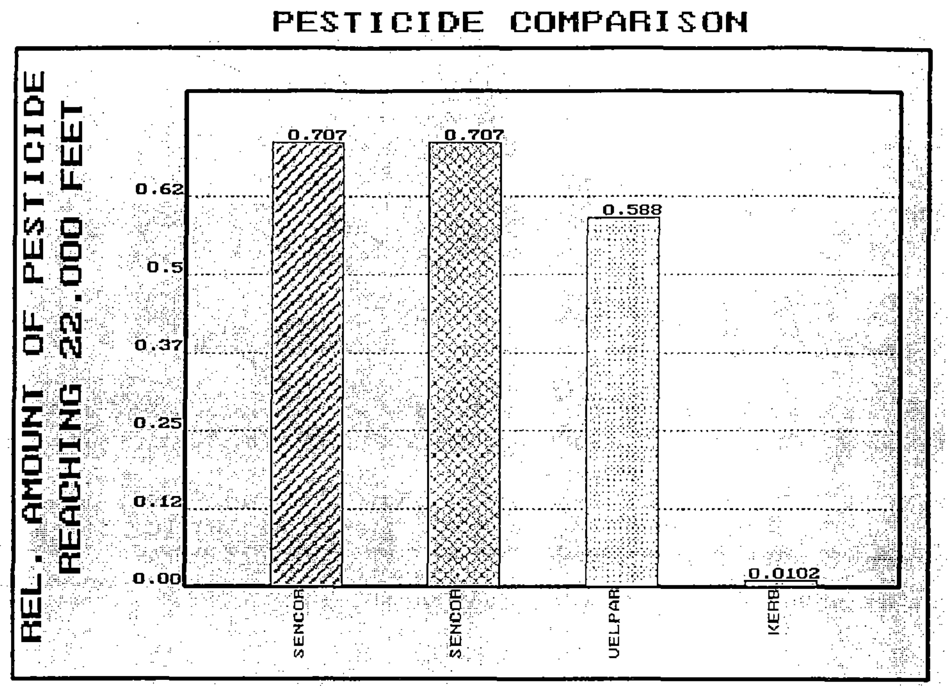

Figure 2. Sample Output from CANDI: Pesticides Comparison Option.

evaluation (probably the depth to water table or capillary fringe). Figure 2 shows typical output from CANDI for this scenario.

2. For a selected range of possible irrigation system designs, CANDI can show which irrigation system design will result in the least relative amount of pesticide reaching a specific depth. For this option, the user provides CANDI with the pesticide's physical and chemical properties, application dates, cultivated crop data, soil data, and weather information. For the surface irrigation system, CANDI produces curves showing relative amount as a function of furrow inflow rate for a range of furrow lengths. Figure 3 shows typical output from CANDI for the furrow irrigation comparison option. For sprinkler irrigation systems, relative amount is shown as a function of a range of two design parameters, uniformity coefficient and fraction of area adequately irrigated. Figure 4 shows typical output from CANDI for the sprinkler irrigation comparison option.

3. CANDI can delineate the zones of contributing groundwater to specified wells during prescribed travel times. This permits the user to know where using pesticides is especially hazardous to groundwater consumers. For this optional output, the user must provide CANDI with pumping wells data and aquifer parameters (storativity and transmissivity or hydraulic conductivity). Figure 5 shows typical output from CANDI for the wellhead protection area option.

Predicting the amount of pesticide that will leach to the groundwater involves using several computer simulation modules in series. CANDI facilitates and automates this process. CANDI is designed for use by persons only slightly familiar with groundwater hydraulics or chemical leaching processes.

Methodology

CANDI contains several simulation modules. The modules are efficiently coded and integrated to achieve rapid processing for all applications (Figure 1). The first module simulates the irrigation system, either furrow or sprinkler. In any irrigation system, reduction in potential pesticide contamination can be achieved by efficient water application. Efficiency, in turn, is a function of several factors.

In furrow irrigation, efficiency is a function of the furrow length, inflow rate, topography, and soil characteristics. These variables are used as inputs for the surface irrigation simulation module, part of SIRMOD (Walker and Humphreys, 1983). It predicts the water storage efficiency for a specified surface irrigation system at the site of interest and for a specific irrigation schedule. The module predicts the total infiltrated depth of water for the prescribed combination of parameters. CANDI provides a database of information needed to apply this simulation approach to Utah conditions.

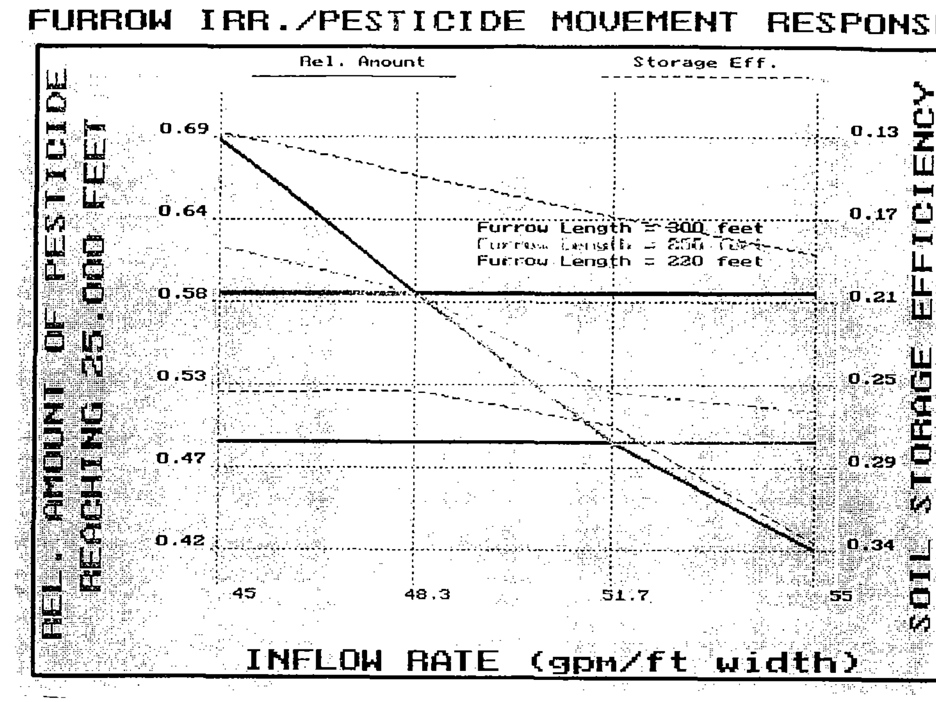

Figure 3. Sample output from CANDI: Furrow Irrigation Comparison Option.

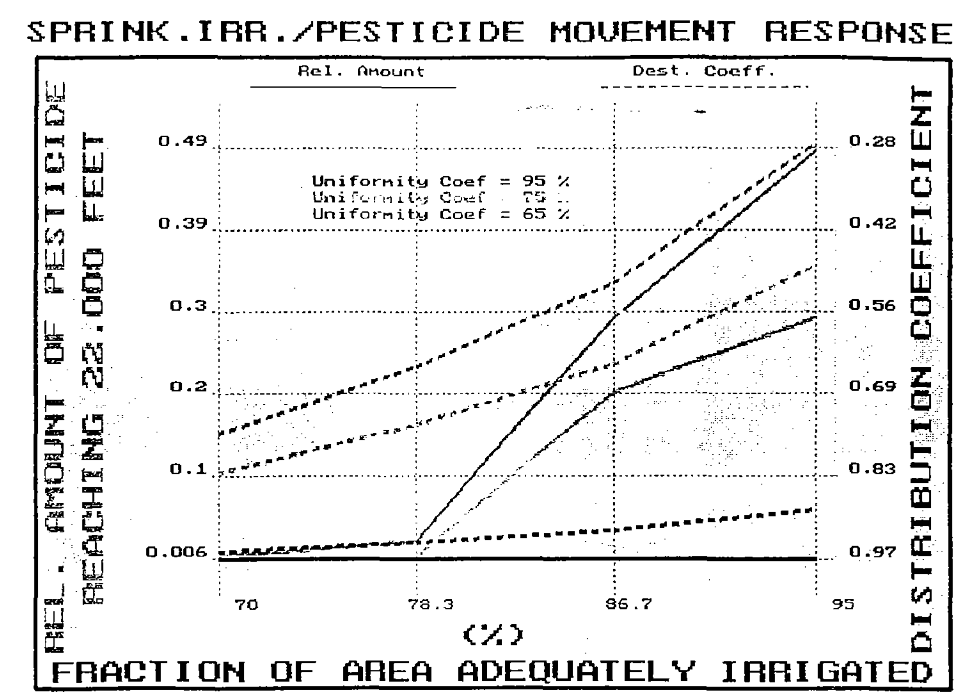

Figure 4. Sample Output from CANDI: Sprinkler Irrigation Comparison Option.