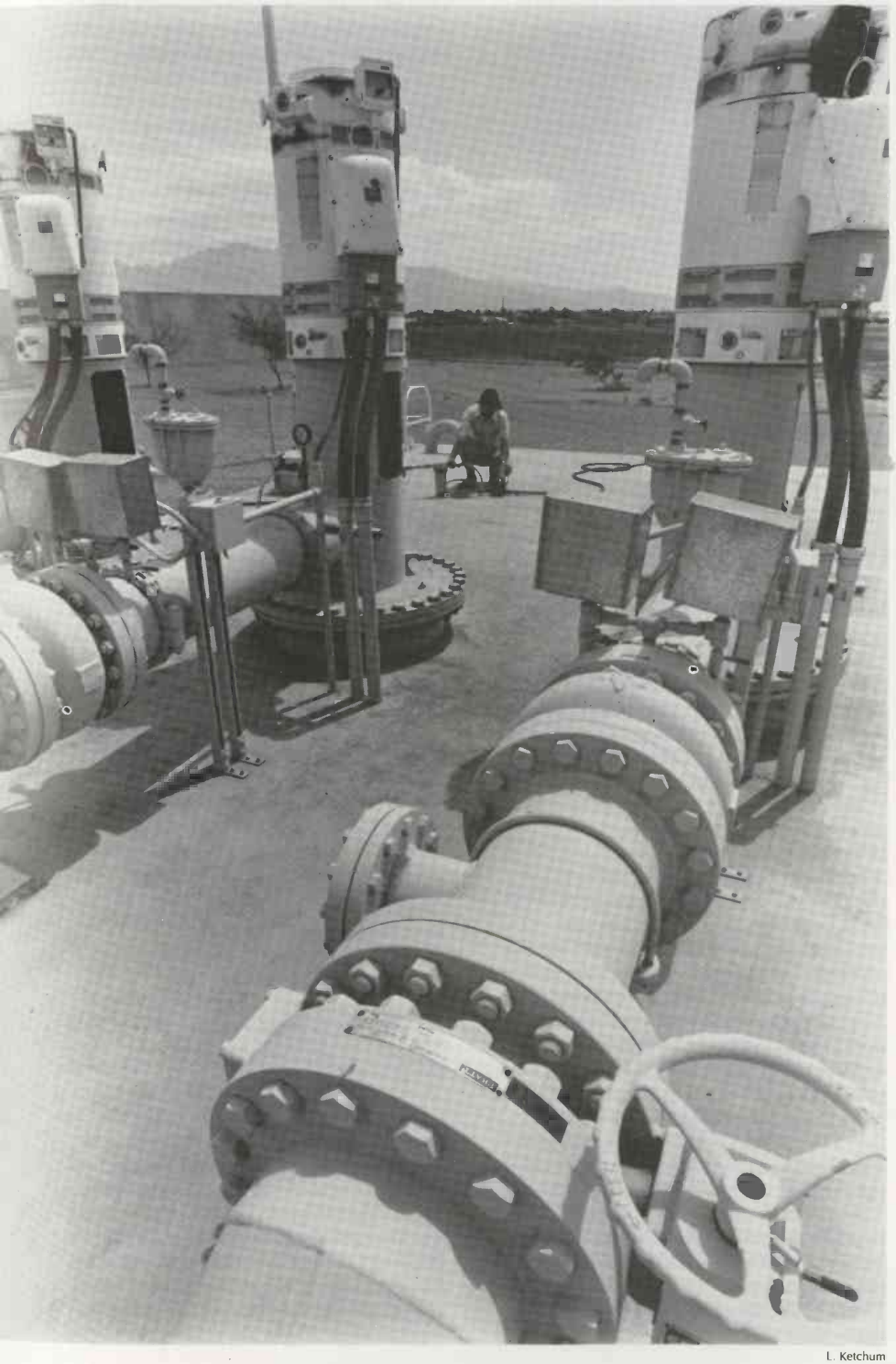
MAKING EVERY DROP COUNT



L. Ketchum

Safe Reuse of Wastewater

Rapid urbanization and resulting population centers in Arizona are exerting an increasing demand on our limited water resources. As a result, reuse of domestic sewage is playing an increasing role to meet current and future water needs in the state. Reclaimed sewage effluents are used at over 100 locations in the state for irrigation of golf courses, parks and crops. While night soil and sewage have been used on agricultural land since ancient times, public health concerns have limited its widespread use in this country. Sewage may contain disease causing organisms which can be transmitted to persons who come into contact with it or through contamination of food or drinking water.

For the public to reap the full benefits of wastewater reuse without suffering potential harmful effects, Arizona has established strict guidelines for the quality of the reclaimed wastewater. In establishing these guidelines, Arizona became the first state to set limits on the occurrence of enteric viruses and parasites in reclaimed wastewater. These organisms are responsible for a wide variety of diseases, including hepatitis and diarrhea. While disease causing bacteria are easily removed by conventional sewage treatment processes, removal of viruses and parasites requires advanced treatment.

The goal of research in our laboratory is the development of simple, low cost, and rapid methods for the detection of these organisms in wastewater and the evaluation of innovative methods for their removal.

Our laboratory has been responsible for the development of methods capable of detecting as few as one virus or parasite in 100–500 gallons of water. Application of such methods ensures the almost complete absence of disease causing organisms in water. This has been possible by the development of filters capable of concentrating the organisms from water and the application of recent advances in the area of biotechnology. Detection of

waterborne parasites such as *Giardia* and *Cryptosporidium* is made easier by the use of monoclonal antibodies labeled with fluorescent dyes. Perhaps most exciting is the development of gene probes in the detection of viruses. Gene probes are small pieces of nucleic acid (either DNA or RNA) that attach to complementary genes of the virus you wish to detect. The attachment is detected by labeling the probe with radioactive compounds or enzymes which in the presence of the proper substance will cause a color change which can be seen. We have been able to develop ultrasensitive gene probes capable of detecting one infectious virus in a water or food sample. These probes now reduce virus detection from 1–6 weeks to 2–3 days and dramatically reduce the costs.

Application of this technology to the monitoring of reclaimed wastewater is ensuring that the maximum safe reuse of this resource is occurring in Arizona.

Dr. Charles P. Gerba
Dr. Aaron Margolin
Joan Rose
Nutrition and Food Science

Desert House

"Desert House," now being planned and designed, is a project to demonstrate water and energy conservation practices and techniques to the general public, developers, home builders, business people and government officials. Conceptual plans call for a family to live at "Desert House," which is to be located at the Desert Botanical Garden in Phoenix. The family is expected to demonstrate conservation practices and techniques as it uses water and energy in its daily, domestic routines. Visitors will be welcomed to tour the facility.

The project involves academic, government and private organizations working together. The UA Office of Arid Lands Studies and the College of Architecture are initiating the project with support from the City of Phoenix and the Salt River Project. Other participants include the Desert Botanical Garden, the Arizona Department of Water Resources and the Valley Partnership, a consortium of development-related organizations in the Phoenix area. A similar project is operating in Tucson. Called "Casa del Agua," it involved relandscaping and redesigning a conventional Tucson residence with water-saving and recycling devices.

Commercially available building materials and equipment as well as generally acknowledged concepts and methods are being considered in the plans for "Desert House." Various aspects of water and energy efficiency are being evaluated for possible demonstration including water-conserving landscaping; indoor use of water-conserving fixtures; cost-effective use of grey water and rainwater harvesting; energy-efficient appliances; energy-efficient heating and cooling; and thermal storage.

Public education is planned to be an important aspect of the home. Along with tours of the facility, a public area is expected to be available for videotape presentations and other educational demonstrations.

Dr. Martin Karpiscak
Arid Lands Studies

"Expertly" Selecting Irrigation Methods

Farmers are routinely asking experts for advise on various production systems in order to make many complex decisions. The evolution of microcomputer-based software packages and more powerful hardware is making possible the availability of tools like expert systems to help farmers in their decision-making.

Expert systems are computer programs which simulate the problem-solving process of a human expert, within a predefined domain. The systems use computer models of human reasoning and, when properly supplied with data and implemented, arrive at the same decision which the human expert would. They have advantages over the human expert because they are permanent, easy to transfer and document, consistent and affordable. Expert systems use a "shell", a program which incorporates a knowledge-representation language. This shell allows the developer of the system to incorporate the data and the reasoning processes necessary to rational decision-making.

Several expert systems have recently been developed for agricultural use and have shown promising results. This report describes a model expert system called ISELECT, developed to illustrate the concepts of water management and the procedures for choosing an irrigation system. It is not a "production" system, but information gained from its development is now being used to develop a full-scale one. The shell which ISELECT uses is called INSIGHT 2+, commercially available from Level Five Research, Inc., Indialamatic, Florida. The shell uses the knowledge-production language called Production Rule Language (PRL) for developing the knowledge base. In PRL, knowledge is represented as IF—AND—OR—THEN—ELSE rules. In ISELECT, these rules tie together site and situation factual information on soil, topography, crops, water supply, water quality, efficiency, labor, capital, energy, etc., and relate them to possible irrigation systems. Those systems which are considered are redesigned existing surface systems and level basins; intermittent- and continuous-move sprinkler systems; solid-set and permanent sprinkler systems; and trickle systems using emitters, porous tubes, bubblers and spitters.

In ISELECT the user is prompted to supply some basic data on soil, topography, crop, water supply, water quality, efficiency, labor, capital available and its cost, energy, and weather or environmental conditions under which it is intended to use the system. The selection is made based on the matching of the predicates given by the user with those in the knowledge base.

ISELECT is very user friendly and all that the user provides as input are the situation factors for the farm, which are asked for in screen prompts. The output, also on the screen, gives a recommended irrigation system.

Dr. Muluneh Yitayew
Dr. William E. Hart
Agricultural Engineering

Reservation Land and Water Use

In 1985, the Department of Agricultural Economics in cooperation with the Bureau of Applied Research in Anthropology and the Department of Political Science initiated a research and training project with the Salt River Pima-Maricopa Indian Community. The project, which is funded in part by the Ford Foundation, focuses on issues of land and water use on the reservation. A separate but complementary project, also

sponsored by the Ford Foundation, was developed by the Community to facilitate its cooperation with the UA.

The 3,500 members of the Salt River Pima-Maricopa Community face a number of dilemmas. The land they control along the urban frontier with Scottsdale, Tempe and Mesa is highly valued for residential and commercial development. Although the Indians cannot sell their land, they can enter into long-term development leases if they wish. The Community is unsure about what to do, especially since many of its members want to preserve their open, rural environment.

Until recently, about 15,000 acres of irrigated reservation land were leased to non-Indian farmers for the production of cotton, small grains and vegetables. The bad economic situation facing many Arizona farmers caused a number of lessees to terminate their leases. Faced with the problem of unutilized land and water, the Community wanted to evaluate its options. Researchers from the UA conducted economic analysis of several possible alternatives: a large tribal farm producing conventional Arizona field crops; a citrus farm producing navel oranges and tangelos; small-scale production and retail sale of desert and temperate trees and shrubs; small-scale production and direct sale of vegetables; tepary bean production; and mint production.

A portfolio management approach that includes costs and returns, market opportunities, and market risks was used to evaluate the above alternatives. Generally, crops with higher potential profits, such as vegetables, exhibit higher risks. Traditional Arizona crops such as cotton, alfalfa, and barley are associated with lower market risks and lower expected returns. Analysis of a hypothetical tribal farm producing conventional field crops under 1987 conditions indicated that it was not an economically feasible alternative to agricultural leasing.

Navel oranges and tangelos are a more favorable option. However, they entail higher market risks. Under the assumption of five years of low citrus prices, the citrus alternative becomes less profitable than leasing.

Small acreages of specialty crops, such as container trees and vegetables for direct marketing to consumers, also are more profitable than leasing. However, due to the uncertain local demand for these crops, they should be considered as one part of a crop mix containing low risk and high risk crops. This observation is relevant also for traditional Indian crops, such as tepary beans. Small acreages may be profitable, but large acreages may significantly reduce the price received.

Market opportunity (window) studies were conducted on alfalfa and 16 varieties of fresh vegetables. Alfalfa is potentially a good, low risk on higher than the rest of the state. Eleven of the 16 varieties of vegetables were rated as having fair to good prospects for profitable marketing.

Because of the need to monitor changing market conditions and to incorporate risk considerations in their decisions, the information provided by this study represents a starting point for the Community's evaluation of the alternative it faces. Community members have to evaluate the trade-off between potential risks and profits, and determine which alternatives best fit their preferences and abilities to bear risks.

Because of the current lack of management skills for operating agricultural enterprises, and in spite of the availability of land and water, the potential for Indian operated farms is extremely limited. It appears that much of the farming on the reservation will continue to involve leasing and other arrangements with non-Indian farmers.

Dr. Roger Fox
Roger Coupal
Agricultural Economics
Dr. Thomas McGuire
Applied Research in Anthropology

Estimating ET

It is difficult to estimate evapotranspiration (ET) over an entire watershed, especially in arid conditions, yet it is important to understand the spatial and temporal distribution of ET in order to develop rational, basin-wide, water management strategies.

The Owens Valley is an arid basin just east of the Sierra Nevada in central California. Despite the low annual precipitation (4 to 6 inches) the basin contains large quantities of ground-water derived from the nearby mountains. The Owens Valley is the major source of water for Los Angeles.

The Owens Valley is presently the focus of an intensive study of the relationships between vegetation and ground-water, conducted by the Los Angeles Department of Water and Power, the U.S. Geological Survey and the Inyo County, California Water Department. As part of this study, a team from the UA School of Renewable Natural Resources measured ET at two locations simultaneously for four days in early June, 1986. These measurements were made with portable battery powered Bowen ratio instrumentation that has been developed in the College of Agriculture to facilitate ET measurements over wildland and irrigated vegetation. A number of cooperators measured ET during this period, using several different methods in order to develop the methodology needed to assess area evapotranspiration.

Much of the Owens Valley is covered with dry site vegetation, such as rabbitbush, saltbush and greasewood. In many areas, this sparse vegetation extracts moisture from the near-surface water table. Wet meadows occupy only a small area of the Owens Valley, but they use water at a high rate from water tables that are typically within 3 feet of the surface, thus making their contribution to total ET losses significant.

The June ET measurements in the Owens Valley were about 0.1 inches per day at the dry site with the near-surface water table, and about 0.3 inches per day at the meadow. In comparison, ET losses during dry summer weather in southern Arizona approach zero in the Sonoran desert, and 0.36 inches per day for irrigated crops.

These results are being used with those of other investigators in the development and testing of a method to estimate ET over large areas from airborne measurements of surface temperature, using infrared sensors. Such information and methodology should prove useful in the development of management plans for the Owens Valley aquifer.

Dr. Lloyd W. Gay
Renewable Natural Resources

J. Chitwood

L. Ketchum

L. Ketchum

L. Ketchum