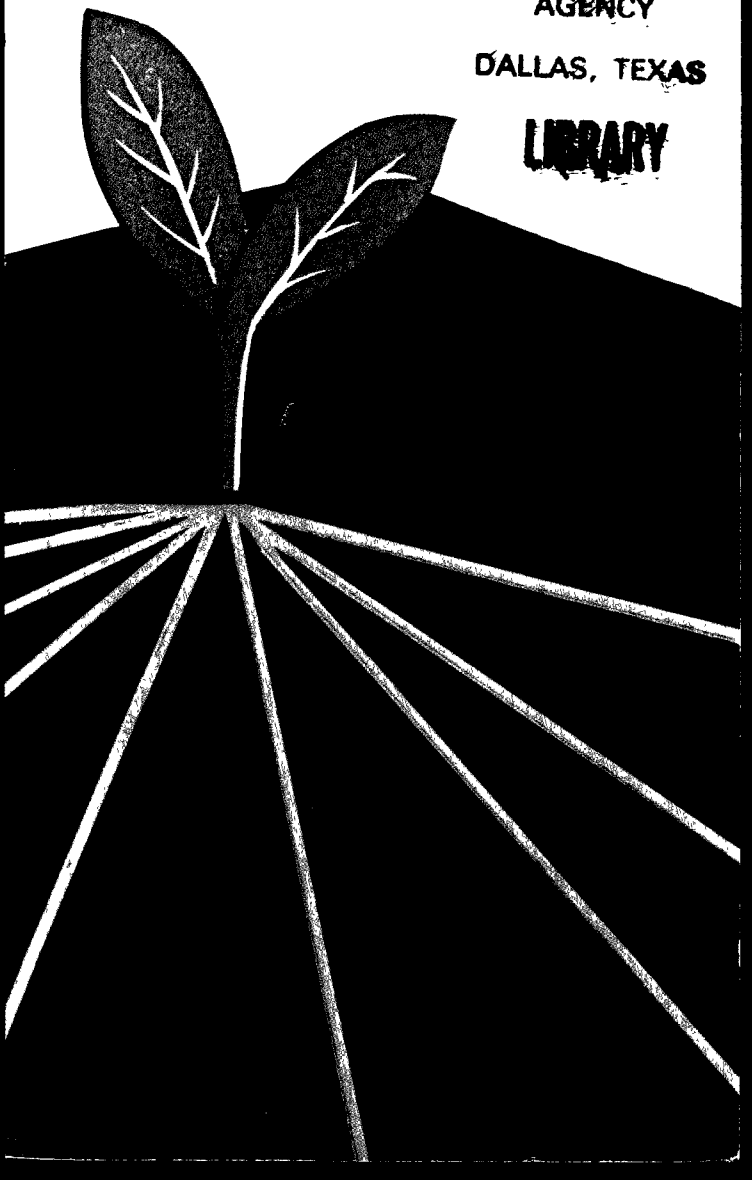
IRRIGATED AGRICULTURE AND WATER QUALITY MANAGEMENT



EPA-625/5-78-014
April 1978

Introduction

The EPA Irrigated Crop Production Research Program, located at the Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma, has made substantial progress in the past five or six years. Numerous research projects and investigations have been recently completed (or are nearing completion) which focused upon defining appropriate technologies for alleviating water quality problems from irrigated agriculture; most of these technologies involve improved water management practices. In addition, case studies have provided necessary experiences as to how such technologies might be implemented. These field experiences, combined with studies of legal approaches, as well as studies concerned with defining the processes of implementation and the socio-economic considerations that must be taken into account prior to and during implementation, have provided valuable insights as to the available alternatives for implementing programs of irrigation return flow quality management.

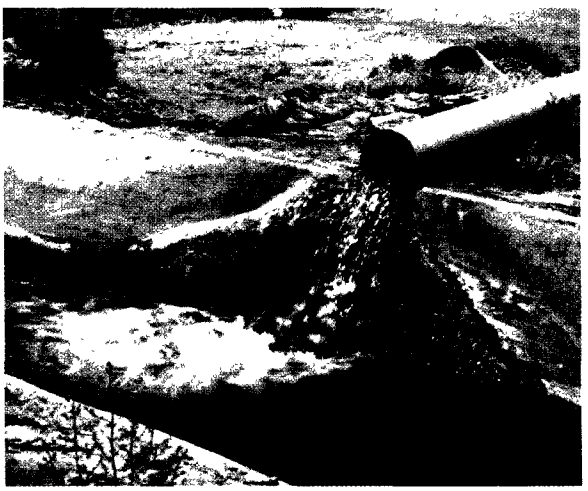
We are now at that point in time where sufficient research and investigation has been completed so that more intelligent decisions can be made to solve the water quality problems of irrigated agriculture. These problems need to be addressed. From a national and local standpoint, now is the time for everyone concerned to provide their input—to weigh the alternatives and voice their opinions—in order that appropriate and viable programs will be implemented that are sensitive to both local and national needs and priorities.

Dr. James P. Law Jr.
Robert S Kerr, Environmental
Research Laboratory
Ada, Oklahoma

Dr. Gaylord V. Skogerboe
Colorado State University
Ft. Collins, Colorado

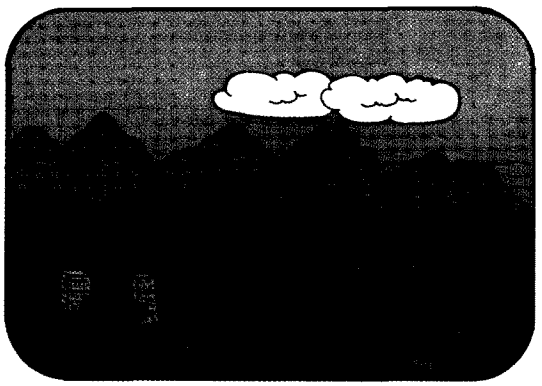
The Problem

All of man's water consumption activities result in pollution

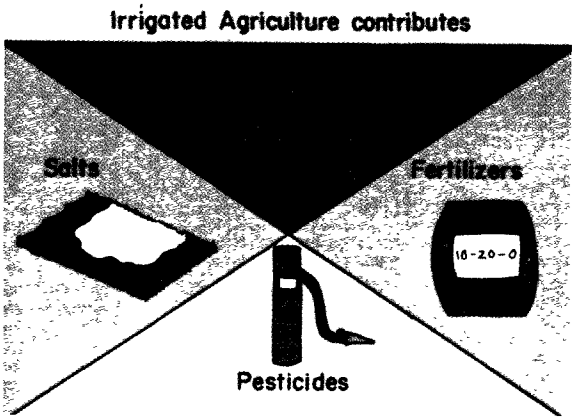


Irrigation Pollutes

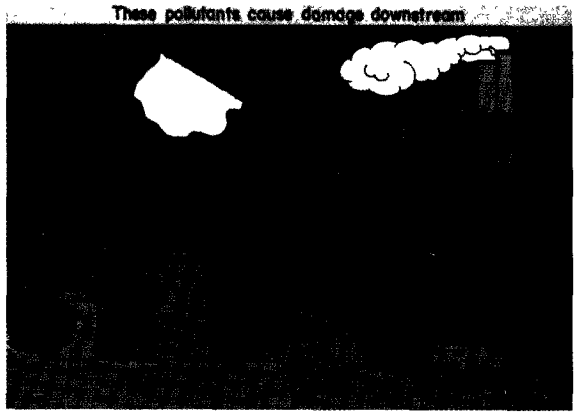
And, irrigation is the largest water consuming activity in the West.



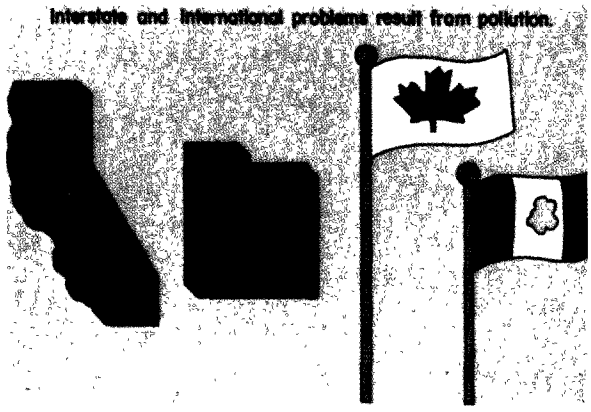
Irrigated agriculture contributes sediment, salts, fertilizers and pesticides (biocides) to ground and surface waters.



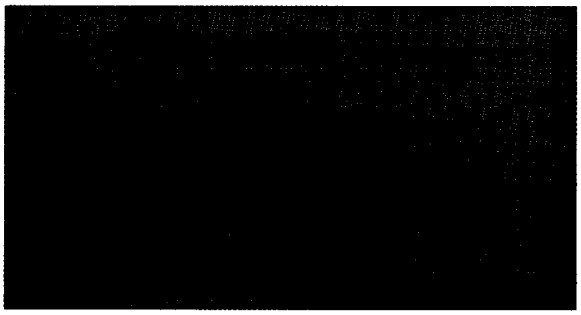
These pollutants result in damages to other irrigated areas, to wildlife habitats, cities and industries.



These pollution problems cross both state and international boundaries and affect our relations with neighboring states, the Republic of Mexico and Canada.

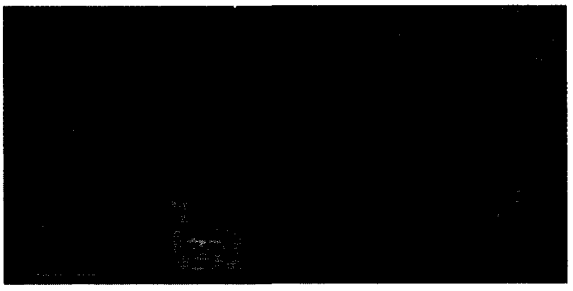


If we want to reduce pollution from irrigated agriculture

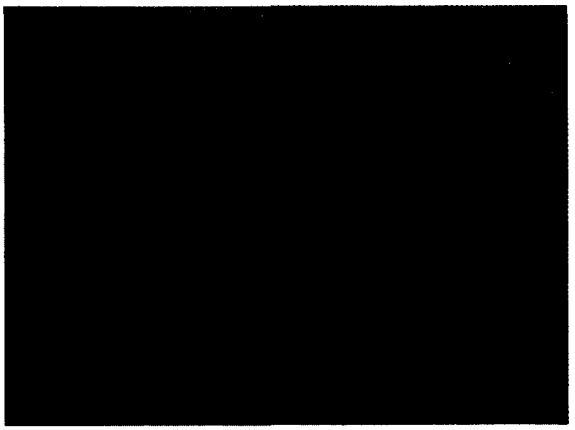


Or increase agricultural production on existing croplands

Or reduce water diversions to irrigated agriculture so that new water demands can be met.



The solutions are identical!!

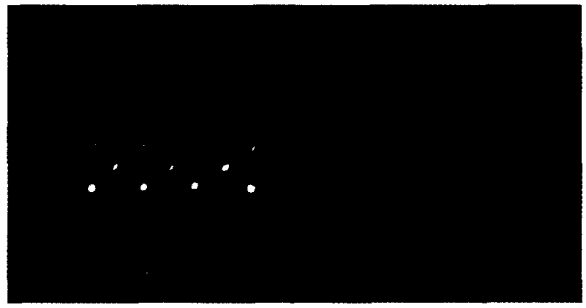


Improved Water Management Practices

But,

the solutions are "site specific" in that each geographical irrigated area is different.

Also,



some irrigated areas....contribute significantly to pollution

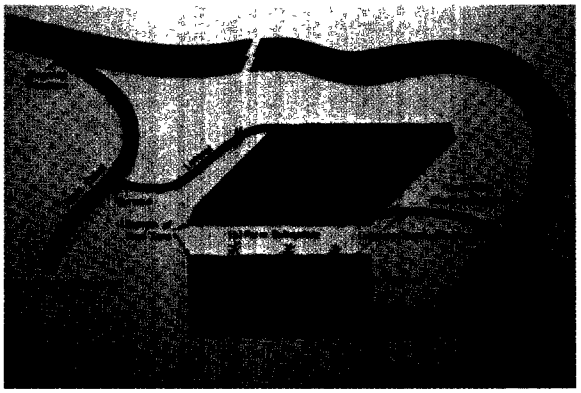
And,

some irrigated areas....contribute relatively insignificant amounts of pollutants.

So, for each geographical irrigated area, the following questions must be asked.

- How significant is the resulting pollution?
- If the pollution is significant, what are the appropriate remedies that suit the "site specific" nature of the particular irrigated area?
- What is the effect of demonstrating these remedies on farmers' fields?
- What mechanisms must be developed for meeting the costs associated with implementing the various remedies?

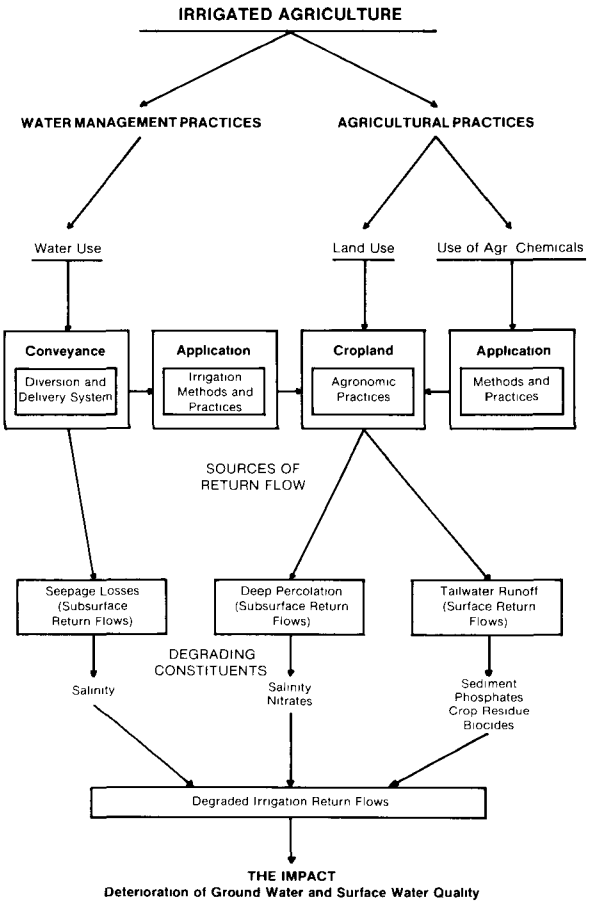
The Irrigation System



An irrigation system is broken down into 4 subsystems

1. Water Source
2. Water Delivery
3. On-Farm Water Use
4. Water Removal

Water Quality Problems

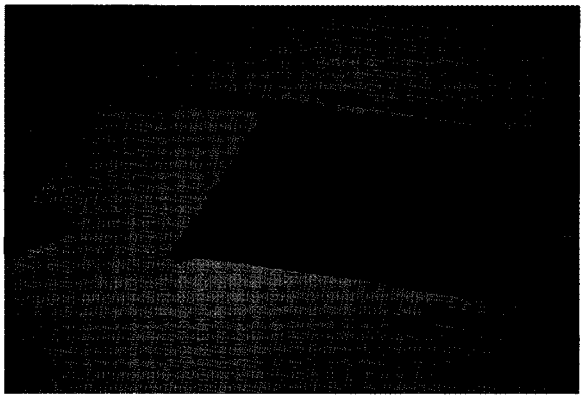


(Radosevich & Skogerboe 1977)

POLLUTION FROM SURFACE RUNOFF

Water Source:

- Tailwater Runoff from Croplands



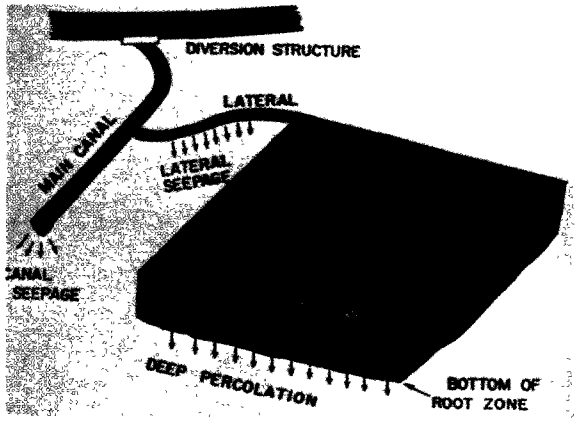
Pollutants Transported during Delivery, Use and Removal of Water:

- Sediments
- Phosphates from fertilizer
- Crop Residue
- Biocides: toxic substances from pesticides and herbicides

POLLUTION FROM SUBSURFACE FLOWS

Water Sources:

- Seepage Losses from Canals and Laterals
- Deep Percolation Losses from Croplands

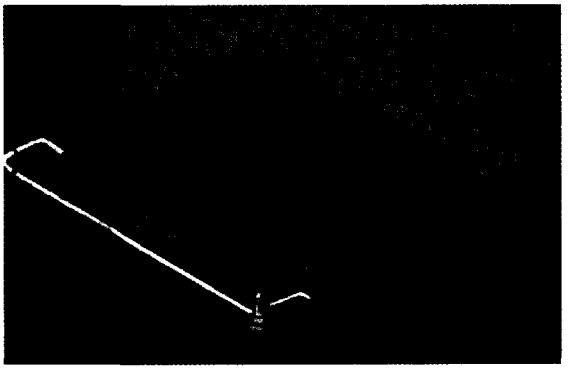


Pollutants Transported during Delivery, Use and Removal of Water:

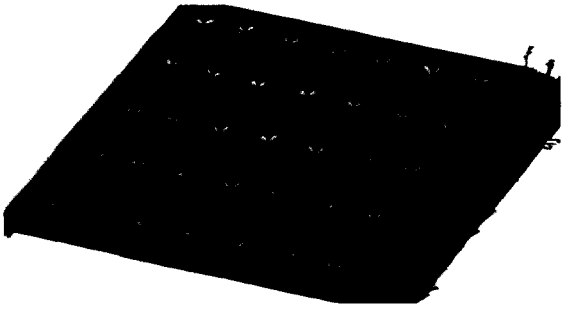
- Mineral Salts
- Nitrates from fertilizer
- And other water soluble constituents

Solutions for Surface Runoff Pollution

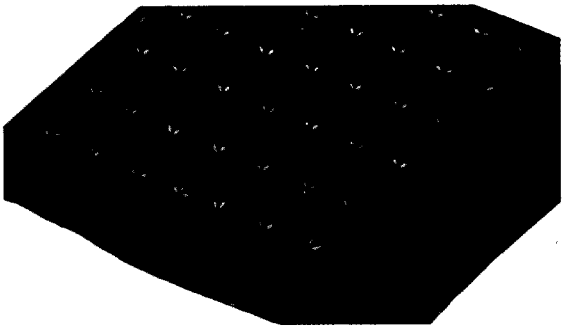
You can treat the problem



Tailwater Reuse System

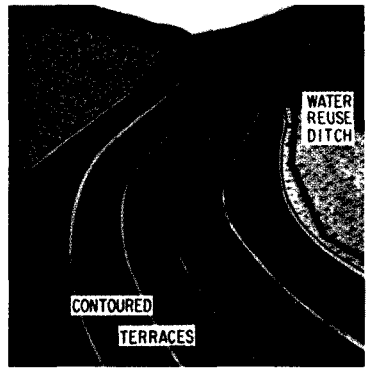


Vegetative Strips



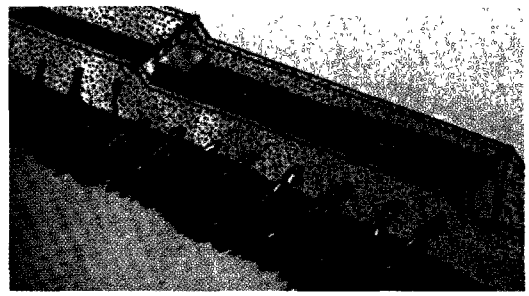
Sediment Collection Basins

OR, you can treat the source

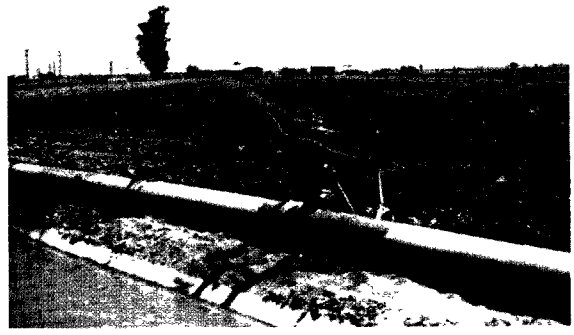


Contour Farming

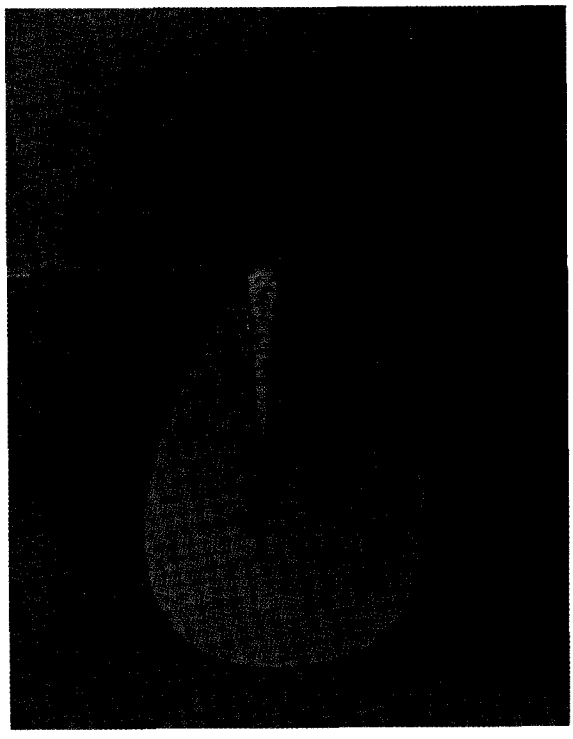
Land Leveling



Cut-Back Furrow Irrigation



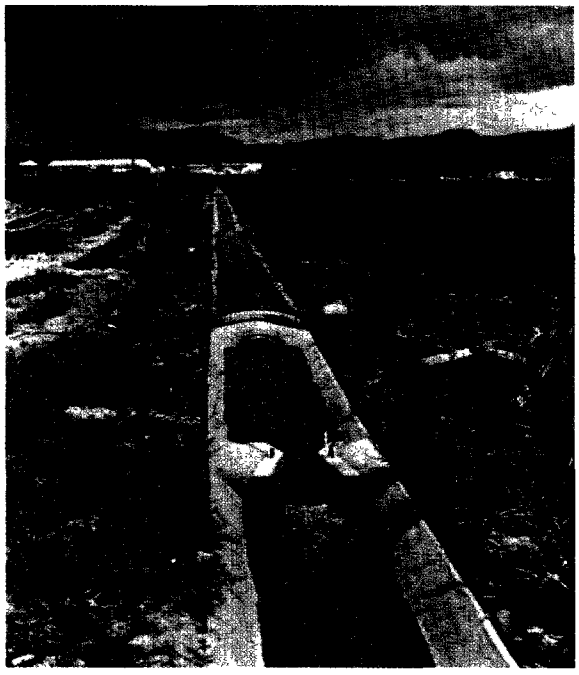
Sprinkler Irrigation



Trickle Irrigation

Solutions For Subsurface Flow Pollution

Seepage losses can be reduced by



Lining Channels with Concrete, Gunnite, Asphalt-membrane, Plastic-membrane, etc.

Or, replace earth ditches with Pipelines

Some deep percolation is necessary to remove the salts from the root zone so that the cropland remains productive.

But, much can be done to reduce deep percolation losses, increase water use efficiency, and assure more uniform water distribution across the field.

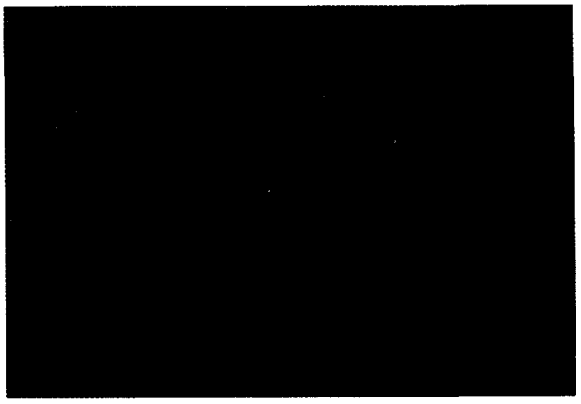
Better furrow flow control

Cut-back furrow irrigation

"Tune Up" the existing surface irrigation systems by improving present management practices.

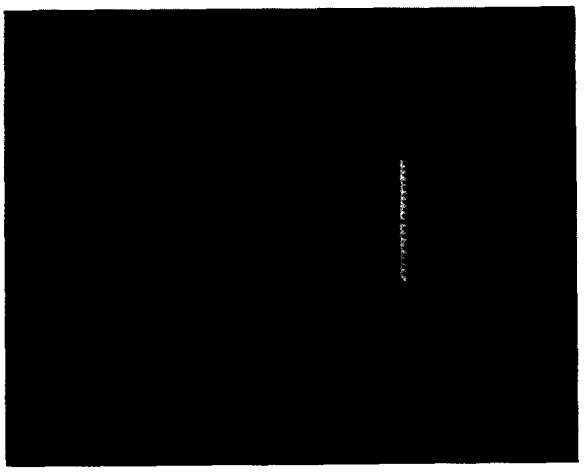
Use pressurized irrigation methods to provide better water control (including automation) so that the proper quantities of water are applied uniformly over a field.

Sprinkler Irrigation

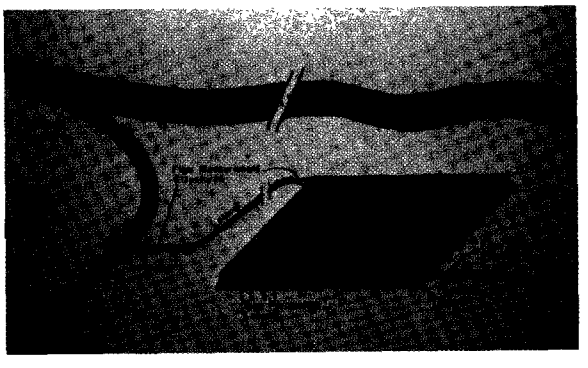


Trickle Irrigation

Employ Flow Measuring Devices throughout the irrigation system in order to distribute the water to each farmer and at each farm inlet equitably so the farmer knows "what he is managing and how much he is applying."



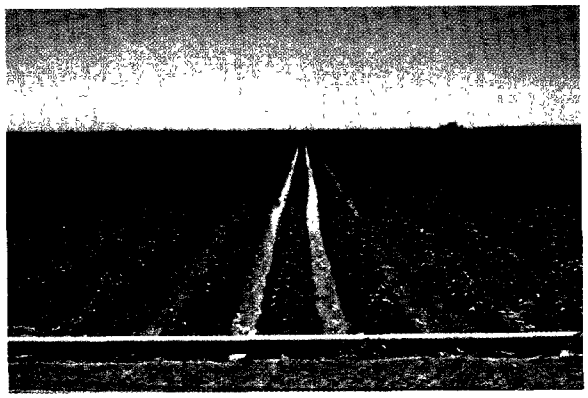
Use "Scientific Irrigation Scheduling" so that each farmer receives the proper amount of water at the right time to insure good crop growth.



Importance of On-Farm Water Management

Usually, the *key* to reducing problems of water pollution resulting from irrigated agriculture is *improved on-farm water management practices.*

MAN is the key to MANagement.... Improved Water MANagement requires *more* and *better* management practices by MAN in the use of his water.



The construction of physical improvements increases the *potential* for improved water management, but it is the operation and management of these improvements that dictates how much of this potential is *achieved.*

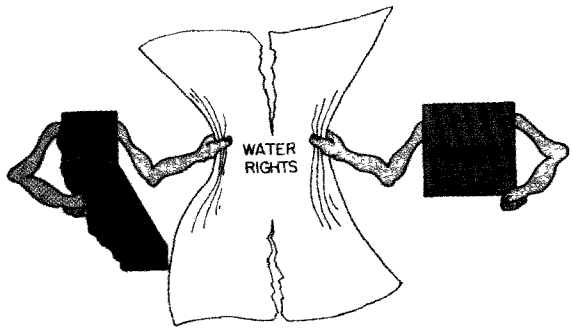
Implementation

Legal Problems

The major impediment to improved water management practices is the irrigator's fear of losing his water rights.

Major cause of the pollution problem is the use of too much water.

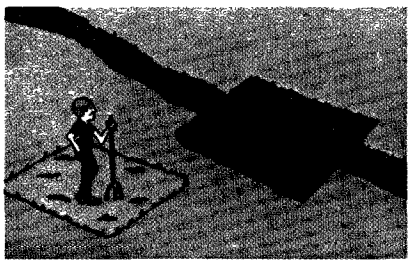
The major constraint to change is our system of water rights.



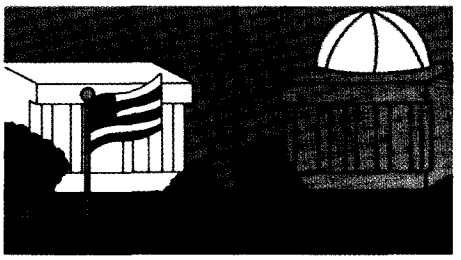
The Doctrine of Prior Appropriation has irrigators diverting their "full" water right for fear of losing their right.

The primary legal elements which contribute to the problem are:

- Failure to enforce existing beneficial use and nonwaste provisions in State water laws.



- Prevention of the transfer of excess and saved water to other lands or users.



- Separate categories of law exist for water quantity and for water quality.

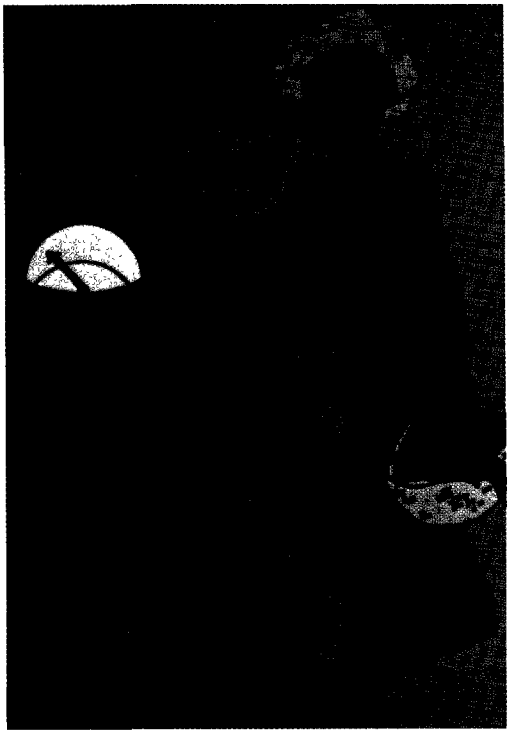
- Lack of funds, or restrictions, for improving irrigation systems to alleviate water quality degradation.

Economic Problems

Water is allocated on a priority of rights rather than on the value of use

And

The price of water is generally the conveyance cost to the farm,

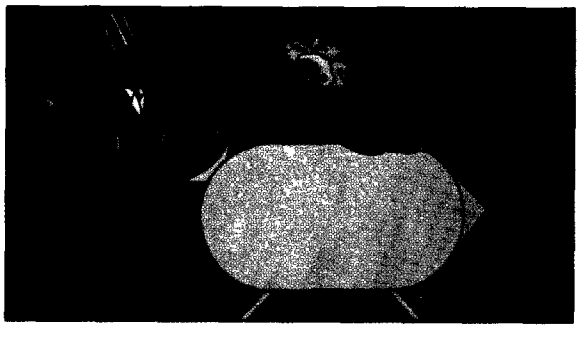


which results in

- Water use not being competitive nor responsive to the market place (e.g., new demands)
- Water that is not allocated to its highest valued use
- Excessive water application because of low price.

Social Goals

A positive incentive should be provided for irrigators to benefit from improving their water management practices by establishing a market for selling, renting and leasing water.

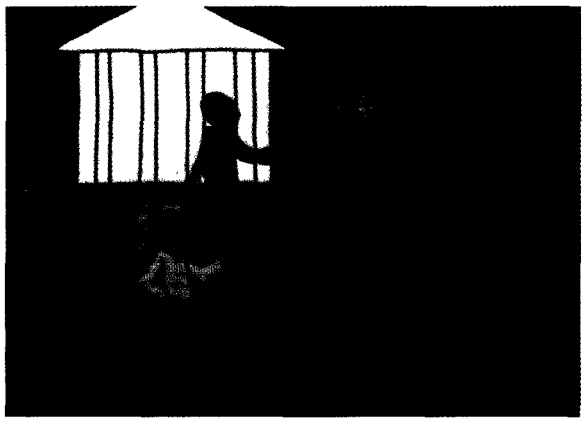


The transfer of saved water to new uses should have safeguards to protect water quality.

Appropriate solutions must be developed with a sensitivity to local conditions.

Since irrigation is a collective enterprise, existing irrigation districts should play a major role in implementing solutions.

State-wide and regional advisory committees should play a role in establishing coordination and cooperation among water users.



Credibility and trustworthiness of federal and state agencies in the eyes of irrigators should be established to provide the important final ingredient.

Influent Control Approach

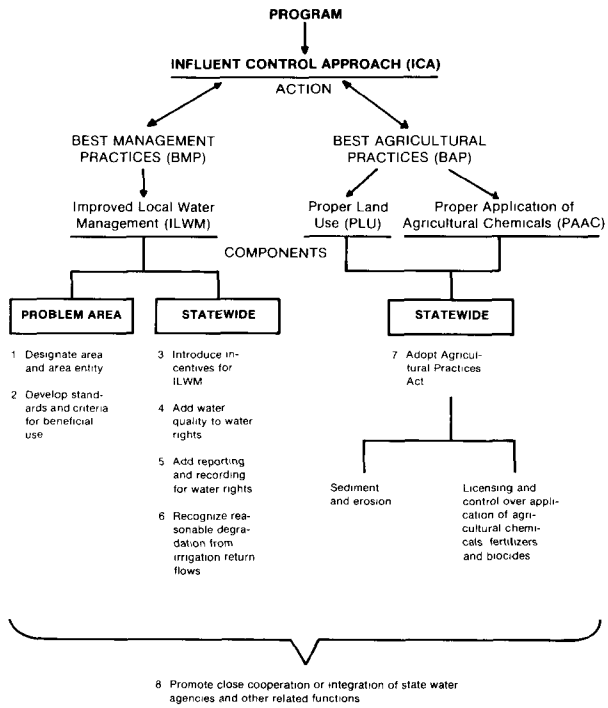
A SOLUTION:

An Influent Control Approach (ICA)

ASSUMPTION:
Improved Agricultural Practices + Improved Water Management =
Improved Water Quality (IAP + IWM = IWQ)

CONCLUSION
Best Management Practices + Best Agricultural Practices =
Irrigation Return Flow Quality Control (BMP + BAP = IRFQC →IWQ)

DEFINITIONS:
BMP = Improved Local Water Management (ILWM)
BAP = Proper Land Use (PLU) and Proper Application of Agricultural Chemicals (PAAC)



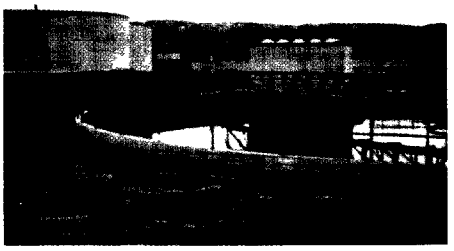
(Radosevich & Skogerboe 1977)

National Goals

Implementing a cost-effective program for improving present irrigation management practices will play an important role in the West to....

...have Cleaner Water

...increase Crop Production



...meet New Water Demands

References

The following reports have resulted from EPA's Irrigated Crop Production Research Program

Report No

EPA-600/2-76-219 Assessment of Irrigation Return Flow Models
BY: W. R. Walker, Colorado State University, Fort Collins, CO
ORDER FROM: GPO
NTIS-PB 263 897/AS
(83 pages)

EPA-600/2-76-237 Control of Sediments, Nutrients, and Adsorbed Biocides in Surface Irrigation Return Flows
BY: D. L. Carter and J A. Bondurant, U.S. Department of Agriculture, Snake River Conservation Research Center, Kimberly, Idaho
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EPA-600/2-76-291 Effects of Irrigation Methods on Groundwater Pollution by Nitrates and Other Solutes
BY: C. W. Wendt, A. B. Onken, and O. C. Wilke, Texas Agricultural Experiment Station, Lubbock; R. D Lacewell, Texas A & M University, College Station, TX
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EPA-600/2-76-226 Irrigation Management Affecting Quality and Quantity of Return Flow
BY: L. S. Willardson and R. J. Hanks, Utah State University, Logan, UT
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EPA-600/2-76-158 Nitrogen and Irrigation Management to Reduce Return-Flow Pollution in the Columbia Basin
BY: B. L. McNeal and B. L. Carlile, Washington State University, Pullman, WA
ORDER FROM: GPO
NTIS-PB 259 328/AS
(141 pages)

EPA-600/2- Scientific Irrigation Scheduling for Salinity Control of Irrigation Return Flows
BY: M. E. Jensen, U.S. Department of Agriculture, Kimberly, ID
ORDER FROM. GPO
NTIS-PB 249 114/AS
(91 pages)

EPA-R2-73-168 Prediction Modeling for Salinity Control in Irrigation Return Flows
BY: A. G. Hornsby, Robert S. Kerr Environmental Research Laboratory, USEPA, Ada, OK
ORDER FROM: GPO-EP 1.23/2:R2-73-168
NTIS-PB 221 647
(55 pages)

Selected Irrigation Return Flow Quality Literature Abstracts
BY: G. V. Skogerboe, et al., Colorado State University, Fort Collins, CO
1968-1969. NTIS-PB 214 105
1970-1971. NTIS-PB 222 796
1972-1973. NTIS-PB 235 385
1974. NTIS-PB 253 664/AS
1975. RSKERL
* 1976

* Evaluation of Measures for Controlling Sediment and Nutrient Losses from Irrigated Areas
BY D. W. Fitzsimmons, et al., University of Idaho, Moscow, ID R-803524

* Best Management Practices for Salinity Control in Grand Valley
BY: W. R. Walker, G. V. Skogerboe and R. G. Evans, Colorado State University, Fort Collins, CO

* Implementation of Agricultural Salinity Control Technology in Grand Valley
BY: R. G. Evans, W. R. Walker, G. V. Skogerboe and C. W. Binder, Colorado State University, Fort Collins, CO

* Western Water Laws and Irrigation Return Flow
BY: G. E. Radosevich, Resources Adm. and Dev., Inc., Fort Collins, CO

* Achieving Irrigation Return Flow Quality Control Through Improved Legal Systems
BY· G. E. Radosevich and G V Skogerboe, Resources Adm. and Dev., Inc., Fort Collins, CO

* Socio-Economic and Institutional Factors in Irrigation Return Flow Quality Control
BY E C. Vlachos, P. C Huszar, G. E. Radosevich, G. V. Skogerboe and W. L. Trock, Colorado State University, Fort Collins, CO
Volume I: Methodology
Volume II: Yakima Valley
Volume III Middle Rio Grande
Volume IV: Grand Valley

* Integrating Desalination and Agricultural Salinity Control Alternatives
BY Wynn R Walker, Colorado State University, Fort Collins, CO

* Assessing the Spatial Variability of Irrigation Water Applications
BY D Karmeli, W. R. Walker and L. J. Salazar, Colorado State University, Fort Collins, CO

If no GPO or NTIS numbers are shown for report, the report-may be ordered by EPA number and title from the appropriate source An asterisk by report indicates report has been forwarded for printing and will be available by Fall, 1978 from RSKERL

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