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REPORT TO THE CONGRESS



BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

Better Federal Coordination Needed To Promote More Efficient Farm Irrigation

Department of the Interior
Department of Agriculture
Environmental Protection Agency

Over half the water delivered to farms for irrigation is wasted through overwatering which can

- limit crop production,
- increase farming costs, and
- contribute to water pollution.

Federal agencies should determine the extent and causes of overirrigating and the role the Government should play in solving the related problems.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

Overirrigation decreases farm productivity, creates environmental problems, and denies water to other beneficial users at a time when their needs are growing. This report discusses opportunities for the Federal agencies having management responsibilities in the water resources area to promote more efficient use of this valuable natural resource.

We made the review to identify needed improvements in the Federal effort to promote more efficient irrigation practices. The review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretaries of the Interior and Agriculture; and the Administrator, Environmental Protection Agency.

James A. Stairs

Comptroller General
of the United States

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ABBREVIATIONS

ACP	Agricultural Conservation Program
ARS	Agricultural Research Service
BIA	Bureau of Indian Affairs
EPA	Environmental Protection Agency
GAO	General Accounting Office
IMS	Irrigation Management Services
NPDES	National Pollutant Discharge Elimination System
OMB	Office of Management and Budget
SCS	Soil Conservation Service

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

BETTER FEDERAL COORDINATION
NEED TO PROMOTE MORE EFFICIENT
FARM IRRIGATION
Department of the Interior
Department of Agriculture
Environmental Protection Agency

D I G E S T

At times the Nation needs all of, or more than, the water it can supply. Our water needs to be protected through better management.

Agriculture uses most of our water. In 1973, the Bureau of Reclamation delivered 8,541.6 billion gallons of water to farms for irrigation. However, less than half of the water delivered to a farm for irrigation is productively used by the crops.

Overirrigating crops contributes to damages, such as

- limiting crop production by removing valuable nutrients from the soil and denying water to other croplands (see pp. 10 and 12),
- increasing farming costs by increasing maintenance, pumping, and drainage requirements (see pp. 13 and 14), and
- contributing to water pollution by washing salts from the soil into streams and rivers and reducing streamflow and oxygen levels necessary for fish and other aquatic life (see pp. 15 to 17).

Farmers inaccurately estimate how often and to what extent they should irrigate, and they overuse low-cost water in lieu of additional labor or system improvements, according to studies by Federal agencies.

However, the Federal agencies did not have comprehensive data

- to measure the severity of damages from overirrigating or

--to identify to what extent (1) low-cost water is overused, (2) inaccurate estimates of when and how much water to use are made, or (3) other factors contribute to the problem.

The adequacy of available techniques and current programs for encouraging more efficient water use, therefore, is difficult to assess.

A coordinated effort among interested Federal agencies should be made to

--develop more complete data on the problems of inefficient irrigation;

--determine the extent to which specific factors, such as pricing of water and inaccurate estimates of when and how much water to use, contribute to the problems; and

--identify what the Federal role should be in alleviating the problems and identify the agencies best structured to administer the programs. (See p. 21.)

Techniques for improving irrigation efficiency range from the costly and sophisticated drip, or trickle, irrigation systems to simple improvement in irrigation scheduling (systematically determining when to irrigate and how much water to use). Because irrigation scheduling is relatively inexpensive, it could be widely used to help farmers improve their irrigation. (See pp. 23 to 26.)

The major Federal effort to encourage irrigation scheduling on Federal projects is through the Bureau of Reclamation program--Irrigation Management Services. Irrigation Management Services has a computerized irrigation scheduling service to help farmers determine when and in what amounts to irrigate their croplands. (See p. 26.)

The success of the Irrigation Management Services program depends on the voluntary response and cooperation of farmers.

Although first demonstrated in 1969, the program has not been widely accepted. The Bureau has not adequately demonstrated the benefits of the program. Since they have not been convinced of the program's economic or technical reliability, farmers are reluctant to use computer services. (See pp. 30 to 33.)

GAO recommends that, to accelerate voluntary implementation of the Irrigation Management Services program, the Departments of Agriculture and the Interior jointly develop Federal objectives, policy recommendations, and action plans integrating the unique capabilities of the Bureau, the Soil Conservation Service, and the Extension Service to educate and assist farmers that wish to improve their irrigation efficiency. (See p. 37.)

GAO recommends that the Bureau:

- Review the Irrigation Management Services program to develop a more flexible, comprehensive program.
- Direct greater attention to setting objectives and benchmarks in Irrigation Management Services demonstration projects so the benefits of the program can be clearly measured and shown to farmers.
- Increase the frequency of field visits, especially during the early stages of projects selected for demonstration, so that Bureau irrigation technicians can work more closely with selected farmers testing the usefulness of program techniques.
- Require the use of more carefully tailored approaches to demonstrating Irrigation Management Services benefits, including identification of regional and national benefits and determination of the need for additional statutory authority for the Bureau to continue the program beyond the demonstration phase. (See p. 37.)

Interior, Agriculture, and the Environmental Protection Agency generally agreed with GAO's

conclusions and recommendations. (See apps. I, II, and III.) Interior and Agriculture agreed that a better coordinated effort is needed. Both Departments pointed out, however, that personnel and funding limitations have hampered a more intensive program.

CHAPTER 1

INTRODUCTION

The National Water Commission 1/ issued a report in June 1973 which stated that, although the United States has a plentiful water supply, it is not always available at the right place or at the right time. In some areas of the country, demands for water are approaching and, in some cases, exceeding supplies. As a result, suppliers and users of water are coming to realize that water is a precious resource deserving more careful management.

Water use is measured in two ways, by water withdrawn and by water consumed. Water withdrawn is water diverted from its natural course for use and may be returned later for further use. Water consumed is water incorporated into a product or lost to the atmosphere and not available for re-use. Water consumed is the more important concern because it represents absolute reductions in water supply.

Agricultural irrigation, the largest user of water, accounts for about 83 percent of the water consumed in the United States. In 1973 there were 51.5 million acres of irrigated farmland in the United States, with about 45.6 million acres (89 percent) located in the Western States. 2/

Irrigation is a relatively inefficient water use, since under present practices less than half of the water delivered for irrigation is actually consumed by the crops. The remainder, which is excess to crop needs, may be absorbed by weeds; may oversaturate the lands causing drainage problems; or may return to the supply system for further uses at a downstream location, degraded in quality by minerals, fertilizers, sediment, and pesticides. These return flows may be used downstream for additional irrigation purposes. In some cases, however, the water may return where it does not benefit potential users located between the point of diversion and the point of return.

1/The National Water Commission was established by Public Law 90-515 for the purpose of reviewing national water resources problems.

2/Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming.

FEDERAL ROLE IN ON-FARM
IRRIGATION WATER MANAGEMENT

Several Federal agencies have an interest in promoting effective management of irrigation water by farm operators. They include the Bureau of Reclamation of the Department of the Interior, three agencies of the Department of Agriculture, and the Environmental Protection Agency.

Bureau of Reclamation's role

The Reclamation Act of 1902 (43 U.S.C. 391 et seq.) authorized the Secretary of the Interior to construct, operate, and maintain works for the storage, diversion, and development of waters for the reclamation of arid and semiarid lands in the Western States. The Bureau of Reclamation carries out these functions.

The Bureau's primary mission includes planning, constructing, operating, and maintaining facilities for storage and delivery of water supplies for irrigation of western lands. The Federal investment in irrigation facilities completed or rehabilitated by the Bureau, as of June 1973, totaled \$1.3 billion. In addition to constructing and operating its own projects, the Bureau was assigned the responsibility for marketing irrigation water from Corps of Engineers projects in the Western States. In 1973 the Bureau delivered 26.2 million acre-feet (8,541.6 billion gallons) of water to irrigate about 9.2 million acres, or 20 percent of the total irrigated western farmlands. Lands irrigated with Bureau-supplied water produced crops during 1973 valued at over \$3.9 billion.

Federal reclamation laws enacted by the Congress since 1902 require that project costs for irrigation and certain other purposes be repaid in full. Repayment of these costs is generally the responsibility of project beneficiaries. However, in the case of irrigation, the irrigation repayment obligation does not include interest and is generally limited to that portion of the Federal costs of irrigation facilities which the Secretary of the Interior determines that the irrigators can afford to pay. The remaining portion of the Federal cost of providing irrigation water is repaid from power and other miscellaneous project revenues.

The Bureau contracts for repayment with a legal entity (water users organization or district) representing groups of irrigators. The water district, in turn, receives the Bureau-supplied water, distributes it to its individual members, and collects irrigation fees for use in repaying the Bureau.

In 1969 the Bureau began experimenting with techniques to improve on-farm water management through computerized irrigation scheduling--part of its Irrigation Management Services (IMS) program. This program is discussed in chapter 3.

Department of Agriculture's role

Department of Agriculture agencies which, through research and technical assistance, are concerned with assisting farmers improve their daily on-farm use of irrigation water include the Agricultural Research Service (ARS), the Soil Conservation Service (SCS), and the Extension Service.

ARS was established in 1953 to conduct research and provide the necessary knowledge and technology for farmers to operate more efficiently, conserve the environment, and meet the Nation's food and fiber needs. ARS does not assist farmers directly; instead, it provides research results to other agencies, such as the Soil Conservation Service and the Extension Service, for dissemination to farmers.

Some ARS research is designed to more effectively use the productive capacity of soil and water resources. In this regard, ARS developed computerized water-scheduling techniques, now being demonstrated by the Bureau, to improve on-farm irrigation management.

SCS was established in 1935 and is responsible for the development and execution of a national program for conservation of soil and water resources. SCS also provides financial and technical assistance to irrigators to develop an adequate water supply, install an efficient irrigation system, and provide onsite assistance in operating the system. Assistance is normally limited to individual farmers or small groups of farmers.

In commenting on the report in a March 12, 1976, letter (see app. II), the Department of Agriculture stated that, historically, on-farm water management systems had been the responsibility of SCS while system management was handled by the Bureau of Reclamation. Agriculture said that, most often, the entire farm cropping and harvesting schedule must be reanalyzed along with the farm budget, cultural practices, fertilizer and pesticide schedule, and erosion control measures. Agriculture further stated that the grass roots relationship its agencies had with individual irrigators and irrigation districts was very important for success of any program dealing with its operations.

An important SCS activity with respect to on-farm water management is the conservation operations program. Under this program, SCS provides technical assistance through conservation districts to landowners and farmers carrying out locally adopted soil and water conservation programs. SCS assists farmers by advising them of their soil potentials and conservation needs, developing plans for installing required treatment measures and making needed land use changes, and helping to apply parts of the conservation plans that require special skills or knowledge.

These SCS services are available to nearly 3,000 soil and water conservation districts which include about 98 percent of the farms and more than 94 percent of the agricultural land in the United States. Although SCS assists farmers in estimating their irrigation needs, such service is primarily for the purpose of assisting the farmers in planning and installing an irrigation system on an individual farm.

The Extension Service was created in 1914 and is the educational agency of the Department of Agriculture. It is one of three partners in the Cooperative Extension Service. State governments, through their land-grant universities, and county governments are the other partners. All three share in financing, planning, and conducting the Extension Service's educational programs.

The Cooperative Extension Service helps farmers, among others, learn and apply the latest technology developed through research by land-grant universities, the Department of Agriculture, and other sources. Area and county agents work directly with individuals and groups to help them apply the newest proven technology to operating problems.

Environmental Protection Agency's role

The Environmental Protection Agency (EPA) was established in 1970 to control pollution through programs of research, monitoring, standards setting, and enforcement. EPA's authority for regulating water quality was greatly expanded by the Water Pollution Control Act Amendments of 1972 (Public Law 92-500).

Under the 1972 amendments, a permit program was established to regulate discharges of pollutants. The act established conditions and criteria for issuing permits for water quality standards of the receiving waters and, through effluent limitations for existing discharges and national performance standards for new dischargers, for the material discharged.

SCOPE OF REVIEW

We reviewed the Bureau's policies, procedures, and practices for promoting efficient on-farm management of irrigation water. We also examined reports and correspondence and interviewed officials of the Bureau; Department of Agriculture agencies, including SCS, ARS, and the Extension Service; EPA; water user organizations and member irrigators; and State water agencies. We made our review at

- the Bureau's headquarters office in Washington, D.C.; Engineering and Research Center in Denver, Colorado; and regional offices in Sacramento, California; Boise, Idaho; and Boulder City, Nevada; and several project offices within these regions;
- EPA regional offices in Seattle, Washington, and San Francisco, California;
- SCS offices in Washington, D.C.; Oregon, Washington, Idaho, California, and Arizona;
- Agriculture Research Service offices in Idaho; and
- Extension Service offices in Idaho, Washington, and California.

We also visited the following water user organizations:

- Westlands Water District, Central Valley Project, California.
- Solano Irrigation District, Solano Project, California.
- Minidoka and A and B Districts, Minidoka Project, Idaho.
- Wapato Irrigation Project, Yakima Project, Washington.
- Wellton-Mohawk District, Gila Project, Arizona.
- Colorado River Indian Irrigation Project, Arizona.

CHAPTER 2

EFFECTS OF INEFFICIENT ON-FARM IRRIGATION PRACTICES

AND ADDITIONAL ACTIONS NEEDED TO IDENTIFY THE

MOST EFFECTIVE COMBINATION OF PROGRAMS TO

REMEDY THE PROBLEM

Interior, Agriculture, and Environmental Protection Agency officials said that inefficient irrigation practices (i.e., overwatering) can limit crop production, increase farming costs, and contribute to water pollution. In addition, other factors, such as seepage of irrigation water from delivery and drainage canals and natural sources (i.e., rainfall and geysers), contribute to the damages. Studies have been made by these agencies which indicate that the damages resulting from inefficient irrigation practices can be substantial, but such damages have not been systematically quantified. Studies by these agencies also identify factors, such as overuse of low-cost water and inaccurate estimates by farmers of irrigation frequency and amounts of water to apply, that contribute to the inefficient irrigation practices; however, the extent that specific factors contribute has not been quantified by these agencies.

We believe that it is difficult to develop the most effective combination of Federal policies and programs needed to alleviate inefficient on-farm irrigation practices and the resulting damages without quantified data on the relationship between the severity of the problem and the extent that specific factors contribute.

ADEQUACY OF FEDERAL EFFORTS TO DEFINE THE PROBLEM

In a March 1973 report entitled "Shut Off the Water-- The Root Zone is Full," the Bureau stated that the average farm irrigation efficiency 1/ at selected farms in

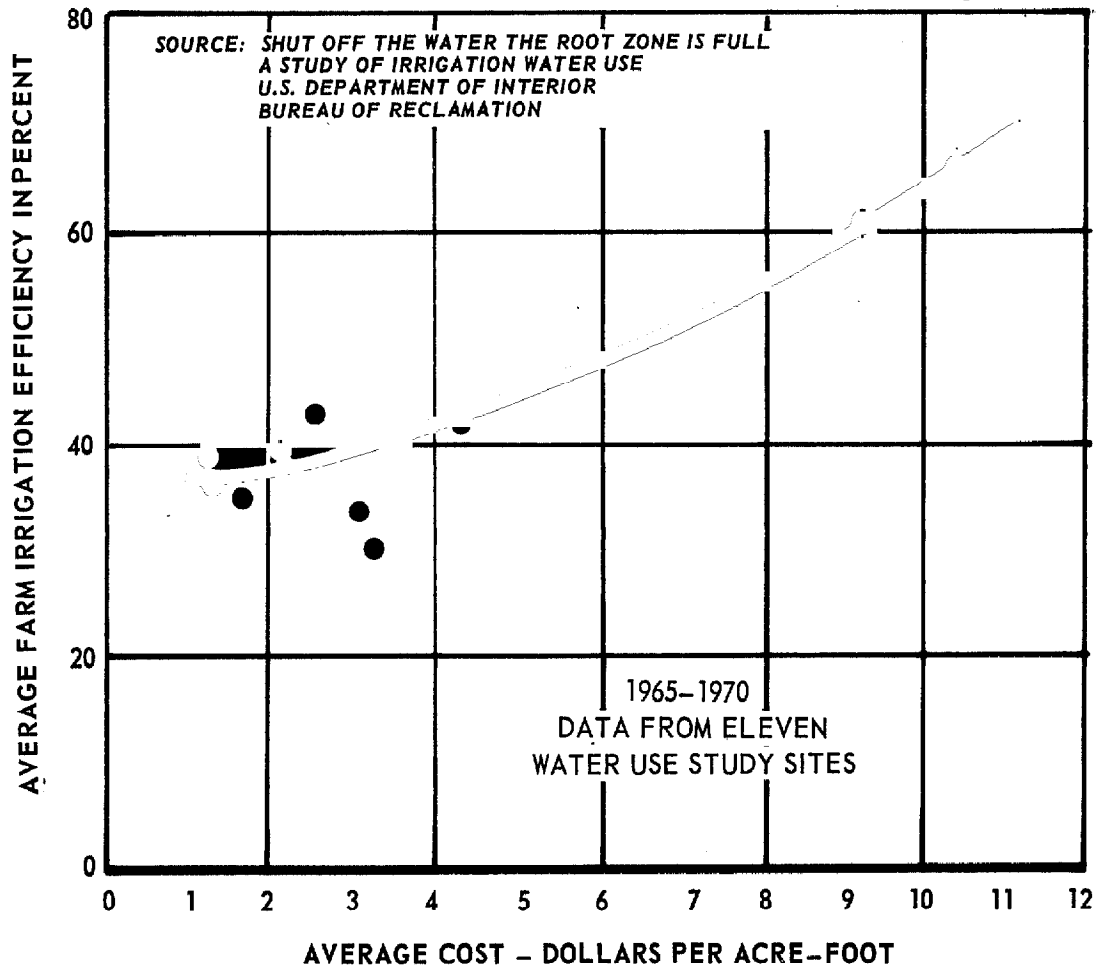
1/Expressed as a percentage which is the amount of water delivered to a given farm compared with the actual consumptive water needs of the crops.

11 Western States was 44 percent. This compared closely with the 46 percent estimated farm irrigation efficiency in the Western United States made in a December 1959 Department of Agriculture study entitled "Estimated Water Requirements for Agricultural Purposes and Their Effects on Water Supplies."

The Bureau of Reclamation, in its 1973 report, cited two major causes for inefficient use of irrigation water

- overuse of low-cost water rather than incurring the labor and/or land and systems improvement costs necessary to irrigate more efficiently and
- inaccurate estimates by farmers of irrigation frequency and amounts of water to apply relative to soil moisture conditions.

Concerning the overuse of low-cost water, the Bureau found a definite correlation between the cost of water and on-farm irrigation efficiency. The following Bureau-supplied graph shows this relationship clearly. When the water cost was only \$1 to \$3 an acre-foot, irrigation



efficiency was less than 40 percent. As the cost increased, however, to nearly \$10 an acre-foot, irrigation efficiency improved to over 60 percent.

Concerning inaccurate estimates by farmers of irrigation frequency and amounts of water to apply, a 1972 ARS study entitled, "Programming Irrigation For Greater Efficiency" stated that irrigation practices had not changed appreciably during the past three decades even though irrigation science and technology made substantial advances. The study indicated that irrigation scientists and technologists know how to optimize production by manipulating irrigation practices, but these specialists are not making current irrigation decisions concerning when and how much water to apply on each farm. These irrigation decisions are being made by farm managers who have limited time and training and, according to the Department of the Interior, lack adequate field tools. We believe that the needs of these farm managers and the acceptability of new irrigation techniques suggested by irrigation specialists have not been adequately evaluated.

In its March 12, 1976, letter (see app. II), the Department of Agriculture said that irrigation practices in the West had become somewhat institutionalized, and because water rights were viewed as property rights, the irrigators must use the water or lose it. Agriculture stated that the role of water rights and other institutional constraints affected the water user's ability to manage irrigation water adequately. It also stated that the requirement for "beneficial use" 1/ needed to be redefined in most States.

In its April 27, 1976, letter (see app. I), the Department of the Interior stated that overirrigating because the water cost was low was a practice that was expensive to farmers in the long run and that it might result from a lack of suitable water-measuring devices as well as lack of knowledge as to how much water to apply.

Also, Interior said that other factors--such as water rights, adequacy of water supply, and human factors--also

1/The beneficial use concept states that, to maintain the right to divert a given amount of water, the water diverted must be used for some beneficial purpose, such as irrigation or municipal and industrial needs.

influenced irrigation management and should be considered in planning programs to improve irrigation efficiencies. In this connection, Interior advised us as follows.

- In some areas, the nature and priority of irrigators' water rights influence efficiency of water use. Farmers may hesitate to change their irrigation practices because of fears of interference with their water rights or possible loss of water rights. Where water rights are tied to the land, there may be no legal way for a farmer to use any water he may "save" on additional acreage. Thus, his incentive to irrigate efficiently may be reduced. More strict interpretation and enforcement of the beneficial use doctrine contained in many State water rights laws could encourage more efficient practices.
- Storage and delivery system limitations and operational procedures for water delivery (i.e., demand system, rotation system, or continuous-flow system) also influence on-farm irrigation management and efficiency. Uncertainty about the future adequacy of water supplies encourages excessive application of water when it is available. Farmers are usually reluctant to follow irrigation scheduling programs when they are not assured of an adequate water supply.
- Human factors, including tradition and custom, personal preferences, and motivation of farmers, also influence their irrigation management. Indications are that farmers often do not irrigate "as good as they know how to." In addition to lack of knowledge as to when to irrigate and how much water to apply, many farmers do not realize that other aspects of their irrigation management are poor. Inappropriate irrigation methods and mismanagement of the water application process are commonly observed. Motivation may be a factor here also. We believe that more comprehensive and effective educational and motivational programs are needed.

None of the studies we reviewed identified the extent that each of the various factors, cited by the agencies, contributed to the inefficient use of irrigation water and the resulting damages. As discussed later, we believe such a determination is needed to identify the most effective combination of actions needed to improve irrigation efficiencies.

OBSERVATIONS ON DAMAGES RESULTING FROM INEFFICIENT IRRIGATION PRACTICES

We visited six irrigation districts in four Western States and observed various adverse situations which Bureau and irrigation district officials attributed to inefficient irrigation practices. In several instances low-cost water appeared to be a factor contributing to the inefficient irrigation practices. Also, the difference in the way farmers paid for water seemed to affect the amount of water used. The farmers which paid on the basis of amount of water used tended to overirrigate to a lesser degree than those which paid on the basis of acres farmed.

Also, in some of the same instances where low-cost water appeared to be a factor, the Bureau was attempting to improve irrigation efficiencies by providing farmers with the information necessary to optimize the proper timing and amounts of water to be applied. (See ch. 3.) Neither the Bureau nor the irrigation district officials we spoke with were able to quantify the extent that damages they attributed to inefficient irrigation practices were caused by overuse of water because of its low cost or inaccurate estimates by farmers of irrigation frequency and amounts of water to be applied.

Limited crop production

Crop production can be adversely affected by overirrigation in two principal ways--first, by damaging crops and croplands and second, by denying water to other croplands.

Damaged crops and croplands

Overirrigation damages cropland by washing away valuable nutrients and topsoils. It damages crops by drowning and stripping the soil of its ability to support plant life.

According to agriculturists, the top 12 to 14 inches of soil are generally the most fertile and productive. Topsoil also holds most of the fertilizer applied to the land. If the topsoil is removed, for example, by overirrigating, the remaining land is left deficient and the crops will not survive nor produce as much as they formerly could.

Overirrigation can also damage crops by raising the water table (the upper level of an underground water body). A high water table damages crops in two ways. First, the water can fill in the air spaces between soil particles

and drown the plants. The water can also carry natural, soluble salts toward the surface, reducing the plant's ability to use water and contaminating the soil so that it will not support plant life. We observed this problem at the Minidoka Irrigation District in Idaho and the Wapato Irrigation Project in Washington.

Minidoka Irrigation District (Idaho)--The Minidoka District was one of the first irrigation districts in Idaho to be constructed under the Reclamation Act. It contains 61,545 irrigated acres with the average size of the farms being about 160 acres. The principal crops grown are alfalfa, barley, wheat, beans, sugar beets, and potatoes. The predominant method of irrigating is by the gravity method; i.e., flooding the surface of the ground.

Farmers in the Minidoka District are assessed a one-time yearly fee for their water, based on acreage farmed, not on the amount of water used. The 1974 assessment was approximately \$8 per acre farmed which, based on the average amount of water used, equates to less than \$1.00 per acre-foot of water.

Bureau officials told us that although typical crops need less than 3 acre-feet of water during a growing season, irrigators usually apply 10 to 12 acre-feet. The manager of the Minidoka District told us that this excessive irrigation raised the water table and brought natural salts into the crop-growing zone, causing a significant reduction in crop production. He estimated that one-half of the District's land had been made saline and that crop values, districtwide, had been reduced by about 25 percent.

One Bureau official told us that at one time the lands of the Minidoka Irrigation District were similar in productive capability to those of an adjacent irrigation district which applies an average of 3 to 4 acre-feet of water to their crops.

Farmers in the adjacent district are assessed a yearly per acre charge which entitles them to 3 acre-feet of water. However, for each additional acre-foot of water, the irrigator is charged a progressively higher rate. For example, in 1974 farmers were assessed \$9.25 per acre farmed for 3 acre-feet of water. For the first acre-foot used over the 3, the cost was \$3.47, for the second \$5.55, and for the third \$6.94.

The Bureau official said that because the lands in the Minidoka District have become saline from overirrigation, the average yearly per acre return in the Minidoka District

is \$249, while the adjacent district is averaging \$314. He said that the difference of \$65 per acre would be a reasonable measure of the crop losses in Minidoka--more than \$4 million per year districtwide--attributable to overirrigation.

Wapato Irrigation Project (Washington)--We also observed damaged crops and croplands in the Wapato Irrigation Project on the Yakima Indian Reservation in central Washington. The project contains about 112,000 irrigated acres, most of which are irrigated by the gravity method. The principal crops are wheat, sugar beets, potatoes, hops, and corn. The average gross crop value per irrigated acre is \$530.

In 1975 the water was marketed at a flat rate of from \$3.65 to \$12.50 per acre farmed depending on the section of the project. Irrigators apply 4 to 10 acre-feet of water during the growing season although--according to Bureau officials--their crops generally need about 3 acre-feet. Bureau officials told us that this excessive use of irrigation water had contributed to a high water table which had reduced crop production and soil fertility.

Bureau of Indian Affairs (BIA) studies showed that, in one 18,000-acre area of the Wapato Project, 4,500 acres had been severely affected by high water tables and 6,000 additional acres had been affected to a lesser degree. Three hundred additional acres are being affected each year. The lands originally supported high-value cash crops, such as potatoes, hops, and sugar beets. As the water table began to rise, irrigators were forced either to convert to low-yield crops, such as salt-grass pasture, or to abandon their lands.

Water denied to other croplands

There are millions of acres of land in the West which reportedly could be farmed if irrigation water were available. The Arizona State Water Commissioner estimates, for example, that Arizona has about 33 million irrigable acres, but only a small fraction (about 1.2 million acres) is now irrigated because of insufficient water supplies.

In the districts and projects we visited, we found instances in which additional lands might have been put into production if irrigation water had not been used excessively on lands already under cultivation.

For example, studies indicate that on the Yakima Project, any savings in water could be used to irrigate up to 200,000 acres more farmland or for other purposes, such as improving

fisheries, as a result of higher stream flows. Also, the Colorado River Indian Irrigation Project is irrigating 65 percent of its irrigable lands but is using 92 percent of its water supply. In 1975 the farmers paid \$11 for the first 5 acre-feet of water and \$2 for each additional acre-foot. According to Bureau officials, farmers within both projects apply more water than is needed to meet crop needs.

BIA is conducting a feasibility study on how to bring 10,000 additional acres of the Colorado River Indian Irrigation Project into production--principally through better water management. Ultimately, the farmers plan to bring as much as 28,000 acres into production.

Increased farming costs

Farm costs for maintenance and water pumping are increased by excessive irrigation. In addition, farmers may incur substantial costs to drain lands which have been over-irrigated and damaged by high water tables. In the districts we visited, we were informed of several instances in which farm costs could have been reduced by avoiding over-irrigation.

Maintenance

The Minidoka District manager said that excessive irrigation has resulted in substantial surface water runoff. This water has carried quantities of silt, seeds, and other debris into drainage systems, creating costly maintenance problems.

The manager also said that it costs the farmers in his district \$40,000 to \$50,000 each year to remove the silt from drains. He said that the debris-laden water in the drains often is used as a source of irrigation water. When it is used in sprinkler irrigation systems, the silt and seeds erode and plug the sprinkler heads, necessitating more frequent cleaning and replacement.

Pumping costs

The Westlands Water District, organized in 1953, is located near Fresno, California, and contains about 600,000 acres. Until 1967 almost all of its irrigation water was pumped from deep ground wells. Beginning in 1967 the district supplemented the ground water with surface water acquired from the Bureau. In 1974 over one million acre-feet of water was delivered by the Bureau and about 400,000

acre-feet was pumped from ground water aquifers. The farmers were assessed \$7.50 per acre-foot of water provided by the Bureau.

The major crop grown in Westlands is cotton, but wheat, barley, alfalfa, and other crops are also grown. According to a Westlands Water District statistical data report, irrigators in the Westlands Water District use an average of 3 acre-feet in each growing season--about one-half an acre-foot more than their crops consumptive needs.

A district official said that farmers in the district could avoid using 100,000 acre-feet of water annually if they improved their irrigation management. Since it costs the district about \$17 to pump an acre-foot of ground water, district personnel said they could reduce district pumping costs about \$1.7 million annually by using more efficient irrigation practices. These cost savings would eventually be passed on to the individual irrigators in the form of reduced district assessments for reimbursement of operation and maintenance expenses.

Drainage

In one area of the Wapato Irrigation Project (described earlier on p. 12) farmers are currently attempting to reclaim their land from the high water tables caused, according to a SCS official, by overirrigation. They drilled wells, from which they are pumping water, and installed tile drains to remove excess water from their lands. So far, they have reclaimed about 3,000 of the 10,000 acres damaged by overirrigation.

The cost of draining land in the one area of the project has been substantial. In 1970 and 1971, about \$120,000 was spent installing drainage systems of which about \$72,000 was paid for with Agricultural Conservation Program funds provided by the Agricultural Stabilization and Conservation Service (ASCS). Since then, we were told that ASCS funds have not been available to irrigators, but they have continued draining the land using their own funds.

A BIA official estimated that costs of reclaiming overirrigated land were about \$200 an acre. On the basis of this estimate, drainage of the remaining 7,000 acres may cost farmers about \$1.4 million.

Increased water pollution

In some areas of the Western United States, water quality has been degraded as the result of overirrigation. According to EPA officials, this pollution has occurred when water applied in excess of crop needs washed or leached materials from the land into streams, lakes, and ground water. In other instances, farmers have diverted so much water from streams that minimum flows necessary for aquatic life were not maintained.

EPA officials also told us that overirrigation can increase pollution by:

- Adding nutrients which stimulate aquatic growth, choking the flow of water in canals and streams, and robbing them of oxygen when the growth decays and decomposes.
- Adding salinity which makes the water unusable for irrigation, because it strips the soil of its ability to support plant life.
- Adding sediment which fills in reservoirs, smothers fish spawning beds, and increases costs of purification for industrial and municipal uses.
- Adding bacteria, parasites, and toxic materials which can be harmful or fatal to humans and animals.
- Increasing temperatures and decreasing dissolved oxygen levels of water, both of which are harmful to fish.

In our visits to irrigation districts, we were told that two pollutants described by EPA--salinity and increased water temperature (resulting in decreased oxygen levels)--were increased more than necessary because of overirrigation.

Pollution from salinity

Salinity is a form of water pollution which occurs when soluble salts are washed out of the soil and into streams, lakes, or ground water. These salts occur naturally and result from the weathering of primary materials found in soils and in the exposed rocks of the earth's crust and are made soluble when water passes over them. Overirrigating flushes these salts from the soil into the natural water courses. To minimize salinity problems, farmers need

efficient irrigation methods and systems which limit the passage of excess water either over or through soils.

An EPA report on pollutants in the Colorado River showed that irrigation contributed 37 percent of the salinity on the upper Colorado River and 9 percent of the salinity of the lower Colorado. The high salinity content of the Colorado River has resulted in the water delivered to Mexico becoming saline to the extent that Mexico formally protested to the United States.

According to a 1974 report prepared by the Advisory Committee on Irrigation Efficiency - Wellton-Mohawk Irrigation and Drainage District, the increased salinity largely resulted from the discharge of highly saline drainage water from the irrigated lands of the Wellton-Mohawk Irrigation District coupled with a decrease in excess flows reaching Mexico. The report also stated that much of the drainage water from the Wellton-Mohawk District was the result of application of water in excess of crop consumption. ^{1/} Irrigators in the district annually apply about 7 acre-feet to crops that need, on an average, about 4.5 acre-feet. In 1974 they were assessed \$12 for the first 4 acre-feet of water, \$3 per acre-foot for the next 4 acre-feet, and a progressively higher rate through the fifteenth, for which they paid \$10. In 1975 the rates were to be \$11, \$4.50, and \$15, respectively. The excessive water which is applied to land but not used by plants percolates deep into the ground. About 210,000 to 220,000 acre-feet of this water, laden with natural salts, is returned annually to the Colorado River.

Mexico formally protested this pollution, and after much negotiation, Public Law 93-320, the Colorado River Basin Salinity Control Act, was passed in June 1974 to provide the means for improving the quality of the water delivered. The act authorized Federal actions to improve

^{1/}The Department of the Interior told us that the high salinity problem resulted from the need to pump highly saline water from the aquifer (ground water) because the ground water table was raised as a result of irrigation water provided by the Bureau's project. The ground water became highly saline because of repeated ground-water recycling through irrigation wells before constructing the Bureau's project.

the quality of this water including (1) reducing saline drainage from the Wellton-Mohawk District by helping farmers avoid overirrigation, (2) making an initial reduction in irrigable acreage of 10,000 acres, and (3) building a desalting plant to remove salts from the drainage flows. Reducing the drainage flows may cost about \$25 million, of which about \$10 million would be for on-farm improved irrigation practices, and the desalting plant is estimated to cost about \$140 million. At the present time, preconstruction activity is continuing on the desalting plant and reports are being prepared on land to be acquired. The first cost-sharing contract for on-farm irrigation improvements administered by SCS was signed in June 1975.

Pollution from temperature increases
and reduced oxygen levels

The diversion of water from a stream for irrigation or other purposes can have adverse effects on fish and other aquatic life. If insufficient amounts of water remain in the stream, heat from the sun or other sources can rapidly raise the temperature of the stream beyond desirable levels, encouraging undesirable aquatic plant growth. These plants then die and decay using up the oxygen supply in the water. According to an EPA official, both the elevated temperature and reduced oxygen supply make the water uninhabitable for certain aquatic life.

The EPA official said that irrigation diversions on the Yakima River in the vicinity of the Wapato Irrigation Project were sometimes so extensive that the riverbed immediately below the point of diversion became essentially dry. So little water remains that stream inhabitants (such as fish) are forced to leave or perish. Farmers at the Wapato Project were applying about twice as much water as their crops needed.

If irrigation diversions were reduced, additional water could be left in the stream. An EPA official said that the farmers would not have to divert nearly as much water if they did not apply excessive amounts to their crops.

Department of the Interior officials said that this type of potential benefit showed that the beneficiaries of better irrigation efficiencies were not limited to the farmer or irrigation district. Interior said that such other beneficiaries could be expected to support some of the costs of irrigation improvement programs.

FEDERAL EFFORTS TO IMPROVE INEFFICIENT IRRIGATION PRACTICES

The Federal Government, recognizing the problems associated with inefficient irrigation practices, is taking or considering the following actions:

- Changes in the Bureau of Reclamation's water-marketing policies and practices which would require applicants for water contracts to submit details and procedures concerning the planned water use.
- An EPA environmental pollution control program, the National Pollutant Discharge Elimination System (NPDES), which may make irrigators more responsible for the quality of unused irrigation water returning to the Nation's waterways.
- A voluntary irrigation scheduling program, the Bureau's Irrigation Management Services Program.
(See ch. 3.)

The Department of Agriculture also plans to initiate studies in selected areas of the Colorado River Basin within the next 5 years, involving over 1 million acres of irrigated land, to determine what contribution improved on-farm irrigation practices can make on reducing return flows and the resulting pollution.

Although these programs are being developed for various reasons, including the potential impact on irrigation efficiency, no studies have been made to determine to what extent each will have an impact on the causes of inefficient irrigation.

The Bureau's water-marketing policies and guidelines

The Bureau does not actually sell water. It stores water in reservoirs and makes the water available to irrigation districts which, in turn, repay a portion of the costs of the reservoirs and conveyance facilities. The 1939 Reclamation Project Act provides that the repayment obligation and the amount of the annual water charge or rate is to be determined within the constraint that they should be sufficient to cover "an appropriate share of the annual operation and maintenance cost and an appropriate share of the fixed (construction) charges."

The Reclamation Project Act provided the Bureau with two methods of contracting to furnish water from Federal

reclamation projects. Under one agreement, known as the repayment contract, the Bureau is authorized to market water under contracts providing for the repayment of a portion of the project costs within a designated period. The other method, known as the water service contract, provides for the payment of appropriate charges for the delivery of water over a designated period. Water service contracts offer advantages not provided by repayment contracts, in that they encourage more efficient use of project water because charges are directly related to quantities used.

In the past, Bureau water-marketing policies had been primarily developed for recovery of project costs. The need for revised water-marketing policies to discourage excessive irrigation has been recognized by the Secretary of the Interior. As a result, a new policy is being drafted which would require applicants for water contracts with the Bureau to submit details and procedures concerning the planned water use. The documentation of details and procedures would require explicit and careful consideration by the applicants of the manner in which they propose to use the water.

Also as a result of marketing-policy studies, the Bureau of Reclamation issued guidelines to be applied in contract negotiations. These guidelines encouraging more efficient irrigation included the following recommendations.

- Water supply and conveyance facilities be contracted under water service instead of repayment contracts whenever possible.
- Water service contracts provide for establishment by contracting entities (irrigation districts) of a base charge for water with significant increases in the charges for additional water quantities.
- Water service contracts provide for rate review and possible adjustment every 5 years.

Although new policies and guidelines are being developed for the water-marketing area, their overall impact on irrigation efficiency may be minimal because existing contracts are not easily amended to restructure the pricing of water service. Therefore, the revised policies and guidelines primarily would have an impact on new marketing contracts. The Department of the Interior said, however, that informal negotiations have resulted in some voluntary adoption of water-pricing incentives.

The National Pollutant Discharge
Elimination System may
encourage more efficient irrigation

The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) have the stated objective of restoring and maintaining the integrity of the Nation's waters. The act established a national goal to eliminate the discharge of pollutants into the waterways of the United States by 1985. In the interim, however, a number of mechanisms and deadlines are established for regulating discharges until the discharges can be phased out.

Section 402 of the act requires all point sources to obtain a permit from EPA to discharge waste water into the Nation's waterways. It is illegal to discharge into waters without such a permit. Discharges of pollutants under such permits must meet effluent limitation established by EPA or more stringent State limitations to meet State water quality standards.

Discharges of pollutants, as defined by the act, mean any addition of any pollutant to the Nation's waterways from any point source. Point sources are defined as any discernible, confined, and discrete conveyance, such as pipes, ditches, etc., from which pollutants are or may be discharged.

The question as to whether irrigation return flows are point sources and, therefore, subject to the permit requirements of the act was highlighted when EPA issued a regulation exempting discharges of irrigation return flows from areas of less than 3,000 acres. The regulation was subsequently voided by district court on the grounds that exemption of an entire class of point sources is in violation of the act.

Although EPA is proceeding with the appeal of this decision, the agency is still required to comply with the court order. As a result, on February 23, 1976, EPA published proposed regulations for applying NPDES to agriculture. In the regulations EPA has classified irrigation return flows as point sources subject to the program. In its March 16, 1976, letter (see app. III), EPA informed us that, although individual sources will not be required to apply for a permit, except when the Administrator or Regional Administrator felt there were extenuating circumstances, because of the burden this would place on EPA,

discharges would be validated by general permit. EPA told us that procedures for issuance of the general permits would be proposed simultaneously with the promulgation of the final regulations.

Even though individual NPDES permits would not be required for irrigation return flows, EPA told us that it would encourage good preventive practices in all cases for the protection of water quality and that irrigation practices would be required to be upgraded to meet the goals established by the Congress. EPA informed us this would be accomplished by developing programs under section 208 of the Federal Water Pollution Control Act Amendments of 1972 in conjunction with the NPDES program. Also in this connection, the Department of Agriculture told us that the National Association of Conservation Districts had resolved to actively participate in non-point pollution control planning and implementation at local and State levels.

CONCLUSIONS

Inefficient irrigation practices contribute substantially to overirrigation which adversely affects crop production, such as damaging crops and croplands and denying water to potentially productive lands, increases farming costs, and contributes to water pollution. Comprehensive data is not available, however, to identify and quantify those damages resulting from inefficient irrigation practices and those resulting from other factors.

Although overuse of low-cost water and inaccurate estimates by farmers of irrigating frequency and amounts and State water rights are recognized as significant causes of inefficient irrigation, quantitative data has not been developed to identify to what extent each contributes. Although some effort is being made within the Federal Government to help reduce inefficient irrigation practices, the absence of data to quantify the degree of contribution by various factors to the problem makes it difficult to assess whether the actions being taken are responsive to the problems and are economically feasible.

RECOMMENDATIONS

We recommend that the Secretaries of the Interior and Agriculture and the Administrator, EPA, undertake a coordinated effort to

- develop more complete data on the adverse effects attributable to inefficient irrigation practices,
- determine the causes for such practices and the extent that each contributes to the problem, and
- determine what Federal actions should be taken to alleviate the inefficient practice and the Federal agency, or agencies, best structured to administer such a role.

AGENCY COMMENTS

In its April 27, 1976, letter (see app. I), the Department of the Interior stated that from a broad national overview, it believes that the recommendation concerning the need for a coordinated effort is generally sound and should be pursued. Interior stated that although the scope of the Bureau of Reclamation's efforts had been on a "pilot project" basis up to now, it was apparent that a broader scoped effort by all involved Federal agencies was now feasible and would enhance the current program. Interior noted that additional time, personnel, and funding would be required and that after the required information had been obtained, the action program for obtaining more efficient water use would have to be developed and put into effect.

Interior stated, also, that it already knows, generally, the factors that contribute to inefficient irrigation and that further detailed studies to precisely quantify the effect of each specific factor would appear to be of lesser importance than development of an overall action program to identify procedures to overcome these impediments.

While we agree that an action program to overcome the factors contributing to inefficient irrigation is a proper goal, we also believe that quantitative data showing the extent that each factor contributes to inefficient irrigation will be needed to adequately justify the necessary funding of priority programs that have an impact on the problem.

CHAPTER 3

IMPROVEMENTS NEEDED IN FEDERAL EFFORTS

TO PROMOTE MORE EFFICIENT IRRIGATION PRACTICES ON

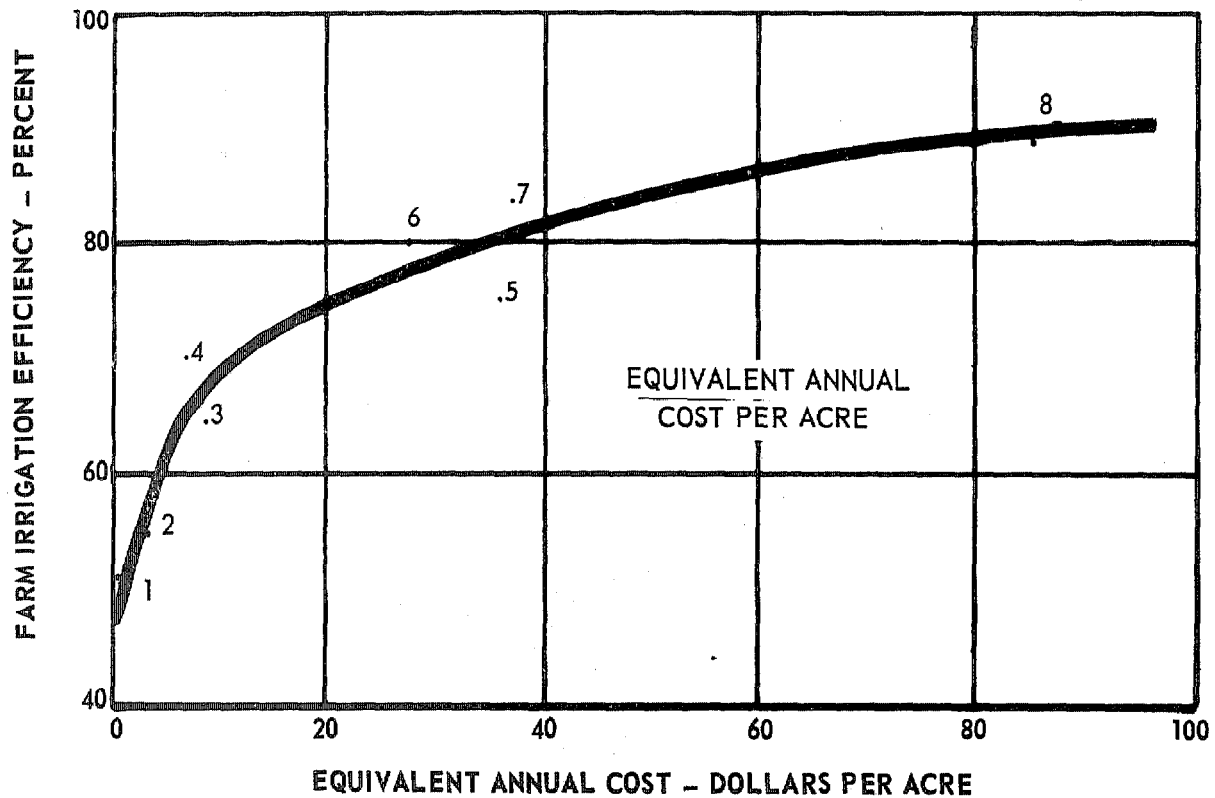
A VOLUNTARY BASIS

Although techniques for improving on-farm water management have been developed through Agricultural Research Service, Soil Conservation Service, and Bureau of Reclamation research, Federal efforts to help farmers implement these techniques have had limited success. Many techniques for improving on-farm irrigation efficiency have been identified by Federal agencies active in agricultural research. They range in cost and efficiency from expensive, sophisticated drip or trickle irrigation systems, which can double irrigation efficiency, to simple improvements in irrigation scheduling (a systematic determination of when to irrigate and how much water to apply) which, although inexpensive, have the potential for increasing irrigation efficiency. (See p. 24.)

From 1965 through 1970, the Bureau made a comprehensive study of water use on selected farms within Federal irrigation projects in 11 States. The Bureau's study indicated that farmers either lacked the necessary information to optimize water management or did not understand the proper timing and amounts of water to be applied. Both of these contributed to low irrigation efficiency--44 percent. The study disclosed that irrigation efficiency could be increased 11 percentage points--from 44 percent to 55 percent--with minor changes in water management. This improvement could be realized at an annual cost to the farmer of about \$3 per acre to receive information on irrigation scheduling and would not require the farmer to provide additional facilities or labor. (See item 2 on the following graph.)

The Bureau's study showed that irrigation efficiency could be further increased to 65 percent with some additional labor and proper water management for an estimated annual cost of \$8 per acre. Efficiencies of 70 to 90 percent could be obtained, using proper irrigation management techniques and improved farm irrigation facilities, for a cost of from \$7 to \$80 per acre, depending on the nature of improvements made. The alternative schemes, their costs, and their potential irrigation efficiencies are illustrated in the following graph.

BUREAU ANALYSES OF ON-FARM IRRIGATION IMPROVEMENTS



ESTIMATED COST IN DOLLARS PER ACRE TO IMPROVE FARM
IRRIGATION EFFICIENCY ON BUREAU OF RECLAMATION PROJECTS

SOURCE: SHUT OFF THE WATER THE ROOT ZONE IS FULL
A STUDY OF IRRIGATION WATER USE. U.S. DEPARTMENT OF INTERIOR
BUREAU OF RECLAMATION

Numbered points represent the following improvements needed to achieve indicated irrigation efficiency (from a practical, project-wide standpoint):

1. Present system, proper timing of irrigations.
2. Present system, proper timing and amount of irrigations (IMS).
3. Present system, proper timing and amount and distribution of irrigations (proper irrigation management), additional labor.
4. Present system, add runoff reuse system, irrigation management.
5. Sprinkler system, proper irrigation management.
6. Present field layout, some leveling and ditch lining, add semiautomated equipment, runoff reuse system, proper irrigation management.

7. Revised field layout, level basins, fully automated equipment, proper irrigation management.
8. Drip or trickle irrigation system, proper irrigation management.

In its March 12, 1976, letter (see app. II), the Department of Agriculture said that the \$3 to \$5 per acre per year cost of the Irrigation Management Services program is a continuous cost, assuming that cooperators will need continued on-site assistance. Agriculture pointed out that improved on-farm systems (other than IMS) involved costs which could be amortized, were more labor saving, probably provided more direct monetary benefits to the farmer, gave him something he could be proud of, saved significant amounts of water, and made the farmer more receptive to water scheduling. It also stated that the ability and understanding of the irrigator, the adequacy of his on-farm system, and the capability of the water delivery system to the farm, were all equally important in achieving good water management.

Agriculture also pointed out that Dr. Marvin E. Jensen of the Agricultural Research Service, who developed the computerized irrigation scheduling program, concluded in a November 1975 report that improved irrigation scheduling technology must be accompanied by the adoption of more efficient irrigation facilities and practices.

IRRIGATION SCHEDULING--AN IMPORTANT STEP TOWARD INCREASING ON-FARM IRRIGATION EFFICIENCY

Because irrigation scheduling is relatively inexpensive, it is potentially the most widely promotable technique for helping farmers to improve their irrigation scheduling practices. However, it is recognized that the capability for controlling water on farms and in distribution systems could have a marked influence on the actual or potential effectiveness of irrigation scheduling. Where facilities are adequate to properly distribute and apply water, irrigation scheduling will be an effective tool in increasing irrigation efficiency. Where facilities are not adequate, the improvement of these facilities should precede irrigation scheduling.

Scheduling techniques range from very simple and general programs which require the farmers to compute their own irrigation schedules to sophisticated, computerized irrigation scheduling services provided by specialized consulting groups. Irrigation scheduling services, both commercial and Federal, are available to farmers in the Western States.

Commercial irrigation scheduling services are offered to farmers for a fee by private consulting firms. A

1975 ARS survey showed that there were at least 10 such firms serving about 250,000 acres in 8 Western States. We visited five of these companies, two in California and three in Idaho, which provided irrigation scheduling services in 1974 to about 126,000 acres. All offered services, in addition to irrigation scheduling, usually advice on fertilizers, and all charged fees for their services ranging from \$3 to \$12 per acre, depending on the crops grown and the services provided.

Two companies in California were very new in the area (one started in 1973 and the other in 1974) but nevertheless served 21,000 acres in 1974 and had contracted to serve 40,000 acres during the 1975 crop year. An Idaho company was serving 70,000 acres in 1974--4 years after startup--and was projecting coverage of as many as 100,000 acres in 1975. We noted, however, that the commercial firms were generally contracting with large farms whereas the Bureau dealt with all size farms.

According to the Department of the Interior, the Bureau's program is not in competition with private services and Interior encourages and supports efforts by the private sector in this area. Interior also said that the Bureau's IMS program encompassed distribution system scheduling which the private sector did not.

FEDERAL IRRIGATION SCHEDULING SERVICES

The Federal irrigation scheduling service got its start in about 1966 when ARS began research to develop a computer program as a tool for providing farmers with scientific estimates of irrigation needs for each field. Although ARS developed the water scheduling program at the request of SCS, the latter never adopted it as an operational tool. According to SCS officials, SCS did not initially adopt the program because some considered it insufficiently developed for practical application, funds and personnel were not available to perform required services, and its data accumulation requirements were believed to be too demanding on the farmers. As a result of the initial decision, SCS did not attempt to establish irrigation scheduling for application as an SCS program.

SCS is, however, providing assistance to the Bureau in implementing their irrigation scheduling service at the Welton-Mohawk District as part of the program to provide cleaner water from the Colorado River for delivery to Mexico. (See p. 16.)

One SCS official, however, expressed the opinion that irrigation scheduling would have logically fit into the technical services provided under the SCS conservation operation program, which is available to about 98 percent of the farms in the United States. In his opinion, implementation through this program would have afforded more personal contacts thereby increasing the possibilities of irrigator acceptance.

The ARS irrigation scheduling program was further developed by the Bureau of Reclamation and subsequently adopted by the Bureau as the Irrigation Management Services program. IMS includes a computerized irrigation scheduling service which the Bureau provides to individual farmers either on a consultive or a service basis through irrigation districts or other local irrigation entities. It is designed to increase farm irrigation efficiencies on Bureau projects by helping irrigation districts develop greater expertise in irrigation scheduling and other on-farm water management practices.

The Department of the Interior views IMS as being potentially much broader than irrigation scheduling as emphasized now. It said that the IMS program was conceived to increase farm and project irrigation efficiencies of Bureau of Reclamation projects by developing the necessary staff expertise and capabilities with water users organizations (usually irrigation districts) so they could assist individual farmers. The districts would eventually finance and operate the programs with minimal assistance from the Bureau. Interior also said that because many factors were responsible for poor irrigation efficiency, the program could involve evaluation and development of irrigation technology, demonstration, and training in areas other than irrigation scheduling.

By December 1974 IMS had been introduced to 20 irrigation districts in 7 Bureau regions. In 1974 there were 31 full-time and 24 part-time Bureau employees working on the program, as well as 18 irrigation district employees working full or part time.

IMS funding and interagency coordination

Funding of the IMS program has been from three Bureau sources: (1) water resources planning and engineering research funds, (2) Colorado River water quality improvement program funds (limited to the Colorado River Basin), and (3) Colorado River salinity control program title I funds (limited to the Colorado River Basin). The amounts provided are summarized below.

Funding of the IMS Program

Fiscal year	Source			<u>Total</u>
	<u>WRPER</u> (note a)	<u>CRWQIP</u> (note b)	<u>CRSCP/title I</u> (note c)	
1970	\$ 43,000	\$ -	\$ -	\$ 43,000
1971	130,000	-	-	130,000
1972	245,000	26,000	-	280,000
1973	342,000	242,442	-	584,442
1974	479,000	477,044	-	956,044
1975	430,000	486,599	199,321	<u>1,115,920</u>
				<u>\$3,109,406</u>

a/Water resources planning and engineering research.

b/Colorado River water quality improvement program.

c/Colorado River salinity control program.

In fiscal year 1973, the Office of Management and Budget (OMB) directed the Bureau to place greater emphasis on improving water management and irrigation efficiency in its planning and operations. The directive stated, in part, that the Bureau should "redirect the research and development and study program that now emphasizes new water supplies--to other alternatives such as * * * improved irrigation efficiency and other water management practices." Although the above table indicated that the program has received increased fiscal emphasis, the two regions located in the Colorado River Basin received a majority of the funds. Five other Bureau regions received an average of \$52,000 in fiscal year 1973 and \$64,000 in fiscal year 1974 to fund their IMS programs.

We believe that although OMB directed that greater emphasis be placed on improved water management and irrigation efficiency, Federal efforts to promote more efficient on-farm irrigation have not been adequately coordinated at policymaking levels of the Departments of the Interior and Agriculture.

The Bureau did not seek cooperation and assistance on a systematic basis from other Federal agencies, such as SCS, except at the lowest field levels. Bureau technicians demonstrating the IMS program attempted to obtain the cooperation of field personnel of other agencies, but we found no instances in which such efforts were successful. For example, we were informed by Bureau regional personnel that local SCS and Extension Service officials expressed interest in the IMS program. However, in some cases the

Bureau did not follow up and secure the assistance, and in others, SCS representatives reconsidered because they did not have sufficient personnel or funds to provide the technicians needed to implement the program. In other instances, the Bureau's program was rejected by representatives of SCS and the Cooperative Extension Service as too complicated and too demanding for farmers to use.

Service provided through IMS

The Bureau provides two methods of irrigation scheduling under the IMS program--the irrigation guide and the field-by-field methods. Only the field-by-field method is considered to be a true irrigation scheduling service.

The irrigation guide method gives irrigation intervals for principal crops in a geographic area based on daily evapotranspiration ¹/ _{rates and average water-holding capacities for several soils in the area. The guide is updated weekly with daily climatic data from a central location in the area. It gives the average daily water use and the total water use for the week and the total water use to date. It also forecasts crop water use for the next week. Reports showing this information are mailed to each farmer in a district for his use in computing his irrigation intervals and quantities of water to apply. No visits are made to the farm by irrigation technicians--all interpretations of the data and computation of irrigation requirements are left to the farmer.}

The field-by-field method is substantially more comprehensive than the irrigation guide method but requires similar kinds of input data. The input data for the irrigation guide method represents the general irrigated area, which in some cases may exceed 70,000 acres. In contrast, the input data for the field-by-field method is much more precise, representing specific fields, which average 26 acres Bureau-wide.

The field-by-field method provides the farmer with the daily soil moisture status of each of his fields in the program. It gives him recommended optimum dates and amounts to apply during the next irrigation. If adequate input data is available, application rates and duration of irrigation can be included. Because the data

¹/Evapotranspiration is water dissipated to the atmosphere by evaporation from water surfaces and moist soil and by plant transpiration.

requirements are substantially greater than in the other method, more technical manpower is needed. The field-by-field method provides the farmer with a computer print-out once or twice weekly which is considered an update of his irrigation needs.

Under the field-by-field method, a trained irrigation technician makes regular visits to each farm. Either the farmer or the technician must determine whether the last irrigation completely replenished the depleted soil moisture. The effectiveness of applying the desired amount of water uniformly on the field must also be determined. The irrigation technician works with the farmer to analyze his irrigation operations. How often the technician must visit the farm depends on the experience, capability, and enthusiasm of the farmer. Experience has shown that visits should be made at least weekly during the initial stages of the program.

Participation by irrigation districts and farmers in the IMS program is purely voluntary. Typically, the Bureau approaches the managers of irrigation districts and proposes to demonstrate irrigation scheduling for a limited period of time, generally 2 to 4 years. The Bureau provides qualified employees and pays their expenses as well as the costs of computer terminal installation and operation during the demonstration period. In return the Bureau requires the district to furnish office space and utilities for the Bureau employees. The irrigation district must also furnish additional personnel as needed.

At the end of the demonstration period, the Bureau expects to have trained district personnel sufficiently for the district to assume operational and financial responsibility for the program. The Department of the Interior told us that no maximum or minimum assistance period had been established and that the duration of assistance and cost-sharing arrangements during the development period depended on the local situation.

In its April 27, 1976, letter (see app. I), the Department of the Interior stated that limitations of the Bureau of Reclamation's statutory authority had largely determined the scope of the IMS efforts. Interior stated that, as a result of the general concept of the 1902 Reclamation Act providing that expenditures be reimbursed by project beneficiaries, their approach had been to develop and assist irrigation districts in establishing programs to improve irrigation efficiencies rather than assuming any continuing obligation for field application.

LIMITED SUCCESS OF THE IMS PROGRAM

Although it was first demonstrated in 1969, the IMS program has not yet achieved wide acceptance. During 1974, 308,658 acres were served by both IMS methods. However, only 96,758 acres received irrigation scheduling service by the field-by-field method. The remaining 211,900 acres were served by the generalized irrigation guide method.

At the end of the 1974 irrigating season, only 1 of the 20 irrigation districts to which the IMS program had been introduced was willing to take over the program and operate it. The Westlands Water District assumed operation of the program in 1975, and the Bureau agreed to continue to provide the computer support and some technical assistance--equal to about 25 percent of the program's cost. Two districts in the Bureau's Rio Grande Project voted to discontinue participation in the program; an action concurred with by local Bureau personnel. The remainder, including the Bureau's first demonstration project started in 1969, agreed to stay in the program if the Bureau continued to operate it. The Department of the Interior told us that the districts experienced problems in funding and paying personnel with the skills necessary for a successful irrigation management program.

Surveys by the Bureau and ARS and our own review showed that many farmers and officials of irrigation districts were impressed with the concept of IMS. Nevertheless, nearly all expressed reservations about what the program could do for them. Many farmers and district officials said they believed that benefits were probably attainable through better irrigation scheduling practices resulting from IMS. They were reluctant, however, to accept IMS and follow its recommendations until they (1) observed tangible evidence these benefits existed and the monetary returns exceeded the cost of improving their water scheduling practices and (2) were convinced that the program was technically sound and was providing accurate scheduling advice.

Reservations with respect to economic benefits of IMS

Bureau officials generally agreed that in most cases farmers would be reluctant to pay higher water charges or extra assessments for IMS without convincing demonstrations

of its on-farm economic benefits. Bureau officials also indicated it has been difficult to convince farmers that there are specific benefits resulting from IMS.

Our review indicated that a successful IMS demonstration program must generate convincing data on the benefits and costs of IMS. The Bureau acknowledged that the benefits and costs of IMS must be quantified to provide a better basis for encouraging adoption of the program by farmers and irrigation districts. Regarding the IMS benefit studies, the Department of the Interior in its April 27, 1976, letter (see app. I) pointed out that theoretical and practical problems are involved. They stated that benefits to farmers, optimum crop yields, and economic returns depended on interaction of many factors, including not only water management but also suitability and timeliness of cultural operations, fertility management, crop variety, and pest control.

The farmers that received the field-by-field service generally believed it helped them. Most, however, could not cite any quantified benefits in terms of increased income or decreased costs. A few farmers cited examples where crop yield or quality was improved or farming costs were reduced compared to previous years or to the districtwide average.

At the start of a demonstration, the Bureau does not identify goals to be achieved on individual farms or in the irrigation districts. Similarly, before introducing IMS, the Bureau does not identify benchmarks, such as operating results, against which improvements can be measured. No system has been developed for the Bureau to obtain feedback from the farmers on their actual results of operations. As a result, progress has not been systematically identified or quantified. Without evidence of tangible benefits, it has been difficult for the Bureau to convince farmers that IMS can help them, and there has not been a strong voluntary response to the program.

The Department of the Interior said that the major reasons for not proceeding more diligently with specific documentation of benefits of the IMS program to farmers, districts, downstream users, and the public have been lack of adequate funding and personnel over the past few years and the theoretical and practical difficulties of making such determinations.

Reservations regarding accuracy
of basic data

Farmers as participants in an ARS irrigation scheduling survey and some Bureau personnel have indicated that there is a need to refine the basic data on which irrigation schedules are based. They said more research is needed in some geographical areas on (1) crop consumption curves--the way a specific crop uses water throughout a growing season--and (2) soil infiltration rates--how fast different soils absorb water. Without valid data on these factors, the local IMS program will be incomplete and its recommendations may be inaccurate.

One Bureau official, however, stated that even with existing data limitations, there is enough soil-moisture-holding and field-mapping data to permit a 60-percent irrigation efficiency with IMS. He said the Bureau could use presently available data and apply it to those areas where efficiencies are below 60 percent. He stated additional research may be necessary after irrigation efficiencies are raised to the 60-percent level and attempts are made to achieve higher efficiencies.

MORE CAREFUL PLANNING AND ANALYSIS IS
NEEDED TO ACCELERATE IMPLEMENTATION OF IMS

A more carefully planned Federal approach is needed to increase farmer acceptance of the IMS program. The Bureau's approach to IMS has been designed to expose a large number of farmers to the concept without committing the Bureau's available resources to an in-depth field-by-field service program. This approach has proved unsuccessful, at least partly because on-farm benefits of IMS are seldom readily apparent to the farmer. Consequently, he is unlikely to implement IMS because of exposure to the concept or to computerized irrigation schedules. To be convinced, he needs to see a real life demonstration of how IMS can increase production, reduce costs, or preserve croplands on his farm or his neighbor's. Also, no alternative approaches were designed for situations where the principal benefits of more efficient irrigation do not accrue to farms but rather to others, such as downstream water users.

There are several opportunities for improving the Bureau's approach to encourage implementation of IMS.

Successful demonstrations require
extensive fieldwork

In carrying out the IMS program, the Bureau attempted in each district selected for demonstration purposes to expose as many farmers as possible to the program. However, technical followup work in the form of field visits to help farmers implement the program were made only when requested by farmers. This approach was selected because Bureau personnel believed that (1) they did not have sufficient funding or qualified personnel to work directly with each irrigator and (2) the benefits realized by those irrigators that requested technical assistance would readily convince others to implement the program.

Bureau officials explained that this approach had limited success because, without the assistance of field technicians, farmers seldom used the scheduling advice provided to them by the Bureau. Representatives of commercial irrigation scheduling services, officials of irrigation districts, and farmers agreed with this observation and stated that frequent (at least once-a-week) work sessions between technicians and farmers were necessary to make the program work. They also advised that this frequent communication led to a better rapport between irrigators and technicians and built farmer confidence in the program.

Frequent field visits also permitted technicians to adjust the irrigation schedules to consider actual field conditions, water delivery schedules, stage of crop growth, and related factors. Farmers suspicious of computer printouts were reluctant to follow IMS recommendations unless technicians checked the computerized data with actual field conditions to verify their reliability. By reconciling the computer forecast with actual conditions, the irrigators became more confident in the program and relied on it when scheduling irrigations.

Bureau officials acknowledged that during developmental and demonstration stages, IMS field technicians must have considerable personal contact with individual farmers to make sure the irrigators (1) understand and properly apply the irrigation scheduling information on computer printouts, (2) keep the necessary records on irrigation times and amounts, and (3) report the data as required.

However, they were also of the opinion that providing a higher level of technical support may be difficult because of IMS funding and personnel constraints. Bureau personnel indicated that funding constraints (1) prevented

them from employing needed technicians and (2) provided insufficient travel allowances for properly demonstrating the program. They said that in some cases, personnel ceilings prevented the Bureau from hiring needed technicians even when funds were available.

Because of the magnitude of personnel and funding that might be required to implement an in-depth, field-by-field service program for all farmers receiving Bureau water service, the Bureau should consider whether it should shift its emphasis to an intensive education program supplemented by only a few hand-picked, on-farm demonstrations.

Alternative ways to implement IMS
must be studied by the Bureau

According to the Department of the Interior, the general concept of the 1902 Reclamation Act provides that expenditures be reimbursed by project beneficiaries, preventing the Bureau from assuming funding obligations for a continuing operational program. Therefore, the Bureau's IMS program has focused largely on demonstrating on-farm benefits to individual farmers and, through that means, encouraging irrigation districts to assume financial responsibility for offering IMS services to their members. In some cases, the principal benefits of IMS do not immediately accrue to the individual farmers implementing the program. In the Westlands Water District, for example, the immediate beneficiary of IMS was the irrigation district, which could have saved over \$1.7 million annually in water pumping costs. While these cost savings would ultimately be passed on to individual farmers in the district, they were most clearly visible and, therefore, most easily demonstrated at the district level. Similarly, in the Wellton-Mohawk District, the use of IMS will principally benefit downstream water users in Mexico, not the farmers whose irrigation return flows have been polluting the Colorado River.

Although the Bureau has recognized that in some cases there are principal beneficiaries other than the individual farmers, little has been done to design more flexible approaches to demonstrate the other benefits of IMS. Since the principal benefits may primarily exist on a regional or national level, it may not always be worthwhile for the Bureau to demonstrate the benefits to the individual farmers, expecting them to assume a continuing obligation for the costs. In these cases, the demonstration program should be tailored to show also the regional or national benefits and to determine the additional statutory authority required for the Bureau to continue the program beyond the demonstration phase.

Resource limitations are another good reason for increased flexibility in Bureau approaches to demonstrating IMS. The resources available to IMS have traditionally been limited and may remain so despite the potential benefits available. To maximize the impact of its IMS resources, the Bureau will have to consider such questions as:

- Should the Government introduce IMS demonstrations in agricultural areas where commercial irrigation scheduling services are rapidly expanding their business?
- Because extensive and costly fieldwork is required to convincingly demonstrate IMS benefits, should the Bureau shift its emphasis to an intensive education program supplemented by only a few hand-picked, on-farm demonstrations?
- What joint programs and coordinative mechanisms between the Bureau, SCS, and the Extension Service are needed to better apply existing Federal resources in educating farmers in the techniques of IMS and in helping them implement voluntary irrigation scheduling programs?

CONCLUSIONS

Federal efforts to assist farmers to voluntarily improve on-farm water management need better planning and coordination. Although techniques for improving irrigation efficiency have been identified by the Federal agencies active in agricultural research, on-farm implementation of the techniques has been slow.

The Bureau's IMS program, currently the principal Federal vehicle for helping farmers implement irrigation scheduling, has had limited impact. The program has been funded and staffed at low levels in most of the Bureau regions; also its progress has not been aided to the extent possible by cooperative interagency programs to help farmers improve their irrigation efficiency.

The Bureau's lack of adequate demonstration of the benefits of IMS has limited its credibility with farmers. They are reluctant to implement the program because they are not convinced that it is profitable or technically reliable. These and other related problems should be considered by Interior in a thorough reappraisal of IMS to strengthen and redirect the program.

RECOMMENDATIONS

We recommend that, to accelerate voluntary implementation of the IMS program, the Departments of Agriculture and the Interior jointly develop Federal objectives, policy recommendations, and action plans integrating the unique capabilities of the Bureau, SCS, and the Extension Service to educate and assist farmers that wish to improve their irrigation efficiency.

We also recommend that the Secretary of the Interior direct the Bureau of Reclamation to:

- Review the IMS program, including its funding levels and priority, to develop a more flexible and comprehensive program plan including analyses of IMS benefits and alternative means of encouraging farmer acceptance of irrigation scheduling techniques.
- Direct greater attention in IMS demonstration projects to setting objectives and benchmarks against which the benefits of IMS can be clearly measured and made visible to farmers and irrigation district managers.
- Increase the frequency of field visits, especially during the early stages of those projects selected for demonstration, so that Bureau irrigation technicians can work more closely with selected farm operators testing the usefulness of IMS techniques.
- Require the use of more carefully tailored approaches to demonstrating IMS benefits, including identification of regional and national benefits and determination of the need for additional statutory authority for the Bureau to continue the program beyond the demonstration phase.

AGENCY COMMENTS

Concerning our recommendation that the Departments of the Interior and Agriculture jointly develop Federal objectives, policy recommendations, and action plans integrating their unique capabilities to educate and assist farmers that wish to improve their irrigation efficiency, the Department of the Interior, in its April 27, 1976, letter (see app. I), expressed the hope that the report would promote interagency

cooperation. In this connection, Interior stated that identification of mutual objectives and a cooperative effort could contribute significantly toward improvement of irrigation management and efficiencies. Interior agreed that more emphasis should be placed on educating farmers and stated that it stands ready to participate in the recommended joint efforts to the extent of available resources.

In commenting on our recommendation, the Department of Agriculture in its March 12, 1976, letter (see app. II) said it seemed very appropriate and recognized the contribution Agriculture could make. However, Agriculture commented that personnel ceilings and the demands for assistance in new programs had hampered its program to individual landowners. It stated that the emphasis placed by ARS and SCS in the Wellton-Mohawk Project and the initiation of additional studies elsewhere in the Colorado River Basin indicated a major redirection of Department of Agriculture programs for water conservation in the West.

Agriculture did state that the Bureau of Reclamation's irrigation programs should not be merged into SCS's conservation operations program; however, it indicated there would be no objection to conferring with other Federal agencies, at their request, to review programs and objectives and to develop better coordinated programs for farm irrigators.

Concerning our recommendations for actions to be taken by the Bureau of Reclamation to evaluate and improve specific aspects of the IMS program, the Department of the Interior said that it is continually reviewing the progress of the program and introducing new ideas for flexibility and simplicity but agreed that it needs to pursue our recommendations with greater vigor. In this connection Interior pointed out that

- to the extent permitted by personnel ceilings and funding, emphasis is being placed on quality control of the IMS program which increases the frequency of field visits and promotes closer cooperation with farmers and irrigation district officials and
- a limited study is underway of on-farm benefits, and a study is also programed on the regional and national benefits of the IMS program.

The agencies' comments indicate that they recognize the need for better planning and interagency coordination to improve on-farm water management. Proposed actions, if properly implemented, should contribute to improvements in the Federal programs.



United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

APR 27 1976

Mr. Henry Eschwege
Director, Resources and
Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

We have reviewed your draft report to the Congress entitled "Improved Federal Efforts Needed to Promote More Efficient Farm Irrigation." Our responses to the specific recommendations in the report are presented below. In addition, we enclose more detailed comments on the report which were provided your staff for consideration in revising and developing certain parts of the discussion to make them as accurate and informative as possible. (See GAO note, p. 42.)

The report identifies problems that have been encountered in efforts to promote improvements in farm and project irrigation efficiencies through the Irrigation Management Services (IMS) program and provides constructive suggestions toward resolution. In some respects, however, the report lacks a full explanation of the decisions and choices that must be made by farm and irrigation system managers and thereby masks some factors that have influenced the development of the IMS program. As pointed out in the enclosure, the lack of such explanations could leave the uninformed with erroneous impressions concerning irrigated agriculture and the scope of ongoing efforts to improve irrigation management and efficiencies.

The limitations of the Bureau of Reclamation's statutory authority have largely determined the scope of its IMS efforts. The general concept of the 1902 Reclamation Act provides that expenditures be reimbursed by project beneficiaries. Therefore, the Bureau's approach has been to develop and assist irrigation districts in establishing programs to improve irrigation efficiencies, rather than assuming any continuing obligation for field application.

Recommendation

A coordinated effort by the Departments of the Interior and Agriculture and the Environmental Protection Agency is recommended to secure more complete data regarding adverse effects attributable to inefficient irrigation, the specific factors contributing to the problem, and to identify what the Federal role should be in alleviating the problem.



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Response

From a broad national overview, this is a generally sound recommendation and should be pursued. Although the scope of Reclamation's efforts has been on somewhat of a "pilot project" basis up to now, it is apparent that a somewhat broader-scope effort by all involved Federal agencies is now feasible and would enhance the current program.

It should be recognized that such an approach would require considerable time, additional personnel, and sizable funding for each of the several agencies. After the required information has been obtained, the action program for obtaining more efficient water use has to be developed and put into effect.

We have reservations concerning the practicability and need for precise quantitative assessment of the extent to which specific factors, such as water pricing or lack of knowledge regarding optimal timing and amount of water application, contribute to inefficient irrigation. Also, the Bureau already knows, in a general way, the factors that contribute to inefficient irrigation, and further detailed studies would appear to be of lesser importance than development of an overall action program to identify procedures to overcome these impediments.

Recommendation

It is recommended that the Departments of the Interior and Agriculture jointly develop objectives, policy recommendations, and action programs that will integrate the unique capabilities of the Bureau of Reclamation, Soil Conservation Service, and the Agriculture Extension Service to educate and assist farm operators who wish to improve their irrigation efficiencies.

Response

We agree that more emphasis should be placed on educating farm operators. We stand ready to participate in the recommended joint efforts to the extent of available resources.

Recommendation

GAO recommended that the Bureau of Reclamation be directed to:

--review the IMS program, including its funding levels and priority, to develop a more flexible and comprehensive program plan including analyses of IMS benefits and alternative means of encouraging implementation of irrigation scheduling techniques,

--direct greater attention in IMS demonstration projects to setting objectives and benchmarks against which the benefits of IMS can be clearly measured and made visible to farm operators and irrigation district managers,

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--increase the frequency of field visits, especially during the early stages of demonstration projects, so that Bureau irrigation technicians can work more closely with farm operators testing the usefulness of IMS techniques, and

--require the use of more carefully tailored approaches to demonstrating and implementing IMS which recognizes that local, regional, or national benefits may exist in farming regions.

Response

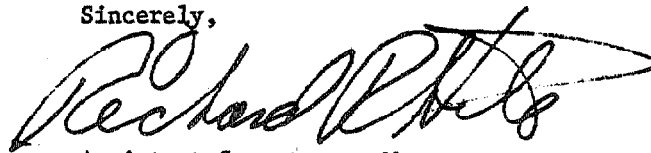
In the development of the IMS program, Reclamation is continually reviewing the progress of the program and introducing new ideas for flexibility and simplicity. To the extent permitted by personnel ceilings and funding, emphasis is being placed on quality control of the IMS program which increases the frequency of field visits and promotes closer cooperation with farm operators and irrigation district officials. Undoubtedly, the Bureau needs to pursue these suggestions with greater vigor. It has underway a limited study of on-farm benefits, and a study is also programmed on the regional and national benefits of the IMS program.

Regarding the IMS benefit studies, we would like to point out that difficult theoretical and practical problems are involved. Benefits to farmers, optimum crop yields and economic returns depend upon interaction of many factors, including not only water management but suitability and timeliness of cultural operations, fertility management, crop variety, and pest control. There is no convenient or easy way to determine the effect of individual variables. Experience has shown that the farmers who use irrigation scheduling provided through IMS are usually already irrigating at efficiencies higher than average for their localities. The Bureau also finds that farmers who are poor irrigation managers tend to neglect other crop production factors. Thus, it is difficult to conduct valid comparisons of with-IMS and without-IMS groups.

Conclusion

We hope this report will promote interagency cooperation among the Departments of the Interior and Agriculture and the Environmental Protection Agency. Identification of mutual objectives and a cooperative effort could contribute significantly toward improvement of irrigation management and efficiencies.

Sincerely,



Assistant Secretary - Management

Enclosure

GAO note: The enclosure is not included here but was considered in this report.

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DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

March 12 1976

Mr. Henry Eschwege
Director
Resources and Economic
Development Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

We have reviewed your draft report entitled "Improved Federal Efforts Needed to Promote More Efficient Farm Irrigation" and find it to be very timely and of considerable interest to the USDA. The problems of low irrigation efficiencies, overuse of water, development of high water tables and resulting drainage and salinity problems, and return flows of salts and drainage water to rivers and streams are some of the major ones identified in this report. The efforts of ES, ARS and SCS have been addressed to each of these problem areas though limited by budgets and personnel ceilings. Research, technical assistance and educational efforts have been and are directed toward evaluation of crop requirements for water and tolerance to salinity, improved irrigation scheduling, improved on-farm water control practices, and improved salinity control techniques.

We have a number of comments that we feel should be addressed in the final report.

1. The report is narrow in scope and not in keeping with its title "Improved Federal Efforts Needed to Promote More Efficient Farm Irrigation."
 - a. The report seems to dwell on Bureau of Reclamation project areas. These projects have accounted for the development of about 20 percent of the irrigated acreage in the U.S. and 70 percent of these have been turned over entirely to local water use organizations. Approximately 80 percent of the irrigated areas in the West are operated through private or local government action. Major consideration should be given to these lands in redirecting federal programs for improved water management.
 - b. The report overemphasizes the role of "irrigation scheduling" which is the primary output of the Bureau's Irrigation Management Services (IMS) program in achieving good water management.

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Henry Eschwege

The title of the report would indicate a more comprehensive approach to be in order. The report appears to justify this approach on the assumption that the IMS program (or water scheduling) can make the greatest contribution for the least cost.

The cost of the IMS program is \$3-5 per acre per year. This is a continuous cost assuming that cooperators will need continued on-site assistance, which our experience would anticipate. Improved on-farm systems involve a cost which can be amortized, are more labor saving, probably provide more direct monetary benefits to the farmer, give him something he can be proud of, and save significant amounts of water. Improved on-farm systems also tend to make the irrigator more receptive to the practice of water scheduling. The ability and understanding of the irrigator, the adequacy of his on-farm system and the capability of the water delivery system to the farm, are all equally important in achieving good water management.

Dr. Marvin E. Jensen of the Agricultural Research Service, who developed the computerized irrigation scheduling program, concludes in a report made to EPA in November 1975 that improved irrigation scheduling technology must be accompanied by the adoption of more efficient irrigation facilities and practices. He further concludes that major improvements in gravity and low pressure surface irrigation systems and practices, along with changes in water delivery policies controlled by institutions and state organizations regulating water rights, will be needed to achieve sufficient increases in irrigation water management efficiencies to significantly reduce salt loads in irrigation return flows without large energy inputs.

2. Because most of the irrigation in the West has been in place for many years, irrigation practices have become somewhat institutionalized. The report does not adequately relate the return flow problem to state water rights. Water rights are viewed as property rights in most Western states, therefore the irrigators must use the water or lose it. The requirement for "beneficial use" needs to be redefined in most states. The role of water rights and other institutional constraints affect the water users ability to manage irrigation water. This is very important in nonfederal project areas.

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Henry Eschwege

3. Historically, on-farm water management systems have been the responsibility of SCS while system management was handled by the Bureau of Reclamation. On many farms, both the water delivery system and the on-farm irrigation system, one capable of being managed to a high efficiency, requires detailed study. Most often the entire farm cropping and harvesting schedule must be reanalyzed along with the farm budget, cultural practices, fertilizer and pesticide schedule and erosion control measures. The "grass roots" relationship USDA agencies have with individual irrigators and irrigation districts is very important for success of any program dealing with their operations.
4. The role of soil and water conservation districts in the various programs needed to improve irrigation efficiency should be recognized in the report. The National Association of Conservation Districts (NACD) has resolved to actively participate in non-point pollution control planning and implementation at local and state levels.

5.

(See GAO note 1, p. 46.)

6. A significant improvement in irrigation efficiencies through "water scheduling" requires a water delivery system designed on a demand basis. Very few irrigation districts have this capability, and therefore, predicted benefits through water scheduling alone may not occur. If an irrigator has to take water when it is made available to him, he may have limited control over on-farm efficiencies.
7. The report does not appear to emphasize the effects of water pricing on irrigation efficiencies. Unless there is a penalty for waste or incentive for being more efficient (direct to the operator) no program will be very successful.
8. We concur in the recommendation, middle of page iii and 47, that USDI and USDA jointly develop objectives, policy recommendations, and action plans. This seems very appropriate and recognizes the contribution Agriculture can make. We have been hampered in our USDA program to individual landowners due to personnel ceilings and the demands for assistance in new programs. The emphasis placed by ARS and SCS in the Wellton-Mohawk project and the initiation of additional studies elsewhere in the Colorado River Basin indicates a major redirection of USDA programs for water conservation in the West. However, it does not follow that the

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Henry Eschwege

Bureau of Reclamation's irrigation programs should be merged into SCS's Conservation Operations program. We are sure that SCS is and will continue to provide technical assistance to cooperators on irrigation techniques and we would have no objection to conferring with other Federal agencies, at their request, to review programs, objectives, and to develop better coordinated programs for farm irrigators.

9. The report states (page 47): "The Bureau's lack of adequate demonstration of the benefits of IMS has limited its credibility with farm managers. Irrigators are reluctant to implement the program because they are not convinced that it is profitable or technically reliable."

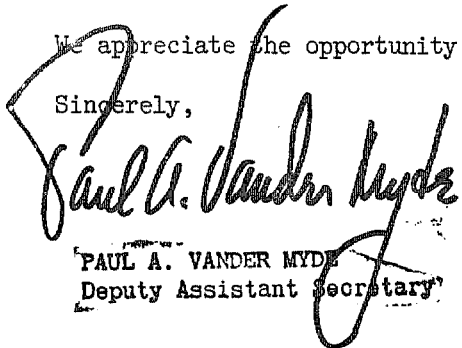
If that is the case, no amount of Federal coordination or funding will improve the acceptance of IMS. The basic benefit of IMS is sustained production. If the system does not generate adequate returns to justify its cost, it will remain unaccepted.

It is the Administration's position that programs that generate immediate monetary returns to the individual can be born by that individual. Perhaps GAO should evaluate the system's effectiveness per se and direct its comments towards that improvement.

10. Additional comments by agencies of USDA, some of which are of an editorial nature, are attached.

We appreciate the opportunity to review and comment on this draft report.

Sincerely,



PAUL A. VANDER MYDE
Deputy Assistant Secretary

Attachments

- GAO notes:
1. The attachment is not included here but was considered in this report. Material no longer related to this report has been deleted.
 2. Page references in this appendix referred to our draft report and may not correspond to the pages of this final report.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 16 1976

OFFICE OF
PLANNING AND MANAGEMENT

Mr. Henry Eschwege
Director, Resources and Economic
Development Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Eschwege:

Your letter of January 23, 1976, asked for our comments on the draft report entitled "Improved Federal Efforts Needed to Promote More Efficient Farm Irrigation."

On February 23, 1976, the Environmental Protection Agency published, in the Federal Register, proposed regulations for applying the National Pollutant Discharge Elimination System (NPDES) to Agriculture (40 CFR, Parts 124 and 125). In the regulations, EPA has classified irrigation return flows as a point source subject to regulation. However, EPA would not require that individual sources apply for a permit except when the Administrator or Regional Administrator feels there are extenuating circumstances. Discharges, in states where EPA issues NPDES permits, will be validated by a general permit and procedures for issuance of general permit(s), including notice and opportunity for a hearing, will be proposed simultaneously with the promulgation of the final regulations. The proposed regulations would authorize states issuing NPDES permits to adopt similar procedures.

Even though individual NPDES permits are generally not required for irrigation return flows, EPA will encourage good preventive practices in all cases to protect water quality. It is our plan to require that irrigation practices be upgraded to meet the goals established by Congress. This will be accomplished by developing programs under Section 208 of the Federal Water Pollution Control Act Amendments of 1972 in conjunction with the NPDES program.

I appreciate the opportunity to comment on this report prior to submission to Congress.

Sincerely yours,

A handwritten signature in cursive script that reads "Alvin L. Alm". The signature is written in dark ink and is positioned above the printed name.

Alvin L. Alm
Assistant Administrator
for Planning and Management

PRINCIPAL OFFICIALS RESPONSIBLE FOR
THE ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
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SECRETARY OF THE INTERIOR:		
Thomas S. Kleppe	Oct. 1975	Present
Stanley K. Hathaway	June 1975	Oct. 1975
Kent Frizzell (acting)	May 1975	June 1975
Rogers C. B. Morton	Jan. 1971	May 1975
Fred J. Russell (acting)	Dec. 1970	Jan. 1971
Walter J. Hickel	Jan. 1969	Nov. 1970
COMMISSIONER, BUREAU OF RECLAMATION:		
Gilbert Stamm (note a)	Apr. 1973	Present
Ellis L. Armstrong	Nov. 1969	Apr. 1973
<u>DEPARTMENT OF AGRICULTURE</u>		
SECRETARY OF AGRICULTURE:		
Earl L. Butz	Dec. 1971	Present
Clifford M. Hardin	Jan. 1969	Nov. 1971
Orville L. Freeman	Jan. 1961	Jan. 1969
<u>ENVIRONMENTAL PROTECTION AGENCY</u>		
ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY:		
Russell E. Train	Sept. 1973	Present

a/Served as Acting Commissioner from April to May 1973.

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