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Strategy Guide for Water Management on Small Farms

Provided by the
United States Agency for International Development (A.I.D.)

There is much exciting drama in building large structures, but we must not forget the small and often tragic dramas that take place daily on millions of small holders' farms where water conservation is a matter of success or failure, and even of life or death.

—*The Assault on World Poverty, 1975*

Strategy Guide for

Water Management on Small Farms

A major challenge of development today is that of overcoming critical food shortages. These shortages have the greatest immediate impact upon the countries and regions of the world where a majority of the population still suffers from some form of malnourishment. Efforts to increase food production are focussing on the large numbers of rural families who engage in small-scale or subsistence farming and who comprise the largest single group within the populations of most of the low income countries. The farmers' livelihood, and that of their countrymen depend largely upon their skill using the basic agricultural resources of land, water and seed that are available to them. This summary document, and the follow-on *Technical Guide* which it introduces, concern the vital resource of water and what farmers can do with it on their land.

The United States Agency for International Development (AID) is one of a number of national and international organizations that supports research aimed at finding solutions to problems besetting farmers in the food-short countries of the developing world. Because water is such a critical and often scarce factor in agricultural production, AID has funded a variety of studies over the past 15 years that have sought to devise better ways for helping the farmer manage this resource. Much of the research has been undertaken by scientists from U.S. universities. Some of the studies have been carried out in laboratories using the most sophisticated technology available, but most of the work has been accomplished in the field with farmers and with extension officers familiar with local customs and agricultural practices.

Results of these studies indicate that dramatic increases in food production can be

achieved by improving existing farm irrigation systems with local labor. Past experience has shown that the technology for doing this can be successfully transferred directly to farms. Pilot programs requiring limited capital and high farmer participation have resulted in significant irrigation improvement, with on-farm water losses cut by as much as 60 percent. Farmers have discovered that improvements to their water delivery systems are relatively easy to implement and the water "saved" can be used to increase cropping intensities and crop yields.

An illustrated *Technical Guide* prepared for the use of agricultural technicians is available as a follow-on to this summary document. The *Guide* contains the distillate of findings and recommendations of agriculturists experienced in every aspect of water management for crops. It offers information that can benefit farmers who desire to improve their way of life, but lack the capital necessary to install sophisticated irrigation systems.

The *Guide* is divided into sections, each dealing with a separate, but interrelated, phase of water management on the farm. Briefly, the sections contain information on the following topics:

Crop Water Requirements: A 1975 study by an AID advisory group reveals that many farmers do not understand the water requirements of crops and that a great deal of guesswork is involved in both timing and quantity of water applied. Some were found to be over-irrigating by large amounts. The ability to accurately determine crop water requirements is a vital tool to help farmers achieve economies in water, while at the same time increasing food output.

Simple methods of determining the water requirements of the crops are needed, such as using evaporation pans so technicians can advise farmers of irrigation requirements. The pans provide accurate measurements of the integrated effects of radiation, wind, temperature and humidity upon evaporation, reflecting responses crops have to the same climatic environment.

In field demonstrations, farmers can be shown how guesswork irrigation scheduling and water application can cost them anywhere from 100 to 150 percent in cropping potential and how measurement of evapotranspiration, cheaply obtained, can save them water, improve yields, and safeguard the soil from ruinous irrigation practices.

Land Grading for Water Control: Scientific grading of land to provide conditions for efficient surface and subsurface irrigation can be counted as one of the greatest water-management improvements within the past century. Farmers are usually aware of its importance, but they often do not have the capital, equipment, or knowledge to accomplish it properly. Land leveling experiments have proved to farmers that crop yields can be cut almost in half in low areas of unleveled fields and that such areas are usually drastically over-irrigated. Basin flooding applied to fields to cover the high spots can cause a large portion of the nitrogen fertilizer to leach down below the root zone, where it is wasted.

Irrigation Methods: In many areas the deficit in agricultural production can be traced to unreliable water supplies, negligent water management, or persistent use of traditional irrigation and farming practices poorly suited to modern agriculture. It is difficult for these constraints to be overcome by individual farmers or groups of farmers without some form of technical or institutional assistance. Until decisive action is taken by governments, irrigated agriculture will remain inefficient regardless of the investment in major works. Given these difficulties, it is not surprising that individual farmers are reluctant to invest in other material inputs necessary for acceptable yields because the supply of the basic input, water, is unreliable.

Farmers are willing to accept new technologies when they are proven to be practically available and the risk of failure is not perceived as being too great. But when technology is presented to them without sufficient explanation or their participation in its selection, then acceptance comes harder. Generally, more is known about technological aspects of water management problems than is known about how to overcome habits, traditions and customs that stand in the way of getting the needed technology applied.

Surface irrigation, especially basin irrigation, is the most widely used and least costly of the methods available to farmers with limited capital and technical expertise. Surface irrigation requires manipulation of the land and watercourses and much of this can be accomplished with labor intensive rather than capital intensive programs.

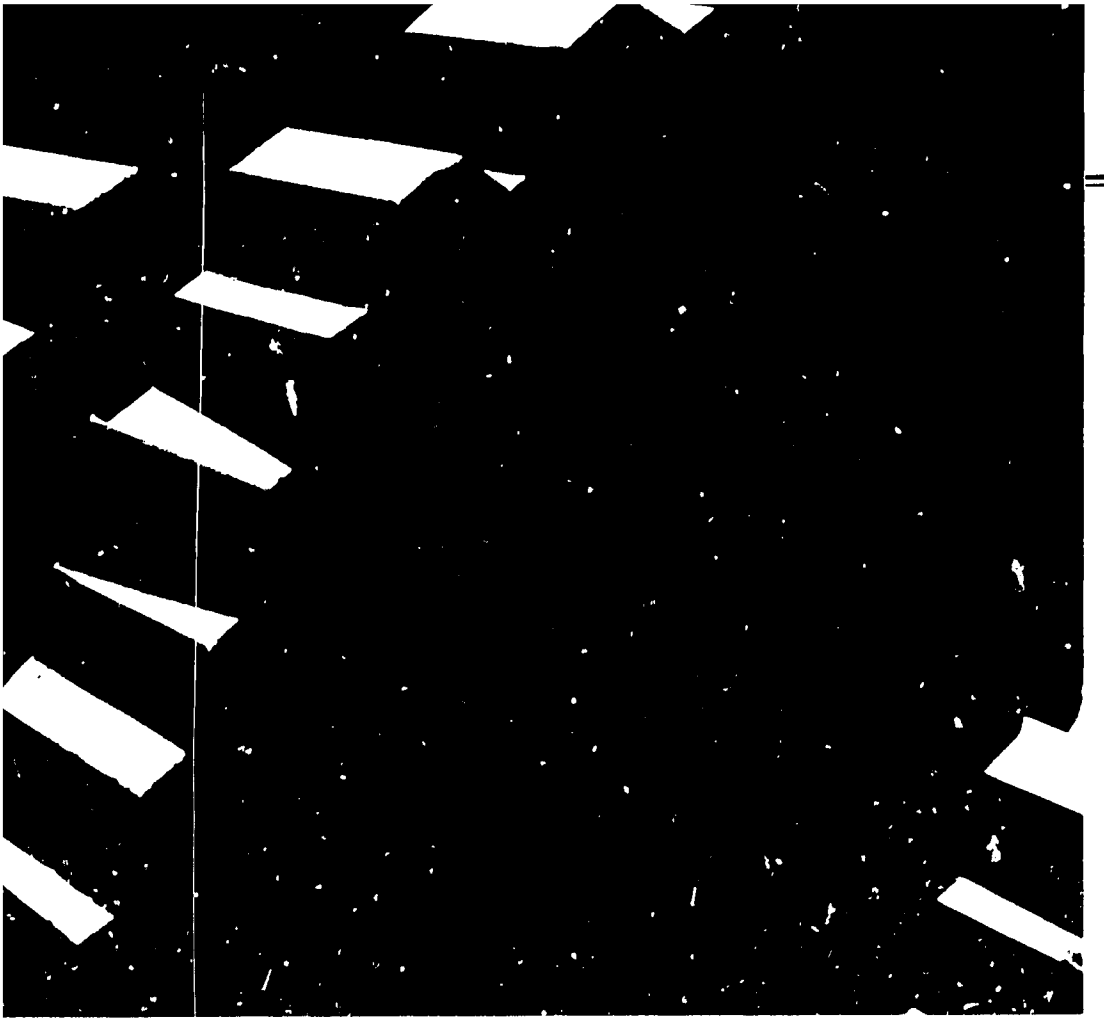
There are innovative and tempting methods of irrigation in use that are efficient in

applying the proper amounts of water for any given crop. Especially attractive are sprinkle and trickle irrigation—but both methods require a fairly substantial initial capital outlay, are dependent upon fossil fuels for power, and require constant maintenance by skilled technicians if they are to function correctly.

Water Quality and Soil Characteristics: Most farmers are unfamiliar with the chemical processes continually at work in the soil.

Salinity and sodic problems are the cancers of the soil, insidious in onset and usually recognized only after so much damage has been done that farmers are faced with abandoning the land or spending a great deal of time and money to bring it back into production. Farmer awarness programs to emphasize the dangers inherent in over-irrigation or inadequate drainage should be considered as an important and integral element in irrigation development project.

Farm Drainage: Extensive field experience bears out the contention that government planners working with farmers to modernize water management



practices should be careful not to inaugurate new irrigation systems without first considering the drainage problems that will inevitably arise, especially in arid lands.

Poor drainage causes serious difficulties for farmers: crops become scalded from summer ponding, soil becomes compacted, salts accumulate, the crop root environment deteriorates and plants are more susceptible to diseases. A thorough study of the problem includes determination of the source, direction of movement and amount of damaging water, review of rainfall and runoff records, analysis of topographic and aerial charts, reference to well logs and soil surveys, and measurements of flow in watercourses. Only after these actions are taken can technicians be in a position to recommend remedial programs.

Interceptor drains and relief drains are the most common methods of drainage. Concrete and clay tile and plastic pipe are

most often used in covered drains. In some cases where the soils have special characteristics, mole drains can be used.

Water Measurement and Distribution Structures: Farmers need to gauge the efficiency of their irrigation systems. Efficiency can be determined from measuring water losses between the main canal and the farmer's fields. In addition, the farmer should be able to tell whether the crop's water requirements are being met. While some methods of water measurements require the services of experienced technicians, farmers can be shown how to make rough measurements that will provide the basic information they need to manage and maintain on-farm water delivery systems.

The most useful and economical device available for accurate flow measurement is the weir. Other devices include the Parshall flume and the cutthroat flume. The latter devices can be manufactured locally and are easy to install.

A number of check-drop-energy dissipators are available to control flow velocities and thus reduce channel erosion. Illustrations in the *Guide* give an idea of the range of these distribution structures available at reasonable cost for use in small irrigation systems. A weir can even be used as a combined drop structure and flow measuring device. All of the needed tables, equations and graphs applicable to these structures are readily available to technicians as precise aids in improving on-farm water management.

Watercourse Management: Loss of water from the watercourse and evapotranspiration

from weeds and trees rob farmers and their crops of large amounts of water; it is not unusual to lose 50 percent of the water along the watercourse. Removing weeds, filling in rodent holes, compacting the earthen sides of the watercourse, removing sediment and insuring that the seals of turnouts are tight are all measures that the farmer himself can take to cut water losses dramatically.

Water Supply for Irrigation: Surface water runoff frequently occurs at times when farmers have no need to irrigate; this runoff, unpredictable in amount and unscheduled in appearance, is too precious a commodity to go to waste, and ways have been developed to capture it and store it until needed. Storage reservoirs can be built in both hilly and flat terrain, and depending on size, will be able to store enough water to irrigate thousands of hectares or just enough to serve a few small holdings.

Research continues on the use of skimming wells that extract fresh water floating on top of a layer of saline water, a natural phenomenon that exists in many parts of the world, both inland and offshore. Skimming wells not only provide fresh water for irrigation but minimize the mixing of salt and fresh water acquifers. The skimming well designs shown in the full *Guide* are capable of local manufacture in most nations. Private skimming well programs can create employment opportunities for village labor.

A Transfer Process: Field experience has enabled AID agricultural advisors to formulate a technological transfer process for on-farm water management that can be used in any country or region of the world where

small farm irrigation problems exist. Key phases in this process include:

I. *Priority Problem Identification:* An interdisciplinary approach is undertaken with farmer participation in order to achieve an understanding of system operation. This phase results in an objective definition of priority problems including those of a physical, socio-economic and institutional nature.

II. *Search for Practical Technologies for Solutions:* An investigation is made of the most economic and easy-to-implement solutions that will produce results highly visible to the farmer, using known principles and on-farm demonstrations of practical technologies.

III. *Assessment of Possible Solutions:* Each solution is systematically assessed to ensure farmer acceptance and to determine what complimentary inputs and supporting services will be required. The evaluation of pilot programs include monitoring of socio-economic and other consequences that may affect long-term applications. Institutional capabilities for assistance in implementing the appropriate technologies are also evaluated.

IV. *Program Diffusion:* Techniques for an on-farm improvement program are tested and applied in an orderly fashion so that a package of technologies can be assembled for implementation on a larger scale. Personnel are trained to work with the farmers involved in the project. After evaluation and alterations as necessary in the initial project, successful results can be reported to farmers in other areas and regional or national programs can be undertaken.

This carefully phased process has several components

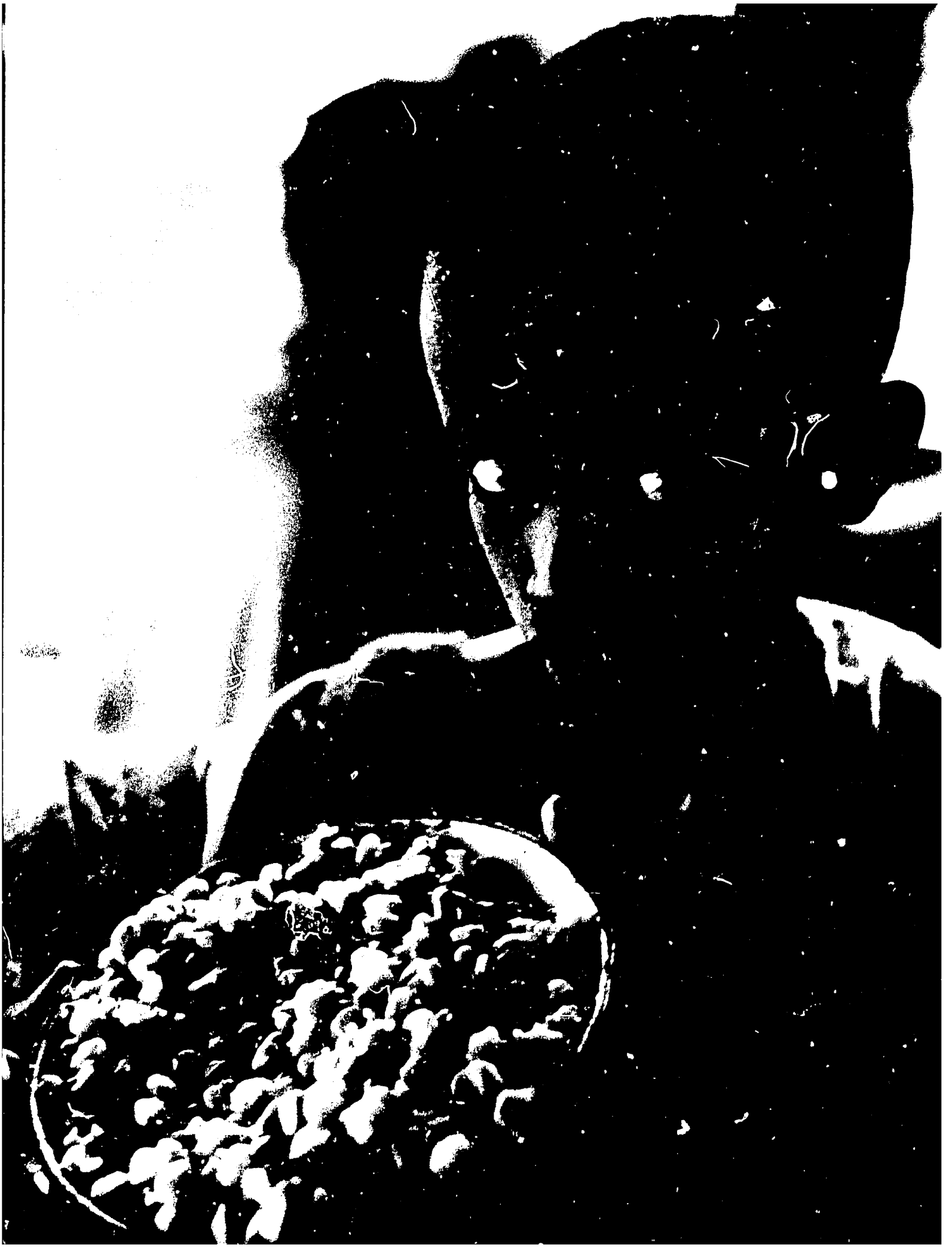
that must be followed for maximum results.

Involving the farmer in each phase is the first priority. His trust must be gained. The farmers' participation is essential in identifying problems and in searching for and implementing solutions. Reciprocal exchange of ideas must take place between researchers, implementors and farmers. Organizations dedicated to serving farmers' needs must be developed, and people involved in the problem-identification and solving process must be carefully selected and intensively trained. Technical expertise is most important at this stage.

Finally, multi-disciplinary teams must collaborate wholeheartedly and unselfishly in planning and executing any improvement program.

The close cooperation between specialists in different disciplines is vital to the systems approach in solving agricultural problems. The plight of the small farmer, the food and population crises, and the lack of institutional development are critical problems today partly because too little effort has been made in the past to systematically involve the farmer in identifying and solving his own problems. Respect for other disciplines and team members is basic to effective communication. Respect for the farmer is indispensable.

Alternative combinations of disciplines will be effective



under different circumstances, but in most situations water management teams should be made up of representatives of the following fields:

- Agricultural Engineering: to ensure correct measurements of variables having to do with water flows, the field design of the irrigation system, and irrigation structures—all to achieve water control on the farm for maximum crop production.

- Agronomy: to ensure that enough attention is paid to soil-water-plant relationships and the most suitable crops are selected.

- Economics: to evaluate alternative investment opportunities and to consider the potential effects the project will have on the overall agricultural sector and the economy of the nation as a whole.

- Sociology: to analyze problems having to do with social organization for irrigation and agricultural production, since there are many aspects of water management that require organized collective action on the part of the farmers.

Depending upon specific circumstances, the team may require the participation of lawyers, civil engineers, animal scientists, public administrators and local governmental officials, all working as a team, their actions dictated by data gathered at farm level, and always with the farmer's active participation.

This new *Guide* can prove to be a stimulating tool to agricultural planners and technicians seeking workable ways of improving water management in their areas of responsibility at least cost to national treasuries and to farmers themselves.

The full *Technical Guide* is available upon request from. . . . . .

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