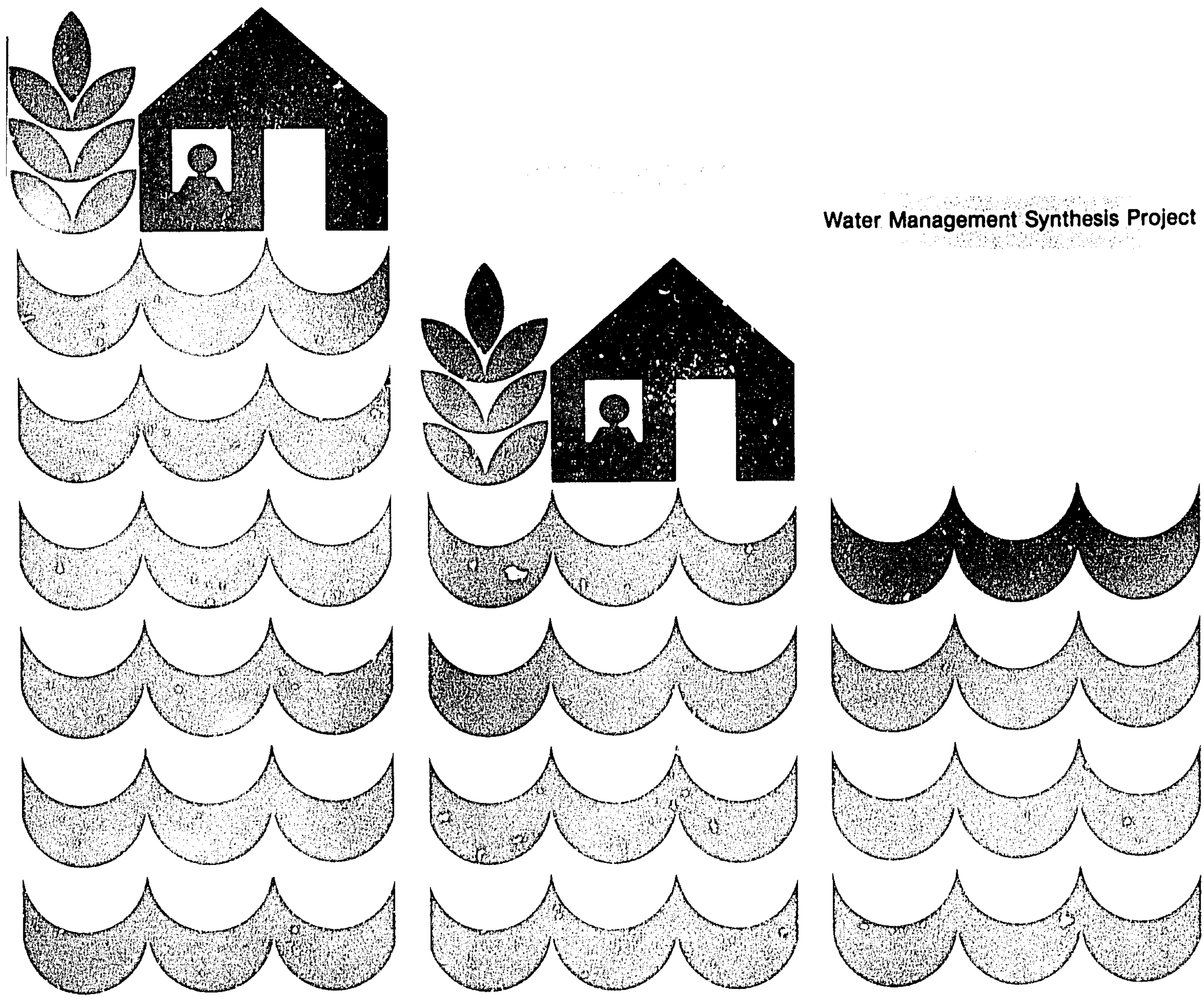
Water Management on Small Farms: A Training Manual for Farmers in Hill Areas

INSTRUCTOR'S GUIDE



Water Management Synthesis Project

WATER MANAGEMENT FOR SMALL FARMS: A TRAINING MANUAL FOR FARMERS IN HILL AREAS

INSTRUCTOR'S GUIDE

by

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INTRODUCTION

It is my firm conviction that most irrigation extension training has limited usefulness in developing countries unless it is accompanied by rigorous hands-on training. Thus, this instructor's guide presents the types of practical exercises that I have found useful in irrigation training.

This booklet is not a detailed guide for hands-on training. It merely suggests the types of exercises that the instructor can use to help the student (farmer or technician) learn the applicable irrigation principles and practices presented in its companion training manual, Water Management for Small Farms: A Training Manual for Farmers in Hill Areas. To use the instructor's guide effectively, the instructor should already have training and experience in the principles covered in the training manual. The sequence of exercises presented is the same as that in Water Management for Small Farms: A Training Manual for Farmers in Hill Areas.

The following is a typical sequence for preparation and training that was developed while conducting irrigation extension workshops for farmers on small farms in the Peruvian highlands.

1. A brief study was made of the target community to determine the irrigation customs and practices, the problems associated with irrigation systems or management, and some social aspects such as the farmers' literacy and willingness to accept new technologies.

2. Based on the evaluation of the target community, training objectives were developed to deal with the basic problems --

such as erosion of steep hillsides and irrigation management of particular irrigation systems.

3. A simple outline of a training session that would accomplish the objectives was made.

4. Drawing on sources such as the book, Water Management for Small Farms: A Training Manual for Farmers in Hill Areas, and on the author's experience, the detailed outline and training materials were assembled.

5. The training itself usually consisted of four phases:

   a. The first phase was an audio-visual class in which a few basic concepts or themes were discussed; either with slides and tapes, blackboard and instructor, demonstrations and instructor, or a combination of these. Handouts, such as the booklet, Water Management for Small Farms: A Training Manual for Farmers in Hill Areas, and other training aids which would serve as future references and reminders for the farmers were distributed at this time.

   b. The second phase followed immediately and consisted of hands-on training to emphasize all that was presented in the first phase.

   c. In phase three, the farmers were asked to demonstrate their newly acquired knowledge. For example, they were asked to evaluate both good and bad water management practices, structures, and systems on a demonstration farm and to recommend improvements, and they were asked to demonstrate the proper use of siphons.

d. In phase four, the instructors evaluated the farmers' skills as they observed the farmers during phase three.

6. Additional training was planned in accordance with the phase four evaluation.

THE IMPORTANCE OF IRRIGATION WATER AND ITS MANAGEMENT IN CROP PRODUCTION AND SOIL CONSERVATION

Background: Irrigators and would-be irrigators usually conceive of irrigation as important both for achieving high yields and for insuring themselves against drought. Irrigation has other advantages, but it also has many disadvantages, some of which can be disastrous. This is why instructors should emphasize the importance of good and bad irrigation practices during training.

Objective:

- To demonstrate the importance of irrigation in general, and of good versus bad management practices.

Exercise: Take a field trip where good and bad irrigation practices and their effects are evident, and where the farmers get a chance to discuss their conceptions of problems. What is seen will depend on site-specific conditions and the problems of the region, but some possibilities are:

- Erosion problems in irrigated fields -- sediment deposits at field outlets, shallow soil at the head of irrigated runs, gullying of furrows and borders.
- Erosion problems in canals.
- Maintenance problems and their effects (seepage losses, erosion).
- Drainage problems that occurred with the advent of irrigation.
- The actual penetration depth of light or heavy rains.
- Quality and quantity of produce harvested from dry land versus irrigated fields.
- Diseases and lowered crop quality resulting from over-irrigation.

- The effects of soil salinity on crop production.
- Experiments on research stations that show production levels at different water and fertilizer levels.
- Production records from well-irrigated farms, poorly irrigated farms, and dryland farms.

BASIC IRRIGATION CONCEPTS

A farmer must understand certain basic concepts to know what constitutes a good irrigation system and good irrigation practices. He must understand weather, soil, plant and water relationships so he can judge rationally the effects that different design and management practices will have on his soil and ultimately on his crop. These and other concepts are presented in this section.

Water Holding Capacity

Background: Many farmers believe that crop roots extend only 15 to 20 cm under the soil surface. This often leads them to believe that this is the depth to which water penetration is important. They therefore fail to take advantage of root zone storage capacity when irrigating.

The farmer will often classify some parts of his field as dry (gravel spots, for example) and others as not needing "that much irrigation" (usually the heavier or deeper soil). Awareness of the differences in soil moisture storage will help him to correct misconceptions and begin to develop criteria for efficient water management.

Objectives:

- To demonstrate to the farmer the relative amount of water storage capacity in different textured soils and the rooting depths of the major crops in the farmer's area.
- To develop in the farmer an understanding of how the soils and rooting depths work together to form the moisture storage reservoir available to the crop.

Exercise:

Part 1.

Gather samples from each primary soil texture group and air dry them. Prepare a soil column with each of the soils at least three days before the class. Do this in clear plastic or glass cylinders or in holes in the ground that have the sides lined with plastic. Compact the soils to approximate field conditions. The holes or cylinders should be approximately the same diameter and depth (for example: 30 cm in depth and 30 cm in diameter). Sprinkle the same amount of water on each column (for example: 3 or 4 cm).

Obtain one soil sample with good structure and one with poor structure.

Excavate a few typical agricultural plants, retrieving as much of the root system as possible. Even using great care, you will not be able to get the entire root system, though you can easily obtain more of the root system from sandy soils.

Part 2.

On the day of the training session, have the students become familiar with soil texture and good and poor soil structure by "feel." Have the students observe and excavate the soil columns in layers, feel the soil, and compare wetted depths. From the wetted depths and with instructor help, most farmers should understand the relative amounts of water that different soils can hold.

Explain to the farmers the various parts of the root system, from the highly visible roots to the microscopic capillary roots. Give them an idea of the depth of penetration of typical crop roots at various stages of growth, and the types of obstacles which stop roots from going deeper. Explain how root concentration, and therefore water uptake, varies with depth.

Part 3.

Take the farmers out to the field with a shovel and soil auger. Have them evaluate soil texture and structure. Have them estimate rooting depths of crops. Correct misconceptions.

Part 4.

Tie together the ideas of Parts 2 and 3, and show how these influence frequency and depth of irrigation. Discuss with them what they can do to improve soil structure and water holding capacity through the use of organic matter.

Rate of Water Entry into Soil

Background: This exercise will help the farmer to learn the importance of controlling irrigation duration and the factors that influence how long the water remains on different parts of the irrigated field.

Objective:

- To demonstrate how the rate of water entry into soil is influenced by texture, compaction, moisture, structure, and time.

Exercise:

Part 1.

Prepare several columns with soils of different texture, compaction, structure, and moisture. These may be made in holes in the ground lined with plastic or they may be made in plastic or metal cylinders on the ground. Make sure the cylinders do not have an impermeable bottom, which will entrap air. It may be best to place them over an absorbent material (soil). Place a sheet of plastic over each cylinder and then pour the same amount of water onto each sheet of plastic (4 or 5 cm is sufficient).

Part 2.

Have several people pull the plastic sheets off the cylinders at the same time so that the water begins to penetrate the soil. Have the farmers make observations and conclusions. Explain whatever they leave out, and tie this exercise to the previous one by explaining how soil moisture storage and infiltration velocity influence irrigation duration.

Part 3.

In many fields, a soil of one type may be right next to a soil of another type, or a dry soil may exist next to a wet soil. Have the farmers construct small basins at different locations and fill them with the same quantity of water. Have them observe the different entry rates of water into the soil. Then, have them comment on how they think this affects their irrigations, and what possible alternatives there might be for irrigating the fields adequately. Discuss their solutions.

Deep Percolation

Background: As with most people, many farmers tend to think that excess is better than deficiency. They don't realize that excess irrigation lowers crop yields, that they can irrigate less land if water is scarce, that they lose fertilizer through leaching, and ultimately, that they may create severe drainage problems. Over-irrigation can leave the soil less productive than it was before irrigation.

Objective:

- To help farmers realize the present and future implications of applying too much water. This exercise will help them appreciate the importance of good farm water management.

<u>Exercises</u>:

Part 1.

Classroom demonstrations on this theme are time-consuming. However, demonstrations using potted plants to illustrate the loss of nitrates can be developed with enough advance notice. The instructor can plant several pots with the same plants, using the same low fertility soils (sandy soils work best), and the same amount of chemical fertilizer. Irrigate all the pots at the same time. However, purposely irrigate some pots with half the water needed by the plants, other pots with about the right quantity, and other pots with two and three times the necessary amount. The resulting differences in growth and color are usually dramatic.

You can carry the demonstration further by collecting the water from the excess irrigations and using it to irrigate additional pots. Plants in these pots will respond to the leached nitrogen. (Make sure other nutrients are in the soil.) Compare them to control pots that have no nitrogen.

Part 2.

If a nearby area has drainage problems because of improper water management, it is usually worthwhile to take the students on a field trip to show them the causes and effects of the problems.

Uniformity of Water Penetration

Background: A crop will develop uniformly in soils of uniform texture, depth, and fertility, and if water is uniformly applied to the root zone. The farmer must recognize the meaning and importance of uniform water penetration into the soil profile so that he knows what to look for as he adjusts his own management.

Most farmers realize the importance of a level or graded field for obtaining uniform water penetration and a good surface irrigation. However, leveling or grading may create irrigation problems as gravel spots are laid bare, especially on shallow soils. The farmer should know the conditions under which leveling or grading is successful. He should also know what goes into doing a good job of leveling, such as soil and topographic surveys, and the equipment to use. He should realize that taking care of minor irregularities in surface relief is necessary and within his ability. Tell him he can use simple leveling devices (such as the level explained in the training manual) to determine if he has eliminated cross slope, and that he can make and use simple land planes. Also make him aware that if leveling or grading is not appropriate to his situation, he may be able to modify his irrigation system or adopt a new system entirely.

Objectives:

- To teach the meaning of uniformity and its importance.
- To demonstrate the advantages of leveling and/or planing for better irrigation, and to demonstrate the disadvantages in particular situations.
- To make the farmers aware of equipment which may be available or which they themselves could construct individually or as a community.

Exercise:

Part 1.

Use an irrigated field to demonstrate uniformity and nonuniformity. You can demonstrate the same results with surface, sprinkler, or trickle systems. For example, in a furrow-irrigated field, select three stream sizes. Make one stream large enough to advance over the field quickly, make another a normal irrigation stream size, and make the last one small, so that the water advances very slowly. Start irrigating the furrows at the same time and stop the flow in all of them when the slowest flow has reached the end of the run. Preferably the soils should be sandy or of high intake so that the differences in penetration are graphic. Have the farmers excavate cross sections along the furrow runs and compare the penetration at the beginning, middle, and end of the furrow.

Part 2.

Select a field that has great variations in texture and intake rate along the irrigated run. After a typical irrigation on that field, probe in different places to determine the penetration depth of the water. Discuss with the farmers the reasons for the different penetration depths. Refer to the probable amount of water infiltrated at each point, and its effect on soil fertility and the crop. Is it necessary to over-irrigate some parts of the field to adequately irrigate others? Do the coarse-textured portions of the field dry out between irrigations because of their low moisture-holding capacities? Are these factors evident in the way the crop grows?

Part 3.

Select a field with an uneven surface and uniform soils -- preferably one that allows water to pond in places while other places receive little water. After a typical irrigation, have the farmers check the penetration depth in the field. If a crop is growing, have them observe the differences in plant development. Discuss possible improvements with them, such as changing the field dimensions, orientation, irrigation system, leveling, or any other alternatives.

Part 4.

Take them on a tour so that they can see the water distribution over a leveled or well-planed field as compared to that over an irregular field. The difference in crop growth between the two fields is usually quite obvious. Take them to see land leveling in action as well as simple equipment appropriate to their planing operations. A good land plane is essential for good surface irrigation. The construction, under technical supervision, of a good land plane for community and individual use is an excellent practical exercise because it fosters community spirit, increases technical ability, and ultimately results in better production and use of resources.

Part 5.

If a sprinkler system is under study, have the farmers check uniformity by probing the field after an irrigation, and have the students determine the cause(s) of nonuniformity (such as differences in texture, soil surface unevenness, and runoff; or sprinkler problems such as improper spacing, inadequate overlap or pressure, wind direction, and malfunctioning or improperly sized nozzles).

Runoff

Background: Runoff from an irrigated field is probably not a problem if water is abundant, if the drains are not eroding, or if the water is used beneficially elsewhere. However, excess runoff can create problems if it seeps into the groundwater, contributes to drainage problems, or gathers in lakes and marshes and creates insect and disease problems.

Objective:

- To demonstrate the magnitude of water lost to runoff by typical irrigation practices, and to demonstrate the magnitude of other problems like drainage and erosion.

Exercise:

Part 1.

Select a furrow or border irrigation system in an area where water is not abundant and where the runoff water is either unused or used poorly. Set up inflow and outflow measurement devices at the entrance and the outlet to the field, or at the entrance and outlet to a border or furrow.

Have a farmer perform a typical irrigation. Obtain a visual idea of the amount of inflow versus outflow. Interpret the readings on the measuring devices for the farmers. At the end of the irrigation, discuss the lost water in terms of the amount of additional land that could have been irrigated, either by reusing the runoff or by reducing the runoff with other management techniques. Have the farmers discuss ways to reduce runoff and if it is worthwhile to do so.

Part 2.

If excess runoff is causing erosion and drainage problems, take the farmers on a short field trip to see those problems.

Erosion

<u>Background</u>: As world population increases and good agricultural land becomes more scarce, more marginal land is put into production. Much of the land is on steep slopes which can soon erode and become totally unproductive. If erosion is a problem or a potential problem, then the farmers should be aware of this so they can apply erosion control techniques before it is too late. A farmer must consider the slope of a field when assessing the potential erosion hazards of different irrigation management practices.

<u>Objectives</u>:

- To teach farmers the erosion dangers of irrigating and farming steep slopes.
- To teach them the appropriate steps to halt the erosion that occurs during irrigation.
- To teach farmers the meaning of slope and how to measure it.
- To give them a physical feel for different slopes.
- To teach them to recognize the erosion potential of different practices on different slopes.

Exercises:

Part 1.

Based on a study of existing or potential erosion problems, take the farmers on a tour where you can point problems out. Explain potential and actual solutions.

Part 2.

Explain the meaning of slope to the farmers (students) and what "percent of slope" means. Take them to the field and show them several predetermined slopes common to the area. Demonstrate to them the erosion effects of different irrigation practices on different slopes. For example, you can show the effects of crop, furrow orientation, and canal slope on erosion in fields with any significant slope (usually slopes of at least one percent).

Part 3.

Explain, in detail, the possible solutions to erosion problems. For example, if a slope should be revegetated or a permanent pasture planted to replace an annual crop, advise the farmer on selecting the appropriate varieties, preparing seed beds, planting, irrigation, maintenance, livestock rotation, and any other factors they should consider.

STRUCTURES AND TOOLS FOR WATER CONTROL ON THE FARM

It is often difficult for a farmer to envision how he can better control his irrigation water and what benefits it will have. To adequately appreciate water control, he should see problems and enacted solutions as well as be able to implement the solutions.

Canals, Drains, and Other Farm Installations

Background: Remember, the technology must be within the farmer's reach.

Objectives:

- To make the farmer aware of his water control problems and possible solutions.
- To teach the farmer how to implement specific solutions.

Exercises:

Part 1.

Take the farmers on a problem identification field trip. Based on your evaluation of the primary water control problems, show the farmers problem areas. Explain to them solutions that have been implemented and those that could be implemented.

Examples:

A. Problem: The farmer does not understand the magnitude of seepage losses on a section of canal.

Exercise: Install flow measuring devices at inflow and outflow sections and explain what the difference in readings signifies in terms of water loss. Have the farmers line the section of canal with clay or other appropriate materials and evaluate the seepage losses again.

B. Problem: Significant canal erosion on steep slopes.

Exercise: Teach farmers how to construct small rock masonry drop structures and how to place them correctly. Supervise them as they protect a section of the canal.

Conservation and Maintenance of Canals, Drains and Other Installations

Background: The maintenance training necessary in an irrigated area depends on how good the maintenance program within the irrigation district is, and if the farmers have their own on-farm maintenance program. It also depends on whether or not certain maintenance problems have been recognized. If no well-organized maintenance program exists, organizing such a program may be difficult as it requires that the community start a separate organizational effort.

Objective:

- To make farmers aware of maintenance needs within their irrigation system and to help them correct problems.

Exercises:

Part 1. If there is an existing maintenance program in effect:

Have the technician in charge of training review existing structures and canals to determine the maintenance needs of the community. Take the farmers out to the field and show them good and bad maintenance practices. If new maintenance practices are needed, then help the farmers implement them.

Part 2. If a new irrigation project or no maintenance program exists:

Make farmers aware of the problems through field trips or other demonstrations. With community leaders, local authorities and farmers, organize a maintenance program to deal with existing or potential maintenance problems. Such organization and training is not within the scope of this work, but organizational and training materials are usually available through government agencies.

Irrigation Tools

Background: When attempting to learn new technology, such as constructing and using portable check dams for surface irrigation, a farmer often has difficulty appreciating its simplicity. Through hands-on inspection and use, he appreciates the simplicity and applicability of the tool to his situation.

Objective:

- Demonstrate how to use appropriate irrigation tools.

Exercise:

Show the farmer the tools under consideration and their use in an actual field situation. Have him take the tools and inspect them with his own eyes and hands. Supervise him as he learns to use them.

Siphons

Background: Siphons are amazingly easy to use, and the small sizes are easy to make if appropriate materials are available. Some people have tried irrigating with siphons and found them inappropriate because they never really learned how to use them or how to modify their existing system to use them.

Objective:

- To teach the proper use of siphons for irrigation.

Exercise:

Part 1.

Demonstrate in a field the proper siphon sizes to use when irrigating furrows, basins, and borders. Explain why you need enough head (the difference in elevation between the water surface in the ditch and the water surface in the field) for them to function properly. Show how discharge varies by varying the head: 1) by raising and lowering the water level in the canal, and 2) by raising and lowering the outlet of the siphon.

Part 2.

Have the farmers modify an existing canal or build a new one under your supervision, making it suitable to use with siphons. Have them make portable or permanent checkdams for the canal and install them.

Part 3.

Show the farmers how to use the siphons, step by step. Have the farmers practice with the siphons until they feel comfortable with them.

Part 4.

If you can make small siphons, and if materials are available, let the farmers construct their own siphons. Demonstrate step by step one of the procedures described in the training manual. Help them construct a few siphons, and then let them construct a few on their own.

Measuring Slope and Laying Out Grade Lines

Background: Slope and the ability to measure slope are important to selecting an appropriate irrigation system as well as constructing it. Normally technicians and engineers measure slopes for the farmers. However, in developing countries with large rural populations and many small farms, there are often not enough technicians to measure all the fields. Lack of technicians and appropriate instruments sometimes keeps the farmers from implementing the appropriate irrigation technology. However, farmers can build simple level for determining slope and laying out contours in the field.

Objective:

- To teach farmers how to make a simple level, how to determine the slope of the terrain with the "homemade" level, and how to lay out grade lines with predetermined slopes.

Exercises:

Part 1.

Gather the materials for making the level instrument described in the training manual or a similar one. Show the farmers the homemade level and explain its construction and uses. Have the farmers themselves proceed, step by step, to build one with instructor supervision.

Part 2.

Show the farmers how to use the level to determine slope. Have them determine some slopes by themselves.

Part 3.

Show the farmers how to use the instrument to lay out grade lines of 0, 1, 2 and 3 percent. Later they will be able to use the levels in their own fields. Have the farmers lay out their own grade lines. Be patient; learning how to use the level may be difficult for some people. It should probably be taught in a class by itself with subsequent reviews!

IRRIGATION METHODS

In places where a variety of irrigation methods are in use or are being planned, a rational choice of the appropriate method must be made.

Irrigation Methods: Selection and Construction

Background: This section describes conditions under which a method can or cannot be used. Some of the procedures described for constructing the systems may only be useful on very small farms and where technical assistance is not available. For example, the procedures for constructing small basins, borders, and terraces are useful for the small scale agriculture found in the mountains of Peru, and could be suitable for similar situations. Other procedures, such as contour furrow construction, could be applicable anywhere.

Objectives:

- To help farmers develop a criteria for selecting the irrigation method most suitable for given physical, economic, and social conditions.
- To teach them how to construct and maintain the irrigation system suitable to their needs in situations where the simplified procedures are applicable.

Exercises:

Part 1.

Where several alternative irrigation methods are possible, a model showing irrigation systems is an excellent training aid which permits the instructor to explain the advantages and disadvantages of one method over another. Mold a 4 ft by 8 ft piece of thin plywood lengthwise on a frame to create slopes from 30 percent at the upper end to 0 percent at the lower end. Use plaster of paris, compacted sawdust-glue mixtures, clay or other materials to form the canals and features of the irrigation systems. Using the model, explain the methods that might be applicable to your farmers' situation. The explanation should include the physical makeup of the system, the crops, terrain, and other conditions under which the method can be used, as well as the advantages and disadvantages of the systems. It should end with a brief comparison of the different methods applicable to typical farms of that region.

Part 2.

Take the farmers to the field to see irrigation methods. Discuss with them the advantages and disadvantages of the methods as they apply to present conditions, and what can be done, if anything, to modify the systems for better irrigation.

Part 3.

If another method shows a distinct advantage over the present one, have the farmers construct the improved system. Follow the step by step procedures, correcting and critiquing during and after the construction.

FARM WATER MANAGEMENT

To make the most effective use of irrigation water, a farmer must be able to make quantitative and qualitative observations before, during, and after irrigating. These observations will enable him to select the correct management alternative.

For the farmer to understand adequately the concepts presented in this section of the training manual, he must be familiar with the contents of the first three sections: the importance of irrigation, basic irrigation concepts, and irrigation tools and structures. This section describes the attributes of a good irrigation and presents the information necessary for achieving efficient irrigation throughout the season.

For this training session, you can follow the presentation in the training manual. During the introduction, identify the attributes of a good irrigation and relate them to the concepts learned in sections one and two. If possible, take a field tour to compare a well-designed, well-managed system with an actively growing, impressive crop to a badly designed and badly managed irrigation system with a poorly growing crop.

Develop on-farm demonstrations to intentionally contrast bad management and good management. In Peru, one such demonstration consisted of three types of irrigation on furrows: one set of furrows received uniform, adequate irrigations; one set was heavily over-irrigated; and in one set of furrows, part of the furrow was over-irrigated, part was adequately irrigated, and part was under-irrigated. In the final set, the advance of water in the furrows was very slow. The water was cut off when it reached the end of a furrow each time the field was irrigated. The end result was excessive application at the head of the furrow, adequate irrigation at the center, and extreme under-irrigation at the end. The effect on the crop was dramatic.

Exercises and training suggestions for the parts following the introduction appear in the succeeding pages.

What are Crop Water Needs?

Background: Many farmers mistakenly believe that if the upper eight centimeters of soil are dry, then the whole soil profile is dry. Many of them also believe that crop water use or soil moisture depletion is only dependent on how hot and windy it is, rather than at what stage of development the crop is. Many times these two misconceptions lead to over-irrigation during initial crop development, to under-irrigation during maximum growth stages, and to over-irrigation during the maturity phase of some crops. Thus it is important that the farmer realize how moisture needs vary through the season.

With uncertain supplies or with water available only on periodic rotation or with soils of low water holding capacity, the farmer must consider the water requirements and moisture-stress effects on different crops when making his crop selection.

To achieve high yields and crop quality, farmers must also recognize the critical stages of plant development during which moisture stress severely affects the crop. Then the farmer can be extra careful with his management during these stages.

Objectives:

- To demonstrate the differences in crop water use for plants in different stages of development, the sensitivity of crops to lack of water or to irrigation frequency, and the sensitivity of crops to water stress at different growth stages.

- To present typical irrigation frequencies for the different crop, soil and climatic conditions of the area.

Exercises:

Part 1.

Differences in crop water use are best demonstrated by growing plants in pots, starting them at different times so that one set is planted or emerging, one set is about at effective cover, and the other set is well into maturity a couple of weeks before the exercise. After wetting all the soils to field capacity at the start of a two-week period, irrigate the pots exactly the same during the two weeks. Apply enough water so that the plants at effective cover have enough water but little excess. Collect the percolant from each one and save it for demonstration purposes. The plants in initial and final development will have much more percolation because their water use is less. Explain the procedure and the result as reflecting differences in water use. If there is any doubt in the students' minds, have them do the experiment. Loamy sands are best as they rapidly drain excess water through the soil profile, thus permitting changes in soil moisture storage to be unimportant in the experiment.

Part 2.

In areas with little or no rainfall or where rain can be kept off of the irrigated plots, conduct a field demonstration that shows the sensitivity of crops to irrigation frequency and moisture stress. Plant plants in different tolerance categories on the same soil, and subject them to the same irrigation frequency. Each time, irrigate the plots to field capacity. For example, on a deep sandy soil, the resulting crop growth will be dramatically different for the different categories of plants if the irrigation frequency is 7 or 8 days. Explain the experiment, the results, and the reasons to the class.

Part 3.

Show the sensitivity of crops to lack of water at different growth stages by taking a crop which is important to the region and growing it under stress at two different stages. Time the demonstrations so that they take place close to harvest. For example, corn production is very sensitive to moisture stress during pollination. Have three corn plots, one that is stressed during the first part of the season, one stressed during pollination, and one not stressed at all. The results should be dramatic.

Part 4.

Present typical optimal irrigation frequencies to the farmers in relation to their crops, soils, climatic conditions and stage of crop development. Be sure they realize that they ultimately must base their decision on field observation and their own rational criteria. Using appropriate evapotranspiration equations, crop coefficients, and climate and soil information, generate schedules for a given set of conditions. Consult irrigation engineers for this information. Many people will be critical of generating typical irrigation schedules as soil, weather and other conditions are seldom constant, but rough estimates are better than no estimates. Also, enough other information is presented that approximations have checks and balances in actual field observations. Such schedules may contain several assumptions, such as nonsaline conditions, and that for the day(s) following an irrigation, the soil can store moisture above field capacity as the water drains through.

soils, this condition may last one day, two days for medium-textured soils, and two to three days for fine-textured soils.

A Method of Determining Soil Moisture by Feel

Background: Determining when to irrigate a soil by feeling it is a simple technique of good water management. However, to arrive at the point where the farmer can use the method effectively requires practice and an instructor who can use the method effectively.

Objective:

- To teach the feel method for effectively determining when to irrigate.

Exercise:

Part 1.

Gather some sample soils with different textures and with moisture contents from field capacity to wilting point. Describe to the farmer how to feel the soil to determine if it is time to irrigate. Go through several examples yourself and have him practice on the other soil samples under your guidance. Stress the importance of taking the soil samples from appropriate depths in the root zone.

Part 2.

Take the farmers out to fields that are being irrigated, and have them determine whether or not the irrigations are on time. Have them practice under instructor guidance until they have achieved the necessary skill.

Erosion, Uniformity, Runoff, and Irrigation Duration

Background: A good farm water manager must be able to recognize the symptoms of excessive erosion, nonuniform irrigation, excessive runoff, and insufficient or excessive penetration; to actually determine the causes of these problems; and to find solutions to the different problems.

Objective:

- To teach the farmer to recognize the symptoms of water management problems, verify his conclusions, and develop solutions to those problems.

Exercises:

Part 1.

Review with the farmers the basic concepts of erosion and uniformity. Explain the symptoms of each problem, the problem verification and the solution. Take them out to the field and have them observe as you do an evaluation and arrive at a solution.

Part 2.

Explain and review with the farmers what a detailed evaluation is and what the end result should be. Then, with farmer participation, completely evaluate an irrigated field and develop design and/or management improvements.

Part 3.

Have the farmers evaluate an irrigation system before, during, and after irrigation. Have them develop recommendations for improvement. Discuss these.

Always remember, you insure the success of a learning process through hands-on training, and evaluation of student (farmer) progress!

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