FARMERS' TRAINING MANUAL

PARTICIPATORY TRAINING AND EXTENSION

IN

FARMERS’ WATER MANAGEMENT
(PT&E-FWM)

Food and Agriculture Organization of the United Nations
AGLW - Water Service of the Land and Water Development Division

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INTRODUCTION TO THE FARMERS' TRAINING MANUAL
1 INTRODUCTION TO THE MANUAL

1.1 Function of the farmers' training manual

This part of the manual contains the guidelines for the facilitator to implement the Farmers’ Training session on a selected range of farmers’ water management related topics. The exercises for the development and introduction of these farmers’ water management related techniques should be used in a creative and critical way. The exercises will need to be interpreted and adapted to the local conditions. Other exercises can be introduced or a different procedure (steps) can be followed that will achieve the same objectives as the exercises suggested in the manual but better suited to the local conditions. The facilitator should not hesitate to make use of those particular exercises or to make some changes in the procedures. If the training is not customized for the facilitator or the farmers it will be stiff and less meaningful.

1.2 Set-up of the farmers' training manual

This introduction of the Farmers’ Training Manual elaborates about the format of the exercises and how some exercises (those of Part B) are grouped in Sub-modules and modules. This introduction also describes which learning and facilitation techniques will be used to facilitate the training according to the Participatory Extension Approach.

In order to make clear which exercises are used for which subject, the Farmers' Training Manual is divided in three parts reflecting the three basic objectives of the Farmers' Training. Each part has its own main subject and consists of exercises related to this subject. The subjects of Part A, B and C are:

- **Part A: Farmers’ Seasonal Plan.** Farmers’ Water Management, Diagnostic and Seasonal Planning. A participating process by farmers for the selection of the technologies to be introduced or improved.
- **Part B: Farmers’ Seasonal Training.** modules 1-5. Support in the design and implementation of the selected techniques.
- **Part C: Feedback and Monitoring & Evaluation.** This part of the manual gives the exercises for the follow up and performance assessment of the introduced and improved techniques.
1.3 Training modules and exercises

1.3.1 Modules and sub-modules (only for Part B)

The training modules of the Farmers' Training in FWM are divided in sub-modules, which correspond to the topics related to the problems identified within the five categories in farmers’ water management. These five main categories (modules) relate to the five levels of water management from source to institutions:

1. Water sources
2. Farmers’ irrigation system improvements
3. Field water management
4. Drainage, Flood and Salinity control
5. Water Users Association

Each topic or sub-module i.e. pumps, corresponds to a specific technology identified and is introduced in all its aspects through a series of exercises throughout the season. Table 1 gives an example of the set-up of a module with sub-modules and exercises.

Table 1: Set-up of a Training Module

<table>
<thead>
<tr>
<th>Module</th>
<th>Sub-module</th>
<th>Planning &amp; Design</th>
<th>Installation/Construction</th>
<th>Management/Operation</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Water sources</td>
<td>1.1 Wells</td>
<td>1.1.A Selection of well techniques</td>
<td>1.1.B Installation of a well</td>
<td>1.1.C/D Follow up Installation of a well and Operation and Maintenance</td>
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<td></td>
<td>1.2 Pumps</td>
<td>1.2.A Introduction of pumps</td>
<td>1.2.B Installation of pumping devices</td>
<td>1.2.C Organizing O&amp;M of pump</td>
<td>1.2.D Monitoring of operation, O&amp;M of the pump</td>
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<td></td>
<td>1.3 Main System</td>
<td>1.3.A Main Water System Supply</td>
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<td>1.4 Reservoirs &amp; Dams</td>
<td>1.4.A Reservoirs and Dams</td>
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<td>1.5 River Diversion</td>
<td>1.5.A River Diversions</td>
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</tbody>
</table>
1.3.2 Exercises

For the introduction or improvement of a selected technology or activity, a number of exercises are developed for the corresponding sub-module. An exercise represents a well-defined activity as part of the introduction of the technology.

The sequence of the exercises of a sub-module follows in general closely 4 typical phases in the introduction of the technology, namely: 1) Planning and Design, 2) Installation/construction, 3) Management and Operation and 4) Maintenance and Rules. In some cases an exercise can cover one or more phases at the same time. Figure 1 shows which symbols are used to indicate to which phase an exercise belongs. These symbols will be indicated at the top of each exercise.

![Figure 1: Symbols of the different phases](image)

Depending on what the farmers identified what they would like to learn in relation to the problem identified, all exercises or only one or two from the sub-module can be selected for the Farmers’ Seasonal Training.

1.3.3 Format of the exercises

In the set up of the exercises, a standard format has been followed. The objectives, requirements and procedures are systematically presented, as outlined below:

**Objectives and Expected outputs**

Each exercise will have a well-defined objective and output and sets the targets to be achieved at the completion of the exercise. This will assist the facilitator in keeping direction during the implementation of the exercises. Although the procedures can be freely interpreted, the targets normally should not be changed.
Requirements for implementation of the exercise

Before starting the exercises, it should be taken care of that all the preparations are carried out, materials are present, the estimated time is available and the timing of conducting the exercise is right.

One training session may contain more than one exercise. It depends on the time available and required and the type of exercise. Some exercises however require reflection time for the farmer after the exercise and before a new exercise is introduced. This should be taken into account when planning the exercises.

Procedure (steps)

The implementation procedure of the exercise is presented in steps. Different facilitation/learning techniques like group discussions, field visit and role-play (see this Introduction) are being used during the exercises. The recommended facilitation/learning method is specified in the procedure as well as the estimated time required.

Guidelines / questions for discussions

Some basic (technical) knowledge, which is needed to facilitate the exercise, is presented in the “Guidelines for (technical) preparations” or in the annex. For relevant technical information, a link is made to the FAO Irrigation Water Management Training Manuals No. 1 to 10. In all exercises some form of discussion related to the topic or activity takes place. To facilitate those discussions the facilitator can constantly ask (leading) questions. Ideas for those questions are presented in “questions for discussions”.

1.4 Training Approach

The participants of a Participatory Extension Programme on Farmers’ Water Management are farmers and farmers are adults. Therefore, to facilitate a training it is important to understand:

- how adults learn
- the role of the facilitator in this process
- the different participatory learning techniques that can be applied

1.4.1 Adult learning

Adult learners normally go through some phases of a learning cycle. These phases are experiencing, analyzing, processing and generalizing (Figure 2).
Adults have a wide experience and have already much knowledge and skills. Learning something new (experiencing) is not just achieved in an instant. Referring back and making use of the knowledge and skill is the basis of the adult learning process. It may sometimes be necessary to break apart and review the existing knowledge/skill (analyzing) as well as test the new ideas. The new learning will have to be internalized (processing) by making it relevant to one’s self. It may have to be shared with other people as part of the process. Only after this can the learning be applied when confronted with a similar situation (generalizing). More theoretical background information on the Adult Learning Process is given in Annex 1.

Figure 2: The learning cycle

1.4.2 Role of the facilitator

The role of the facilitator and his relationship to farmers contrasts significantly from that of the instructor or trainer. The instructor imparts knowledge to farmers who adopt a passive role of merely receiving information. In contrast, a facilitator creates conditions for farmers to learn, by arranging opportunities for the farmers to observe and interpret differences in conditions and crop performances, to carry out simple tests and exercises, and through discussions. The facilitator encourages farmers to adopt an active role in the learning process.

The main features of the attitude and role of a facilitator:

- To accept that there is no monopoly of wisdom or knowledge on the part of the facilitator,
- To listen to farmers and respect their knowledge, experiences and perceptions,
- To give farmers the confidence to share their knowledge and experiences,
- To create suitable conditions and activities from which farmers can learn,
- To be responsive to farmers’ needs and flexible in organizing the course,
- To increase farmers’ knowledge, skills, problem-solving ability and capacity for innovation so that the facilitator becomes redundant.

In this Programme where the facilitator has direct contact with the farmers to assist them taking decisions for the introduction of new technologies, he has also the role as technical resource person explaining new technologies and approaches. In case a new technique can help solving the (by farmers) indicated problem, this new technique will be proposed as a possibility. Eventually it can be demonstrated in the field. It is upon the farmers’ choice to
decide whether they want to introduce the new technique or not. If the farmers decide to improve an existing technique, the facilitator can suggest new approaches to solve problems regarding this technique. These new approaches and techniques introduced by the facilitator should be additional to the suggestions from farmers’ side so that they always have a choice which approach or technique they want to introduce or develop.

Normally the field extension agent is the principal facilitator with the subject matter specialist in Farmers’ Water Management (district engineer, irrigation agronomist) assisting in providing technical guidance. Only in exceptional cases should the Technicians and Subject matter specialist carry out the role of facilitator.

1.4.3 Facilitation & Learning techniques

Different learning techniques are used in the discovery-based exercises used in the Farmers' Training. Descriptions, advantages and disadvantages of the different learning techniques used in the exercises on ‘farmers’ water management’ are presented below.

1 Plenary Introduction
A Plenary Introduction is normally the first activity to start a new training session. Its’ main objective is to introduce the subject and to familiarize the participants to some basic concepts by referring to familiar and related topics.

Procedure (Steps)
1. Attain a relaxed group atmosphere. Exercises can be used to introduce the participants to each other and to create a sphere for group work.
2. One participant, who was assigned for this in the previous training session, gives a review of the previous training session: objectives, exercises and major findings.
3. If a group task (whole group or small groups) of the previous training session had to be finished, the results are presented and discussed.
4. Explanation of the specific objectives and expected output of today’s exercise by the facilitator.
5. Eventually the characteristics and terminology of the topics of today’s exercise can be explained and discussed briefly.

Advantages
- The outcome of the previous training session is again clear to everybody.
- Everybody knows the meaning and expected outcome of today’s training session.
- Terminology and characteristics of today’s topics are clear to everybody.

Disadvantage
- Participant may not be familiar with giving a short presentation.
- May be time consuming if not only the major issues are discussed.
2 Brainstorming

The main objective of a brainstorming session is to introduce new topics and to discover new ideas and responses very quickly by having the group describing the topic or idea by listing an exhaustive list of related characteristics and conditions.

Procedure (Steps)
1. Ask the group to appoint a recorder who will not participate, but merely record the ideas
2. Ask the group to think of issues, topics and questions that they want to tackle in relation to a particular issue
3. Encourage the group to think adventurously. Everything must be included, even the most outlandish and wild idea
4. Encourage quantity rather than quality: the more ideas the better
5. There are two options for brainstorming:
   - People call out their ideas and the facilitator/recorder writes each idea up on a flipchart. No comments and evaluation can be made, it must remain a free flow of ideas
   - Each member of the group writes down a series of issues, topics or questions on small bits of card. These are fed back by sticking them to the wall
6. After the ideas are written down - they can be discussed further and evaluated, for example listing the best options in a systematic way
7. Ideas can be grouped (exact duplicates removed) and analyses so that they belong to the group rather than individuals (the group must agree on how the cards are to be clustered into theme areas)

Advantage
- A good way to get or bring out ideas.
- The focus is on generating as many ideas as possible without judging them.
- The list of issues, topics and questions use the collective insight of a group.
- All ideas are given equal credence (weight).
- Participants are encouraged to let ideas flow freely, building on and improving from previous ideas
- Brainstorming can fully exhaust an idea by focusing specifically on that idea.
- Generated ideas usually lead to a very animated and energizing session.
- Reserved participants may feel bold enough to contribute.
- Brainstorming sessions can work well with a large group and take less time.

Disadvantages
- It can be difficult to record the points accurately
- If people don’t know the subject - it is difficult to brainstorm

3 Small group discussions

Instead of discussing one subject with the whole group, more subjects can be discussed by using small groups. The main objective is to give every participant a way to actively participate in the discussion.
Procedure (Steps)
1. The plenary discussion can break into sub-groups to discuss one or two specific questions or issues.
2. One member of each group can report its findings back to the plenary.
3. Depending on the numbers, the groups can be made up of 3, 4 or 5 people.
4. Facilitators watch time and manage feedback.

Advantages
- Everyone can express his or her opinion - it is participatory.
- Exchange and sharing of ideas (interaction) and draw on their wide collective experience.
- Facilitators can gauge the mood by listening to some of the discussions.
- It changes the pace of the session.
- It encourages participants to reflect on what they have learnt and how they might apply it in their work.
- Groups can be mixed with different types of stakeholders in each group.
- The facilitators can also learn from the small group discussions.

Disadvantages:
- People may not be familiar with the use of group work.
- It takes time - in particular to get all the feedback from each group.
- You need leaders or facilitators within each sub-group, though care has to be taken that one person does not dominate.
- Need to arrange tables and chairs in a way that allows for quick easy discussion

Note: In order to save time in presenting ideas after the group discussions: one group presents all their ideas, and the other groups only contributing new ideas, avoiding any repetition.

4 Plenary discussion / presentation
The plenary discussion can follow directly after small group discussions, but does not need to do so. The objective of the plenary discussion/presentation is to synthesize the ideas of the participants about a (new) topic or information that is discussed within the group. A training session using the method of plenary discussion may split up in small groups (for step 5 of the procedure described below) for small group discussions and continue with a plenary discussion for the formulation of the conclusion.

Procedure (Steps)
1. Introduce shortly the topic.
2. Ask the participants a number of pre-prepared questions related to the topic.
3. Discuss the answers with the participants.
4. Introduce brief and in an easy to understand way the new technology (topic) / additional information.
5. Discuss with the participants the positive and negative sides of using the new technology (topic) / additional information.
6. Try with the participants to reach a conclusion on the topic.

Advantages
- Participants are often familiar with plenary activities.
• Does not need to (re)organize the participants.

**Disadvantages**
• Difficult to obtain full participation from all participants.
• Only a few participants will express their opinions.
• Does not encourage participants to reflect on what they learn.

5 **Practical (field) activities**
To give participants the opportunity to go to the field and experience a new technology by watching and doing. The objective is to learn through practicing new practices.

**Procedure (Steps)**
1. Introduce the topic and objectives of the exercise (Figure 3).
2. Divide the participants in groups of 4-5 people.
3. If needed, go to the place where the practices will be carried out.
4. Go with the participants through the different steps of the activity.
5. Demonstrate the different steps.
6. Ask the groups to divide tasks, who is doing what?
7. Let the participants practice the different steps of the activity.
8. Participatory discussion, asking questions on:
   – how the participants experienced the different steps of the activity;
   – the total activity; and
   – usefulness of the activity for the participants.
9. Try with the participants to reach a conclusion on the practice.

**Advantages**
• Participants learn through practicing.
• Encourage participants, who do not feel confident to speak in a group, to participate in a practical way.
• Close to real live situations.

**Disadvantages**
• Time consuming.
• Need for good planning, material, timing, place.
6 Field walk / field observations

The objective of a field walk or field observation is to give participants the opportunity to learn through observations in the field. The areas to be visited are their own fields within their irrigation scheme.

Procedure (Steps)
1. Introduce the topic and objectives of the exercise.
2. Organize the field walk with the participants:
   - Decide on where to go and/or which route to take;
   - Decide on what to observe;
   - Decide on going in one large group or in several small groups; and
   - Divide tasks among the participants; who is going to report on what after the completion of the walk/visit?
3. Start with the field walk/visit.
4. Stop at interesting places and ask the participants what they observe.
5. Discuss their observations shortly on the spot.
6. Back from the field walk / visit, ask the reporters to report on their observations.
7. Discuss and summarize the observations.

Advantages
- Learning through real live observation.
- Change of learning environment.
- Participants feel confident in their own environment.
Disadvantages
- It is time consuming.
- Participants need to be physical fit.
- Must be enough to observe in the field during the time of the visit, timing is important.

7 Role-play
In role-plays, participants use their own experiences to play a real life situation. The objective of the role-play is to face the participants with (a problem in) their real life situation, from different points of view and to let them find a solution in a creative way.

Procedure (Steps)
1. Assign roles / set up the role play.
2. Introduce the role players in their roles.
3. Do the role play (Figure 4).
4. Manage time.
5. Ask the reaction of people who played the roles.
6. Get observers comments.
7. Summarize main points.

Advantages
- Role-plays can be interesting to do and fun.
- They are easy to understand, and useful for illiterate people.
- It allows time for audience reflection.
- When done well, role-plays increase the participants' self-confidence.
- Give them the opportunity to understand or even feel empathy for other people’s viewpoints or roles and usually end with practical answers, solutions or guidelines.
- They can also be useful for examining the complexities and potential conflicts of group meetings.
- They help participants to consolidate different lessons in one setting and also are good energizers.

Disadvantages
- Can be time-consuming.
- Their success depends on the willingness of participants to take active part.
- Some participants may feel a role-play is too exposing, threatening, or embarrassing.

Note: Participants' reluctance to participate may be overcome at the outset through careful explanation of the objectives and the outcome. Some role-plays can generate strong emotions amongst the participants. A through debriefing must follow role-play. This will provide the opportunity for the facilitator and the participants to raise and assess new issues.
Figure 4: Role-play

8 Demonstrations
The objective of demonstrations is to introduce and demonstrate new or alternative farming practices or technologies. Through demonstrations farmers may be convinced of improving or selecting a technology. There are several types of demonstrations in the field. Field trials and field tours are described below.

8a Field trials
A field trial is the introduction of a technology by the farmers themselves on a test area.

Procedure (Steps)
1. Shortly introduce the new or alternative farming practices or technologies.
2. Ask the participants what they already know and think about the new technology.
3. Discuss with the participants if they would like to know more about it and if they would like to try it out in a small demonstration plot on one of their fields.
4. If so, first make clear to the participants that they in the first place will be responsible for the demonstration.
5. Clearly define with the participants what will be demonstrated and how.
6. Make with the participants a planning for the demonstrations including:
   – the levels, if relevant, of the new technologies, which needs to be included;
   – decide if a control (normal practice) needs to be included;
   – what the activities are that need to be carried out during the demonstration;
   – decide on the timing of the activities;
   – estimate what materials are needed;
   – select farmers who will be responsible for the activities;
   – identify indicators to measure the impact of the new technology; and
   – establish a procedure how and when to evaluate the demonstration.
7. Start together with the participants the preparations for the demonstration.
8. Implement the demonstration with the participants.
9. Monitor and discuss the with the participants the demonstrations at key moments.
10. Evaluate the demonstration at the end with the participants.
11. Reach to a conclusion with the participants on the usefulness and, if proven well, the adaptation of the demonstrated new technologies by the participants.

Advantages
- Proven method in promoting the adaptation of new technologies.
- Participants learn through experience.
- Real life learning.

Disadvantages
- Needs a lot of time and often material inputs.
- The success depends on the willingness of participants to take active part.

8b Field Tour
A Field Tour is an exchange visit to another area where new or alternative farming practices or technologies are used by other farmer(s) and demonstrated to the participants.

Procedures (steps)
1. Shortly introduce the new or alternative farming practices or technologies.
2. Ask the participants what they already know and think about the new technology.
3. Discuss with the participants if they would like to know more about it and if they would like to try it out in a small demonstration plot on one of their fields.
4. Inform the hosting farmers about the visit of the participants and organize a demonstration programme with the hosting farmers.
5. Organize transport for the participants to the hosting farmers, and visit the hosting farmers.
6. Assist the hosting farmers in demonstrating the new or alternative farming practice or technology by showing and discussing the following points:
   - what are the activities needed to carry out the practice/technology;
   - what is the timing of the activities;
   - materials needed;
   - who is responsible for the activities;
   - what are the indicators for measurement of the impact of the practice/technology;
   - what are the advantages; and
   - what are the disadvantages?
7. Monitor and discuss with the participants and the hosting farmers the demonstration at key moments.
8. Give enough time for questions and exchange of information.
9. Evaluate the demonstration at the end with the participants and the hosting farmers.
10. Reach to a conclusion with the participants on the usefulness and if, if proven well, the adaptation of the demonstrated practice/technology by the participants.
11. Organize the transport of the participants back to their own villages.

Advantages
- Proven method in promoting the adaptation of new technologies.
- Participants learn through experience.
- Real life learning.
Disadvantages

• Needs a lot of time and often material inputs (money) for transportation.
• The success depends on the willingness of the participants and hosting farmers to take active part.
PART A

EXERCISES FOR FARMERS’ SEASONAL PLANNING

Problem observed
First solution found
Solution proposed to the group
Group discussion
Contribution from the group
Final solution
1 INTRODUCTION TO PART A

Part A contains the farmers’ water management exercises for a diagnostic and seasonal planning activity with the farmers. A distinction has been made between the first Farmers Seasonal Planning and the next Farmers Seasonal Planning sessions.

1.1 Farmers’ Seasonal Planning

1.1.1 First Farmers’ Seasonal Planning

During the first FSP much attention is given to the assessment of the FWM situation and development of an overall FWM plan for the entire time frame of the project/programme. Farmers evaluate, through a diagnostic process, the functioning and performance of the farm irrigation system and analyse the main problems and possible solutions, related to the following five main farm water management categories:

1. Water sources
2. Farmers’ Irrigation System Improvements
3. Field water management
4. Drainage, Flood and Salinity control
5. Water Users Association

Based on the identified problems and solutions farmers will identify the technologies and practices they would like to introduce and the corresponding topics they would like to do and learn within the time frame of the project/programme (FWM plan). Based on what can be implemented of the FWM plan during the coming season, farmers will select the topics, technologies and practices of the Farmers Seasonal Plan for the coming season.

It will take five to six half day sessions, preferably spread over five to six succeeding weeks, to conduct the first FSP. The diagnostics and seasonal planning activity needs to be completed a few weeks before the start of the cropping season, in order to ensure timely procurement and arrangements to introduce the new technologies and practices.

The photos taken from the On Farm Water Management Training and Development Programme in Indonesia give an example of how a FSP exercise takes place.

1.1.2 Next Farmers’ Seasonal Planning

During the second and following FSP the farmers will evaluate the implementation of the farmers’ seasonal plan. Based on the evaluation, farmers will update the FWM plan and prepare new farmers’ seasonal plan for the next season.

It will take two half day sessions, preferably spread over two succeeding weeks, to conduct the next FSP.
1.1.3 Objective of the Farmers' Seasonal Planning

To prepare/update with the farmers a plan of activities for the entire time frame of the project/programme (FWM plan) and based on the (updated) FWM plan a plan for the next season (FSP). The plans include introduction of new technologies and practices, topics/curriculum for farmers’ seasonal training (FST) and other relevant farmer support activities.

1.1.4 Expected output

The output of the diagnostics and seasonal planning activity is twofold. First an (updated) FWM plan will be prepared which will define the various water management technologies and practices to be introduced within the (remaining) time frame of the project/programme. Secondly, a farmers’ seasonal plan which will define the various water management technologies and practices to be introduced during the growing season and the programme of the farmers seasonal training.

1.1.5 Selection of farmers

As also explained in chapter 5.3 of the Guidelines for PT&E-FWM, in the selection of farmers, care is taken to have an appropriate representation of the different irrigation blocks, the different social groups, women farmers, land tenure and literacy. In case of an existing Water Users Association, the selection will often be made among the members of this Association.

1.2 Exercises of the diagnostics and seasonal planning process

To facilitate analysis of the present farming situation and systematic identification of opportunities for change, a number of exercises are presented. The exercises of the diagnostics and seasonal planning activity follow a logic sequence: inventory, problem identification, proposed solutions and planning of activities. When well planned and with enough time available, exercise 1D can directly follow exercise 1B (or 1C if done). After exercise 1E, farmers should be given some time to reflect on the outcome before they start to prepare the FSP.
1.2.1 First FSP

**Exercise 1A: Participatory Assessment of the irrigation and drainage system - mapping exercise**

Farmers assess the irrigation and drainage systems in the area through a mapping exercise. The focus of the assessment is on the irrigation and drainage infrastructure and layout.

**Exercise 1B: Participatory Assessment of the irrigation and drainage system - review of field conditions**

Farmers assess the irrigation and drainage system in the area. The assessment is more focussed on the knowledge farmers have related to farmers’ water management. This will be done through a transect walk with ballot box questions related to situations in the field.

**Exercise 1C: Cropping calendar (optional)**

Through the preparation of rainfall, temperature, available irrigation water and crop rotation diagrams farmers assess the crop rotations practised and discuss possible improvements.

**Exercise 1D: Problem identification and priority ranking**

In a Brainstorming exercise farmers identify the problems they experience in water management. Through discussion the priority of the problems is indicated.

**Exercise 1E: Identification of solutions and selection of appropriate technologies**

Through a series of small group discussions and plenary discussions the farmers will identify solutions to the identified problems in exercise 1D and rank them according to priority.

**Exercise 1F: Preparation and presentation of Farmers’ Seasonal Plan**

Finally in Exercise 1E the facilitator(s) will propose a plan of activities for the coming season based on the results of exercise 1D and 1E. The plan of activities, including the FST, will be discussed with the farmers, where needed amendments will be made and the FSP endorsed. A planning for the FST and a following meeting is agreed upon.

1.2.2 Next FSP

**Exercise 1G: Evaluation implementation Farmers’ seasonal plan**

By visiting the different activities planned in the FSP and discussing them on the spot, the farmers will evaluate the implementation of the FSP.

**Exercise 1H: Updating FWM plan and preparation of farmers’ seasonal plan for next season**

Based on the evaluation of the previous FSP, the farmers will first update the FWM plan. Using the updated FWM plan farmers will prepare the farmers’ seasonal plan for the next season.
EXERCISE 1A: PARTICIPATORY ASSESSMENT OF IRRIGATION & DRAINAGE SYSTEM - MAPPING

Introduction

Before starting discussing possible improvements in farmers’ water management technologies and practices for better crop production, it is important to conduct with the farmers an assessment of the present water management situation and constraints farmers’ experience. The assessment starts with a mapping exercise (1A) followed by a transect walk (1B). During the mapping exercise an assessment is made of the layout and infrastructure of the irrigation and drainage system and the main characteristics.

Objectives

- To identify and locate the lay-out of the irrigation and drainage canals
- To define irrigation command areas and irrigation units (blocks).
- To group farmers according to the irrigation sub-units (blocks).
- To define present land uses in relation to farmers’ water management, soil and geomorphic conditions.

Expected outputs

- An irrigation map of the area indicating the layout of the irrigation system, location of intake, irrigation pumps, wells, structures, canals, rivers and drainage system.
- Extend of irrigated areas
- Farmers grouped according to irrigation sub-units (blocks).
- A preliminary analysis of constrains and potentials of the farmers’ water management situation.

Materials required

- Pre-prepared sketch map of the (irrigation) area that indicates the main characteristics of the area: village(s), roads, rivers, main canals, characteristic points and meeting place of the training.
- Example of an irrigation and drainage layout map prepared by farmers
- Large sheets of paper.
- Coloured markers.

Time required

- Two and half hours

Timing

- Approximately six weeks prior to the start of the season
Procedure (Steps)

**Plenary Introduction** (10 min)

1. Explain the specific objectives and expected output.

**Plenary activity** (20 min)

2. Present the pre-prepared sketch map of the area with the main characteristics of the area. If needed, add more characteristics.

3. Ask each farmer to mark the location(s) of his or her field(s) on the map and discuss about the position of the main intake and main canal

4. Identify the various sub-irrigation units.

5. Group the farmers according to the location of their fields in the different sub-irrigation units.

**Small group activity** (1 hour)

6. Present the drawing materials: paper, coloured pens and show an example of an irrigation map prepared by farmers.

7. Ask each group to make a detailed map of their sub-irrigation unit indicating the intake(s) to the irrigation unit, the location of possible irrigation pumps, wells, structures, canals, drainage and water flow directions.

8. In case the farmers are unable to finish the map during the session, ask them to finalise them at home and to present them during the next session.

**Plenary discussion** (1 hour)

9. Ask the different groups to present their maps, as far as completed.

10. Combine the different maps into one big map for the entire area and discuss the final product.

11. Ask the farmers to indicate the main structures, flooding areas, irrigation areas and where the irrigation areas can be extended.

12. Identify and discuss the main limitations and problems and indicate these areas on the map.

---

1 If a group contains more then 9 farmers split them up in two or more groups of 5-6 farmers.
13. Take care that the map will be preserved well (framed and/or protected with plastic) for further use during the following FST sessions.


Guidelines for (technical) preparations / questions for discussions

Example of an irrigation and drainage map prepared by farmers
List of elements which can be included in the irrigation and drainage map

<table>
<thead>
<tr>
<th>General</th>
<th>Irrigation and drainage</th>
<th>Small irrigation structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads</td>
<td>Water intake (weir, pumps, wells, reservoirs)</td>
<td>drop structures</td>
</tr>
<tr>
<td>Houses/villages</td>
<td>Canal layout (primary, secondary, tertiary, field canals and</td>
<td>cross regulators</td>
</tr>
<tr>
<td>Temples/churches/Mosques</td>
<td>drains)</td>
<td>distributors</td>
</tr>
<tr>
<td>Rivers, streams, lakes</td>
<td>Irrigate command area</td>
<td>tertiary off-take</td>
</tr>
<tr>
<td>North-south directions</td>
<td>boundaries of sub-irrigation units</td>
<td>field canal off-take</td>
</tr>
<tr>
<td>FFS meeting place</td>
<td>water flow directions in the field</td>
<td>siphons, aqueducts</td>
</tr>
<tr>
<td>Bridges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hills/mountains</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions for discussions

- Does the map give a good representation of the irrigation and drainage situation in the area?
- Can you indicate areas inadequately irrigated or frequently flooded/water logged?
- Can you identify on the irrigation and drainage systems where you experience problems?
- Where would you expect problems with poor canal conditions, lacking structures, etc?

See example of FSP exercise in Indonesia
EXERCISE 1B: PARTICIPATORY ASSESSMENT OF IRRIGATION & DRAINAGE SYSTEM - REVIEW OF FIELD CONDITIONS

Introduction

Before starting to discuss possible improvements in farmers’ water management it is important to review with the farmers the conditions of the current situation regarding the water management. Further it is important to assess in the field the specific problems and difficulties and to define constraints farmers experience, to identify technologies and practices to improve water supply or to increase irrigated areas. During the transect walk the assessment focuses on the farmer’s knowledge in relation to the irrigation and drainage situation and their ideas for improvements.

Objectives

- To review the conditions of the irrigation system.
- To review the farmers’ knowledge in relation to the irrigation and drainage systems in the area and identify common constraints and potentials for improvements.

Expected outputs

- Assessment of farmers’ knowledge, ideas and priorities in relation to farmers’ water management.
- A list of identified potential improvements in relation to identified farmers’ water management problems.

Preparations required

- In advance conduct, with the local extension officer, irrigation officer and/or a few key farmers a field visit to identify locations representing interesting (learning) elements, constrains and/or areas of potential improvements related to the existing irrigation and drainage systems.
- Design a course for the transect walk passing most of the identified locations.
- Develop ballot-box questions related to the identified learning elements, constrains and potential improvement areas (annex 4 and 5).
- Prepare the ballot-box boards and place them along the transect.
- Prepare cards with the group number for each group of farmers.

Materials required

- Pieces of cardboard or folders
- Tape, rubber bands, markers, thread, thumb tacks, large sheets of paper, markers.
- Bamboo sticks.
- Map prepared in exercise 1A

Time required

- Three hours and 15 minutes

Timing

- After completion of the mapping exercise.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc.1, Part C)

2. Explain the specific objectives and expected output of this exercise.

3. Recall the main characteristics, constraints and possible improvements of the irrigation system.

Field Exercise - Small group activity (2 hours)

4. Split the farmers up in small groups of 4-5 persons. Use the same groups as already formed in exercise 1A.

5. Inform the farmers on the course and the procedure for the ballot box:
   - The small groups walk along the indicated course.
   - On the route questions will be found, written on a board attached to a stick in the ground, related to a specific situations in the field.
   - Each group will discuss the question and select the right answer from the three indicated answers (A, B or C) on the board.
   - Each group will drop the given card with their group number in the pocket/box with the letter corresponding with the answer they have selected.
   - They will proceed to the next question, etc., until they have completed the transect walk and have answered all the questions.

6. Explain the course to follow using the map prepared by the farmers in exercise 1A

7. Ensure before starting the transect walk that all farmers have understood what is expected from them and ask if there are no further questions. Give each group a set of cards with their group number on it.

8. Allow each group to start with the transect walk with intervals of 10 minutes.

9. As facilitator, follow the last group and assist the groups where it is needed.

Plenary discussion (1 hour)

10. Go back to the place where the FT are organized and take all the ballot boxes with you. Open and discuss them one by one. Remind the participants about the location in the field and type of problem posed.

11. Ask the first group what their answer was on the first question and why they have selected that answer. Ask the other groups for their comments on the question and selected answer. Write down on a large sheet of paper the identified problems, their causes and possible solutions/options for improvement.
12. Go to question two, ask the second group how they have answered the question, Why and ask comments from the other groups. Etc.


**Guidelines for (technical) preparations / questions for discussions**

**Ballot box questions**

**Guidelines for formulating ballot box questions**

Ballot box test is a field-based test without pen and paper. In developing ballot box questions it is a condition that the questions are related to a situation in the field. The questions have to be formulated in such a way that the questions can be answered only after an observation in the field has been made. A simple way of checking this is by trying to answer the questions at a place where no field observations can be made. If it is possible to answer the questions, they need to be re-formulated.

Ballot box questions are of a selection type (multiple choice, i.e. A, B or C). The questions should be in the dialect or vernacular of the farmers and formulated in a simple way, understandable for everybody.

The situation in the field, to which the question is referring to, should be visible from where the question is asked/located. The formulation of the question should contain a reference to the concerning situation in the field (fore example: this canal etc.) or through, for example, connecting the question and the related situation in the field using a piece of thread.

The first part of Annex 5 gives an overview of the “visible” problems in an irrigation scheme with related causes and solutions. If a location is selected for a ballot box question, find the cause of the proposed problem and make the question. At least one of the answers should be related to the cause of that specific problem. A list with possible ballot box questions is given in Annex 4.
Preparing the Ballot box exercise in the field

Make as many ballot boxes as questions prepared (20-25 pieces). A simple way of doing this is to use a folder, see drawing.

Mound the cardboard or folders on bamboo sticks with thumbtacks and set the ballot boxes up in the field. Prepare for each group also the cards of paper with their assigned number on it.

The facilitator should write down the identified problems, the causes and suggested solutions and options for improvement while processing the results of the Ballot Box questions. The same format as used in Annex 5 can be used. See example below.

Example of Annex 5: Problems-Causes-Solutions

<table>
<thead>
<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Obstruction of canal</td>
<td>• excessive vegetation in canal</td>
<td>• regular cleaning of canals</td>
</tr>
<tr>
<td>(visible)</td>
<td>• silt/sediment in canal</td>
<td>• remove sediment</td>
</tr>
<tr>
<td></td>
<td>• obstruction for water diversion (increase water level)</td>
<td>• improve field inlets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• improve water distribution among farmers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• realignment of canal to raise water level</td>
</tr>
</tbody>
</table>

Questions for discussions

- What did you learn from the exercise in relation to farmers’ water management?
- Did the questions cover most of the problems in the area?
- Where questions related to topics that were unfamiliar to you?
- Which were these topics, and would you like to learn more about these topics?
- Are there other topics/problems, which were not covered by the ballot box questions but are interesting to learn more about?

See example of FSP exercise in Indonesia

See photo album on Problem and Solutions
EXERCISE 1C: PARTICIPATORY ASSESSMENT OF IRRIGATION & DRAINAGE SYSTEM
- SEASONAL CALENDAR

Introduction

Beside the availability of irrigation water, the effective use of the irrigation water for crop production is as important. Through assessing the different crop rotations practised by the farmers and different crops/varieties grown, maybe more efficient crop rotations, crops and crop varieties could be identified to further improve the efficient use of the available irrigation water.

Objectives

- To identify more efficient crop rotations, crops and crop varieties to further improve the efficient use of the available (irrigation) water.

Expected outputs

- Rainfall distribution over the year.
- Temperature fluctuation with in the year.
- Fluctuation of available irrigation water or pumping hours.
- Different crop rotations practised and different crops/varieties grown by the farmers with the planting and harvesting dates.
- Possible improvements in the crop rotations, crop and variety selections as well as the identification of the optimal planting dates of the crops in the different crop rotations to improve the efficient use of irrigation water.

Preparations required

- None.

Materials required

- Large sheets of paper and markers
- 50 beans for each group

Time required

- Two hours

Timing

- Following exercises 1A and 1B.
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of the previous training session (Exc. 1, Part C)

2. Explain the specific objectives and expected outputs of this exercise.

**Small group discussion** (45 min)

3. Draw a line on a large piece of paper and define the line in the number of month’s (12), put the local month names under it. Explain to the farmers the drawing (timeline).

4. Split the participating farmers up in small groups of 4-5 persons. Provide each group with a large sheet of paper, marker and 50 beans.

5. Ask each group to draw three of those lines under each other on the paper and to define the lines in 12 months. Ask the groups to divide 50 beans over the months of the first line according to the rainfall intensity (more beans when it rains more and no beans in the months when it does not rain).

6. Ask the groups to mark the height of the bean row in each month with the marker.

7. Ask the groups to do the same with the second and third line. The second line by dividing the beans according to the fluctuation of the temperature (coolest month no beans and warmer months more beans) and the third line according to the fluctuation of the available irrigation water or pumping hours (more irrigation water or pumping hours, more beans).

8. Ask the groups to indicate under the third line the different crop rotations by indicating for each crop in the crop rotation the planting and harvesting period, as well as the estimate area (%) under each crop rotation.

**Plenary discussion** (30 min)

9. Ask all the groups to present their seasonal calendars and discuss the presentations.

10. Discuss with the farmers the efficiencies of water use in the different crop rotations and how this could be further improved by introducing other crops or new crop varieties.

Guidelines for (technical) preparations / questions for discussions

Questions for discussions

- What can be improved to optimise the use of irrigation water?
- What other cropping systems/crops/varieties could be introduced?
- Are there differences in irrigation water availability between the different irrigation units? Why?
- How can the distribution of irrigation water be improved?

See example of FSP exercise in Indonesia
EXERCISE 1D: PROBLEM IDENTIFICATION AND PRIORITY RANKING

Introduction

This manual for Participatory Training and Extension only farmers’ water management issues. It only introduces appropriate technologies and practices that might improve farmers’ water management. It is therefore important that during the diagnostics and seasonal planning activity farmers identify and prioritise their main problems in farmers’ water management (exercise 1D) as well as identify potential solutions and appropriate technologies and practices (exercise 1E). Based on the results of the two exercises a plan can be made for the introduction and demonstration of water management improvements and to address the related learning needs through the Farmers Seasonal Training.

Objectives

• To identify and list (into the five given categories) the main shortcomings and constraints farmers experience in their water management in the existing irrigation and drainage system.

Expected outputs

• Lists of identified shortcomings based on farmers’ experience for each of the five categories:
  - Water sources
  - Farmers’ Irrigation system improvements
  - Field water management
  - Drainage, Flood and Salinity control
  - Water Users Association (WUA)
• A priority list of problems in relation to farmers’ waters management which farmers would like to address during the FST.

Preparations required

• Based on the results of the mapping, transect walk with ballot box and/or cropping calendar exercises prepare a first analysis of what farmers experience as their main problems for each of the five categories.

Materials required

• Irrigation and drainage layout map prepared by the farmers.
• Results ballot box questions: sheets with problems, causes and solutions.
• Results seasonal calendar exercise.
• Large sheets of paper and markers

Time required

• Two hours

Timing

• Following exercises 1A, 1B and 1C.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc.1, Part C)

2. Explain the specific objectives and expected output of this exercise

Brainstorming (40 min)

3. Recall with the farmers the problems already identified during the mapping, transect/ballot box and/or seasonal calendar exercises by showing the large sheet of paper on which the problems, causes and solutions were written in exercise 1A, 1B and 1C.

4. Explain the farmers that the majority of the problems identified are the “visible” problems, which can be directly observed in the field. Ask the farmers to inventorize and add all the problems they experience but that are not directly visible, like management problems, conflicts, reduced crop production, etc.

5. Let the farmers group the mentioned problems for each of the five farmers’ water management categories (mentioned on previous page) on five large sheets of paper.

6. Discuss briefly all the problems mentioned. Try to prioritize the problems in each category with the input of the farmers, so for each category 1 or 2 main problems are indicated as priority.
   • If some of the problems mentioned, although described in different ways, are related to one and the same problem, select one covering description and take out the others.
   • Reduce the list to only those problems that are affecting most of the participating farmers and not only a few individuals.

Small group discussion (40 min)

7. Split the participating farmers up in small groups of 4-5 persons.

8. Assign to each group one or two of the problems listed and ask the groups to identify and discuss the cause(s) and impact of the problems. Explain to them that a cause of a problem is again a problem on a higher level. In this way a “problem tree” with a sequence of problems at different levels can be made.

9. Ask all the groups to report the identified cause(s) and impact(s) in one pre-prepared table on a large sheet of paper. Asked them to identify the problems that have causes at their own field level.

Plenary discussion (30 min)

10. Discuss the different causes, problems and impacts identified.
11. Discuss with the farmers if the produced list represents the main problems farmers experience in water management and if the farmers would like to address that problem during the FST.


**Guidelines for (technical) preparations / questions for discussions**

**Example of causes-problem-impact table**

<table>
<thead>
<tr>
<th>cause</th>
<th>problem</th>
<th>impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low rainfall (upstream)</td>
<td>Insufficient irrigation water</td>
<td>Small irrigated area</td>
</tr>
<tr>
<td>Unequal distribution</td>
<td></td>
<td>Not enough water for the entire season</td>
</tr>
<tr>
<td>Water losses</td>
<td></td>
<td>Lower yields</td>
</tr>
<tr>
<td>Too much water off-take at the beginning of block distribution system</td>
<td>Unequal water distribution within the irrigation block</td>
<td>Lower yields from the fields situated at the end of the distribution canal</td>
</tr>
<tr>
<td>Leaking canals</td>
<td></td>
<td>Low average block yield</td>
</tr>
</tbody>
</table>

**List of possible problems and solutions**

See Annex 5.
See photo album on Problem and Solutions

**Questions for discussions**

- Are there descriptions of problems on the list which are representing one and the same problem or are overlapping each other?
- Which of these problems listed do present the main problems in the area?
- Do they affect most of the farmers in the community?
- Which of the listed problems would you like to see addressed during the FST?
- What causes these problems?
- What impact does this problem have on the crop yield, farm management, etc.?

See example of FSP exercise in Indonesia
EXERCISE 1E: IDENTIFICATION OF SOLUTIONS AND APPROPRIATE TECHNOLOGIES

Introduction

After having identified the main shortcomings and constraints the next step is the identification of potential solutions and/or appropriate technologies and practices to address those main shortcomings and constraints identified with the participating farmers. It is therefore important that during the diagnostics and seasonal planning activity farmers together with the facilitators continue to identify potential solutions and appropriate technologies and practices to address the main shortcomings and constraints identified during exercise 1D. In comparing the different identified improvements, the costs and resources needed to implement those improvements need to be identified as well as main constraints in order to contribute to a rank of priority as if the constraints are the basis for the priority.

Objectives

- To identify solutions and appropriate technologies to the problems identified (FWM plan).

Expected outputs

- A list of possible solutions to the identified main problems.
- A list of identified appropriate technologies and practices to improve the FWM.
- For each of the improvements proposed, the expected benefits in terms of water saving, increase irrigation area and agricultural production.
- For each of the technologies and practices a specification of inputs, knowledge, time and resources required.
- An FWM plan including a priority list of solutions and/or technologies in relation to FWM which farmers would like to introduce and learn more about within the time frame of the project/programme.

Preparations required

- Identify for each main problem (identified during exercise 1D) at least one solution, see Annex 5, photo album on Problems - Solutions, examples out of the area, colleges, literature, etc.
- Prepare an introduction of new technologies.
- Prepare the Options Assessment Chart on a large sheet of paper. Mention the criteria for assessment, leave the first column blank.

Materials required

- Irrigation and drainage layout map prepared by the farmers.
- List of identified main problems and causes
- Large sheets of paper and markers

Time required

- 2 and half hours

Timing

- After exercise 1D
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc.1, Part C)
2. Explain the specific objectives and expected output of this exercise.
3. Recall the list of identified problems and causes (exercise 1D).

Small group discussions (40 minutes)

4. Split the participating farmers up in small groups of 4-5 persons, preferably the same groups used for exercise 1D. Divide the listed problems and causes among the different groups.
5. Ask each group to discuss, for each of their assigned problems and causes, possible solutions they know or have thought of and to write the identified solutions on a large sheet of paper.

Plenary discussion (40 min)

6. Ask each group to present the results of their discussions.
7. Discuss with the farmers the presented solutions to the assigned problems and causes identified.
8. Introduce possible additional solutions and/or appropriate technologies to further improve the farmers’ water management into the discussion.

Plenary discussion (60 min)

9. Start with the Options Assessment Chart by writing down the solutions/options for improvement in the first column of the Options Assessment Chart.
10. Discuss and reach consensus on the impact (negative, no impact, positive, very positive, unknown) of each solution on: water saving, increase of irrigated area, productivity, sustainability, equability.
11. Further assess the time before a solution will be implemented (long, medium, short), the cost (high, medium, low), labour required (high, medium, low) and knowledge required (farmers knowledge, training needed, external knowledge needed).
12. On the basis of the chart, discuss the Best Bet and decide which solution would be the most appropriate solution for each of the identified problems.
13. Decide on the solutions and options, which can be realistically introduced, that farmers would like to introduce and learn more about. Prepare on a large sheet of paper the FWM plan indicating the problems, selected solutions and options farmers would like to introduce and learn more about and optimal period for implementation.


**Guidelines for (technical) preparations / questions for discussions**

**Options Assessment Chart**

**Purpose**
The Options Assessment Chart is a tool that helps us to make choices between different options, resulting in concrete and realistic plans for implementation. The purpose of the Options Assessment Chart exercise is to select the best development option.

**Example of Options Assessment Chart**

**Example: Options to increase water availability, Mbusyani Village, Kenya**

<table>
<thead>
<tr>
<th>Solution or Innovation</th>
<th>Water Saving</th>
<th>Increase of irr. areas</th>
<th>Productivity</th>
<th>Sustainability</th>
<th>Equability</th>
<th>Time to benefit</th>
<th>Cost</th>
<th>Labour required</th>
<th>Knowledge required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boreholes</td>
<td>0</td>
<td>+</td>
<td>?</td>
<td>-</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Natural Springs</td>
<td>0</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rehabilitate dams</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Shallow wells</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>New surface dams</td>
<td>0</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Key**

<table>
<thead>
<tr>
<th></th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>?</td>
<td>Unknown</td>
</tr>
<tr>
<td>-</td>
<td>Negative impact</td>
</tr>
<tr>
<td>0</td>
<td>No impact</td>
</tr>
<tr>
<td>+</td>
<td>Positive impact</td>
</tr>
<tr>
<td>++</td>
<td>Very positive impact</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>time</th>
<th>cost</th>
<th>labour</th>
<th>knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>long</td>
<td>high</td>
<td>many</td>
<td>external</td>
</tr>
<tr>
<td>2</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
<td>training needed</td>
</tr>
<tr>
<td>1</td>
<td>short</td>
<td>low</td>
<td>little</td>
<td>farmers</td>
</tr>
</tbody>
</table>

**Example of possible problems and solutions**

See Annex 5.
See photo album on Problem and Solutions
Format of FWM plan

<table>
<thead>
<tr>
<th>FWM problems</th>
<th>Selected Solutions, options farmers would like to introduce and learn more about</th>
<th>Time frame(^2) for implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c)</td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td>a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c)</td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td>a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c)</td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td>a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c)</td>
<td></td>
</tr>
</tbody>
</table>

Questions for discussions

- Have there been already potential solutions mentioned during the mapping and transect walk exercise for each of the listed main problems?
- What have you already tried to solve each of the main problems listed and what were you experiences?
- Do you know of some other possible solution(s)?
- Is there any overlap of solutions for the priority problems of each group? And among the different groups?
- Which solutions can be implemented by the local community? Which require external assistance?
- What do you think of the possible solutions mentioned?
- Are the possible solutions mentioned for you realistic solutions?
- Would you like to try out one of the mentioned solutions? Which one?
- What needs to be done to implement the proposed solution, technology or practices?
- What are the inputs needed?
- Do farmers have to invest money?
- Is credit needed and will it earn enough to pay for the investments?

See example of FSP exercise in Indonesia

\(^2\) Number and names of seasons selected for implementation.
EXERCISE 1F: PREPARATION AND PRESENTATION OF FARMERS’ SEASONAL PLAN

Introduction

A plan of activities for the coming cropping season will be developed based on the FWM plan. To guarantee maximum participation of the farmers in the development and implementation of the activities planned, the farmers need to participate also in this final stage of the preparation of the plan of activities. The plan of activities includes the plan and time schedule for the FST.

Objectives

- To develop and decide with the participating farmers on the work plan for the implementation of various identified possible solutions for the coming season (technologies and practices).
- To develop the content and time schedule for the FST.

Expected outputs

- A detailed work plan for the implementation of identified possible solutions for the coming season.
- A list of topics for the FST
- A time schedule for the FST.
- A place where farmers will meet to participate in the FST
- Starting date for the FST.
- Names of farmers who have committed themselves to participate in the FST.
- Agreement on inputs and resources to be provided by farmers/ facilitators/ others.

Preparations required

- Prepare a list of the technologies and practices farmers have identified they would like to introduce and learn more about (FWM plan, exercise 1E) and relate this to the 5 elements of farmers’ water management.
- Prepare a format for a work plan for the introduction of a technology or activity on a large sheet of paper.
- Prepare on a large sheet of paper a proposed list of topics for the FST related to the introduction of the selected technologies and practices.
- Prepare on a large sheet of paper a proposed time schedule for the FST.

Materials required

- Large sheets of paper and markers.

Time required

- Three and half hours

Timing

- After exercise 1E
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc.1, Part C)

2. Explain the specific objectives and expected output.

Plenary discussions (20 min)

3. Present the technologies and practices farmers have identified they would like to introduce and learn more about (FWM plan). Ask the farmers if the presented list of technologies and practices is complete. Make corrections where it is needed.

4. Discuss with the farmers which crop(s) they would like to select to study the different FWM techniques/topics on during the next cropping season.

Small group discussion (40 min)

5. Split the farmers up in small groups.
   A) Ask at least two groups to prepare a crop management plan for the selected crop for the next season on a large sheet of paper (including the crop management activities, dates, inputs needed).
   
   B) If relevant, ask the other groups to identify and prepare an implementation plan for the activities that need to be undertaken during the coming season to implement the planned structural improvements and/or improve the operation and maintenance of the irrigation system.

Plenary discussion (45 min)

6. Ask the groups to present the results of their discussion. Identify with the farmers what the main FWM problems/activities are during the next season in relation to the selected crop(s), operation and maintenance of the irrigation system and structural improvements.

7. Based on the identified main FWM problems/activities and the FWM plan ask the farmers to identify and decide on the technologies, practices and topics they would like to introduced or implemented during the coming season.

8. Present the format of the work plan for the coming season. Discuss the scheduling of the different selected technologies, practices and topics based on the crop management, implementation and/or improvement plan(s) prepared.
**Small group discussions**  (30 min)

9. Ask the farmers to split up in small groups and ask each group to discuss and prepare a work plan for the coming season on a large sheet of paper.

**Plenary discussion**  (60 min)

10. Ask each group to present their work plan on a large sheet of paper. Discuss the presented work plans, differences and resemblance.

11. Based on the discussion, prepare one work plan and ask the farmers to endorse the final content and final time schedule for the FST.

12. Discuss the logistics of the FST and ask the farmers to decide on the meeting place for the FST, starting date, which day of the week, session hours, etc.

13. Summarise all the decision taken for the seasonal plan including the work plan for the introduction of the technologies and practices as well as the content, time scheduling and logistics for the FST.

14. Ask the farmers to commit themselves to the seasonal plan (FSP) prepared as well as to participate in the FST during the coming cropping season. Send a list around on which farmers can fill in their name for participating in the FST.


**Guidelines for (technical) preparations / questions for discussions**

**Example format of a Crop management plan**

<table>
<thead>
<tr>
<th>Week</th>
<th>Crop management activity</th>
<th>Inputs needed</th>
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</table>
Example format of a work plan for the coming season (FSP) (introduction of structural improvements, technology, practice or improved operation and maintenance)

<table>
<thead>
<tr>
<th>Structural improvement, Technology practice or O&amp;M</th>
<th>Labour input (Man-days)</th>
<th>Materials needed</th>
<th>costs</th>
<th>responsibility</th>
<th>Time schedule</th>
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Example of a time schedule for the FST

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<th>Week</th>
<th>Topic</th>
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The FST will be held on Wednesday mornings (8.30 – 12.00), starting first week of January

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3 Completed by the facilitator(s).
4 Completed by the facilitator(s).
Questions for discussions

• What were for you the main results of the diagnostics and planning activity exercises?
• Are your main results of the diagnostics and seasonal planning activity included in the summary (FWM plan) presented?
• Are there results presented in the summary of which you thing they should not be there?
• Are some results of the diagnostics and planning activity missing in the summary?
• Does the selected FST topics reflex the results of the diagnostics and planning activity?
• Are all the selected topics represented in the time schedule for the FST?
• Are you willing to commit your self to FST during the whole season?

See example of FSP exercise in Indonesia
EXERCISE 1G: EVALUATION IMPLEMENTATION PREVIOUS FARMERS’ SEASONAL PLAN

Introduction

This is the first exercise of the next Farmers Seasonal Planning sessions. Part of the problems, possible solution and appropriate technologies (FWM plan) identified during the previous Farmers Seasonal Planning have been dealt with or implemented during the season. In preparing the seasonal plan for the coming cropping season it is important to know what has already been implemented and what still needs to be done and what kind of follow up is needed. Also other issues/topics may have become important which have to be included in the seasonal plan for the coming season.

Objectives

- To evaluate the progress made with the implementation of the farmers seasonal plan prepared during the previous FSP.

Expected outputs

- A list of topics/issues and related problems dealt with during the previous/present season.
- List of follow up activities.
- List of new topics/issues which need to be included in the planning

Preparations required

- Farmers’ seasonal plan prepared during the previous FSP.

Materials required

- Large sheets of paper and markers.

Time required

- Three hours

Timing

- First sessions of the next FSP
**Procedure (Steps)**

**Plenary Introduction** (10 min)

1. Review of the previous training session (Exc.1, Part C)

2. Explain the specific objectives and expected output of this exercise.

**Field visit** (2 hours)

3. Visit with the farmers each of the meeting places, study plots and/or construction places where the different FST activities (FWM-FFS, WUA training, Structural improvements programme, etc.) have been implemented. At each place ask the farmers what they have done during the different FST activities. List all these topics/activities down on a large sheet of paper.

4. Ask the farmers to explain the different activities, studies, constructions carried out and to indicate what they have learnt from these activities. Add this to the list of topics/activities done.

**Plenary discussion** (50 min)

5. Discuss with the farmers (and WUA members) the listed topics, activities and what farmers have learnt during the season by participating in the activities of the FST.
   A) Does the list include all the activities, topics and what farmers have learnt? Add the missing ones to the list.
   B) Discuss for each of the listed topics/activities, what kind of problems the farmers had and what was done about the problems.
   C) Have the farmers learnt enough about the listed topics and their related problems?
   D) What do they want to do and/or learn more about these topics and related problems? (follow up)

6. Discuss with the farmers if this was/is what they wanted to do and learn during this season and if additional activities/topics have come up during the season that they would have like to do and/or learn more about? List these down on the large sheet of paper.

7. Summary and Closure (Exc.2, Part C).
## Guidelines for (technical) preparations / questions for discussions

### Example of reporting format evaluation of season activities

<table>
<thead>
<tr>
<th>Topic/issue*</th>
<th>Problems**</th>
<th>Dealt *** (Y/N)</th>
<th>What kind of follow up needed****</th>
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<tr>
<th>Topic/issue:</th>
<th>Problems</th>
<th>Dealt</th>
<th>What kind of follow up needed?</th>
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</table>

*) List all the topics/issues identified by the farmers dealt with during this season
**) Major problems farmers/WUA members had in relation to this topic/issue?
*****) Did you manage to deal with this problem, Yes or No?
*****) What kind of follow up is needed to deal with this problem sufficiently?
Questions for discussions

- What have you learnt from this activity?
- Which of the things you have learnt are you planning to implement yourself?
- Which of the topics/activities did you not like?
- What do you suggest the project should do to assist you further in the future?
EXERCISE 1H: PREPARATION FARMERS SEASONAL PLAN

Introduction

This is the second exercise of the next FSPs. During the first FSP the farmers have prepared a long list of problems, possible solutions and appropriate technologies they identified to improve their Farmers’ Water Management (FWM plan). Based on the FWM plan a seasonal plan was made for the season. After having evaluated the activities, topics and what the farmers have learnt during the season a new updated FWM plan can be prepared by the farmers. Based on the updated FWM plan a seasonal plan can be made for the next season.

Objectives

- To update the FWM plan with the identified problems, possible solutions and appropriate technologies farmers still would like to introduce and learn more about.
- To prepare a seasonal plan for the coming season.

Expected outputs

- Updated the FWM plan with the list of problems and possible solutions and appropriate technologies farmers still would like to introduce and learn more about.
- Crop management plan for the selected crop(s) for next season.
- Present status of the structural improvement program and planning for coming season.
- Seasonal plan for the next season (including the topics, time schedule, meeting place, starting date, name of participating farmers and an agreements on inputs and resources to be provided by farmers, facilitators and others).

Preparations required

- FWM plan with the lists of problems, solutions and appropriate technologies prepared during the previous FSP.
- Lists of activities, topics and what the farmers have learnt during this season from exercise 1G.

Materials required

- Large sheets of Paper and markers.

Time required

- Three hours.

Timing

- After having evaluated the implementation of the previous Farmers Seasonal Plan (exercise 1G).
**Procedure (Steps)**

**Plenary Introduction** (10 min)

Review of the previous training session (Exc.1, Part C)

Explain the specific objectives and expected output.

**Plenary discussion** (1 hour)

Present to the farmers the lists of problems, solutions and appropriate technologies (FWM plan) prepared during the previous FSP and the Lists of activities, topics and what the farmers have learnt during the season (prepared during exercsie1G).

Ask the farmers to compare the two lists and to indicate which of the items for the FWM plan, a) have been fully covered, b) have been partly covered and c) have not been covered during this season.

Discuss with the farmers what still needs to be done on the partly covered items on the list. Prepare a new list of problems, solutions and appropriate technologies that the farmers still would like to learn more about in relation to FWM (updated FWM plan). Add the new topics identified during the evaluation exercise to the list.

Discuss with the farmers which crop(s) they would like to study during the next cropping season.

**Small group discussion** (50 min)

Split the farmers up in small groups.

A) Ask at least two groups to prepare a crop management plan for the selected crop for the next season on a large sheet of paper (indicating the crop management activities, dates, inputs needed).

B) If relevant, ask the other groups to identify and prepare an implementation plan for the activities that need to be undertaken during the coming season to implement the planned structural improvements and/or improve the operation and maintenance of the irrigation system.

**Plenary discussion** (1 hour)

- Ask the groups to present the results of their discussion. Identify with the farmers what the main FWM problems/activities are during the next season in relation to the selected crop(s), operation and maintenance of the irrigation system and structural improvements.
Based on the identified main FWM problems/activities and the FWM plan ask the farmers to identify and decide on the technologies, practices and topics they would like to introduced or implemented during the coming season.

Present the format of the work plan for the coming season. Discuss the scheduling of the different selected technologies, practices and topics based on the crop management, implementation and/or improvement plan(s) prepared.

**Small group discussions** (30 min)

- Ask the farmers to split up in small groups and ask each group to discuss and prepare a work plan for the coming season on a large sheet of paper.

**Plenary discussion** (60 min)

- Ask each group to present their work plan on a large sheet of paper. Discuss the presented work plans, differences and resemblance.

- Based on the discussion, prepare one work plan and ask the farmers to endorse the final content and final time schedule for the FST.

- Discuss the logistics of the FST and ask the farmers to decide on the meeting place for the FST, starting date, which day of the week, session hours, etc.

- Summarise all the decision taken for the seasonal plan including the work plan for the introduction of the technologies and practices as well as the content, time scheduling and logistics for the FST.

16. Ask the farmers to commit themselves to the seasonal plan (FSP) prepared as well as to participate in the FST during the coming cropping season. Send a list around on which farmers can fill in their name for participating in the FST.

**Guidelines for (technical) preparations / questions for discussions**

**Example format of a Crop management plan**

<table>
<thead>
<tr>
<th>Week</th>
<th>Crop management activity</th>
<th>Inputs needed</th>
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**Example format of a work plan for the coming season (FSP) (introduction of structural improvements, technology, practice or improved operation and maintenance)**

<table>
<thead>
<tr>
<th>Structural improvement, Technology practice or O&amp;M</th>
<th>Labour input (Man-days)</th>
<th>Materials needed</th>
<th>costs</th>
<th>responsibility</th>
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**Example of a time schedule for the FST**

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<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Exercise no. (^5)</th>
<th>Topic</th>
<th>Exercise no. (^6)</th>
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The FST will be held on Wednesday mornings (8.30 – 12.00), starting first week of January

**Questions for discussions**

- Are there results presented in the summary of which you think they should not be there?
- Are some results of the diagnostics and seasonal planning activity missing in the summary?
- Is there equal participating of the different irrigation blocks in the different planned activities under the FWM-project for next season?
- Are you willing to commit yourself to participate in one or more of the planned activities under the FWM-project for next season?

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\(^5\) Completed by the facilitator(s)
\(^6\) Completed by the facilitator(s)
PART B

EXERCISES FOR THE FARMERS' SEASONAL TRAINING
Module 1: WATER SOURCES

1. River Diversion
2. Direct inlet
3. Pumping
4. Diversion weir
5. Groundwater lift
6. Reservoir
7. Major supply canal

Diagram:

[Diagram illustrating water sources and processes, including river diversion, direct inlet, pumping, diversion weir, groundwater lift, reservoir, and major supply canal.]
MODULE 1

WATER SOURCES

IMPROVING SUPPLY AND AVAILABILITY OF WATER FOR IRRIGATION

Introduction

This module is the first of the five modules with possible exercises for the FST. The exercises in this module deal with topics related to the availability and reliability of water for irrigation.

A first condition for successful irrigation is the timely and adequate availability of water. A farmer can obtain water for irrigation from a main water supply system, rivers, lakes, reservoirs or ground water. Farmers have different levels of control over the availability of the water from these different types of water sources. No control over water supplied from large irrigation systems but full control over water from a private owned deep well pump. In the diagnostics and seasonal planning an assessment is made on the problems farmers experience. With regard to the water source these problems could be related to water shortages and periods of unreliable water supply. Water supply can be improved by increasing water supply from groundwater, dams, introduction of irrigation pumps or by improving supply from the main system, reservoir or river diversion. Depending on the techniques and practices identified during the diagnostics and seasonal planning exercises can be selected for the FST from the following three sub-modules.

References

In the preparation of the exercises in the module use is made of the following publications:

- Irrigation water management training manual No 1, Introduction to Irrigation, 1985, FAO.
- Irrigation water management training manual No. 6, Scheme Irrigation water needs and supply, 1992, FAO
- Irrigation water management training manual, No. 7, Canals, 1992, FAO
- Irrigation water management training manual No.10, Irrigation scheme operation and maintenance, 1996, FAO
- Irrigation water management training manual, Small-scale pumped irrigation: energy and cost, 1992, FAO

Additional technical information can be obtained from the above mentioned publications.
Sub-module 1.1: Groundwater development - well development

Through plenary discussions and visits to existing well type(s) farmers will learn about the characteristics of different well types in exercise 1A (phase: Planning). In exercise 1B (phase: construction) they will plan for the construction of a well. Monitoring of the progress made in the construction of the well takes place in exercise 1C (phase: operation and maintenance).

Sub-module 1.2: Pumps

In exercise 1D (phase: planning) farmers will learn about the characteristics of different types of pumping devices. The installation of the pumping device(s) will be planned during exercise 1E (phase: construction). Farmers will prepare an operation and maintenance and discuss the organisational aspects in exercise 1F plan (phase: operation). Monitoring of the progress made in the installation, operation and maintenance of the pumping devices takes place in exercise 1G (phase: maintenance).

Sub-module 1.3: Main water system supply, Reservoirs and River diversions

Farmers will assess the functioning and organisation of the water supply from the main system in exercise 1H (phase: planning). In exercise 1I (phase: planning) farmers will assess the operation and functioning of the existing reservoirs and the same will be done for the river diversions in exercise 1J (phase: planning).
SUB-MODULE 1.1

GROUNDWATER DEVELOPMENT
– WELL DEVELOPMENT

EXERCISE 1A: SELECTION OF WELL TECHNIQUES AND INSTALLATION REQUIREMENTS

Introduction

Before starting the digging of a new well a whole range of criteria have to be considered before choosing a type of well. What are the hydro-geological conditions, and in particular the depth and quality of groundwater? Who will use the water? How will the pump be financed? Who will do the well development? How skilled and how well equipped are the crews of well diggers available for the job? How will the maintenance of the well be organised? These are only a few of the questions that need to be answered first.

Objectives

• Assess potential for groundwater development and to introduce different well drilling techniques and their installation requirements.

Expected outputs

• Assessment of groundwater depth and potential for development
• Selection of suitable well locations
• Expected area irrigated and farmers to benefits of the well
• Farmers have defined the potential and suitable type of well development.
• Selection made of the most suitable well type(s)

Preparations required

• Conduct a short survey in the area to identify the groundwater depth and well types used in the area, who build them, how they are/were financed and managed.
• To arrange, if feasible, to visit with the FST two or three nearby situated different types of wells
• Prepare large drawings of the different well types and well development techniques.
• Prepare outline table: Characteristics of different well types

Materials required

• Examples of different types of wells in the area for the visit
• Large sheets of paper and markers

Time required

• Three and half hour

Timing

• Well before start irrigation season
Procedure (Steps)

Plenary Introduction (15 min)

1. Explain the specific objectives and expected output.

Plenary discussion (50 min)

2. Ask the farmers what different types of wells they know of and which of those are used in the area. Ask the farmers what the characteristics are of the wells in the area, depth of the wells and purpose of use (drinking water, irrigation).

3. Introduce the large diameter open well, tube well and the combined well. Show on a large piece of paper drawings of the different well types and ask the farmers if they recognise the different well types.

4. Prepare on a large sheet of paper a table listing the different well types and different well characteristics (see example table: “well characteristics” on the next page) and discuss the different well characteristics listed for all the different well types. Write the results of the discussions in the table.

5. Ask the farmers, based on the well characteristics listed in the table, groundwater level(s) in the area, and costs to select the most suitable well type(s) and suitable pump type(s).

Small group discussion (1 hour)

6. Split the farmers up in small groups of 4-5 persons according to irrigation block and ask the groups
   • to identify a suitable location in their block for well development,
   • to estimate costs for well and pump development,
   • to discuss the area and crops which can be irrigated, possible supply of drinking water and the expected profit from the well and pump,
   • the availability and reliability of water for the well and pump,
   • to determine the number of farmers to share in the installation and operation of the well,
   • to assess funding and credit sources for well and pump development and
   • to report their discussion results on a large sheet of paper.

7. Discuss the results of the small group discussions

Field visit (1 hour and 30 min)

8. Visit with the farmers a nearby situated well and discuss the advantages and disadvantages of the well. If available, discuss with the operator the operation
and maintenance of the well and water lifting device (labour needs, financial costs, typical problems, etc.).

9. Visit a second well, preferably a different type, and discuss the same topics as at the first one. If available and relevant visit also a third one. Summarise the discussions and try to reach a conclusion on what the most suitable type of well would be and the costs and funding requirements.

## Guidelines for (technical) preparations/ questions for discussions

### Table: Well characteristics

<table>
<thead>
<tr>
<th>Well characteristics:</th>
<th>Well type:</th>
<th>traditional well</th>
<th>open well</th>
<th>Tube well</th>
<th>combined well</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth (*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter (*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction material</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of the materials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction costs (#)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour need for construction (#)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water lifting device/power</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge (l/s or m³/hour)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operation costs (#)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance costs (#)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability of water over the season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) range, (#) if an estimate is to difficult, indicate only high, medium or low
Advantages/disadvantages of different well types

Large diameters open well:
- Construction time (hand dug or with an engine)
- Construction season
- Workforce needed to construct the well
- Buckets, hand pump and motor pump can be used as pumping device
- Effect on groundwater table
- Construction cost

Tube well
- Small seasonal variation in pumping height
- High well discharge
- Hand pump, treadle pump, motor pump and submersible pump can be use as pumping device
- Maintenance cost
- Construction cost

Combined well
- Used as water storage tank
- Well size in function of consumption needs
- Hand pump, Bucket, Treadle pump and motor pump can be used as pumping device
- Maintenance cost
- Construction cost

For more technical information, see also:
- Irrigation water management training manual No 1, Introduction to Irrigation, 1985, FAO. Chapter 2: Soil and Water.
- Irrigation water management training manual No. 6, Scheme Irrigation water needs and supply, 1992, FAO. Chapter 2.4.

Questions for discussions

- What kinds of materials are used in the construction of the well?
- Who did constructed the well in the past?
- How long did it take to construct the well?
- How is the water intake constructed?
- What is the texture of the (sub) soil and are there hard layers in the soil?
- What is the depth of the groundwater table in the dry and wet season?
- How is the well discharge?
- How is the quality of the well water?
- Is there any protection provided against contamination?
- Who is responsible for the operation and maintenance of the well?
- What is the favourable season for well construction?
EXERCISE 1B: INSTALLATION, OPERATION AND MAINTENANCE OF A WELL

Introduction

After the selection of possible well types the next step is to plan for the construction of the well. The construction phase starts with the final decision on the well type and place of construction. Further, construction materials, financing, labour, etc. need to be arranged before the construction can start. During this phase it is important to discuss also the operation and maintenance of the well after the construction has been completed.

Objectives

- To plan for the installation, operation and maintenance of a well.

Expected outputs

- An installation plan for the well, including location, what type, materials used, where, how, when and by whom the well will be installed and water lifting device.
- Time schedule for well installation
- Agreement on contribution of the farmers
- A provisional plan on how and who to operate and maintain the well and water lifting device, including area and crops to be grown.

Preparations required

- Through a survey collect Information and costs of different well types and types of pumping devices available in the area, what kind of construction materials are available, availability of construction equipment and skilled labour.

Materials required

- Large sheets of paper and markers

Time required

- 3 hours

Timing

- Well before start irrigation season
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

**Plenary discussion** (20 min)

3. Discuss and decide with the farmers on the selection of well type, location(s), estimated groundwater depth(s) and number of farmers that will benefit from the well(s).

**Brainstorming** (40 min)

4. Ask the farmers to mention all the materials needed for the well construction and write them on a large sheet of paper.
5. Discuss briefly all the materials mentioned and add the missing ones.
6. A) In the case of open well, ask the farmers to mention all the labour skills needed for the construction and write them down on a large sheet of paper.
6. B) In case of tube well, discuss briefly all the labour skills mentioned and add the missing ones and write them down on a large sheet of paper.

**Small group discussions** (50 min)

7. Ask the farmers to discuss in small groups of 4-5 persons the (a) quantities needed and (b) estimated costs of each type of material listed, (c) labour requirements, (d) where to find the labour skills and (e) labour costs for the construction of the well.
8. Ask each group to fill in their estimates on a pre-prepared table.

**Plenary discussion** (50 min)

9. Discuss and compare the estimations of the different groups and try to conclude on the most realistic ones.
10. Discuss time schedule, how to organise the construction of the well and contributions in cash and kind. Prepare a plan of action.
11. Take some time to discuss also the operation and maintenance of the well after its construction has been completed and prepare a temporary operation and maintenance plan.

12. Summary and Closure (Exc. 2, Part C)

**Guidelines for (technical) preparations / questions for discussions**

**Example format table: Material and labour needs for well construction**

<table>
<thead>
<tr>
<th>materials</th>
<th>quantities</th>
<th>costs</th>
<th>Labour skills</th>
<th>Quantity man-days</th>
<th>source</th>
<th>costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Questions for discussions**

- What is the expected groundwater table during the dry and wet season at the place selected for the well?
- What is the texture of the (sub) soil at the place selected for the well?
- What is the expected discharge of the well at the place selected for the well?
- Is the place selected for the well easily accessible?
- Can irrigation water economically distributed to a large number of fields from the place selected for the well?
- Who will be the people that will benefit from the water out of the well?
- Who will you organise the distribution of the irrigation water from the well?
- What type of water lifting device will be used?
- What kind of construction materials will be used for the casing, intake, and platform of the well?
- Which construction method(s) will be used?
- Who has the skills to construct such a well?
- What kind of equipment is needed for the construction and can this be made available?
- Who will provide labour for the construction of the well?
- How will the construction of the well be financed and by who?
- Who will be responsible for the construction of the well?
- After it has been completed, how and by whom will the well be operated and maintained?
EXERCISE 1C: FOLLOW UP INSTALLATION AND OPERATION OF THE WELL

Introduction

In most cases the installation of the well will be carried out in the same period but not during the sessions of the FST. It is more practical to complete the installation in, for example, one-week time than to spread it out over a large number of half-day FST sessions. But during the installation of the well it is important to pay in the FST regularly attention to the follow up of the (planned) installation of the well and after the completion to follow up on progress, operation and maintenance.

Objectives

- To follow up on the planned installation of the well.

Expected outputs

During the installation

- An assessment of the progress made on the planned installation of the well.
- A list of activities which need to be carried out during the following weeks.
- Assignment of responsibilities for the implementation of those activities.

After installation

- Assessment of the area irrigated
- Responsibilities in operation and maintenance (O&M).
- Status repayment of credit.

Preparations required

- None

Materials required

- The installation plan for the well prepared during exercise 1B
- The provisional operation and maintenance (O&M) plan

Time required

- One hour

Timing

- A few weeks after exercise 1B
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Plenary discussion (50 min)

3. If possible, move with the FST to the location where the well is being installed.
4. A) In case of a follow up on the installation, recall the planning prepared for the installation of the well and ask the responsible farmers to report on the progress made.
5. B) In case of a follow up on the operation and maintenance, recall the provisional plan on how and who to operate and maintain the well and water lifting device and ask the responsible farmers to report on the O&M including area irrigated, who is receiving water, crops planted and repayments of credit
6. Discuss the problems encountered and identify solutions how they can be solved.
7. Discuss and decide on what needs to be done during the following weeks as well as who will be responsible for those activities. Write this down in a final Operation and Maintenance plan.
8. Summarise the plan of action for the following weeks.

Guidelines for (technical) preparations / questions for discussions

Questions for discussions

- What progress has been made in (the preparation of) the installation of the well?
- Is the installation of the pump still on schedule? If not, why not?
- Why were some activities not carried out?
- What were the problems that you had? And will that delay further progress?
- Are the financial arrangements for the well installation functioning well?
- What needs to be done to make some further progress?
- What needs to be done during the following weeks?
- When shall we discuss again the follow up on the installation of the well?
SUB-MODULE 1.2

PUMPS

EXERCISE 1D: INTRODUCTION OF WATER LIFTING DEVICES

Introduction

Many small-scale irrigation schemes rely on pumps for supply of water for irrigation, lifting water from wells or from rivers, ponds or dams. Lifting water requires energy provided either by petrol, or diesel engine, an electric motor or powered by human or animal traction. Many different pump types and energy sources exist and adequate care need to be given to the selection of the right type of pump and appropriate energy source suitable for the socio-economic environment of the users. Farmers should be able to operate and maintain the pump and be able to pay for repair, energy costs and purchase of the pump. It is therefore important for farmers to be aware the differences between pumping systems as well as their maintenance and operation characteristics.

Objectives

- To define benefits and disadvantages and requirements for installation and operation of irrigation pumps
- To introduce different pumps and lifting devices which can be considered.
- To familiarise farmers with the main characteristics to consider for selection of a suitable pump.
- To select a suitable pumping device and number of farmers to benefit.
- To assess costs for purchase and operation and maintenance.

Expected outputs

- Awareness of the benefits and characteristics of different pumps.
- Appropriate pump type(s) selected and number of benefiting farmers and area covered defined.
- Benefits and requirements for purchase and operation defined.

Preparations required

- Make a list of the different irrigation pumps presently used in the area.
- Arrange if feasible a field visit to a working pump.
- Ensure that the pump(s), to be considered are available during the exercise for demonstration

Materials required

- Pumps arranged by the programme and/or working pump site on a convenient distance.
- Large sheets of paper and markers

Time required

- Three and half hours

Timing

- Before start irrigation season
Procedure (Steps)

Plenary Introduction (15 min)

1. Explain the specific objectives and expected output.
2. Review of the previous training session (Exc. 1, Part C).

Brainstorming (40 min)

3. Ask the farmers to indicate on the map suitable locations for a pump and areas that they think can be irrigated and discuss them.
4. Ask the farmers to mention all the benefits and requirements they can think of using a pump to supply water to their agricultural fields. List them down on a large sheet of paper.
5. Ask the farmers to mention which types of pumps they know of and list them down on another large sheet of paper. Add the missing one.

Small group discussions (40 min)

6. Split the farmers up in small groups of 4-5 persons and ask the groups to discuss for each pump type the main characteristics and requirements for purchase, installation and operation. Ask the groups to report the results of their discussions on a large sheet of paper.
7. Discuss the results of the small group discussions.

Plenary discussions (1 hour)

8. Ask the farmers to look at the specifications listed on the motor pump and ask them what kind of information it provides about the pump.
9. Discuss the meaning of lifting head, pump efficiency, discharge, power and power unit, pump suction, fuel consumption and energy requirements.
10. Ask the farmers to estimate the size of the area that they could irrigate with the motor pump made available by the programme by estimating discharge, water requirements (assume 1,2 l/s/ha) and number of hours.
11. Discuss the number of farmers the pump can serve and how this could be organised. Elaborate on costs and credit and operation costs. Select with the farmers the most suitable pump type.
Field visit/observations (1 hour)

12. Visit a close by situated irrigation pump, and discuss with the owner(s):

- The selection and characteristics of the pump.
- Area irrigated, pump operation/irrigation schedule.
- Fuel use, additional operation costs and maintenance of the pump.

13. Summary and Closure (Exc. 2, Part C)

Guidelines for (technical) preparations / questions for discussions

Situations in which an irrigation pump can be used

For the right choice of a pump it is important to know

- the type and level of the water source: surface water (river, canal, reservoir or lake) and groundwater (well or borehole),
- the type of water distribution system: pipes or open channels and
- the irrigation method that can be used: surface, sprinkler or drip irrigation.

The most common combinations of components for an irrigation system are:

- Surface water ➞ pump ➞ open channel ➞ surface irrigation
- Surface water ➞ pump ➞ pipe ➞ surface, sprinkler or drip irrigation
- Shallow well or borehole ➞ pump ➞ pipe ➞ sprinkler or drip irrigation
- Shallow well or borehole ➞ pump ➞ open canal ➞ surface irrigation

Selection of pump Type

<table>
<thead>
<tr>
<th>Groundwater depth</th>
<th>Well type</th>
<th>Pump type</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 7m.</td>
<td>Shallow tube well</td>
<td>Centrifugal pump</td>
</tr>
<tr>
<td></td>
<td>Open well</td>
<td>Treadle pump</td>
</tr>
<tr>
<td>&gt; 7m.</td>
<td>Medium/deep tube well</td>
<td>Multi-stage axial flow pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rope and washer pump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sub-murgeable pump</td>
</tr>
<tr>
<td>Surface water &lt;7m.</td>
<td></td>
<td>Low lifting and Axial(^1) pump</td>
</tr>
<tr>
<td>7-15m.</td>
<td></td>
<td>Centrifugal(^2) and Mixed flow pump</td>
</tr>
</tbody>
</table>

\(^1\) Axial pumps are most effective in lifting large volumes of water at low pressure (few meters).
\(^2\) Centrifugal pumps are most effective in lifting small volumes of water at high pressure.
**Pump characteristics**

**Head or pressure**
Pressure describes the force to lift water. Pressure is normally measured in head of water, or bar (10m head of water = 1 bar).

**Discharge**
The discharge is the volume of water flowing out of the pipe and is measured in litres per second (l/s). Discharge can be measured on many ways. Special flow meters can be used but also the bucket methods.

**Power**
Power is the rate of using energy and is commonly measured in kilowatts (kW) or horsepower (1 kW = 1.36 HP). The power needed to pump water is called waterpower and can be estimated from the discharge and the suction lift (water power (kW) = 9.81 x discharge (m³/s) x head (m)).

**Suction lift**
Suction lift is the height to lift water from the water source.

**Efficiency**
The losses in the system are caused by friction and water turbulence and are usually expressed as efficiency. This can be expressed in terms of energy or power use (Pumping plant efficiency (%) = (water energy or power / actual energy or power x 100) and normally range between 60% and 90% (±70%).

**Power unit**
Pumps are driven by different types of power units such as a diesel or petrol engine, or an electric motor. In some cases solar or wind power, or even hand or animal power, may be used to provide the power source for the pump.

**Calculation of pump capacity**
The scheme water demand is the discharge in litres per second (l/s) required to meet the crop water requirements, plus the losses that occur in the field application and the distribution system (irrigation efficiency).

**Crop water requirements**
The pump capacity need to be such that even in a period when the crop needs most water (peak) the pump can meet requirements within the daily operation time. Peak requirements are approximately double the average crop water requirements.

The average crop water requirement (mm/d) = Seasonal crop water requirement (mm) / Length of crop duration (days).
Table: Indicative values for crop water needs and growing periods

<table>
<thead>
<tr>
<th>Crop</th>
<th>Crop duration (Days)</th>
<th>Need (mm)</th>
<th>mm/day</th>
<th>Peak mm/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>120-140</td>
<td>450-650</td>
<td>4-5</td>
<td>8</td>
</tr>
<tr>
<td>Vegetables</td>
<td>90-120</td>
<td>400-600</td>
<td>4.5-5</td>
<td>8</td>
</tr>
<tr>
<td>Rice (paddy)</td>
<td>90-120</td>
<td>800-1500</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>

Losses/efficiency
The distribution efficiency in a small sized irrigation scheme (<200 ha) are 80 to 90% when earth canals are used and 95% when the canal are lined or pipes are used. The irrigation efficiencies for surface, sprinkler and drip irrigation are 60, 75 and 90%.

Table: Pump capacity in Horse power (efficiency = 0.75)

<table>
<thead>
<tr>
<th>Discharge (l/s)</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.25</td>
<td>0.50</td>
<td>0.75</td>
<td>1.00</td>
<td>1.25</td>
</tr>
<tr>
<td>10</td>
<td>0.50</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
</tr>
<tr>
<td>15</td>
<td>0.75</td>
<td>1.50</td>
<td>2.25</td>
<td>3.00</td>
<td>3.75</td>
</tr>
<tr>
<td>20</td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
<td>4.00</td>
<td>5.00</td>
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<tr>
<td>25</td>
<td>1.25</td>
<td>2.50</td>
<td>3.75</td>
<td>5.00</td>
<td>6.25</td>
</tr>
<tr>
<td>30</td>
<td>1.50</td>
<td>3.00</td>
<td>4.50</td>
<td>6.00</td>
<td>7.50</td>
</tr>
<tr>
<td>Area irrigated (ha)*</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

* 12 hours pumping/day and a crop water need of 4.5 mm/day (1.25 l/s/day)

For more technical information, see also:
- Irrigation water management training manual, Small-scale pumped irrigation: energy and cost, 1992, FAO, Chapter 3, 4 and 5.

Questions for discussions

- For what purpose do you want to use a pump?
- Do you expect that with the pump you will earn so much more that you will be able to pay for the purchase, operation and maintenance of the pump?
- Would this be possible if you organise you self in a pump-user group?
- Will the pump stay at one place or will it be moved constantly?
- Who has experience with operating and maintaining a pump?
- What are the problems that can be expect in operating and maintaining a pump?
- Are their shops in the area which sell pumps, spare parts for pumps and/or provide repair services?
- What are the purchase conditions of a pump?
EXERCISE 1E: PREPARATIONS FOR THE INSTALLATION OF PUMPING DEVICE (S)

Introduction

Farmers will be more committed to maintain a pump properly (only) when they feel ownership over the pump. This can only be reached when farmers do participate right from the start in the discussions and decision-making concerning purchase, installation and operation of the pump. The costs of the pump should (be on a realistic way) be paid for by the farmers, if possible, and where appropriate, assisted through credit schemes. Farmers can organise as a group the management, operation and maintenance of the pump as well as the distribution of the irrigation water, water fee collection and payment of the pump. This can be done through a Water Use Association (see module 5). In case there is one pump owner who is supplying water to other farmers, part of the costs of purchase, installation and operation can be recovered by selling water.

Objectives

- To define the location of the pump and canal layout for the water distribution system.
- To prepare a plan and time schedule for the installation of the pump.
- To introduce the concept of a water use association if pump shared by several farmers or water sales in case of one pump owner.

Expected outputs

- Detailed plan on where, when and how to install the Pump and who will do what.
- Pump operator assigned
- Canal layout prepared.
- Financial plan for purchase and installation of the pump and canal system.

Preparations required

- Arrange that the pump is present at the meeting place of the FST.
- Check the calculation of the total area that can be irrigated with available water and the pump and put the results on a large piece of paper.
- Prepare some proposals for an irrigation schedule and canal layout.

Materials required

- Pump map prepared by the farmers

Time required

- 2 hours

Timing

- Following exercise 1D.
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of the previous training session (Exc. 1, Part C).

2. Explain the specific objectives and expected output.

**Plenary discussion** (50 min)

3. Present on a large sheet of paper the calculations of the total area that can be irrigated with the pump (exercise 1A) as well as the time the pump needs to irrigate an average sized field.

4. If the pump will be shared by several farmers introduce and discuss the concept of a pump group and joint ownership ([WUA, module 5](#)) as well as the concept of water sales in case of one pump owner (see introduction).

5. Discuss and Try to conclude on if the farmers are willing to participate in a pump group for the management and operation of the pump and construction of irrigation system. Most of the participating farmers in the school should participate to be able to make the pump group a success.

6. Discuss and try to conclude on the best location to install the pump and the layout of the canal system to reach all participating farmers (use the map prepared by the farmers).

**Field observations** (1 hour)

7. Visit with the farmers the location(s) selected for the installation of the pump.

8. Discuss where and how the pump has to be installed at that location and how the water can be distributed from there to the fields. Decide if a survey is needed, lined or earth canals and any structures.

9. Prepare with the farmers a plan of action for the installation of the pump and preparation of the water distribution system(s), selection and training of pump operator as well as a financial plan including payment arrangements.

10. **Summary and Closure** (Exc. 2, Part C).
Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual, Small-scale pumped irrigation: energy and cost, 1992, FAO, Chapter 3, 4 and 5.

Questions for discussions
- How long will it take for the pump to irrigate an one-hectare rice field?
- What would be the normal number of hours per day farmers can spend irrigating their land?
- How many farmers can in an effective way make use of the pump?
- Are their already farmer’ organisations in the community present?
- Are some farmers members of a farmer’ organisation?
- What are the experiences with farmer’ organisations?
- Will do the farmers think of creating a Water Use Association
EXERCISE 1F: ORGANISING THE OPERATION AND MAINTENANCE OF THE PUMP(S)

Introduction

It is important that the farmers agree on the operation and maintenance of the pump. The pump group (WUA) or individual owner has decided on who will operate the pump and irrigation systems (exercise 1E). Follow-up need to be made on how the operation of the pump and distribution of water will be organised, who will be responsible for the maintenance and repair of the pump and how will the farmers pay for the operation costs as fuel costs, labour, maintenance and repair.

Objectives

- To organise the operation and maintenance of the pump and water distribution system
- To decide on record keeping, water fees and payment schedule.

Expected outputs

- Operation plan for the pump and water distribution system.
- Maintenance plan for the pump and water distribution system.
- Plan for record keeping on fuel use, pump use per farmer and operation and maintenance costs.
- Water fees and payment schedule.

Preparations required

- Pump installed

Materials required

- Pump

Time required

- 2 hours

Timing

- Just after the installation of the pump
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

**Plenary discussions** (50 min)

3. Ask the pump operator to explain how the pump is operated, operation schedule followed, water fee and water fee collection. Ask the operator if he/she experience any problems and if how the operation can be improved.
4. Discuss the suggestions made and try to reach a conclusion on the different elements of operating the pump.
5. Review and discuss the records being kept on pump operation and maintenance as well as water fee collection. Ask for suggestions to further improve record keeping.
6. Summarise the conclusions in an operation plan and define records to be kept by pump owner(s) and operator.

**Field visit / Plenary discussions** (1 hour)

7. Visit with all the farmers the just installed pump and irrigation system and measure the discharge of the pump (for example with a bucket and watch). Discuss the distribution of the water and if every farmer receives enough.
8. Discuss with the farmers what has to be done to maintain the pump properly. During the discussion show the farmers those elements of the pump, which need special attention in maintenance. Assess weak parts for improvements (base plate, shelter, canal intake, etc.)
9. Prepare with the farmers a list of maintenance activities for the pump and canal system and conclude on a maintenance plan.
Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual, Small-scale pumped irrigation: energy and cost, 1992, FAO

Questions for discussions
- What are the parts of the pump that need special attention during maintenance?
- Is there money available for a proper maintenance of the pump?
- What kinds of spare parts are needed?
- Do you have the knowledge and tools to carry out small repairs on the pump?
- Is additional training needed on how to operate, maintain and/or repair a pump?
- What are the organisational arrangements for the payment, operation, maintenance and repair of the pump?
- What are the organisational arrangements for the distribution of the water and water fee collection.
EXERCISE 1G: MONITORING OF INSTALLATION, OPERATION AND MAINTENANCE OF THE PUMP

Introduction

The farmers will carry out the installation, operation and maintenance of the pump and canal system, when needed with technical assistance of the supplier of the pump or technical assistance. During the FST sessions it is important to monitor the installation of the pump and construction of the canal system as well as the operation and maintenance of the pump and canal system regularly.

Objectives

• To monitor the planned installation of the pump, construction of canal system as well as the planned operation and maintenance of the pump and canal system.

Expected outputs

• An assessment of the progress made on the planned installation of the pump and construction of canal system.
• An assessment of the operation and maintenance of the pump and canal system.
• A list of activities which need to be carried out during the following weeks.
• Assignment of responsibilities for the implementation of those activities.

Preparations required

• None

Materials required

• The installation plan for the pump prepared during exercise 1E.
• Operation and maintenance plan for the pump and canal system prepared during exercise 1F.

Time required

• One hour

Timing

• During installation and/or operation of the pump and canal system.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Plenary discussion (50 min)

3. If possible, move with the FST to the location where the pump will be or has been installed and the canal system will be or has been constructed.
4. A) In case of monitoring the installation and construction, recall the planning prepared for the installation of the pump and construction of the canal system and ask the responsible farmers to report on the progress made.
5. B) In case of monitoring the operation and maintenance, recall the planning prepared for the operation and maintenance of the pump and canal system and ask the responsible farmers to report on the progress made.
6. Discuss the problems encountered and identify solutions how they can be solved.
7. Discuss and decide on what needs to be done during the following weeks as well as who will be responsible for those activities.
8. Summarise the plan of action for the following weeks.

Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:

- Irrigation water management training manual, Small-scale pumped irrigation: energy and cost, 1992, FAO, Chapter 3, 4 and 5.

Questions for discussions

- What progress has been made in (the preparation of) the installation of the pump and construction of the canal system?
- Is the installation of the pump and construction of the canal system still on schedule? If not, why not?
• Why were some activities not carried out?
• What were the problems that you had? And will that delay further progress?
• Are the financial arrangements for the pump installation and canal construction functioning well?
• What needs to be done to make some further progress?
• What are the problems in operation and maintaining the pump and canal system?
• Are the financial arrangements for the operation and maintenance of the pump and canal system well?
• What needs to be done during the following weeks?
• When shall we discuss again the follow up on the installation of the pump?
SUB-MODULE 1.3
MAIN WATER SYSTEM SUPPLY,
RESERVOIRS AND RIVER DIVERSSIONS

EXERCISE 1H: MAIN WATER SYSTEM SUPPLY

Introduction

When farmers obtain their water from a main water system supply they normally have little control over timing and amount of the water supply. Farmers have to plan their crop management according to the water supply schedule of the main water supply system. Therefore, the reliability of the water supply has become very important for the farmers. Unreliable and untimely supply of water will lead to ineffective water use, as farmers will take water when available even if not needed, and low production, as water stress due to unavailable or insufficient water will lead to crop damage. Operation of the main system is normally the responsibility of the irrigation agency. It is with the irrigation agency that the farmers have to discuss the problems related to the water supply from the main water system.

Objectives

• To assess the functioning and organisation of the water supply from the main system.
• To discuss with the irrigation agency in which way water supply can be improved.

Expected outputs

• Evaluation of the functioning and organisation of the main water supply system
• List of problems farmers experience in the water supply from the main water supply system and their impact.
• List of possible actions that can be undertaken to improve the reliability and distribution of the water supply.

Preparations required

• Invite and when needed, collect the local irrigation officer of the main irrigation system agency.

Materials required

• Irrigation layout map prepared by the farmers in exercise 1A (of FSP) and the map of the main irrigation supply system.
• Large sheets of paper and markers

Time required

• two hours

Timing

• No timing restrictions
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Explain the specific objectives and expected output.
2. Preview of the previous training session (Exc. 1, Part C).

**Plenary discussion** (50 min)

3. Ask the farmers to explain, through making use of the irrigation layout map, the main water system supply in the area. (source of water, distribution system, organisation of the distribution, etc.)
4. Ask the local irrigation officer to comment and to explain the functioning of the main water supply system.
5. Discuss with the farmers the influence of (a) the water source of the main water supply system, (b) water distribution infrastructure and (c) water distribution schedule/organisation on the reliability and availability of the water supply.
6. Discuss what should be improved in the main water system supply and list them down on a large sheet of paper. Ask the local irrigation officer to comment on the assessment made of the main water system supply by the farmers.

**Field visit** (1 hour)

7. Go to a point in the main water supply system where problems have been identified and discuss and identify possible actions with the farmers and the local irrigation officer that can be undertaken to solve the problem and improve the water supply.
8. Go the next point in the water supply system where problems have been identified and discuss etc. (a nearby situated WUA can be visited as well).
9. Summarise the activities mentioned, discuss the feasibility of the activities mentioned and ask the farmers to discuss if they would like to undertake one of them. If so, discuss a plan of action for the activity.
Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual No. 6, Scheme Irrigation water needs and supply, 1992, FAO. Chapter 2: Water Sources and Water Availability.

Questions for discussions

- Is the water supply to the area through the main water supply system constant throughout the year? How does it fluctuate and what causes the fluctuation?
- Do the farmers at the end of the main water supply system receive the same amount of water as the farmers located at the beginning of the supply system?
- What needs to be done to establish a more equal and reliable distribution of the water? And, what can farmers do on this?
- Would farmers have more influence on the distribution of water through the main water supply system if they get organised in a cooperation of WUA?
EXERCISE 1I: RESERVOIRS AND DAMS

Introduction

A reservoir is an artificial lake for various purposes. It can be formed by building a dam across a valley, by excavating the land or by surrounding a piece of land with dykes. The water is stored in the reservoir and can be used for irrigation, aquaculture or drinking water for cattle. For many centuries farmers have built small and medium sized reservoirs to increase their control over the availability of water. A reservoir needs to be properly operated and maintained (including the dam or dykes and catchment area).

Objectives

• To assess the operation and functioning of an existing reservoir.

Expected outputs

• List of beneficiaries of a dam
• List of suggestions on how to improve the operation of the reservoir(s).
• List of what needs to be rehabilitated.

Preparations required

• Conduct a short survey in the area to identify the different existing reservoirs in the area.

Materials required

• Irrigation layout map prepared by the farmers during exercise 1A (of FSP).

Time required

• Two and half hours

Timing

• No timing restrictions
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1)
2. Explain the specific objectives and expected output.

Plenary discussion (30 min)

3. Ask the farmers to indicate on the irrigation layout map where reservoirs are located and for what purpose the reservoirs are used.
4. Ask the farmers how the different reservoirs are managed (operation, maintenance).

Field visit (one hour and 50 min)

5. Visit with the farmers one reservoir and ask the farmers to identify the beneficiaries of the dam.
6. Ask the farmers first to inspect the condition of the Dam/dykes and spillway arrangements.
7. Discuss the condition of the reservoir. Ask the owner/management of the reservoir about the construction of the reservoir, operation and maintenance of the reservoir. Ask the farmers to list what needs to be rehabilitated.
8. Discuss the conditions for a good management of a reservoir. Ask the farmers to list suggestions on how to improve the operation of the reservoir(s).
9. Summaries the discussions and suggested rehabilitation’s in the construction and improvements of the operation of the reservoir.

Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual No. 6, Scheme Irrigation water needs and supply, 1992, FAO. Chapter 2: Water Sources and Water Availability.

Questions for discussions

- What are common maintenance problems on reservoirs?
- What is the size of the area that can be irrigated with a normal size of reservoir?
- What kinds of materials are needed to construct a reservoir?
- What are the labour requirements to construct a reservoir?
- What are the selection criteria for the location of the reservoir?
- How will the water be distributed to the fields?
EXERCISE 1J: RIVER DIVERSSIONS

Introduction

Farmers often divert directly water from a river to irrigate their fields. When the offtake canal is directly excavated through the riverbank and no gate is provided, there is no control of the discharge into the canal. The diverted discharge depends on the water level in the river. That means the discharge will be high during periods of high water and low during periods with a low water level. To avoid the problems caused by fluctuating water levels in the river a control gate can be installed in the offtake canal and a weir can be build across the river. The control gate can prevent too much water flowing in the offtake canal. With the weir the water level upstream of the weir will show little variation during the year, and it will remain higher during the dry season than it would without the weir.

Objectives

• To assess the possibilities to improve the control over the water discharge in river diversions.

Expected outputs

• List of suggestions to improve the water discharge in the canal offtake.

Preparations required

• Conduct a short survey in the area to identify the different existing river diversions.

Materials required

• Layout map prepared by the farmers during exercise 1A (of FSP).

Time required

• Two and half hours

Timing

• No timing restrictions
Procedure (Steps)

**Plenary Introduction** (15 min)
1. Review of previous training session (Exc. 1, Part C)
2. Explain the specific objectives and expected output.

**Plenary discussion** (30 min)
3. Ask the farmers to indicate on the layout map where farmers divert directly water from the river.
4. Ask the farmers what kind of problems they have with controlling the discharge of water in the canal offtakes.

**Field visit** (one hour and 50 min)
5. Visit with the farmers one of the river diversions and ask the farmers to inspect the construction and structures to control the discharge in the canal offtake.
6. Discuss the condition of the river diversion. Ask the owner of the river diversion about the construction, operation and maintenance of the river diversion.
7. Discuss the operation of the river diversion. Ask the farmers for suggestions on how to improve the control over the discharge in canal offtake.
8. If not mentioned already, introduce and discuss the control gate in the canal offtake and weir in the river to improve the control of water discharge.
9. Summarize the discussions and suggested actions to improve the control of water discharge in the water offtake. When farmers are interested, visit another river diversion and repeat step 4-8.

**Guidelines for (technical) preparations / questions for discussions**

For more technical information, see also:
- Irrigation water management training manual No. 6, Scheme Irrigation water needs and supply, 1992, FAO. Chapter 2: Water Sources and Water Availability.

**Questions for discussions**

- What are common problems with river diversions?
- How should the farmers’ field be situated if he/she would like to make use of a river diversion?
- What does influence the water level in the river?
- How does this influence the water level (throughout the day and season) in the canal offtake?
- What kinds of materials are needed to construct a control gate or weir?
- What are the financial and labour requirements to construct a control gate and/or weir?
MODULE 2

FARMERS’ IRRIGATION SYSTEM IMPROVEMENTS

LAYOUT OF IRRIGATION CANALS AND REGULATING STRUCTURES

Introduction

The conveyance and distribution of water from the main intake to the different farmers and fields is referred to as the farm irrigation system. Much of the losses and inadequacies of irrigation systems occur at this level. The operation and maintenance of the farm irrigation is a main area for improvement. The exercises of this module are aiming on assisting farmers in improving the operation and maintenance of the canals and regulating structures, the irrigation infrastructure.

The exercises have been sub-divided in 3 sub-modules.

References

In the preparation of the exercises in the module use is made of the following publications:

- Irrigation water management training manual No. 1, Introduction to irrigation, 1995, FAO
- Irrigation water management training manual No. 3, Irrigation water needs, 1986, FAO
- Irrigation water management training manual No.4, Irrigation scheduling, 1989, FAO
- Irrigation water management training manual No. 7, Canals, 1992, FAO
- Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
- Irrigation water management training manual No. 10, Irrigation scheme operation and maintenance, 1996, FAO
- Photo album on Problems and Solutions

Additional technical information can be obtained from the above mentioned publications.
Sub-module 2.1: Canals

Through observations and small group discussions on the conditions of the canal systems farmers will identify in exercise 2A (phase: planning) canal parts where rehabilitation activities are needed and will prepare a planning of the repairs and rehabilitation. The follow up on the planning will take place in exercise 2B (phase: construction).

Sub-module 2.2: Irrigation structures

During exercise 2C (phase: planning) farmers will review the existing irrigation structures. Repair of the structures and construction of additional ones will be planned during a field visit in exercise 2D (phase: construction). The follow up on the planned repairs on the structures takes place in exercise 2E (phase: maintenance).

Sub-module 2.3: Water distribution and system maintenance

During exercise 2F (phase: planning) farmers will discuss and determine in the field how the distribution schedule and the timing of water supply can be improved. Finally the farmers will discuss in exercise 2G (phase: operation) the organisation required for the operation and maintenance of the irrigation system and how it can be strengthened through the Water Users Association.
EXERCISE 2A: PLANNING OF CANAL REHABILITATION

Introduction

A common problem in many irrigation schemes is the poor condition and inefficient way of water conveyance in the farm canal network. To improve the exploitation of the canal system it is important that farmers do understand the functioning of the canal system, the different problems that may occur in irrigation canals, their causes and how to avoid or overcome these problems. This will be discussed in the field and in small groups when farmers identify canal sections for repair, rehabilitation and/or areas for extension of the canal system. In addition to the identification farmers will decide on how to repair or rehabilitate the canal parts selected, taking into account the cause of the canal damage. Further, areas which are not or inadequately irrigated will be identified and the need or potential for extending the canal system evaluated. Finally, a plan of action will be developed.

Objectives

- To improve layout and functioning of the canals ensuring efficient conveyance of water to all areas, reducing water losses, frequent repair and maintenance.

Expected outputs

- Map and list of identified problems restricting functioning of the canal systems
- Detailed plan for realignment and extension of canal sections, rehabilitation to be done as well as short term repairs, resources (labour, materials, cost) and time schedule.
- Assignment of tasks to each farmer for the canal reconstruction per irrigation block.

Preparations required

- Carry out topographical survey of the canal system (length profile)
- Investigate all canal parts that need to be improved, identify how repairs need to be carried out, and the materials and tools needed.
- Select a canal section where different problems can be observed for the field visit

Materials required

- Irrigation map prepared by the farmers during exercise 1A of FSP.
- Large sheets of paper and markers.

Time required

- Four hours.

Timing

- Well before the irrigation season
Procedure (Steps)

Plenary Introduction (10 min)

1. Explain the specific objectives and expected output.

Field visit (1 hour and 20 min)

2. Visit with the farmers an irrigation-block where different canal problems have been identified. Follow the canal system and discuss the condition of the canals.

3. Discuss the problem, the cause and what can be done to avoid or overcome it (repair, rehabilitation or extension of canal). Identify where the canal system needs to be repaired, rehabilitated or be extended and how it should be done.

Small group activity/discussion (40 min)

4. Split the farmers up in small groups according to irrigation blocks and ask them to draw on a large sheet of paper a map of the canal system in their irrigation block.

5. Ask the groups to indicate on the map for each section of the canal system a short description of the condition of the canal (size, lining). Distinguish main, tertiary and quartair canals.

6. Ask the groups also to indicate on the map the sections where they experience problems in the canal system and areas that can not be reached adequately for irrigation, and to describe the problems listed and their causes.

Plenary discussion (40 min)

7. Ask each group to present their map and identified problems. Discuss the presentations and list down the different problems identified and their causes.

8. Discuss how to avoid or overcome the identified problems (repair, rehabilitation or extension of canal) and how it should be carried out.

Small group discussions (40 min)

9. Back in their small groups, ask the farmers to prepare a list of repairs and improvements (to be achieved before start of irrigation season) and long-term (several seasons) rehabilitation plan for its block. The plans have to include resources needed (labour, materials, costs), time schedule and assignments of tasks to each farmer.
**Plenary discussion** (30 min)

10. Ask the groups to present their plans. Discuss and agree on the plans.


**Guidelines for (technical) preparations / questions for discussions**

**Overview of possible problems and causes in earthen canals resulting in excessive water losses**

**Seepage**
Seepage of water through canal banks and canal bed (see drawing) is an invisible loss of water.

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Serious seepage appears when: (A) Coarse materials (sand) are used for the construction of canal bank and canal bed and (B) because of bad compaction of the canal banks.

What to do?
- Compaction and sealing of the canal banks
- Lining of the canal on highly pervious sections

**Breakage and Leakage**
Leakage is the loss of water through cracks and fissures openings of the canal bank. Breakage is the frequent rupture of canal banks.

Breaks and leaks develop because of (A) rat holes, (B) organic material (roots) in canal bunds, which eventually leads to holes and piping, (C) eroded sections along canal banks, (D) tunnelling in bad compacted canal sections, (E) piping around hydraulic structures and (F) cracks in concrete canal linings.

What to do?
- Rehabilitation of the canal bank addressing the specific cause of the problem.
Overtopping of canal banks
Inundation and overtopping of canal banks will result in excessive bank erosion and the eventual collapse of the canal bank.

Overtopping happens: (A) When canal bed have been insufficiently raised (canal passing depression). (B) Because of a bad upstream control; Hydraulic control structures are not available, not working or in-correctly operated. (C) Obstruction of the canal by plants, stones or blocks. (D) Hand made weirs from farmers downstream which raises the water level and blocks a free water flow. (E) No drainage facilities are available nor outlets towards the drains. (F) Drainage capacity of drains is too low. (G) Sedimentation of the canal bed, reduces the discharge capacity of the canal. (H) When canal banks are too low.

What to do?
• Construction of appropriate canal dikes
• Improvement of the upstream control; Put control structures in place to secure excessive flows, improve the operation capabilities of the gate operator
• Provide drains along canal banks to stabilise the canal banks
• Provide spillways along the canal banks
• Cleaning of canals
• Deepening and widening of the canals
• Instead of using weirs to raise the water level use moveable siphons

Canal erosion
Erosion of the canal bed and canal banks: Excessive water velocity will weaken the canal banks enhancing breakages; Sedimentation downstream the eroded canals nearby structures will cause a malfunctioning of these structures

Canal erosion happens when: (A) The canal slope is too steep. (B) Discharge in the canal is too high. (C) Unstable soil materials are used.

What to do?
• Installation of drop structures
• Compaction of canal banks
• Lining of certain sections

Overview of repair procedures of canal damage

a. Reduction of the permeability of the bank
The permeability of a canal bank can be reduced by compacting the centre, or core of the embankment. The core is first excavated by digging a narrow trench, and then replaced with soil in layers, compacting each layer. The compacted core should extend above the water level.
b. **Reduction of the width of the canal bed**

Earthen canals are often wide and shallow due to collapsing banks, resulting in high water losses due to evaporation and seepage. Canals should be constructed (see drawing) preferably by digging its profile into slope or on well-compacted embankment.

![Wrong vs Right Diagram]

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**Wrong**

**Right**

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c. **Repair of a leak**

1. Determine the place of leakage with pegs
2. Empty the canal
3. Remove the vegetation
4. Excavate the canal bank below the leak
5. Rebuild the canal bank by filling the bank in layers with moist soil and compact well each layer

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d. **Repair damage due to overtopping of the canal bank**

1. Remove the vegetation
2. Hammer pegs in the canal section at both sides of the section. Check the level with these pegs and a rope
3. Excavate the top and sides of the bank like stairs
4. Rebuild the canal bank by filling the excavated portion with clayey soil and compact it in wet condition
5. Trim the sides and lay grass sods on the bank when the top is reached

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When it is impossible to avoid high water levels an emergency outlet or spillway can be installed along the canals.

e. **Reshaping an eroded cross-section**

1. Construct a wooden template. Slope of the wooden frame must be the same as the slope of the canal bank to repair. If the material of the bank is unstable, use a flatter template
2. Hammer in reference pegs to indicate the original level of the canal banks on each side of the canal. Excavate the bed and sides of the eroded canal section in steps until they reach slightly under the actual bed level
3. Fill and compact moist soil, layer by layer
4. Check the cross-section and bank levels with the template and the reference pegs

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f. **Repair of cracks and gullies in a canal embankment**

1. Remove any plants from banks which show cracking and in which small gullies have been formed by overtopping water or by heavy rainfall
2. In the case of deep cracks and gullies, excavate the banks partly. Small cracks are to be filled with fine-textured soil, moistened and compacted
3. Rebuild the bank by filling in the layers and compacting the moist soil

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g. **Reducing the flow velocity to reduce erosion**
If the canal bed slope is too steep, cuts and fills can change the slope. If this involves too much earth moving, drop structures have to be built. If the canal discharge has to remain constant, the cross section of the canal after the drop structure has to be enlarged. Sometimes a series of check structures needs to be installed along the canal. Type of possible drop structures: Bamboo, Stones, Pipe drops and Concrete structures.

h. **Lining of the canals**
Canal lining increase of the flow velocity, decreases seepage and maintenance. The most commonly used types of lining are concrete lining, concrete block, bricks or stone masonry lining and compacted clay or soil cement lining.

Since the costs of concrete and masonry lining are very high, lining of canals with compacted clay can be considered although it will be labor intensive. The clay is moistened and placed in layers on the canal bed. Each layer needs compaction.

i. **Extension of the canal system**
To increase the distribution area an extension of the canal system with additional irrigation canals can be considered.

**For more technical information, see also:**
- [Irrigation water management training manual No. 7, Canals, 1992, FAO](#)
- [Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO](#)
- [Photo album on Problems and Solutions](#)

**Questions for discussions**
- Are there water losses from the canals through seepage, leakage or overtopping?
- What soil texture is used for the construction of the canals?
- Is there a lot of vegetation present on and around the canals?
- How is water flowing in the canals? Are there blockages in the canals formed?
- Is it still possible to distribute water equally to all fields along the canal system?
- Is there a need to construct additional canals to improve water distribution?
- What is the impact of the identified canal problem on the water availability?
- Will everybody help in the repair, financially and/or through contributing labour?
- Where will you get the materials and tools for the repair?
- How will you transport the materials to where they are needed?
- How will the costs for materials, use of tools and hired labour be financed?
- Will you all work together, finishing one repair after the other?
- Or, will each irrigation block be responsible for its own repairs?
- Could it be a better idea to organise the repairs through a WUA?
EXERCISE 2B: FOLLOW UP ON CANAL REPAIRS, REHABILITATION AND EXTENSION

Introduction

Repairs and rehabilitation works will be carried out by farmers according to the schedule determined in exercise 2A in which each farmer or household of the WUA was allocated a well-defined task. During the subsequent FST sessions follow up will be given to the progress of work, when delays occur causes will be discussed and rectified.

Objectives

- To monitor the progress of canal repairs and rehabilitation.
- To adjust plan and tasks of canal repairs and rehabilitation

Expected outputs

- An updated list of activities and assignments which need to be carried out during the following weeks.

Preparations required

- None

Materials required

- The repair and rehabilitation plan for the canal systems prepared during exercise 2A

Time required

- One hour

Timing

- Prior to start irrigation season
Procedure (Steps)

**Plenary Introduction** (15 min)

1. Review of the previous training session (Exc. 1, Part C)
2. Explain the specific objectives and expected output.

**Field visit** (50 min)

3. Go with the farmers to the location where the canal is under repair.
4. Recall the planning prepared for the repair of the canal systems and ask the responsible farmers to report on the progress made.
5. Discuss the problems encountered and identify solutions how they can be solved.
6. Discuss and decide on what needs to be done during the following weeks as well as who will be responsible for those activities.
7. Summarise the plan of action for the following weeks.

Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual No. 7, Canals, 1992, FAO
- Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
- Photo album on Problems and Solutions

Questions for discussions

- What progress has been made in (the preparation of) the repair and rehabilitation of the canal systems?
- Is the repair and rehabilitation of the canal systems still on schedule?
- If not, why not?
- Why were some activities not carried out?
- What were the problems that you had? And will that delay further progress?
- Are the financial arrangements for the canal repairs functioning well?
- What needs to be done to make some further progress?
- What needs to be done during the following weeks?
- When shall we discuss again the follow up on the rehabilitation of the canal systems?
SUB-MODULE 2.2
IRRIGATION STRUCTURES

EXERCISE 2C: INVENTORY OF EXISTING IRRIGATION STRUCTURES

Introduction

Different hydraulic structures are regulating and distributing the flow of water to the various parts of the irrigation system. They can be simple temporary constructions (earth plugs, stones, branches) or more permanent-durable structures with gates or other regulating devices. The structures play a very important role in the effective control of water flow in the right quantities. If farmers like to improve the operating and control of the distribution of the irrigation water it is therefore important that they understand the functioning of the different structures.

Objectives

- To understand the functioning of the different hydraulic structures in the distribution of irrigation water
- To define weak points and inadequate functioning and distribution of water
- To define criteria for the proper distribution of water to the irrigation blocks and sub blocks.

Expected outputs

- Inventory of the distribution and regulation structure in the canal systems.
- Definition of the operational system.
- Identification of the need for repair and/or construction of additional hydraulic structures.

Preparations required

- Conduct a short survey in the area to identify the different hydraulic structures present.
- Prepare drawing of the distribution network and identify the key distribution points and corresponding areas.
- Select an area for a field visit where different hydraulic structures can be studied.

Materials required

- Irrigation maps prepared by the farmers in exercise 1A (of FSP) and 2A (of FST).
- Large sheets of paper and markers.

Time required

- two and half hours

Timing

- Before start of irrigation
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Brainstorming (20 min)

3. Put the irrigation map up prepared by the farmers in exercise 1A. Ask the farmers to locate all the different hydraulic structures in the scheme, to describe their functions and to categorise the structures according to their functions in (a) distribution structures, (b) water-height regulation structures, and (c) crossing structures.

Field visit (30 min)

4. Visit the hydraulic structures present in the area and discuss the functioning of the structures.
5. Ask the farmers also to identify the simple temporary devices farmers use to regulate and distribute the water as well as to identify illegal or uncontrolled off-takes.

Small group discussion (40 min)

6. Ask the farmers to split up in small groups according to irrigation blocks.
7. Ask the groups to indicate on the map of their irrigation block, prepared during exercise 3A, the distribution network, key division points and the locations and types of temporary and permanent hydraulic structures.
8. Ask the groups to discuss the operation and control possibilities and limitations of the distribution of water through the canal system with the use of the different structures present.
9. Ask the groups to summarise the discussion results in two columns on a large sheet of paper, one for the possibilities and one for the limitations.

Plenary discussion (50 min)

10. Ask each group to present the map and the results of their discussions.
11. Discuss the presentations and identify where the operation and control of water distribution can be improved through the repair and/or construction of additional hydraulic structures in the irrigation system.

12. Agree on a tentative plan for short (repair) and long term (construction) of regulating structures. Summarise the results of the discussions.


Guidelines for (technical) preparations / questions for discussions

Irrigation structures:

a. Water intake
   - Breaches: A temporary opening in the embankment of a field canal, made by a farmer whose field is to be irrigated.
   - Gates: A gate of wood, masonry or concrete which the farmer opens to let water flow from the field canal into the field.
   - Spills: A short pipe of PVC or concrete buried in the canal embankment. By removing the plug water from the field canal will flow into the field.
   - Siphons: Curved pipes of PVC are filled with water and laid over the canal bank at every irrigation.

b. Drop structures (water height and slope regulating)
   In order to create a gentler slope to prevent erosion of canal bed and canal banks the canal is split into sections. Part of each section is constructed in cut, and part in fill, with each section having a bed level which is lower than the canal section upstream of the section concerned.

c. Bridges (crossing)
   A bridge is a structure that enables people or traffic to cross a canal

d. Aqueducts (crossing)
   Aqueducts are self-supporting canal sections used to carry water across drainage canals, gullies or depressions.

e. Culverts (crossing)
   Culverts and inverted siphons are buried pipes used to carry irrigation water underneath roadways, drainage canals, natural streams or depressions.

f. Stilling basin (velocity regulating)
   A basin with protected walls and floor and which is filled with water. Its function is to convert fast flowing water into turbulence, so that the flow enters at low speed into the canal downstream of the basin.

g. Spillway (excess regulating)
   A spillway is a structure that guides excess water safely to the drainage system.
h. **Off takes** (distribution)
Canal offtakes are usually sited just upstream of a structure for water-level control.

i. **Weirs** (water height regulators)
Weirs are sharp-crested, overflow structures that are built across open canals. Weirs can be used to measure water flow.

j. **Division boxes** (distribution)

- **Proportional flow** Division box with a constant proportional delivery: water remains proportional whether the water rises or falls in the source canal.
- **Rotational flow** Division box with gates; the total discharge of the source canal flows into a branch canal.
- **Delivery on demand** Use of cross regulators. The flow can be adjusted in function of the demand by regulating the opening of the gates.

**Common problems in and around structures**

**Leakage** The water upstream of a structure is higher than the downstream water level. Therefore water may search for another way underneath or along the structure, or even through a crack in the bottom or sides of the structure to this lower level. The moment that water has found a small path there is a leakage problem, and at the same time the beginning of an erosion problem. Leaking water will enlarge the path by washing out the soil and so the leakage will increase. Finally the structure will collapse if the process is not stopped. To avoid such problem, the structure can be equipped with vertical cut-offs. They hinder the water flow along and underneath the structure. The cut-offs are part of a structure and can be driven into the bed and the embankments of a canal.

**Erosion** Sections of an unlined canal immediately downstream of a structure or downstream of a lined canal section often suffer from erosion. Downstream of a structure the canal bed may suffer from a water jet that flows through a gate or pipe, or it will be caved in by water that spills over a weir. In both situations a stilling basin is needed to dissipate the energy of the incoming water. The basin should be constructed immediately downstream of the weir or pipe.

**Siltation** The deposition of soil and debris can effect the functioning of a structure. If, for instance, a stilling basin collects soil deposits the available water mass diminished and energy dissipation will be less effective. Similarly in the case of soil deposits in a flow division box, the division of the flow will be less accurate due to the changes in flow velocities and water levels. Siltation is difficult to avoid. Depending on the local conditions, large sand traps could be constructed at the upper end of the main canal.

**Rot and rust** Wooden and steel parts in structures suffer from being alternately wet and dry. The wooden parts will rot and disintegrate, while steel parts will rust, expand and get jammed in the slides. Routine maintenance is necessary to avoid these problems, or to reduce their effect to a minimum.
For more technical information, see also:
• Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
• Photo album on Problems and Solutions

Questions for discussions

• What do you use for the intake of water from the field canal into the field?
• What is the effect of the different methods used for water intake on the condition of the field canal banks?
• Which structures are used in the distribution of water to all the fields?
• What kind of water distribution system do you have?
• How is the water flow control carried out?
• Do special gate operators operate the gates?
• Who is responsible for the maintenance of the structures?
• Are all structures still functioning well?
• Does the condition of (some of) the structures influence a proper water distribution?
• Are more structures needed to improve the water distribution?
• Who is going to construct those additional structures needed?
• Could it be a better idea to organise the construction of additional structures through a WUA?
EXERCISE 2D: PLANNING FOR REPAIR AND/OR CONSTRUCTION OF ADDITIONAL IRRIGATION STRUCTURES

Introduction

After having identified where the operation and control of water distribution can be improved through the repair and/or construction of additional hydraulic structures (exercise 2C), farmers need to decide on how to carry out the repairs and additional constructions. Farmers will investigate the condition of the structures and identify proper repair methods. They will discuss how to organise the construction of the additional structures and, finally, a plan of action for the repairs and/or constructions will be developed.

Objectives

• To prepare a plan of action for the repair (short term) and construction (long term) of additional irrigation structures.

Expected outputs

• Detailed workplan for repair and construction of additional irrigation structures (including procedures, who will do what, materials and tools, and financial contributions).

Preparations required

• Investigate the irrigation structures identified for repair in exercise 2C and identify how those structures can be repaired.
• Work out the different steps in repairing those structures, materials and tools needed.
• Select an irrigation block for a field visit, where different kinds of needed repairs and construction have been identified.

Materials required

• Irrigation maps prepared in exercise 2A and 2C.

Time required

• Three and half hours

Timing

• Before the fields need to be irrigated
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C)

2. Explain the specific objectives and expected output.

Plenary discussion (20 min)

3. Recall the selection made of irrigation structures for repair or improvements (exercise 2C) and discuss where to go for a field visit and to develop the planning for the repair and construction activities.

Field visit/activity (2 hours)

4. Visit with the farmers the irrigation block selected. Ask the farmers to observe the structures identified for repair or improvement before the irrigation season and which need to be rehabilitated over time. Identify and discuss the problems, needed repairs and constructions.

5. Explain and discuss the procedures (steps, materials, tools needed) how each structure can be repaired or constructed in a proper way.

Plenary discussion (1 hour)

6. Summarise all the planned repairs and constructions. Discuss the materials, tools and labour skills needed.

7. Discuss the planning for the repairs and constructions to be carried out before the season and over the season, including who will be responsible for the materials and tools needed, who will help in the repair, when will the repairs be carried out and how it will be financed.

8. Discuss the role of the WUA in organising the repairs and constructions.

9. Summarise the decisions taken on the planned repairs / rehabilitation of the irrigation structures and prepare a plan of action with specifications on materials, tasks for each farmer, labour, time schedule, etc.

Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
- Photo album on Problems and Solutions

Questions for discussions

- What kinds of problems do we have, leakage, erosion, siltation or rot and rust?
- What has caused these problems and how could it have been prevented?
- Will everybody help in the repair, financially and/or through contributing labour?
- Where will you get the materials and tools for the repair?
- How will the costs for materials, use of tools and hired labour be financed?
- Will each irrigation block be responsible for their own repairs?
- Could it be a better idea to organise the repairs through a WUA?
- Do you think you can carry out the construction of the structures yourselves or do you need assistance? And where can you get it?
EXERCISE 2E: FOLLOW UP OF PLANNED REPAIRS AND LONG-TERM REHABILITATION WORKS ON IRRIGATION STRUCTURES

Introduction

In most cases the planned repairs and long-term rehabilitation works on irrigation structures will not be carried out during the sessions of the FST. It is more practical to complete the repairs in, for example, one-week time than to spread it out over a large number of half-day FST sessions. But during the sessions it is important to pay regularly attention to the follow up of the (planned) repairs and long-term rehabilitation works on the irrigation structures.

Objectives

- To monitor the progress of the planned irrigation structure repairs and rehabilitation works.
- To adjust plan and tasks of repair and rehabilitation of irrigation structures

Expected outputs

- An updated list of activities and assignments which need to be carried out during the following weeks.

Preparations required

- None

Materials required

- The rehabilitation plan for the irrigation structures prepared during exercise 2D

Time required

- One hour

Timing

- Prior to start irrigation season
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Field visit (50 min)

3. Visit with the participants of the FST the location where an irrigation structure is under repair.
4. Recall the planning prepared for the repair of the irrigation structure and ask the responsible farmers to report on the progress made.
5. Discuss the problems encountered and identify solutions how they can be solved.
6. Discuss and decide on what needs to be done during the following weeks as well as who will be responsible for those activities.
7. Summarise the plan of action for the following weeks.

Guidelines for (technical) preparations / questions for discussions

For more technical information, see also:
- Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
- Photo album on Problems and Solutions

Questions for discussions

- What progress has been made in (the preparation of) the repair of the irrigation structures?
- Is the repair of the irrigation structures still on schedule? If not, why not?
- Why were some activities not carried out?
- What were the problems that you had? And will it delay further progress?
- Are the financial arrangements for the irrigation structure repairs functioning well?
- What needs to be done to make some further progress?
- What needs to be done during the following weeks?
- When shall we discuss again the follow up on the repair of the irrigation structures?
SUB-MODULE 2.3
WATER DISTRIBUTION AND SYSTEM MAINTENANCE

EXERCISE 2F: DISTRIBUTION SYSTEM

Introduction

The effective operation of the irrigation system will be to a large degree determined by the appropriate distribution of water, timely and in sufficient quantities, to each block and farm. The needed water supply depends on two basic factors (size of serving area and, crops to be irrigated). The distribution of water is determined by discharge, duration and the interval between irrigation.

Objectives

- To evaluate and, where possible, improve the water distribution.

Expected outputs

- A plan of actions to improve the water distribution.

Preparations required

- none

Materials required

- Measuring tape at least 5 meters long, 4 stakes, stopwatch or watch capable of measuring time in seconds, floating object (bottle or coconut).
- Maps prepared by the farmers of their own irrigation blocks during exercise 2A.
- Large sheets of paper and marker.

Time required

- Three hours

Timing

- No timing requirements
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Field visit (2 hours)

3. Go with the farmers to the water source or where the main irrigation canal enters the area. Ask the farmers to indicate on the irrigation map (exercise 1A of FSP) how the water is distributed to the blocks, sub-blocks and farmer’s fields.
4. Walk with the farmers the entire distribution system from where the water enters the area, flows into an irrigation block, sub-block and farmer’s fields.
5. Discuss at each distribution point, water offtakes and water inlets, how the water distribution takes place (functioning), who is responsible and if there are any problems (unequal distribution between areas (head/tail problem) and in time, illegal or uncontrolled water uses, etc.).
6. Discuss, at a point where water is canalled to a block or sub-block, how to measure the quantity of water (discharge) available for the block.
7. Explain how the discharge can be measured and practice this with the farmers. Ask the farmers to estimate the total irrigated area in the block and the available water per hectare.

Plenary discussion (50 min)

8. Summarise the functioning of the water distribution system, using the irrigation map (exercise 1A, FSP). Ask the farmers to recall the problems observed and discussed in the field and to locate them on the map.
9. Discuss with the farmers how the distribution system could be further improved and better managed to obtain a more equal distribution of the water over a larger area. Include in the discussions the roll of the WUA.
10. Recall the estimated available water per hectare. Discuss with the farmers if this is enough, too much or too little.
11. Ask the farmers how they determine the amount of water / the irrigation time needed to irrigate their fields and discuss the different methods mentioned.
12. Explain and demonstrate on a large sheet of paper how the water demand of a one-hectare sized field can be calculated. Compare the results of the calculation with the estimated water supply and discuss the result(s) with the farmers.

13. Discuss and prepare a plan of action to improve the water distribution in the irrigation system.


**Guidelines for (technical) preparations / questions for discussions**

**Calculation of the peak water demand**

The peak scheme water demand is the discharge in litres per second (l/s) required to meet the peak crop water requirements, plus the losses which occur in the field application and the distribution system (irrigation efficiency).

**Table: Indicative values for crop water requirements and growing periods**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Seasonal crop water requirement (mm)</th>
<th>Crop duration (Days)</th>
<th>Average crop water requirement* (m³/d/ha)</th>
<th>peak crop water requirement** (m³/d/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>450-650</td>
<td>120-140</td>
<td>38-46</td>
<td>75-93</td>
</tr>
<tr>
<td>Vegetables</td>
<td>400-600</td>
<td>90-120</td>
<td>44-50</td>
<td>89-100</td>
</tr>
<tr>
<td>Rice (paddy)</td>
<td>800-1500</td>
<td>90-120</td>
<td>89-125</td>
<td>178-250</td>
</tr>
</tbody>
</table>

* The average crop water requirement (m³/d/ha) = Seasonal crop water requirement (m³/ha) X 10 / Length of crop duration (days)
** The peak crop water requirement (m³/d/ha) = average crop water requirement (m³/d/ha) x 2

**Table: Indicative values of distribution efficiency (%) in small schemes (<200 ha)**

<table>
<thead>
<tr>
<th>Earth canals</th>
<th>Lined canals</th>
<th>Pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>sand</td>
<td>Loam</td>
<td>clay</td>
</tr>
<tr>
<td>80</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>48</td>
<td>51</td>
</tr>
<tr>
<td>Sprinkler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Example:** calculation peak water supply of one-hectare paddy (rice, 120 days) field.

The peak crop water requirement (m³/d/ha) = 125 m³/d/ha X 2 = 250 m³/d/ha
The distribution efficiency (%) in a small irrigation schedule with clay canals and surface irrigation = 56%
Peak water supply is 250 m³/d/ha / 0.56 = 463 m³/d/ha. (m³/d/ha X 0.0116 = l/s/ha).
Flow estimation procedure

The following presents the procedure for measuring the discharge using a floating object: Equipment: a) Measuring tape at least 5 meters long, b) Stakes, c) Stopwatch or watch capable of measuring time in seconds, and d) Floating object such as a bottle or coconut.

Procedure (steps)
1. Select a straight section of the canal at least 10 meters long. The shape of the canal along this section should be as uniform as possible.
2. Place two stakes, one each side, at the upstream end of the selected portion of the canal. They should be perpendicular to the centreline of the canal (A). Measure 10 meters or more along the canal.
3. Place two stakes at the downstream end of the selected section of the canal, also perpendicular to the centreline of the canal (B).
4. Place the floating object on the centre line of the canal at least 5 m upstream of point A, and start the stopwatch when the object reaches point A.
5. Stop the stopwatch when the floating object reaches point B, and record the time in seconds.
6. Repeat steps 5 and 6 at least four times in order to determine the average time necessary for the object to travel from point A to point B. The object should not touch the canal embankment during the trial. But if it does, the operation must be repeated and the time for the bad trial must not be included when calculating the average time.
7. Measure the following in the selected canal section: the canal bed width (b), the surface water width (a), and the water depth (h). The cross-section within the selected portion of the canal will usually not be regular, and so b, a and h need to be measured in several places to obtain an average value. If working with a canal with a rectangular cross-section the surface water width a will equal the bed width b.
8. Calculate the average flow velocity (V): \( V = 0.75 \times L/t \), where t is the travel time in seconds and 0.75 a reduction factor for subsurface which flows slower.
9. Calculate the wetted area of the cross-section A, using the following formula: \( A = (b + a)/2 \times h \) (b, a and h are average values)
10. Calculate the discharge, Q in the canal, using the following formula: \( Q = V \times A \) m³/s or \( Q = 1000 \times V \times A \) l/s.

For more technical information, see also:
- Irrigation water management training manual No. 1, Introduction to irrigation, 1995, FAO, Chapter 1
- Irrigation water management training manual No. 3, Irrigation water needs, 1986, FAO
- Irrigation water management training manual No. 4, Irrigation scheduling, 1989, FAO, Chapter 3 and 4
- Irrigation water management training manual No. 7, Canals, 1992, FAO, Chapter 3
- Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
Questions for discussions

- How and who is controlling the distribution of water?
- What influence do the farmers have on the distribution of water?
- With a better distribution, would it be possible to irrigate more land?
- Does every body get enough water during all periods?
- Who gets first water, who gets last?
- Are there conflicts, fights on water distribution?
- Could it be possible for the farmers to increase their influence on the distribution of water through a WUA?
- How do you plan the time needed to irrigate your fields?
- Are there many water losses when you irrigate? What kind of losses?
- Does the water level in the (field) canal fluctuate a lot?
- Is every body irrigating at the same time or on rotation?
- Is there often not enough water for a proper irrigation of you field(s)?
- Do all farmers respect the rotation schedule?
- Are some farmers receiving more water then others?
- Do some areas receive more water then others?
- Do you have to pay a water-fee for the irrigation water?
- How does the irrigation office measure the amount of water used?
- Do they use measuring tools/structures?
EXERCISE 2G: REVIEW OF OPERATION AND MAINTENANCE
OF THE IRRIGATION SYSTEM

Introduction

A properly designed and constructed canal system and hydraulic structures will function well for as long as they are operated well and maintained with care. That means that the irrigation system needs to be operated in an optimal way. That there is neither leakage nor erosion, that the canals and structures are clean, and that there are no rusty or rotten movable parts in the structures. A good properly organised operation and maintenance can optimise functioning and prolong the life of canals and structures.

Objectives

- To monitor operation and maintenance of canals and structures.

Expected outputs

- An up-dated operation and maintenance plan.

Preparations required

- None

Materials required

- Large sheets of paper and markers.

Time required

- two and half hours

Timing

- Before the end of the irrigation season
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Preview of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

**Field visit** (30 min)

3. Visit with the farmers one or two distribution structures and recall the operation rules for the water distribution. Ask the responsible farmers to report on the operation.
4. Discuss the problems encountered and identify solutions how they can be solved. Discuss and decide on what needs to be done to improve operation. Update the plan of operation.

**Brainstorming** (20 min)

5. Ask the farmers to mention all the activities needed to properly maintain irrigation canals and structures. List the maintenance activities on a large sheet of paper in two columns, for canals and structures one each.
6. Summarise and complete the list of maintenance activities. Discuss shortly the final list of maintenance activities.

**Small group discussions** (40 min)

7. Split the farmers up in small groups of 4-5 persons and ask each group to discuss, for each of the listed maintenance activities:
   - Why it should be done (reason),
   - Who is responsible for the implementation (farmers, irrigation department, etc.,
   - Who carries out,
   - Which part of the season/year is it normally carried out.
8. Ask the groups to summarise the results of their discussion in a table on a large sheet of paper.

**Plenary discussion** (50 min)

9. Ask the groups to present the results of their discussions. Compare and discuss the results of the group presentations.
10. Discuss if, and if so, how maintenance should be improved, how that can be organised and what the role of the WUA could/should be in this. Prepare with the farmers a maintenance plan for the coming season.

11. Summary and Closure (Exc. 2, Part C)

Guidelines for (technical) preparations / questions for discussions

Maintenance of the canal and structures

Maintenance is usually carried out in between two irrigation seasons, or at times of low water demands. It consists of inspecting, cleaning, weeding, de-silting, re-shaping, painting, lubricating and executing minor repairs.

- A Canal system, and in particular the structures, can be safeguarded from problems such as leakage, erosion, rot and rust by regular inspection and immediate repair action.
- Bushes or trees on canal embankments should be removed. They may obstruct the water flow and their roots will open the compacted soil in the banks and cause the development of leakage.
- Plants, silt and debris in the canal and structures should be removed. While cleaning the canal bed, care must be taken that the original shape of the cross-section is kept. For this, a wooden frame, or template, with the exact dimensions of the designed cross-section of the canal being cleaned, can be of great help.
- Breaches and rat holes in the embankments should be filled with compacted soil, inside as well as outside of the embankment. For compacting, the soil should be wetted.
- Structures are alternately wet or dry, and this causes rot in wooden parts and rust to form on iron parts. Frequently painting preserves these parts from rot or rust.
- To prevent movable iron parts like sluice gates and valves from being jammed, regular lubrication is essential.
- Weak sections and sections of canal embankments where people or animals cross the canal should be strengthened with compacted soil or with bricks.
- Eroded sections of a canal should be rebuilt to the original shape.

For more technical information, see also:

- Irrigation water management training manual No. 7, Canals, 1992, FAO
- Irrigation water management training manual No. 8, Structures for water control and distribution, 1993, FAO
- Irrigation water management training manual No. 10, Irrigation scheme operation and maintenance, 1996, FAO, Chapter 4
- Photo album on Problems and Solutions
Questions for discussions

- Is everybody happy how the irrigation system is operated?
- What could be improved in the operation of the irrigation system?
- What needs to be changed in the operation to improve the water distribution?
- Is everybody assisting in the maintenance of the canal system?
- Is there a formal organisation structure and plan for maintenance?
- Who organise and mobilise all farmers for maintenance?
- Are regular inspections of the canals and structures carried out?
- Who is responsible for the inspections?
- Do you report maintenance problems to the person/office responsible?
- What could be the role of a WUA in organising maintenance?
Module 3: FIELD WATER MANAGEMENT

a: Basin Irrigation
b: Furrow Irrigation
c: Overhead Irrigation
1: Evapotranspiration
2: Canal losses
3: Percolation
MODULE 3

FIELD WATER MANAGEMENT

Introduction

An adequate water supply is important for plant growth. When rainfall is not sufficient, the plants must receive additional water from irrigation. The farmer can use various methods to supply irrigation water to the plants. To choose an irrigation method, the farmer must know the advantages and disadvantages of various methods. He or she must know which method suits the local conditions best.

The two main areas of this module, field irrigation practices and crop water management are the topics of the two sub-modules.

References

In the preparation of the exercises in the module use is made of the following publications:

- Irrigation water management training manual No. 1, Introduction to Irrigation 1985, FAO
- Irrigation water management training manual No. 3, Irrigation water needs 1986, FAO
- Irrigation water management training manual No. 4, Irrigation Scheduling, 1989, FAO
- Irrigation water management training manual No. 5, Irrigation methods, 1988, FAO

Additional technical information can be obtained from the above mentioned publications.
Sub-module 3.1: Field Irrigation practices

An introduction and review of different irrigation method(s) takes place in exercise 3A (phase: planning). The basin, furrow, overhead and localized irrigation methods are being reviewed in exercise 3B (phase: planning), 3C (phase: planning) and 3E (phase: planning). In exercise 3D (phase: construction) farmers will observe and discuss land preparation and levelling to prepare the land for surface irrigation.

Sub-module 3.2: Crop water management / practices

The crop water requirements are discussed in the field by the farmers in exercise 3F (phase: planning) and irrigation scheduling in exercise 3G (phase: operation).
SUB-MODULE 3.1
FIELD IRRIGATION PRACTICES

EXERCISE 3A: INTRODUCTION OF DIFFERENT FIELD IRRIGATION METHODS

Introduction

Various methods can be used to supply irrigation water to the plants. Each method has its advantages and disadvantages. Farmers should take these into account when choosing the method that is best suited to their own local circumstances.

Surface irrigation is by far the most widespread irrigation method. It is normally used when conditions are favourable: mild and regular slopes, soil type with medium to low infiltration rate, and a sufficient supply of surface or groundwater. In the case of steep or irregular slopes, soils with a very high infiltration rate or scarcity of water, sprinkler and drip irrigation may be more appropriate. When introducing sprinkler and drip irrigation it must be ensured that the equipment can be maintained.

Objectives

- To review presently use and other field irrigation methods and assess shortcomings.
- To introduce possible alternative field irrigation methods.

Expected outputs

- List of constraints of presently used and other field irrigation methods.
- Selection of suitable field irrigation methods for the farmers in the area.

Preparations required

- Field survey to evaluate different field irrigation methods practised and to select an area for field visit.
- Prepare demonstration on infiltration rates and water retention capacity.

Materials required

- 3-4 empty (milk powder) tins with drainage holes in the bottom, buckets, bottles with water, (stop-)watch.
- Large sheets of paper and marker.

Time required

- Three hours

Timing

- No timing restrictions
Procedure (Steps)

Plenary Introduction (10 min)

1. Explain the specific objectives and expected output.

Field visit / activity (one hour and 50 min)

2. Visit with the farmers agricultural fields where different irrigation methods are being practised. Ask the farmers to observe the type and slope of the soil, if there is excessive run off (see drains), unequal growth as result of unequal water distribution, unequal infiltration rates, etc. and discuss the time required to apply the water.

3. Demonstrate the differences in infiltration rate and water retention capacity between the different soil types collected during the observations. (a) Fill empty milk powder tins, with holes in the bottom, each half with of the collected soil samples. (b) Poor carefully an equal amount of water on top of the different soil samples. (c) Measure the time till water starts to drip out of the holes in the bottom of the tins and (d) collect the percolated water in buckets. (e) List down the time needed and the amount of water collect for each of the different soil samples.

4. Discuss the differences in infiltration rates and retention capacities observed for the different collected soil samples in relation to irrigation method(s) used.

Brainstorming (20 min)

5. Ask the farmers to mention all the irrigation methods they have observed in the field and others they know off. List them down on a large sheet of paper and, If needed, add the once missing.

6. Ask the farmers to recall the observations made in the field on soil type and slope, water distribution for each irrigation method and time needed. List the observation made in a column behind the irrigation methods listed.

Plenary discussion (40 min)

7. Discuss the methods listed and observations made. When needed, explain some of the irrigation methods listed. Conclude on what the soil type and slope restrictions are of each method observed.

8. Discuss shortly other restrictions (climate, water availability, water quality, type of crop, level of technology, labour inputs and costs) of each irrigation listed. At these to the column behind the irrigation methods listed.
9. Ask the farmers what the most appropriated irrigation methods are which can be used in their situation. Ask the farmers to indicate why.

10. Summarise the discussions and observations made.


**Guidelines for (technical) preparations/ questions for discussions**

**Various methods to supply irrigation water to the plants**

**Surface irrigation:**
Application of water by gravity flow to the surface of field.

**Basin irrigation:**
Basins are flat areas of land, surrounded by low bunds. In general, the basin method is suitable for crops that are unaffected by standing in water for long periods (12-24 hours). Large application gifts (50-120 mm) are normally given and crops will be irrigated over long interval period (10-20 days).

**Furrow irrigation:**
Furrows are small channels, which carry water down the land slope between the crop rows. The crop is usually grown on top or half way down the ridges between the furrows. This method is suitable for row crops that cannot stand in water for long periods. The method allows applying light irrigation (30-50 mm) and can be laid out in sloping fields along the contour. Considerable water savings can be obtained if layout is well done.

**Border irrigation:**
Borders are long, sloping strips of land separated by bunds. They are sometimes called border strips. Require accurate land levelling and good control of flow to be efficient.

**Overhead and localised irrigation:**

**Sprinkler irrigation:**
Sprinkler irrigation is similar to natural rainfall. Water is pumped through a pipe system and then sprayed onto the crops through rotating sprinkler heads. For a more localised water supply the use of **mini/micro sprinklers** can be considered.
Drip irrigation
With drip irrigation, water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers that are located close to the plants. Only the immediate root zone of each plant is wetted. Drip irrigation is sometimes called trickle irrigation.

Watering plants with a watering can or bucket:
Bringing water from the source to each plant with a bucket or a watering can. This can be a very time-consuming method and involves very heavy work. However, it can be used successfully to irrigate very small plots of land, such as vegetables gardens, that are close to the water source.

Improving field irrigation methods

The suitability of the various irrigation methods depends mainly on the following factors: previous experience with irrigation, natural conditions, type of crop, type of technology, required labour inputs and costs and benefits.

a. Previous experience with irrigation
Introducing a previously unknown method may lead to unexpected complications. Often it will be easier to improve the traditional irrigation method than to introduce a totally new method.

b. Natural conditions
- **Soil type:** Sandy soils have low water storage and a high infiltration rate. They need frequent but small irrigation applications and sprinkler or drip irrigation are therefore more suitable.  
- **Slope:** Sprinkler or drip irrigation are preferred above surface irrigation on steeper or unevenly sloping lands as they require no land levelling.  
- **Climate:** Strong wind can disturb spraying of water from sprinkler. For only supplementary irrigation, sprinkler or drip irrigation may be more suitable because of their flexibility and adaptability.  
- **Water availability:** Water application efficiency is generally higher with sprinkler and drip irrigation and is preferred when water is in short supply.  
- **Water quality:** Surface irrigation is preferred if the irrigation water contains much sediment. If the water contains dissolved slats, drip irrigation is particularly suitable, as less water is applied. Sprinkler systems are more efficient than surface irrigation in leaching out salts.

c. Type of technology
In general drip and sprinkler irrigation are technically more complicated methods. The purchase of equipment requires high capital investment per hectare and the maintenance of equipment a high level of ‘know-how’. Also, a regular supply of fuel and spare parts must be maintained. Basin irrigation is considered as the simplest of the surface irrigation methods.

d. Required labour inputs
Surface irrigation often requires a much higher labour input – for construction, operation and maintenance – than sprinkler or drip. Basin irrigation uses the least labour and the least skill.
e. Costs and benefits

On the cost side not only the construction and installation, but also the operation and maintenance should be taken into account and compared with the expected benefits (yields).

Example table characteristics of irrigation methods

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>Watering can</th>
<th>basin</th>
<th>furrow</th>
<th>border</th>
<th>sprinkler</th>
<th>drip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil type</td>
<td>all</td>
<td>No sand</td>
<td>No cause sand</td>
<td>No coarse sand</td>
<td>all</td>
<td>All</td>
</tr>
<tr>
<td>Slope</td>
<td>all</td>
<td>&lt; 0.1%</td>
<td>0.05-0.5%</td>
<td>0.05-5%</td>
<td>all</td>
<td>All</td>
</tr>
<tr>
<td>Climate</td>
<td>all</td>
<td>all</td>
<td>all</td>
<td>all</td>
<td>not windy</td>
<td>All</td>
</tr>
<tr>
<td>water use efficiency</td>
<td>high</td>
<td>60%</td>
<td>60%</td>
<td>60%</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>Water quality</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Low in sediments</td>
<td>Low in sediments</td>
</tr>
<tr>
<td>Type of crop</td>
<td>Home garden</td>
<td>Grains, trees</td>
<td>Row crops</td>
<td>All except paddy</td>
<td>High value</td>
<td>Trees, row crops</td>
</tr>
<tr>
<td>technology</td>
<td>low</td>
<td>low</td>
<td>medium</td>
<td>medium</td>
<td>high</td>
<td>High</td>
</tr>
<tr>
<td>costs</td>
<td>low</td>
<td>low</td>
<td>medium</td>
<td>medium</td>
<td>high</td>
<td>High</td>
</tr>
<tr>
<td>Labour inputs</td>
<td>high</td>
<td>Low-med.</td>
<td>medium</td>
<td>medium</td>
<td>medium</td>
<td>low</td>
</tr>
</tbody>
</table>

For more technical information, see also:

- Irrigation water management training manual No. 1, Introduction to Irrigation, 1985, FAO, Chapter 2.2: Entry of water into the soil, and chapter 5.3: Field application systems.
- Irrigation water management training manual No. 5, Irrigation methods, 1988, FAO, Chapter 7: Choosing an irrigation method.
- FAO Filmstrip Sprinkler Irrigation

Questions for discussions

- Which irrigation method is most used in the area?
- Is the selection of irrigation method dominated by the selection of crop? Or
- The selection of crop dominated by the selection of irrigation method?
- Could another irrigation method maybe be more economical?
- If money is a problem would you consider sprinkler or drip irrigation?
- Which irrigation method uses water most efficiently?
EXERCISE 3B: BASIN IRRIGATION

Introduction

Paddy rice is always grown in basins and probably therefore a very widely spread irrigation method. But also many other crops can also be grown in basins. In general it can be stated that to operate the system, basin irrigation requires the least labour and the least skill of the three different surface irrigation methods.

Objectives

• To evaluate performance present basin irrigation.
• To assess the suitability of basin irrigation, basin construction, operation and maintenance.
• To identify shortcomings and potential improvements.

Expected outputs

• Plan of the optimal basin sizes and levelling and construction methods.
• Operation plan for basin irrigation.

Preparations required

• Select an area for a field visit with basin irrigation in operation.

Materials required

• Digging materials to check wetting front.
• Large sheets of paper and markers.

Time required

• Three hours

Timing

• When some basins contain water
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C)

2. Explain the specific objectives and expected output.

Field visit (2 hours)

3. Visit with the farmers a nearby-situated area with basin irrigation in operation (with standing water). Ask the farmers to observe and discuss how the basins have been constructed, the techniques used to level the land and to construct the bunds.

4. Ask the farmers what the important factors and indicators are on the size and shape of the basin, in the levelling of the land and construction of the bunds.

5. Summarise these factors and indicators and ask the farmers to inspect the irrigation basins if the levelling and constructions have been carried well. Discuss and conclude on what should be done to improve levelling and construction of the basins.

6. Introduce and discuss the two methods of supplying irrigation water to basins; direct and cascade methods. Ask which method is being used in the area.

7. Ask the farmers what important is in obtaining an ideal wetting pattern and ask them to inspect the wetting patterns in the basins.

Plenary discussion (50 min)

8. Summarise the discussions and observations made during the field visit.

9. Ask the farmers about the scheduling of water supply and different water levels farmers try to obtain during the different stages of the crop. Discuss the importance of the water level in the basin in relation to the crop development, weed growth and pest management.

10. Discuss if there is a need to improve the scheduling of water supply and, if so, how this should be done?

11. Summarise the observations and discussions. Prepare a construction and operation plan for basin irrigation.

Guidelines for (technical) preparations / questions for discussions

Suitable crops

Crops that are suited to basin irrigation include:
- Pastures, e.g. alfalfa, clover;
- Trees, e.g. citrus, banana;
- Crops which are broadcast, such as cereals;
- To some extent row crops such as tobacco.

Not suitable are crops that cannot stand in wet or waterlogged conditions for periods longer than 24 hours (root and tuber crops).

Limitation of basin width and size

Slope
The main limitation on the width of a basin is the land slope. If the land slope is steep, the basin should be narrow, otherwise too much earth movement will be needed to obtain level basins.

Soil texture and Stream size
The size of basins depends also on the infiltration rate of the soil and the speed of which water is flowing over the surface (stream size).

Table: Approximate values for the maximum basin or terrace width (m)

<table>
<thead>
<tr>
<th>Slope (%)</th>
<th>Maximum width (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>average</td>
</tr>
<tr>
<td>0.2</td>
<td>45</td>
</tr>
<tr>
<td>0.5</td>
<td>28</td>
</tr>
<tr>
<td>1.0</td>
<td>20</td>
</tr>
<tr>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>2.0</td>
<td>10</td>
</tr>
<tr>
<td>4.0</td>
<td>5</td>
</tr>
</tbody>
</table>

Table: Suggested maximum basin area (m²) for various soil types and available stream sizes

<table>
<thead>
<tr>
<th>Stream size (l/sec)</th>
<th>Sand</th>
<th>Sandy Loam</th>
<th>Clay Loam</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>35</td>
<td>100</td>
<td>200</td>
<td>350</td>
</tr>
<tr>
<td>10</td>
<td>65</td>
<td>200</td>
<td>400</td>
<td>650</td>
</tr>
<tr>
<td>15</td>
<td>100</td>
<td>300</td>
<td>600</td>
<td>1000</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
<td>600</td>
<td>1200</td>
<td>2000</td>
</tr>
<tr>
<td>60</td>
<td>400</td>
<td>1200</td>
<td>2400</td>
<td>4000</td>
</tr>
<tr>
<td>90</td>
<td>600</td>
<td>1800</td>
<td>3600</td>
<td>6000</td>
</tr>
</tbody>
</table>

Irrigation depth
If the required irrigation depth is small, the basin should be small to obtain good water distribution.

Mechanisation
In mechanised farming the basin dimensions are chosen to be some multiple of the width of the machines.
Summary how basin sizes should be

Basins should be small if the:
1. Slope of the land is steep
2. Soil is sandy
3. Stream size to the basin is small
4. Required depth of the irrigation is small
5. Field preparation is done by hand or animal traction.

Basin can be large if the:
1. Slope of the land is gentle or flat
2. Soil is clay
3. Stream size to the basin is large
4. Required depth of the irrigation application is large
5. Field preparation is mechanised.

Basin construction

Step 1 Setting out of the basin(s)
Step 2 Forming the bunds
Step 3 Smoothing (levelling) the land

Irrigating Basins

The direct method: Each field receives water directly from the field channel.
The cascade method: On sloping land, where terraces are used, the irrigation water is supplied to the highest terrace, and then allowed to flow to a lower terrace and so on.

Wetting pattern

It is important to obtain a uniformly wetted root zone (ideal wetting pattern).
- The surface of the basin must be level.
- The basin should have a uniform soil type
- Prevent a compacted sub-soil, which slows down infiltration resulting in water logging (not for growing rice)
- Apply sufficient irrigation water (required irrigation depth), not too much or too little. Irrigation time depends on; a) the stream size (l/sec), b) the required irrigation depth (mm) and c) the size of the field to be irrigated (ha). Irrigation time (hours) = (2.78 x b x c)/a.
- Irrigation water must be applied quickly to minimise the percolation losses near the field channel. The stream size should be large enough for the water to cover the entire field in a quarter of the time needed to fill the root zone with sufficient water (“rule of thumb” called quarter time rule).
For more technical information, see also:

Questions for discussions

- Why do you only grow rice in you basins?
- Would there be a market for the other identified potential crops that can be grown with basin irrigation?
- What would be the advantages of diversifying the types of crops you are growing in your basins?
- Do you sometimes change the size of your basin(s)? Why?
- Do you experience problems in obtaining a uniform wetting of the root zone in your basin? If so, what have you done to prevent these problems?
- What would you do if not enough water is available to irrigated the entire basin (under-irrigate or irrigate only a part of the basin)?
- How do you determine the time you irrigate your field?
EXERCISE 3C: FURROW IRRIGATION

Introduction

Furrow irrigation is suitable for many crops, especially row crops. Furrow irrigation can be used with crops that could be damaged if water covers their stem or crown (basin irrigation). Furrows are small, parallel channels, made to carry water in order to irrigate the crop. The crop is usually grown on the ridges between the furrows.

Objectives

- To evaluate performance present furrow irrigation.
- To assess the suitability of furrow irrigation, furrow construction, operation and maintenance.
- To identify shortcomings and potential improvements.

Expected outputs

- Plan of the optimal furrow layout.
- Operation plan for furrow irrigation.

Preparations required

- Select an area for a field visit where furrow irrigation is being practised.

Materials required

- Digging materials to check wetting front.
- Large sheets of paper and markers.

Time required

- Three hours

Timing

- When furrow irrigation is being practised.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).

2. Explain the specific objectives and expected output.

Field visit (2 hours)

3. Visit with the farmers a nearby-situated area with furrow irrigation in operation. Ask the farmers to observe and discuss how the furrows have been constructed, length and positioned with respect to the slope of the land.

4. Ask the farmers what the important factors and indicators are on the length, shape and slope of the furrows and how they have been constructed.

5. Summarise these factors and indicators and ask the farmers to inspect the irrigation furrows if the layout has been carried out well. Discuss and conclude on what should be done to improve layout of the furrows.

6. Introduce and discuss the use of siphons, spiles and gated pipes for supplying irrigation water to furrows and the number of furrows that can be irrigated at the same time.

7. Ask the farmers what important is in obtaining an ideal wetting pattern and ask them to inspect the wetting patterns in the furrows.

Plenary discussion (50 min)

8. Summarise the discussions and observations made during the field visit.

9. Discuss what the influence is of soil texture on obtaining an ideal wetting pattern during irrigating the furrows. Ask the farmers what the consequences are of that on furrow spacing.

10. If not yet mentioned, introduce and explain how the factors “slope”, “soil type”, “stream size”, “irrigation depth” and “cultivation practice” and “field length” influences the maximum furrow length.

11. Summarise the observations and discussions. Prepare a layout and operation plan for basin irrigation.

Guidelines for (technical) preparations / questions for discussions

Suitable crops for furrow irrigation

- Row crops such as maize, sunflower, sugarcane, soybean;
- Crops that could be damaged by inundation, such as tomatoes, vegetables, potatoes, beans;
- Fruit trees such as citrus, grape;
- Broadcast crops (corrugation method) such as wheat.

Furrow layout

Length

Slope Although furrows can be longer when the land slope is steeper, the maximum recommended furrow slope is 0.5% to avoid soil erosion. A minimum grade of 0.05% is recommended so that effective drainage can occur. Further the slope should be uniform.

Soil type Furrows should be shorter in sandier soils, so that water will reach the downstream end without excessive percolation losses.

Stream size Normally stream sizes up to 0.5 l/sec will provide an adequate irrigation. It is advised not to use stream sizes larger than 3.0 l/sec to prevent erosion.

Irrigation depth Applying larger irrigation depths usually means that furrows can be longer as there is more time available for water to flow down the furrows and infiltrate.

Cultivation practice Shorter furrows require more attendance but can be irrigated more efficiently. Longer furrows are easier for mechanised farming.

Table: Practical values of maximum furrow lengths (m) depending on slope, soil type, stream size and net irrigation depth.

<table>
<thead>
<tr>
<th>Furrow slope (%)</th>
<th>Maximum stream size (l/s) per furrow</th>
<th>Clay Net irrigation depth (mm)</th>
<th>Loam</th>
<th>Sand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>0.0</td>
<td>3.0</td>
<td>100</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>0.1</td>
<td>3.0</td>
<td>120</td>
<td>170</td>
<td>90</td>
</tr>
<tr>
<td>0.2</td>
<td>2.5</td>
<td>130</td>
<td>180</td>
<td>110</td>
</tr>
<tr>
<td>0.3</td>
<td>2.0</td>
<td>150</td>
<td>200</td>
<td>130</td>
</tr>
<tr>
<td>0.5</td>
<td>1.2</td>
<td>150</td>
<td>200</td>
<td>130</td>
</tr>
</tbody>
</table>

Shape

Soil type On sandy soils, narrow deep V-shaped furrows are desirable to reduce the soil area through which water percolates. In clay soils a wide, shallow furrow to obtain a large wetted area to encourage infiltration.
Stream size  The larger the stream size the larger the furrow must be to contain the flow.

Spacing

Soil type  Coarse sand: 30 cm; fine sand: 60 cm; clay soils 75-150 cm.

Cultivation practices in mechanised farming a compromise is required between spacing requirements of the machinery, ideal spacing for crops and to provide adequate lateral wetting off the soil.

Construction of furrows

Straight furrows

Step 1: A straight line is set out in the field along the proposed line of furrows. This can be done by setting up ranging poles or marking a line on the ground with chalk powder.
Step 2: The ridger is moved along the line. The resulting furrow should be straight.
Step 3: About every 5 m. a new straight line should be set out.

Contour furrows on sloping or undulating land

Step 1: A guide furrow must first be set out along the upper edge of the field close to the farm channel using a levelling device (A frame) to locate the contour line. Further guide furrows are set out every 5 m. on undulating ground and 10 m. on uniform sloping land.
Step 1: Working from each guide furrow, furrows are made to halfway along the next guide furrow.

Wetting patterns

In an ideal situation adjacent wetting patterns overlap each other, and there is an upward movement of water (capillary rise) that wets the entire ridge.

The wetting patterns are different in sandy and clay soils. In sandy soils water infiltrates quickly to deeper layers and there is little horizontal (lateral) movement of water. In clay soils the water infiltrates slowly to deeper layers and there is a substantial lateral movement of water in the soil as well as capillary rise. Therefore to obtain an overlapping wetting pattern the spacing in clay soils can be larger then in sandy soils.
For more technical information, see also:
• Irrigation water management training manual No. 5, Irrigation methods, 1988, FAO, Chapter 3: Furrow irrigation

Questions for discussions

• Do you consider furrow irrigation more difficult and labour demanding comparing with other irrigation methods?
• How do you decide between using basin or furrow irrigation?
• Do you sometimes change the length of your furrows? Why?
• Do you experience problems in obtaining a uniform wetting of the root zone in your field with furrow irrigation?
• If so, what have you done to prevent these problems?
• What would you do if not enough water is available to irrigate the entire field (under-irrigate or irrigate only a selection of furrows?)
• How do you determine the time you irrigate your field/furrow(s)?
WATER INFILTRATION AND PLOT LAY-OUT (furrow)

Plot length and fieldslope adapted to field conditions. Waterflow and application time adjusted to soil condition (infiltration rate) and field lay-out.

A too high flow-rate will result in erosion, excessive run-off or under-irrigation.

A too low flow-rate will result in over-irrigation at the top, and under-irrigation at the bottom of the field.

A too steep slope gives a rapid water-flow over the field, resulting in under-irrigation and excessive run-off.

A too flat slope gives a slow water movement over the field, resulting in over-irrigation in the first part, and under-irrigation at the lower part of the field.
A too long plot gives a strongly reduced flow rate at the lower end, resulting in under-irrigation.

In too short a plot, the water will reach the lower end too soon, resulting in either too short an infiltration time, thus under-irrigation, or excessive run-off.

Poor field levelling will give an uneven water movement over the field, resulting in over-irrigation in the depressions and possible waterlogging.

Poor drainage at the plot end can result in standing water and waterlogged soils in that section.

Different soil-types in one plot will give different infiltration rates.
Exercise 3D: LAND PREPARATION

Introduction

One of the factors that affect plant growth is land preparation. Properly prepared fields promote root development and better weed pest and disease management. Particularly in irrigated farming a proper levelling of the land is very important to obtain an equal distribution of water in the field.

Objectives

• To improve land preparation, field layout and land levelling to obtain a more equal distribution of water in the field.

Expected outputs

• Plan for improved field layout, levelling and land preparation practices

Preparations required

• Select a nearby-situated newly planted area for the field visit.

Materials required

• Large sheets of paper and markers.

Time required

• Two and half hours

Timing

• Few weeks after planting/sowing
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Brainstorming (30 min)

3. Ask the farmers to mention all the things that can be noted on a field and crop in relation to (bad) land preparation, field layout and land levelling. Write it down on a large sheet of paper.
4. Discuss the listed “indicators”. Come to an agreement on the important indicators to assess land preparation, field layout and land levelling.

Field visit / small group activity (1 hour and 50 min)

5. Visit with the farmers a newly planted area. Ask the farmers in small groups to study and discuss the performed land preparation, field layout and land levelling in a newly planted field.
6. Ask each group to prepare a presentation on a large piece of paper, listing the different land preparation, field layout and land levelling activities carried out and the quality of how they have been carried out. Ask the groups to make use of the listed indicators.
7. Ask the groups to present their observations and discussions.
8. Discuss the presentations. Ask how the land preparation, field layout and land levelling influence the effectiveness of irrigation. Summarise the main points discussed and prepare a plan for improved field layout, levelling and land preparation practices.
Guidelines for (technical preparations) / questions for discussions

List of questions (indicators) to assess land preparation

Is the presence of weeds a problem? Is seed germination even? Is the crop healthy? Is it well established? Is the field prepared in beds? Are there localised irrigation and/or drainage problems in the field? When was the land preparation carried out?

Questions for discussions

- What is good land preparation?
- What is the importance of thorough land preparation?
- What are the characteristics of a well-prepared field?
- When is the best time to do first ploughing and succeeding harrowing?
- What is the importance of straight furrowing?
- What are the advantages and disadvantage of frequent or intense land preparation?
- How can land preparation help in weed pest and/or disease management?
EXERCISE 3E: OVERHEAD AND LOCALISED IRRIGATION

Introduction

Sprinkler irrigation (overhead) and drip irrigation (localised) are two systems that distribute water through a system of pipes usually by pumping. In the case of sprinkler irrigation the water is sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. With drip (or trickle) irrigation water drips onto the soil at very low rates from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Water is applied close to plants or root zone so that only part of the soil in which the roots grow is wetted.

Objectives

• To evaluate performance of present sprinkler or drip irrigation.
• To assess the suitability of sprinkler or drip irrigation, layout, operation and maintenance.
• To identify shortcomings and potential improvements.

Expected outputs

• Plan of the optimal sprinkler or drip layout.
• Operation plan for sprinkler or drip irrigation.

Preparations required

• Select an area for a field visit where sprinkler or drip irrigation is being practised.

Materials required

• Digging materials to check wetting front.
• Large sheets of paper and markers.

Time required

• Three hours

Timing

• When sprinkler or drip irrigation is being practised
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Field visit (2 hours)

3. Visit with the farmers a nearby-situated area with sprinkler or drip irrigation in operation. Ask the farmers to observe and discuss the layout and positioning of the sprinklers or drippers.
4. Ask the farmers what the important factors and indicators are on the distance between the sprinklers or drippers in obtaining an ideal wetting pattern. Discuss what the influence is of soil texture on obtaining an ideal wetting pattern.
5. Summarise these factors and indicators and ask the farmers to inspect the layout and distribution of sprinklers or drippers and the wetting pattern. Discuss and conclude on what should be done to improve layout.
6. Observe and discuss the type of pump, pipes, filters, etc. used and the suitability (quality) of the water for sprinkler or drip irrigation.

Plenary discussion (50 min)

7. Summarise the discussions and observations made during the field visit.
8. Discuss the water pressure needed in the system and its consequences on the maximum length of the pipe system.
9. Summarise the observations and discussions. Prepare a layout and operation plan for sprinkler or drip irrigation.
10. Summary and Closure (Exc. 2, Part C)
Guidelines for (technical) preparations / questions for discussions

Suitable crops for sprinkler and drip irrigation

• Sprinkler irrigation: Most crops are suitable with the exception of delicate crops as lettuce because the large drops may damage the crop.
• Drip irrigation: Most suitable for high value row crops.

Slope

Both irrigation methods are adaptable to any farmable slope.

Soil type

Both irrigation methods are suitable for most soils. The application discharge rates of the sprinklers or drippers is always chosen to be less than the basic infiltration rate of the soil to avoid surface ponding and runoff. Sprinklers are not suitable for soils that easily form a crust. On sandy soils higher emitter discharge rates will be needed to ensure adequate lateral wetting of the soil.

Irrigation water

A good clean supply of water, free of suspended sediments, is required to avoid problems of sprinkler nozzle or dripper (emitters) blockage and, in the case of sprinkler irrigation, spoiling the crop by coating it with sediment. If the water is not free of sediments, filtration of the water is needed. Blockage may also occur if the water contains algae, fertiliser deposits and dissolved chemicals which precipitate such as calcium and iron.

Sprinkler system layout

A typical sprinkler irrigation system consists out of:

• A pump unit, usually a centrifugal pump that takes water from the source and provides adequate pressure for delivery into the pipe system.
• Mainline and sub mainlines, pipes that deliver water from the pump to the laterals. They can be permanent and laid on the ground or buried, and can be moved from field to field.
• Laterals, which deliver water from the (sub-) mainlines to the sprinklers. They are often portable but can be permanent.
• Sprinklers, most common are the rotary sprinklers spaced 9-24 m. apart along the lateral.

A common problem with sprinkler irrigation is the large labour force needed to move the pipes and sprinkler around the field. To overcome this problem (expensive) mobile systems have been developed.
Operation sprinkler system

The main objective of a sprinkler system is to apply water as uniform as possible to fill the root zone of the crop with water.

- Wetting patterns: The wetting pattern from a single rotary sprinkler is not very uniform. The heaviest wetting is close to the sprinkler. For good uniformity several sprinklers must be operated close together so that their patterns overlap. For good uniformity the overlap should be at least 65% of the wetted diameter. Spray from sprinklers is easily blown about by even a gentle breeze and this can seriously reduce uniformity further. Another influencing factor is a too low or too high pressure.
- Application rate: The application rate depends on the size of sprinkler nozzles, the operating pressure and the distance between sprinklers.
- Sprinkler drop size: Larger sprinklers produce large drops, which can damage delicate crops and soils. In such a case it better to select smaller sprinklers operating at or above the normal recommended operating pressure.

Drip system layout

A typical drip irrigation system consists out of:

- Pump unit, see sprinkler irrigation
- Control head, this consists of valves to control the discharge and pressure in the entire system. It may also have filters and a fertiliser or nutrient tank.
- Mainlines, submains and laterals, see sprinkler system
- Emitters or drippers, are devices used to control the discharge from the laterals to the plants.

Operation drip system

A drip system is usually permanent and therefore can easily be automated. Water can be applied frequently (every day if required).

- Wetting patterns: Drip irrigation only wets part of the soil root zone. The wetting pattern that develops from dripping water onto the soil depend on discharge and soil types. With a higher discharge the wetting pattern will be broader but less deep. The same happens in a heavier soil (clay).

- The water savings that can be made using drip irrigation are the reductions in deep percolation, in surface runoff and in evaporation from the soil. These savings depend as much on the user of the equipment as on the equipment itself.
For more technical information, see also:

- FAO Filmstrip Sprinkler Irrigation

Questions for discussions

- Is there sufficient knowledge on how to operate the sprinkler/drip irrigation system and to deal with common problems?
- Are there enough skilled technicians available to carry out repairs?
- Is the quality of the water a problem?
- How do you deal with bad quality water?
- Are there problems with obtaining an equal water distribution with sprinkler irrigation when there are strong winds?
- How do you deal with these situations?
- Does it pay back the costly investments and high operation costs?
- Is there a marked for high value crops?
- Is there a risk of stealing of equipment in the field?
- What is the power source for the pump?
- How reliable is the availability of the source?
SUB-MODULE 3.2
CROP WATER MANAGEMENT / PRACTICES

EXERCISE 3F: CROP WATER REQUIREMENTS

Introduction

Without water crops cannot grow. Too much water is not good for many crops either. Excess water must be removed through drainage. If there is too little water from rain, water must be supplied from other sources. The amount of irrigation water which is needed depends not only on the amount of water already available from rainfall, but also on the total amount of water needed by the various crops. The crop water need mainly depends on the climate, the crop type and growth stage of the crop.

Objectives

• To determine the water needs of the crops cultivated.

Expected outputs

• List of factors influencing crop water needs.
• List of water needs of the crops cultivated for each month of the cropping season.

Preparations required

• Collect or calculate the crop water uses of the main crops cultivated by the farmers for each month of the cropping season. Present the crop water uses in a table on a large sheet of paper.

Materials required

• Irrigation equipment, buckets and measuring tape.
• Large sheets of paper and marker.

Time required

• Two hours

Timing

• During the cropping season.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of previous training session (Exc. 1, Part C)
2. Explain the specific objectives and expected output.

Plenary discussion (50 min)

3. Ask the farmers which major climatic factors influences crop water needs, and how? List them down on a large sheet of paper.
4. Ask the farmers if they think that, under the same climatic conditions, all crops have the same water need or if there are differences. Ask the farmers examples of crops, which do need less and once that need more water.
5. Discuss with the farmers the influence of the growth stage of the crop on crop water needs. Discuss the different stages and the corresponding water needs (initial (50% of maximum), crop development (50-100%), mid-season (100%) and late season (100% for fresh harvested and 25% for dry harvested crops).
6. Introduce the Et crops (mm/day) for the main crops cultivated by the farmers for each month of the cropping season (calculated by the facilitator or obtained from research stations). Translate mm/day into bucket water (20L.)/m²/day. Discuss the different values of Etcrop using all the influencing factors discussed before.

Field visit (1 hour)

7. Go into the field with the farmers and ask the farmers to irrigate a small area of their crop (1-10 m².) as they are used to do. Estimate the area irrigated, total amount of water used and the expected number of days before the crop needs to be irrigated again in case it will not rain.
8. Assist the farmers in the calculation of the irrigation water use (mm/day). Discuss how the calculated irrigated water use and how it relates to the crop water need during that time.

---

1 In case of basin irrigation, the estimated drop (mm) in water level in one day without any rain can be used as well.
Guidelines for (technical) preparations / questions for discussions

Relation between climate, crop, ET, local conditions and irrigation requirement:
Effect of major climatic factors on crop water needs

<table>
<thead>
<tr>
<th>Climatic factor</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunshine</td>
<td>Sunny (no clouds)</td>
<td>Cloudy (no sun)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Hot</td>
<td>cool</td>
</tr>
<tr>
<td>Humidity</td>
<td>Low (dry)</td>
<td>High (humid)</td>
</tr>
<tr>
<td>Wind speed</td>
<td>windy</td>
<td>Little wind</td>
</tr>
</tbody>
</table>

Average daily water need (Eto) of standard grass during irrigation season

<table>
<thead>
<tr>
<th>Climatic zone</th>
<th>Mean daily temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desert/arid</td>
<td>Low (&lt; 15°C)</td>
</tr>
<tr>
<td></td>
<td>4-6*</td>
</tr>
<tr>
<td>Semi arid</td>
<td>4-5</td>
</tr>
<tr>
<td>Sub-humid</td>
<td>3-4</td>
</tr>
<tr>
<td>humid</td>
<td>1-2</td>
</tr>
</tbody>
</table>

4-6 litres of water per m²/day

Crop water needs (Et crop) in peak period of various field crops as compared to standard grass

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>-30%</td>
<td>-10%</td>
<td>Same as standard grass</td>
<td>+10%</td>
<td>+20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy rice</td>
<td>Sugarcane</td>
<td>Banana</td>
<td>Nuts &amp; fruit trees with cover crop</td>
<td></td>
</tr>
</tbody>
</table>

Four growth stages of a crop

1. **The initial stage**: This is the period from sowing or transplanting until the crop covers about 10% of the ground.
2. **The crop development stage**: This period starts at the end of the initial stage and lasts until the full ground cover has been reached (ground cover 70-80%).
3. **The mid-season stage**: This period starts at the end of the crop development stage and lasts until maturity; it includes flowering and grain-setting.
4. **The late season stage**: This period starts at the end of the mid season stage and lasts until the last day of the harvest; it includes ripening.

The relation between the reference grass crop and the crop actually grown is given by the crop factor, Kc, as shown in the following formula. Each crop has for each crop stage its own crop factor (Kc)

\[
Eto \times Kc = ET
\]

### Values of the crop factor (Kc) for various crops and crop stages

<table>
<thead>
<tr>
<th>Crop</th>
<th>Initial stage</th>
<th>Crop development stage</th>
<th>Mid-season stage</th>
<th>Late season stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>days</td>
<td>Kc</td>
<td>days</td>
<td>Kc</td>
</tr>
<tr>
<td>Barley/wheat</td>
<td>15</td>
<td>0.35</td>
<td>25-30</td>
<td>0.75</td>
</tr>
<tr>
<td>Bean, green</td>
<td>15-20</td>
<td>0.35</td>
<td>25-30</td>
<td>0.70</td>
</tr>
<tr>
<td>Bean, dry</td>
<td>15-20</td>
<td>0.35</td>
<td>25-30</td>
<td>0.70</td>
</tr>
<tr>
<td>Cabbage</td>
<td>20-25</td>
<td>0.45</td>
<td>25-30</td>
<td>0.75</td>
</tr>
<tr>
<td>Cotton</td>
<td>30</td>
<td>0.45</td>
<td>50</td>
<td>0.75</td>
</tr>
<tr>
<td>Cucumber</td>
<td>20-25</td>
<td>0.45</td>
<td>30-35</td>
<td>0.70</td>
</tr>
<tr>
<td>Eggplant</td>
<td>30</td>
<td>0.45</td>
<td>40</td>
<td>0.75</td>
</tr>
<tr>
<td>Grain, small</td>
<td>20-25</td>
<td>0.35</td>
<td>30-35</td>
<td>0.75</td>
</tr>
<tr>
<td>Lentil/Pulses</td>
<td>20-25</td>
<td>0.45</td>
<td>30-35</td>
<td>0.75</td>
</tr>
<tr>
<td>Lettuce</td>
<td>20-35</td>
<td>0.45</td>
<td>30-50</td>
<td>0.60</td>
</tr>
<tr>
<td>Maize, sweet</td>
<td>20</td>
<td>0.40</td>
<td>25-30</td>
<td>0.80</td>
</tr>
<tr>
<td>Maize, grain</td>
<td>20-30</td>
<td>0.40</td>
<td>35-50</td>
<td>0.80</td>
</tr>
<tr>
<td>Melon</td>
<td>25-30</td>
<td>0.45</td>
<td>35-45</td>
<td>0.75</td>
</tr>
<tr>
<td>Millet</td>
<td>15-20</td>
<td>0.35</td>
<td>25-30</td>
<td>0.70</td>
</tr>
<tr>
<td>Onion, green</td>
<td>25</td>
<td>0.50</td>
<td>30-40</td>
<td>0.70</td>
</tr>
<tr>
<td>Onion, dry</td>
<td>15-20</td>
<td>0.50</td>
<td>25-35</td>
<td>0.75</td>
</tr>
<tr>
<td>Peanut</td>
<td>25-30</td>
<td>0.45</td>
<td>35-40</td>
<td>0.75</td>
</tr>
<tr>
<td>Pea, fresh</td>
<td>15-20</td>
<td>0.45</td>
<td>25-30</td>
<td>0.80</td>
</tr>
<tr>
<td>Pepper, fresh</td>
<td>25-30</td>
<td>0.35</td>
<td>35-40</td>
<td>0.70</td>
</tr>
<tr>
<td>Potato</td>
<td>25-30</td>
<td>0.45</td>
<td>30-35</td>
<td>0.75</td>
</tr>
<tr>
<td>Sorghum</td>
<td>20</td>
<td>0.35</td>
<td>30-35</td>
<td>0.75</td>
</tr>
<tr>
<td>Soybean</td>
<td>20</td>
<td>0.35</td>
<td>30</td>
<td>0.75</td>
</tr>
<tr>
<td>Sunflower</td>
<td>20-25</td>
<td>0.35</td>
<td>35</td>
<td>0.75</td>
</tr>
<tr>
<td>Tomato</td>
<td>30-35</td>
<td>0.45</td>
<td>40-45</td>
<td>0.75</td>
</tr>
</tbody>
</table>
**Example:** Calculation of crop water need for sweet maize in a Semi-arid climate with a medium daily temperature. Average daily water need of standard grass is 5-6 mm.

<table>
<thead>
<tr>
<th>Sweet maize</th>
<th>Initial stage</th>
<th>Crop development stage</th>
<th>Mid season stage</th>
<th>Late season stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kc^2</td>
<td>0.40</td>
<td>0.80</td>
<td>1.15</td>
<td>1.00</td>
</tr>
<tr>
<td>Crop water need (mm/day)</td>
<td>2-2.4</td>
<td>4-4.8</td>
<td>5.75-6.9</td>
<td>5-6</td>
</tr>
</tbody>
</table>

For more technical information, see also:

**Questions for discussions**
- What will be the influence of a windbreak on the crop water need?
- Is all rain, effective rain for crop growth? And irrigation water?
- How does the length of the crop growth period influence the crop water need?

^ Kc values are influenced also by the humidity and wind speed.
EXERCISE 3G: IRRIGATION SCHEDULING – FREQUENCY AND AMOUNTS

Introduction

When there is already a form of irrigation in place still it is important that the farmer knows how much he/she has to irrigate and how often. In most cases the water sources are scares and the farmer should make use of the water in an optimum way. Over irrigation is a waist of water, time and energy, but under irrigation will reduce yield. For farmers it is often difficult to find the right balance.

Objectives

- To assist farmers in defining a proper irrigation frequency and irrigation amounts.

Expected outputs

- Farmers know how they can determine the irrigate amounts.
- The frequency of a piece of land that has to be irrigated.

Preparations required

- Investigate if there is a clear difference in crop performance among the fields as result of differences in irrigation intensities.

Materials required

- Irrigation equipment available on the field.

Time required

- Three hours.

Timing

- During irrigation season.
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

**Field visit/field practice** (two hours and 20 min)

3. Visit with the farmers one of their irrigation fields where the crop is not performing well, most likely as result of too much or too little irrigation.
4. Ask the farmer to show how he or she normally irrigates the field on a small part of the field.
5. After the demonstration of the farmer ask the other farmers if the piece of land has been sufficiently irrigated and what the indicators are they use to determine if the land has been irrigated sufficiently.
6. Discuss the indicators mentioned by the farmers, the plant observation method (change in colour, curling of the leaves, leaf orientation and leave temperature) and the change in soil moisture content.
7. Ask the farmers to dig a hole at the just irrigated land close to where the crop is planted to observe the wetting front and crop rooting depth. Determine if sufficient water was irrigated. Discuss the influence of the rooting depth and soil type on the total amount that can be irrigated during one application.
8. If there are indications that the water has been unequally distributed in the field, dig also holes at different locations within the field for observation. Discuss how the layout of the field can be changed to support an equal water distribution.
9. If more could be irrigated or too much was irrigated, ask the farmer to irrigate another piece of the field with an adjusted amount of water. Dig again a hole to let the farmers check the wetting front.

**Plenary discussion** (30 min)

10. Summarise the discussions and observations made in the field. Discuss the influence of the rooting depth on the total amount of water per irrigation application and, consequently, the intervals between the applications.
11. Discuss the irrigation water need as the crop water need (see exercise 3F) minus the effective rainfall and consequently, the influence of climate.
12. Summarise the factors influencing the irrigation scheduling (amount or net irrigation depth and application intervals). Introduce the estimated irrigation schedules for the crops grown by the farmers from the table and compare the estimated intervals and amounts with the farmer’s practice.


**Guidelines for (technical) preparations / questions for discussions**

**Plant observation method**

Plant observation method is based on observing changes in the plant characteristics, such as changes in colour of the plant, curling of the leaves. When a plant comes under water stress the appearance change from vigorous growth to slow or even no growth. Some crops change their leaf orientation when little water is available. Another indicator is the leaf temperature, which increases during the hot part of the day when there is a shortage of water.

The disadvantage of the plant observation method is that by the time the symptoms are evident, the irrigation water has already been withheld too long for most crops and yield losses are already inevitable. Unfortunately it is often the only method farmers can use together with checking the moisture content of the soil. To reduce the negative effect of this method the farmer should select the sandiest spot in his or her field for the observations, where the plants will first show stress characteristics.

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Shallow rooting crops</th>
<th>Medium rooting crops</th>
<th>Deep rooting crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow and/or sandy soil</td>
<td>15</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Loamy soil</td>
<td>20</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Clayey soil</td>
<td>30</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>Climate</td>
<td>Shallow and/or sandy soil</td>
<td>Loamy soil</td>
<td>Clayey soil</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td></td>
<td>Interval (days)</td>
<td>Net irr. Depth (mm)</td>
<td>Interval (days)</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>9 6 5</td>
<td>40</td>
<td>13 9 7</td>
</tr>
<tr>
<td>Banana</td>
<td>5 3 2</td>
<td>25</td>
<td>7 5 4</td>
</tr>
<tr>
<td>Barley/Oats</td>
<td>8 6 4</td>
<td>40</td>
<td>11 8 6</td>
</tr>
<tr>
<td>Beans</td>
<td>6 4 3</td>
<td>30</td>
<td>8 6 4</td>
</tr>
<tr>
<td>Cacao</td>
<td>9 6 5</td>
<td>40</td>
<td>13 9 7</td>
</tr>
<tr>
<td>Carrot</td>
<td>6 4 3</td>
<td>25</td>
<td>7 5 4</td>
</tr>
<tr>
<td>Citrus</td>
<td>8 6 4</td>
<td>30</td>
<td>11 8 6</td>
</tr>
<tr>
<td>Coffee</td>
<td>9 6 5</td>
<td>40</td>
<td>13 9 7</td>
</tr>
<tr>
<td>Cotton</td>
<td>8 6 4</td>
<td>40</td>
<td>11 8 6</td>
</tr>
<tr>
<td>Cucumber</td>
<td>10 7 5</td>
<td>40</td>
<td>15 10 8</td>
</tr>
<tr>
<td>Crucifera*</td>
<td>3 2 1</td>
<td>15</td>
<td>4 3 2</td>
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<tr>
<td>Eggplant</td>
<td>6 4 3</td>
<td>30</td>
<td>8 6 4</td>
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<tr>
<td>Fruit trees</td>
<td>9 6 5</td>
<td>40</td>
<td>13 9 7</td>
</tr>
<tr>
<td>Grains, small</td>
<td>8 6 4</td>
<td>40</td>
<td>11 8 6</td>
</tr>
<tr>
<td>Grapes</td>
<td>11 8 6</td>
<td>40</td>
<td>15 11 8</td>
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<tr>
<td>Grass</td>
<td>9 6 5</td>
<td>40</td>
<td>13 9 7</td>
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<tr>
<td>Groundnuts</td>
<td>6 4 3</td>
<td>25</td>
<td>7 5 4</td>
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<tr>
<td>Lentils</td>
<td>6 4 3</td>
<td>30</td>
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<tr>
<td>Lettuce</td>
<td>3 2 2</td>
<td>15</td>
<td>4 3 2</td>
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<td>Maize</td>
<td>8 6 4</td>
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<td>13 9 7</td>
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<td>Millet</td>
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<td>Olives</td>
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<td>Onions</td>
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<tr>
<td>Peppers</td>
<td>6 4 3</td>
<td>25</td>
<td>7 5 4</td>
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<tr>
<td>Potatoes</td>
<td>6 4 3</td>
<td>30</td>
<td>8 6 4</td>
</tr>
<tr>
<td>Safflower</td>
<td>8 6 4</td>
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<td>11 8 6</td>
</tr>
<tr>
<td>Sorghum</td>
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<td>40</td>
<td>11 8 6</td>
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<tr>
<td>Soybeans</td>
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<td>11 8 6</td>
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<tr>
<td>Spinach</td>
<td>3 2 2</td>
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<td>4 3 2</td>
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<tr>
<td>Squash</td>
<td>10 7 5</td>
<td>40</td>
<td>15 10 8</td>
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<td>Sugarcane</td>
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<td>40</td>
<td>10 7 5</td>
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<tr>
<td>Sunflower</td>
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<td>40</td>
<td>11 8 6</td>
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<tr>
<td>Tea</td>
<td>9 6 5</td>
<td>40</td>
<td>13 9 7</td>
</tr>
<tr>
<td>Tobacco</td>
<td>6 4 3</td>
<td>30</td>
<td>8 6 4</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>6 4 3</td>
<td>30</td>
<td>8 6 4</td>
</tr>
<tr>
<td>wheat</td>
<td>8 6 4</td>
<td>40</td>
<td>11 8 6</td>
</tr>
</tbody>
</table>

*) cabbage, cauliflower, etc.
For more technical information, see also:
- Irrigation water management training manual No. 4, Irrigation Scheduling, 1989, FAO

Questions for discussions

- What time do you spend on irrigating your field each day?
- Can you irrigate your entire field in that time or only a portion?
- How do you estimate if you have irrigated a piece of land long enough?
- Do you know how much water you irrigate per plant or m²?
- How deep do you think the irrigation water should infiltrate the soil?
- What will happen with the water that infiltrates below the rooting zone?
- What will happen if the irrigation water will only infiltrates a part (top) of the rooting zone?
- Will it take the same amount of water to saturate the entire rooting zone with water on a sandy soil compared to a heavy clay soil?
- What needs to be done to irrigate the entire rooting zone?
- How often do you irrigate the same plants?
- What is the relationship between the irrigation amount and irrigation frequency?
- Does the frequency of irrigation differ with the development of the crop?
Module 4:
DRAINAGE, FLOOD AND SALINITY CONTROL
MODULE 4

DRAINAGE, FLOOD AND SALINITY CONTROL

Introduction

Drainage, or coping with the problem of excess water, is an essential element of water management and crop production, but often a neglected topic when dealing with farmers’ water management. The basic need from drainage derives from the fact that most agricultural crops do not grow well under prolonged waterlogged conditions and are sensitive to water ponding on the soil surface. In general crops prefer moisture condition in the root zone around field capacity. In (semi) arid areas the problems of waterlogging are often accompanied by salinity problems, which further inhibits crop production. Removal of excess water by artificial drainage is necessary if the natural drainage is inadequate and causes prolonged waterlogged conditions and related salinity problems during critical periods. Also crops that grow under wet conditions, like rice, will benefit from drainage.

Causes of waterlogging, water ponding, and related problems are always a combination of excess water inflow and insufficient (natural) drainage.

Besides increased crop production, drainage might serve a wide range of additional purposes e.g., to obtain crop diversification and to overcome farm management constraints. In addition to agricultural benefits, drainage can contribute to the protection and improvement of the environment and rural development. Non-agricultural/social benefits of drainage include the improvement of public health and sanitation condition, lowering maintenance costs of infrastructure and buildings, and improved animal health.

Drainage and salinity control related to irrigation

For areas experiencing prolonged conditions of water shortage irrigation is essential for crop production. With the introduction of irrigation additional water is brought into an area. Poor irrigation water management both at scheme and farm level, seepage and leakage from mostly large-scale irrigation systems in combination with insufficient (natural) drainage, has resulted in rising water tables and has subsequently led to waterlogging and related salinity problems in many irrigated areas around the world.

In irrigated areas, drainage is indispensable to maintain favourable water and moisture conditions for optimal crop growth and control of waterlogging and salinity problems. The provision of surface drainage is normally implemented to remove ponding water from the soil surface. Surface drainage is also helpful to control waterlogging and salinity problems but in general it has limited effect due to its limited depth and intensity. Especially when salinisation is a major concern, the provision of subsurface (pipe) drainage is the preferred remedial measure as for the control of salinity leaching through the soil profile has to be induced.
Under influence of the growing world population and increasing demand for food, large-scale irrigation intensification has taken place to boost crop production of a region or country. To supplement the scarce surface water resources, groundwater is exploited through tubewell developments mainly in the fresh groundwater zones. In many of these areas water tables are actually dropping due to over-exploitation of groundwater resources. Therefore, at present, problems of waterlogging and salinity in irrigated agriculture are mainly confined to saline groundwater zones.

Waterlogging and salinity are mostly dealt with as a twin-menace. Although in (semi) arid areas waterlogging is often accompanied by salinity problems, not all salinity problems do necessarily stem from waterlogging problems. Salinisation of agricultural lands could also result from irrigation with marginal and poor quality (ground) water, weathering of parent material, and seawater intrusion. Especially salinisation as a result of irrigation with marginal and poor quality water is increasing rapidly due to shortages of fresh water resources in many parts in the world. Also salinisation due to seawater intrusion is gaining more importance as a result of large-scale development of surface water resources and thus reducing the outflow to the sea.

**Drainage and flood control**

Areas that are characterized by high temperatures, high rainfall and recurrent flood events have resulted in farming systems traditionally based on rice production. Inundation depth, during and timing determined cropping patterns, crop selection and yields. With the introduction of improved varieties, crop intensification, diversification, and farm mechanization better water control conditions are required. Better water control can be achieved through the implementation of drainage alone or in combination with flood control measures.

Especially in lowlands, delta and tidal areas excess rainfall and floods are the main limitations for crop intensification and diversification. Although, lowlands, delta and tidal zones are in general unsuitable for development due to soil conditions, waterlogging and inundation risks, and their environmental value there is often enormous pressure to develop these areas due to their strategic location. Development of these areas involves flood control schemes, in combination with the provision of drainage and in several cases polder development. The type and extend of flood protection and drainage development in an area depends on rainfall patterns, the type, intensity and depths of flooding, and the advance in rural development.

Floods exist in various types, depths and intensities:

- **Flash floods** are caused by run-off during exceptionally heavy rainfall occurring over neighboring upland areas.
- **River floods** are a recurrent event resulting from heavy (monsoon) rainfall in upland and upper catchment areas combined, sometimes, with snowmelt from high mountainous areas.
- **Rainwater floods** are caused by heavy monsoon rainfall resulting in local run-off to accumulate in depressions and lower parts of valleys.
- Storm surges are raised sea levels normally associated with tropical cyclones causing sudden, but temporary, flooding of coastal areas with seawater or brackish estuarine water.

Besides the natural floods there are also floods caused by human intervention in nature these include: sudden breaching of an embankments; sustained failure of polder drainage pumps during the monsoon season, thus allowing ponding of rainwater within a polder; abnormally high rates of release of water from dams; ponding of water behind road, railway and flood embankments following heavy rainfall; drainage congestion; and river siltation.

The exercises have been divided in four sub-modules.

**References**

In the preparation of the exercises in the module use is made of the following publication:

- Irrigation water management training manual No. 1, Introduction to Irrigation, 1985, FAO
- Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO

Additional technical information can be obtained from the above-mentioned publication.
**Sub-module 4.1: Assessment of drainage, flood and salinity problems**

In many cases the relation between waterlogging, water ponding and salinity on the one hand and irrigation, drainage and floods on the other hand are very complex. In exercise 4A (phase: assessment) farmers will identify problem areas and assess the actual problems through cause and effect diagramming. The final output of this exercise is identified potential solutions.

**Sub-module 4.2: Drainage**

Before farmers can actually make a detailed drainage improvement plan they need to be familiar with the concept of drainage and understand how the different components of the system work. In Exercise 4B (phase: planning) farmers will be familiarized with the concepts of drainage through an exchange visit or by the presentation of audio-visual training materials and select the type of drainage measures that are required for their area. In exercise 4C (phase: planning) farmers will make a design proposal and identify the activities that can be done by themselves and for which activities they need support from an external organization. If part of the design/planning has been made by an external organization, farmers will need to approve them prior to implementation. This will be done in Exercise 4D (phase: planning). After the approval the farmers will need to make an action plan for the implementation which will be done in exercise 4E (phase: construction). Exercise 4F (phase: construction) provides guidelines and methods for regular follow-up of the planned activities. In Exercise 4G (phase: operation and maintenance) farmers will make an action plan for the operation and maintenance activities. Exercise 4F can be used again for regular follow-up of the planned operation and maintenance activities.
Sub-module 4.3: Flood Control

In exercise 4H (phase: planning) farmers will discuss whether flood control is desirable and feasible. When farmers decide that flood control measures should be implemented they will plan the required measures. When control measures concern a large area, farmers will also look for cooperation in the design and implementation from government and other farmers. At the same time they will identify the measures that can be implemented by them without external support. After the plans and designs have been made and approved farmers will need to make an action plan for the implementation, operation and maintenance activities. This will be done in exercise 4I (phase: construction, operation and maintenance). Exercise 4F can be used for regular follow-up of the planned implementation, operation and maintenance activities.

Sub-module 4.4: Salinity Control

On the basis of the established causes of the salinity problems, (exercise 4A) farmers will plan a set of measures to control the salinity problems in exercise 4J (phase: planning). When high groundwater tables cause salinity problems, it is likely that drainage is a component of the salinity control plan. In this case Sub-module 4.3 should be followed as well. For the planning of the implementation activities and follow-up and the implementation of the selected measures slightly adjusted versions of Exercises 4E and 4F can be used.
<table>
<thead>
<tr>
<th><strong>Glossary</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capillary rise</td>
<td>Upward movement of water in soil through fine soil pores.</td>
</tr>
<tr>
<td>Drainage outlet/outfall</td>
<td>The terminal point of the entire drainage system, from where the drainage water is discharged into a river, a lake, or a sea.</td>
</tr>
<tr>
<td>Flood control</td>
<td>Control of floods through measures like dikes, river regulation and flood retention.</td>
</tr>
<tr>
<td>Gravity sluices</td>
<td>Structure through which the drainage effluent discharges into a river, lake, or sea normally equipped with a gate to prevent intrusion of water when outer level is higher than inner level.</td>
</tr>
<tr>
<td>Inundation</td>
<td>Flooding of land with rainfall or flood waters.</td>
</tr>
<tr>
<td>Leaching</td>
<td>Removal of soluble salts from the soil profile by water percolating through the soil.</td>
</tr>
<tr>
<td>Perched water table</td>
<td>Temporarily water table developing on impermeable or poorly permeable soil layers situated at a certain depth below the soil surface.</td>
</tr>
<tr>
<td>Percolation</td>
<td>Downward movement of water through soil profile.</td>
</tr>
<tr>
<td>Polder</td>
<td>Level area, separated from the surrounding hydrological regime through dikes to protect it from floods and equipped with drainage pumps to control (ground) water levels within the endiked area.</td>
</tr>
<tr>
<td>Salinisation</td>
<td>Accumulation of soluble salts at or near the soil surface.</td>
</tr>
<tr>
<td>Salinity</td>
<td>Concentration of total dissolved salts in water or soil solution. Salinity becomes a problem when the concentration is high enough to negatively effect crop production.</td>
</tr>
<tr>
<td>Sodicity</td>
<td>High sodium to calcium and magnesium ratio in water or soil solution. Sodicity becomes a problem when the ratio is high enough to cause soil degradation or negatively effect crop production.</td>
</tr>
<tr>
<td>Subsurface drainage</td>
<td>Removal of excess water from the soil surface by diverting it into improved natural or constructed drains supplemented when necessary by shaping and grading of the soil surface towards the drains.</td>
</tr>
<tr>
<td>Surface drainage</td>
<td>Removal of excess water (and dissolved salts) from the soil profile though groundwater flow to the drains so that the water table and soil moisture content in the root zone are controlled.</td>
</tr>
<tr>
<td>Water ponding</td>
<td>Accumulation of water on the soil surface.</td>
</tr>
<tr>
<td>Water table</td>
<td>Upper boundary of the groundwater. Below the water table all soil pores are filled water.</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Accumulation of excess water in the root zone (water saturated soil).</td>
</tr>
</tbody>
</table>
SUB–MODULE 4.1

ASSESSMENT OF DRAINAGE, FLOOD AND SALINITY PROBLEMS

EXERCISE 4A: IDENTIFICATION OF FLOOD, DRAINAGE AND SALINITY PROBLEMS, CAUSES AND EFFECTS

Introduction

In many cases the relations between waterlogging, water ponding and salinity on the one hand and irrigation, drainage and floods on the other hand are very complex. Causes and effects are often not obvious. During the Farmers Seasonal Planning major problems have been identified. This exercise will deepen farmers’ understanding and assist them in distinguishing the actual problem, its causes and effects. This will enable the selection of appropriate measures.

Objectives

• Identify main problems causes and effects of waterlogging, water ponding and salinity problems.

Expected outputs

• Map of (natural) drainage system, source(s) of excess water, flow directions, slopes and obstructions.
• Identified regular flooded, waterlogged and salinised areas.
• Identified main causes and effects of floods, drainage and salinity problems in the area.
• Identified potential solutions.

Preparations required

• Carry out a short assessment of the area to identify: 1) areas with flood, drainage and salinity problems; and 2) causes and effects of flood, drainage and salinity problems.
• Prepare training material in the form of drawings showing the relation between causes and effects of local flood, drainage and/or salinity problems.

Materials required

• Layout map of the area prepared by the farmers.
• Coloured cards
• Markers
• Training material

Time required

• Three hours and thirty minutes.

Timing

• After Farmers’ Seasonal Planning.
• First exercise in the season.
Procedure (Steps)

**Plenary Introduction** (10 min)

1. Explain the specific objectives and expected output.

**Plenary discussion** (30 min)

2. Present the map prepared by the farmers during the Farmers Seasonal Planning.

3. Discuss with the farmers the meanings of “drainage”, “water ponding”, “waterlogging”, “salinisation” and “flooding” and how they can be recognized in the field.

**Plenary group exercise** (1 hour)

4. Visit with the farmers one of the locations identified with a possible salinity, drainage and/or flooding problem.

5. Ask the farmers to verify the areas where they (sometimes) experience water ponding, waterlogging and/or salinisation problems. If necessary modification can be made on the map.

6. Ask the farmers in the field to indicate (natural) drainage system, source(s) of excess water, floods, flow directions, slopes and obstructions and ask them to indicate these on the map.

7. Mark the actual problem areas and discuss the main problem(s).

8. List the main problems.

**Small group exercise (cause and effect diagramming)** (1 hour)

9. Divide the farmers in small groups and give each group one of the main problems, written on a card, to work on.

10. Place the card with the main problem in the center. This will be the starting point to create the cause and effect diagram.

11. Ask farmers to identify the causes of the main problems. Write each cause down on a card and place them below the main problem.
12. Sometimes the causes mentioned for the main problems might not be the root problems, questions need to be ask to find the underlying causes. Write these causes on cards and place them below the first mentioned causes.

13. Repeat the same procedure to identify the effects. Ask farmers what the effects are of the main problem. Write the effects down on cards and place them above the main problem.

14. The exercise is complete when insight is obtained in the root causes and final effects of the main problem.

**Plenary discussion** (50 min)

15. After completing the diagram(s) ask one participant or the representatives of individual groups to present their results to each other.

16. Check whether the diagram is logic and complete.

17. When gaps in farmers’ knowledge are observed these have to be explained and discussed making use of the prepared training materials.

18. Based on the diagram discuss the potential solutions.

Guidelines for (technical) preparations / questions for discussion

How to recognize surface drainage problems?
Surface drainage problems can be recognized by prolonged ponding of water on the soil surface after flooding, rainfall or irrigation. Surface ponding often occurs in depressions, valley bottoms and behind obstructions in natural drainage flows.

Depending on the time and length of water ponding conditions, symptoms in crops are poor germination, poor crop growth, sensitivity to fungal diseases, and in extreme case decay of stems and roots and finally crop failure.

How to recognize subsurface drainage problems?
Subsurface drainage problems might manifest in the same way as surface drainage problems, i.e. prolonged ponding of water on the soil surface after flooding, rainfall or irrigation due to reduced storage capacity and infiltration as the soil profile is already saturated. However, subsurface drainage problems differ from surface drainage problems, i.e. in areas with subsurface drainage problems waterlogging can occur without surface ponding. Waterlogging problems normally occur in flat lands. Sometimes impermeable or poorly permeable layers, located at a certain depth below the soil surface, impede deep percolation. On this layer a so-called perched water table might develop. Normally its occurrence is temporarily, however, it might exist long enough to cause damage to crop growth.

Waterlogging problems are recognized by farmers through observation of wet soil conditions and shallow water table when cultivating their land or observed in open wells and pits. Depending on the time and length of waterlogged conditions, symptoms in the crop are poor germination, poor root development, poor crop growth, sensitivity to fungal diseases, and in extreme cases decay of roots and crop failure. In areas with long periods of drought in which the upward movement of water and salts in the soil profile dominates over the downward flux, waterlogging is often combined with salinity problems.

How to recognize salinity/sodicity?
Salinity and sodicity problems only become visible in the field if they are in an advanced stage. Also for the typical salinity symptoms in the crops to appear the concentration of salts in the soil must be quite high. At low levels the growth will be uniformly depressed and yields will be reduced. Salinity and sodicity problems can be recognized through a whole range of physical phenomena and crop characteristics. High salinity concentrations can be recognized by a white soil crust, a powdery like layer covering the soil surface, white patches and an oily appearance of the soil surface. Typical high sodium concentrations might be recognized by black soil patches on the soil surface, hard soil crust, dense/massive soil structure, and poor water infiltration. Typical salinity/sodicity symptoms in the crops are poor germination, irregular and stunted crop growth, withering of plants and yellow leaf burn.

Causes and potential solutions for surface drainage problems
Surface drainage problems are caused by excessive rainfall, irrigation or flooding in combination with insufficient natural outflow. These situations occur in depression
areas or valley bottoms without a natural outlet or when the outlet that is too small for sufficient outflow. Surface drainage problems might also be caused by blocking natural drainage flows by building roads, railway lines, canals etc, across natural drains. Soil crusting, compaction and poor land leveling might also result in surface ponding. Normally latter causes are small-scale, localized and occur randomly.

Potential solutions are:
- Reduce the flow of excess water through improvements on irrigation system and management (see modules 2 and 3) or flood control measures (see sub-module 4.3).
- Improve the natural surface drainage.
- Construct artificial surface drainage.
- Grade the land to enhance surface runoff towards the (natural) drains.

Causes and potential solutions for subsurface drainage problems
Subsurface drainage problems normally occur in flat areas where the hydraulic gradient and the hydraulic conductivity are too small to evacuate recharge of the groundwater sufficiently quick to prevent excessive rise in groundwater table. Rainfall, flood or irrigation water which infiltrates in the soil but which is not used by crops for transpiration nor evaporated at the soil surface will recharge the groundwater. Sources of excessive recharge from irrigation are seepage and leakage from irrigation canals and deep percolation of irrigated field as a result of poor irrigation methods and poor leveling of fields.

Potential solutions are:
- Reduce the recharge to the groundwater through improvements on irrigation system and management (see modules 2 and 3) or flood control measures (see sub-module 4.3).
- Construction of a subsurface drainage system.
- In case waterlogging is caused by a shallow thin impermeable layer, deep ploughing to break the layer could improve the situation.

Causes and potential solutions for salinity/sodicity problems
In (semi) arid areas subsurface drainage problems are often accompanied by salinity problems. Dissolved salts move upward to the soil surface with increasing groundwater tables. Subsequently, salts accumulate near or at the soil surface through evapo(transpi)ration of water, leaving behind the salts. Though, not all salinity problems do necessarily stem from waterlogging problems. Salinisation of agricultural lands could also result from irrigation with marginal and poor quality (ground) water, weathering of parent material, and seawater intrusion.

Potential solutions are:
- If water tables are deep and there is no threat of rising water tables, it is sufficient to provide additional water to leach the salts from the root zone.
- If salinity is caused by high saline groundwater tables, subsurface drainage need to be provided to reduce the groundwater table and evacuate leaching water and dissolved salts.
- If sodicity is the main problem apply soil or water amendments to prevent soil degradation.
• Shift to more salt tolerant crops if salinity can not be controlled on acceptable levels
• Irrigation and cultivation management practices to mitigate the effects of salinity on crop production

Causes and potential solutions for floods
Recurrent flood events are natural phenomena in many areas in the world. In itself regular flooding do not form a problem. Traditionally, farming systems were based on rice production and incorporated floods. Damage to crops under these conditions is restricted to abnormal conditions, i.e. when floods occur much earlier or later, or when water level rise higher or quicker than normal. However, with the introduction of improved varieties, crop intensification, diversification, and farm mechanization better water control conditions are required and all floods started to be considered as problematic. Also under influence of the ever-increasing world population there is often enormous pressure to develop tidal, deltaic and other flood prone areas due to their strategic location. These factors have led to increased necessity for flood control and protection measures.

Not all floods are natural. Human interventions in the drainage catchment area have often resulted in increased flooding risks. Examples are deforestation, canalization of river streams and disappearance of wetlands.

Potential solutions are:
• Introduction of flood control and protection measures often in combination with drainage.
• Integrated river basin management to reduce the risks of flooding.
• Introduction of precaution measures to reduce damage to crops.

For more technical information, see also:
• Irrigation water management training manual No. 1, Introduction to Irrigation, 1985, FAO, Chapter 6 & 7.
• Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO, Chapter 2.

Questions for discussion related to drainage
• Do you have problems with water ponding and/or waterlogging?
• Where are these areas situated?
• Is the drainage problem field specific or a problem of the entire area?
• How often does this take place?
• How long do the areas remain waterlogged and/or ponded?
• Does the waterlogging and/or water ponding cause a reduction in crop yield?
• Are there areas that are not in production or taken out of production because of these problems?
• Do the waterlogging and/or water ponding problems have any other negative effects? For example:
  - Poor health conditions.
  - Poor sanitation.
- Increased maintenance to houses and infrastructure.
- Poor animal health.

- What are the causes of the waterlogging and/or water ponding?

Questions for discussion related to floods

- Does flooding of the area take place regularly?
- Which areas are subject to flooding?
- How long and how often does this take place?
- What are the causes of these floods?
- Do they affect crop production and/or farm operations?
- Do extreme flood events occur?
- How long and how often do these extreme floods take place?
- What are the causes of these extreme floods?
- What is the effect of extreme floods on crop production?

Questions for discussion related to salinity

- Do you have salinity problems?
- Do salinity/sodicity problems relate to yield reduction?
- What are the causes of salinity/sodicity problems?
- Are these problems related to specific fields, spots or irrigation water sources or do the problems occur over the entire area?
- When did the problems first appear?
- Is this period related to any major change in irrigation management, hydrologic conditions or natural event?
- How deep is the water table?
- Is the groundwater fresh or saline?
- What source of irrigation water do you use?
- What is the effect of irrigation with this water?
- When are the problems most pronounced?
SUB–MODULE 4.2

DRAINAGE

EXERCISE 4B: SELECTION OF DRAINAGE IMPROVEMENTS

Introduction

Sometimes drainage development is not new in an area and farmers might be well aware of the benefits and functioning of drainage. In other areas drainage might be a new innovation. In latter cases it is not likely that farmers are familiar with the concept of drainage. This exercise will familiarize farmers with the concept of drainage and will enable them to select and plan the required drainage improvements.

Objectives

• To identify the type of drainage improvements required.
• Prepare farmers for the planning of drainage improvements.

Expected outputs

• Identified type of drainage measures required.
• Understanding and awareness about the benefits of drainage and the functions of the different components of a drainage system.

Preparations required

• Prepare brainstorm discussion.
• Prepare discussion on type of drainage measures required.
• Prepare exchange visit. Select an area that has similar physical conditions as the area under consideration.

• If exchange visit is not feasible prepare video presentation supplemented by drawing, maps etc.

Materials required

• Small cards and markers.
• For exchange visit: transport, layout and drawings of the drainage system. Or audio-visual training materials e.g. video, drawings, maps, etc.

Time required

• Two hours 30 minutes when audio-visual training materials are used.
• Full day when a field visit is included.

Timing

• When the drainage problem is visible.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review the previous training session (Exc. 1, Part C)
2. Explain the specific objectives and expected output.

Brainstorming (30 min)

3. Brainstorming on benefits of drainage.
4. Write the benefits on little cards.
5. Group the cards into three categories, i.e. increased crop production, improved farm management, and other benefits including improvement of the environment and contributions to rural development.
6. Supplement benefits mentioned by farmers.

Plenary discussion (20 min)

7. Recall outcome of cause and effect diagramming (Exercise 4A).
8. Discuss with the farmers what type of drainage intervention is required, i.e. surface drainage, subsurface drainage or a combination of both. Also explore the possibilities to solve the drainage problems through changing irrigation management, irrigation practices, improvements to the canal system, grading of land, changes in land use or farm practices, etc.
9. Reach consensus on the required drainage interventions and list the selected measures on a large sheet of paper.
10. Explain purpose of exchange visit or audio-visual presentation.

Exchange visit (3 hours plus travelling time)

The main objective of the exchange visit is to familiarize the farmers with the functioning of the different component of the required drainage system to enable them to plan their own drainage improvements. A secondary objective of the exchange visit is for farmers to exchange experiences with the host farmers. For this reason an exchange visit is preferred over an audio-visual presentation. The following programme is proposed:
11. Welcome (5 min)

12. Introduction: Reasons for the exposure visit and objectives (5 min)

13. Introduction on the drainage system including a brief presentation of the layout and design (20 min).

14. History of the area and changes since the introduction of drainage system presented by one of the host farmers (30 min).

15. ‘Walk-through’ by visiting farmers, host farmers and drainage/irrigation engineers. All different components of the drainage system will be inspected and a little explanation on their function will be given. During the walk through visiting and host farmers will have time to further discuss the function and benefits of drainage (1 hour 30 min).

16. Plenary discussion and questions (20 min)

17. Summary and Closure (Exc. 2, Part C)

OR: Training session based on audio-visual materials (1 hour 30 min)

11. Video presentation. Video should clearly show the different components of a drainage system, explain their function and the physical conditions should be similar to those of the area under consideration. Preferably the video should include a discussion on the effects and benefits of drainage.

12. Ask farmers to recall all components of the drainage system.

13. Clarify the function of the components of the drainage system, making use of drawings, maps etc.
Guidelines for (technical) preparations / questions for discussion

Benefits of drainage

The main direct benefit of installing a drainage system, to remove excess water for crop development and growths, is that the soil is better aerated. This leads to a higher productivity of cropland or grassland because:

- The crops have better root development and root more deeply.
- There will be better nutrient uptake and therefore fertilizers will be used more efficiently.
- Activity of micro-organisms will be increased and therefore the decomposition of organic matter will be enhanced.
- In the absence of oxygen certain soil bacteria will transform nitrate, which is a plant nutrient, into nitrogen gas. When the soil is better aerated less nitrate is lost.
- Salinity can be controlled better.

Other agricultural benefits of well-drained soils are:

- The land is easier accessible, with a better bearing capacity and workability.
- The period in which tillage operations can take place is longer.
- The choice of crops is greater.
- The growing seasons will be extended, as early planting will be possible.
- The soil structure is better, which also improves permeability.
- Soil temperatures are higher, so that crops (particularly horticultural crops) and grasses can be grown earlier.

Besides the agricultural benefits there are a number of social benefits that direct contribute to rural development and improvement of the environment. These benefits include:

- Improved public health through reduced risks of vector born and water-born diseases.
- Better sanitation.
- Improved animal health.
- Reduced maintenance cost to infrastructure, buildings etc.
Selection of drainage improvement measures

The best solution for drainage problems is not always the implementation of an artificial drainage system. Depending on the causes of the drainage problem, solution lay sometimes in:

- changes in irrigation management
- changes in irrigation practices
- improvements to the canal system
- grading of land
- changes in land use or farm practices
- removal of blockages in the natural drainage system

If an artificial drainage system is required, alone or in combination with one of the aforementioned options, a choice has to be made concerning the type of drainage measures required. The following points need to be taken into consideration:

- Implementation of surface drainage is sufficient when drainage is only required to remove surface ponding. Surface drainage consists of shallow open drains supplemented, when necessary, by land sloping and grading to make it easier for excess surface water to flow towards these drains.

- Subsurface drainage is required when waterlogging (and salinity) is a major problem. Subsurface drainage either consists of open drains or buried pipes.

**Advantages open drains:**
- they can receive overland flow; and
- can also serve as surface drainage.

**Disadvantages open drains:**
- loss of land
- interference with the irrigation system
- splitting up of the land, which hampers farming operations
- regular maintenance is required

**Advantages pipe drains:**
- no loss of land
- no interference with irrigation system
- land is not split up in small blocks
- less maintenance is required

**Disadvantages of pipe drains:**
- expensive materials
- installation is expensive
- it needs heavy equipment for installation
- they can not receive overland flow
- can not function as surface drainage
If drainage problems are caused by a perched water table, developed on a shallow impeding soil layer, ripping or deep ploughing could probably solve the drainage problem. When the impeding soil layers are too deep or too thick for these measures, implementation of a subsurface drainage system is required.

**Components of a drainage system**

Drainage systems whether surface or subsurface consist, at least, of the following three components:

- **Field drainage system**, which is a network that gathers the excess water from the land by means of field drains (also called laterals). In surface drainage, field drains are shallow graded channels. In subsurface drainage, field drains can either be ditches or buried pipes.
- **Main drainage system**, which is a water-conveyance system that receives water from the field drainage system and transports it to the outlet point. The main drainage system normally consist of collector drains and a main drain. When the field drains consist of drainpipes, the collector drains can be either a buried pipe or an open ditch. In case of surface drainage and open subsurface drainage the collectors will consist of open ditches. The main drain is under normal conditions an open canal.
- **Outlet**, which is the terminal point of the entire drainage system, from where the drainage water is discharged into a river, lake, or sea. Depending on the outer water level and the variation over time the outlet might consist of: a free fall structure, a gated structure or sluice (either automatic or manually adjustable), or a pump outlet.

**For more technical information, see also:**

**Questions for the discussion on benefits of drainage**

1. What benefits do you expect from improved drainage conditions?
2. What are the benefits for crop production?
3. Are there other agricultural benefits that you expect from improved drainage?
4. If the drainage situation is improved, do you expect other positive impacts besides agricultural improvements?

**Questions for the discussion on selection of drainage improvement measures**

5. Would changes in irrigation management or irrigation practices solve the drainage problems?
6. Could improvements to the canal system solve the drainage problems?
7. Could the drainage problem be reduced with land grading or bedding?
8. In case of a local depression, could rice cultivation, fishpond or water reservoir not be a better land use?
9. Could a change of land use be the solution to the drainage problem?
10. Would removal of blockages in the natural drainage system solve the drainage problems?
11. What is further needed to drain the water out of the area into a river, lake or sea?
12. Is waterlogging or water ponding the major problem?
13. Do waterlogging and water ponding both occur and impede crop production?
14. Would it be sufficient to implement a surface drainage system or is subsurface drainage required?
15. If subsurface drainage is required what is the preferred solution, open drains or buried pipes?
16. What are the advantages and disadvantages of open drains and buried pipes?
17. Are impermeable layers common in this area?
18. How deep and how deep and thick are these layers?
19. If you manage to drain the excess water, where will it be drained to?
20. Will it not shift the drainage problem to a different area?

Questions for field visit/ video presentation

21. What type of drainage system can you observe?
22. What are the various components of the system?
23. What is the function of the components?
24. What are the benefits of the drainage system?
25. What are the implications of drainage for farmers’ water management, role and function of water users groups, financial matters, etc?
EXERCISE 4C: PLANNING OF DRAINAGE IMPROVEMENTS

Introduction

Before the farmers can make a start with the planning and preparations for the drainage improvements the following points need to be covered: cause(s) of drainage problems; benefits of drainage; required drainage intervention; and functioning of the different components of the drainage system. The outcome of this exercise is a drainage plan which including a step-by-step plan, which lists the activities that have to be undertaken from planning/design to operation and maintenance. In this plan farmers should also define which activities can be done by themselves and for what activities support from an external (governmental) organization has to be requested.

Objectives

- To plan and prepare for drainage improvements.

Expected outputs

- Layout and plan for the improvements of the drainage situation.
- Step-by-step activities plan.
- Identified tasks and responsibilities that can not be implemented solely by the farmers.

Preparations required

- None.

Materials required

- Copies of the map prepared in Exercise 4A.
- Sheets and markers.

Time required

- Three hours and 30 minutes.

Timing

- When the drainage problem is visible.
- After Exercise 4A and 4B.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Plenary discussions (10 min)

3. Decide with the farmers which area with a drainage problem will be selected to plan and prepare drainage improvements for.
4. Discuss drainage planning and design considerations.

Field visit/small group activities (1 hour and 30 min)

5. Visit with the farmers the selected area and ask the farmers to split up in small groups of 4-5 persons.
6. Give each group a copy of the map prepared in Exercise 4A.
7. If it is required, ask the groups to prepare a more detailed layout map of the drainage problem area, on the basis of the map prepared during Exercise 4A, indicating slopes, drainage flows, agricultural fields, roads, rivers, drainage obstructions, etc.
8. Ask each group to draw the layout of the selected drainage measures (Exercise 4B) and to discuss what needs to be done further to improve the drainage situation.
9. Ask each group to present their layout map and drainage improvement plan.

Plenary discussions (40 min)

10. Discuss the different proposals. Pay special attention to: the layout of proposed field drainage systems; length of and distance between the field drains; outlet and land form between the field drains; alignment of the collector drains; drainage outlet; field and collector drain alignment versus existing infrastructure; drainage boundaries versus other existing social/organizational boundaries; size of independent controllable drainage units; implications for drainage management; possibilities for reuse of drainage water; additional requirements to improve the drainage situation.
11. Try to decide on the best and most realistic proposal that the farmers will be able to construct, manage, operate and maintain.
**Plenary exercise** (1 hour)

12. On the basis of the selected proposal ask the farmers to list down all the steps (activities) that have to be taken from planning/design until operation and maintenance. The purpose is not to go in great detail but to get an overview (feeling) of the activities that can be done by the farmers themselves and for which external help/support is required.

13. Write the steps down in a chronological order grouping them under the headings planning & design, implementation, and operation & maintenance (see example in guidelines for (technical) preparation).

14. Discuss which activities can be solely done by the farmers and for which activities external help is required or which activities have to be completely done by an external organization.


**Guidelines for (technical) preparations / questions for discussion**

**Considerations for planning drainage improvements**

- Planning of measures to improve the drainage situation in an area normally depend on the expected benefits compared to the costs. As discussed in Exercise 4B, the benefits do not only comprise improved crop yields but other agricultural and social benefits as well.

- Drainage is not the only factor determining the increase in farm returns. Only when drainage is a major constraint significant increase in farm returns can be expected. Therefore when low input farming is predominant in an area it might not be profitable to implement high cost drainage measures such as pipe drainage. The level of drainage investment should suit the level of agricultural development.

- Unless the area under consideration is located in the vicinity of a natural drainage outlet, a main drainage infrastructure needs to be planned and implemented. Normally planning and implementation of the main drainage infrastructure is beyond the capacity of a single group of farmers.

**Layout and design of surface drainage systems**

Surface drainage at field level can have two different layouts: the random field drainage system or the parallel field drainage system.

**Random field drainage system**

This system is applied when shallow depressions occur in the field but where complete land forming is not considered necessary. The random field drainage system connects the depressions by means of a field drain and evacuates the water into a collector drain.
Parallel field drainage system
This system is suitable in flat areas with irregular micro-topography and where farming operation require regular field shapes. The parallel field drains collect the surface runoff and discharge it into a collector drain. In technical terms the spacing between the field drains is determined by the time span within which excess water on the land, resulting from the design rainfall and excess irrigation water must be evacuated to avoid crop damage. In practice the spacing between the field drains also depends on the minimum size of fields that can be cultivated economically, the cost of land shaping, field and farm boundaries, and layout of farm roads and (tertiary) irrigation canals.

Layout and design of surface drainage systems
For subsurface drainage systems the choice between open drains or buried pipe drains has to be made at field level and for collector drains. If the field drains are to be pipes the collector drains can be either open ditches or pipe drains.

Singular drainage system
If the field drains are pipes and all field drains discharge into an open collector drain the system is called a singular drainage system.

Composite drainage system
When all field drains and collector drains are buried pipes, the system is called a composite drainage system.

The choice between singular and composite systems depend on:

- the need to provide an outlet for excess surface water;
- tolerable field size and land loss;
- outflow of pipe drains into a ditch is easy to inspect and blockage affects a small area only;
- ditch collectors require more maintenance;
- pipe collectors require more hydraulic gradient than ditch collectors;
- the costs of installing a composite pipe system are considerably higher than for a singular system;
- open ditches often interfere with irrigation canal systems.

Points for considerations in planning and design of a drainage system
There are a number of points that need to be considered in planning and design of a drainage system:

- Drainage boundaries should not only be determined by hydraulic boundaries. Moreover, from management point of view it is often more important that drainage boundaries coincide with existing social/group boundaries such as boundaries of irrigation water users associations, village boundaries, administrative boundaries, ethnic and religious group boundaries, etc.
- Drainage units should be such that farmers can operate and maintain the system
conveniently and cost-effectively.

- In water shortage areas, if the drainage effluent quality allows, the layout and design of the drainage system should allow farmers to reuse drainage water to supplement scarce irrigation water resources.
- In areas where rice and dry-land crops are grown simultaneous it is desirable that the system is designed in such a manner that small units of the drainage system can be closed to prevent high percolation losses from rice fields.

Example of a step-by-step plan for a subsurface drainage system

<table>
<thead>
<tr>
<th>Steps (activities)</th>
<th>Responsibilities</th>
<th>External organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning &amp; Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning and layout of on-farm system</td>
<td>Entirely done by the farmers</td>
<td></td>
</tr>
<tr>
<td>Technical survey</td>
<td>Farmers will assist I&amp;D department</td>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Detailed design</td>
<td>Farmers have to approve design</td>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Planning and layout main system</td>
<td>Farmers have to approve on points that relate to operation of their own system like drainage base</td>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting out the drains</td>
<td>Farmers</td>
<td>I&amp;D technical supervision</td>
</tr>
<tr>
<td>Digging collector drain</td>
<td>Farmers</td>
<td>I&amp;D technical supervision</td>
</tr>
<tr>
<td>Laying subsurface laterals</td>
<td>Farmers will assist</td>
<td>Contractor, I&amp;D tech. supervision</td>
</tr>
<tr>
<td>Construction of hydraulic structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main system</td>
<td>Farmers have to approve</td>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Operation &amp; Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular cleaning collector drain</td>
<td>Farmers</td>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Maintenance of hydraulic structures</td>
<td>Farmers</td>
<td></td>
</tr>
<tr>
<td>Operation of hydraulic structures</td>
<td>Farmers up to the collector outlet</td>
<td></td>
</tr>
<tr>
<td>Removal blockages in laterals</td>
<td>Request contractors</td>
<td>Contractor who has equipment</td>
</tr>
<tr>
<td>Maintenance of main system</td>
<td>Contribute according to work distribution</td>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Operation of main system</td>
<td>Involved in joint decision making</td>
<td>I&amp;D department</td>
</tr>
</tbody>
</table>

For more technical information, see also:
- Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO, Chapter 4-7.

Questions for discussion on considerations of drainage planning

1. What are the expected financial benefits of drainage compared to the expected costs for installation, operation and maintenance?
2. Can this group of farmers manage the implementation, operation and maintenance of the planned drainage system themselves or is co-operation with other farmers necessary?
3. Is it necessary to involve the irrigation and drainage department in design and implementation?

Questions for discussion on design considerations for surface drainage

4. Would it be sufficient to drain only shallow depression areas?
5. Is it required to drain the entire area?
6. Are regular field shapes required?
7. What is the minimum field size that can be (economically) cultivated?

**Questions for discussion on design considerations for subsurface drainage**

8. Is there a need for surface drainage as well?
9. What is the minimum field size that can be (economically) cultivated?
10. Is labour readily available for maintenance activities?

**Questions for discussion on general design considerations for drainage**

11. Are there any existing social/group boundaries?
12. Is it possible to make the drainage boundaries correspond with these boundaries?
13. What is the maximum size of a drainage unit that can be operated and maintained efficiently by a single group of farmers?
14. Do water shortages occur?
15. Is the drainage water expected to be of good quality?
16. Would farmers like to reuse the drainage water for irrigation during water shortage periods?
17. What measures have to be taken to enable reuse of drainage water?
18. Are rice and dry-land crops grown in the same area?
19. Would it be necessary to keep the water table higher in the areas where rice is grown?
20. Would it be necessary to maintain different water table levels in various seasons?
21. What measures have to be incorporated in the design to enable water table control?

**Questions for the preparation of the step-by-step plan**

22. What activities have to be initiated and completed before the actual implementation of the drainage plans can start?
23. What activities have to be done to finalize the implementation works?
24. What are the maintenance activities have to be undertaken on a regular or ad hoc basis?
25. What has to be done to operate the system?
26. Can the farmers do the activities that have been identified themselves?
27. In case an activity can not be done solely by the farmers, what part can be done by the farmers and what part can not?
28. Why can farmers not do certain (parts of) activities themselves?
29. Which external organization(s) might be able to assist the farmers in the implementation of the activities?
30. What will be the tasks and responsibilities of the selected external organizations in relation to these activities?
EXERCISE 4D: APPROVAL DRAINAGE DESIGN AND DIVISION IN TASKS

Introduction

If, on the basis of the outcome of previous exercise, (parts of) the detailed designs of drains, canals and hydraulic structures are made by the responsible governmental agency, this exercise should be included as the final designs should always be discussed and approved by the farmers before implementation. Further agreement on the division of tasks during implementation, operation and maintenance between the farmers and the external organization(s) should be reached.

Objectives

- To approve the drainage design.
- Agreement on the division of responsibilities and tasks during implementation, operation and maintenance.

Expected outputs

- Approved design.
- Approved division of tasks and responsibilities.

Preparations required

- Study the designs and extract information important for the farmers and present it in a format that is understood by them.
- Familiarize with the alignment of drains and other structures in the field.
- Invite responsible governmental organization.

Materials required

- Detailed designs.
- Presentation of the design in a simple manner.
- Sheets and markers.

Time required

- Three hours and 15 minutes.

Timing

- After Exercise 4C and completion of detailed designs.
- Before implementation of the drainage system.
Procedures (Steps)

**Plenary introduction** (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain specific objectives and expected outputs.
3. Present visitors from the responsible governmental organization and other relevant external organizations.

**Presentation and field walk** (1 hour 30 min)

4. Present the drainage design making use of pre-prepared flip charts.
5. Walk with the farmers and representatives of the governmental organization along the alignment of the drains and point out the locations of important structures.

**Small group discussions** (30 min)

6. Divide the farmers in small groups of 4-5 farmers.
7. Ask the groups to identify important features on which they will evaluate the design and to write these down on a sheet.
8. Ask the farmers to evaluate the design on the basis of these features by writing behind each feature whether it fulfils their requirements or not.
9. Ask the farmers to give an overall evaluation by indicating whether they accept the design or what has to be changed before they can accept the design.

**Plenary discussion and approval of design** (1 hour)

10. One representative of each group should present the group evaluation.
11. Discuss differences in evaluations.
12. If certain aspects of the design are not approved by the farmers ask the representative of the governmental organization to explain the rational of certain design aspects and whether changes can be made or not.
13. Ask farmers to come to a final conclusion whether to accept or reject the design.
14. If the design is accepted by the farmers conclude by signing the design documents.
15. Discuss the step-by-step plan for the project phases ‘implementation’, ‘operation’ and ‘maintenance’ as prepared in Exercise 4C with the government officials and representatives of other organizations involved. Reach consensus on the division of tasks and responsibilities.


**Guidelines for (technical) preparation / questions for discussion**

**Important features of the drainage design to be evaluated before approval**

- Design groundwater table depth in relation to prevailing cropping patterns.
- Drainage boundaries versus other existing social/organizational boundaries.
- Farmers included or excluded from the drained area.
- Size and shape of plots.
- Expected land losses.
- Interference of the drainage system with irrigation system, other infrastructures and access to fields.
- Maintenance requirements.
- Expected cost for operation.
- Opportunities for reuse of drainage effluent.
- Size of individual drainage units.
- Possibility to close individual drainage units to maintain high groundwater table.

**For more technical information, see also:**

- *Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO, Chapter 4-7.*

**Questions for discussion**

1. Is the design water table suitable for the prevailing cropping patterns and especially for the economically most important crops?
2. Do the planned drainage boundaries coincide with any existing social/organizational boundaries?
3. Are the boundaries acceptable for all farmers?
4. Do the drainage boundaries include or exclude any (influential) farmers?
5. Are the sizes and the shapes of the plots for optimal farm operations?
6. Are the expected land losses acceptable?
EXERCISE 4E: IMPLEMENTATION OF DRAINAGE

Introduction

After the plans and designs have been completed and approved and consensus is reach about the tasks and responsibilities of all parties involved, planning of the activities for implementing the drainage measures need to be undertaken.

Objectives

- To plan activities that have to be implemented in order to realize the approved drainage design.

Expected outputs

- Action Plan defining the activities, responsibilities and a timeframe for implementation of drainage measures.

Preparations required

- Carry out a short assessment of all activities that need to be undertaken to implement the selected measures and the required resources.

- Make a short assessment of the cost of possible construction materials and other inputs required.

Materials required

- Large sheets
- Small coloured cards
- Markers
- Pre-prepared tables

Time required

- Three hours and 45 minutes.

Timing

- After Exercise 4D.
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of previous training (Exc. 1, Part C).
2. Explain the specific objectives and expected outputs.

**Plenary Action Planning** (1 hour 30 min)

3. Discuss with the farmers that the planned drainage measures can be regarded as the final output or goal for which the Action Plan will be made.
4. Ask farmers which intermediate-results or intermediate-outputs have to be achieved to reach the final output. Write the intermediate-outputs on cards.
5. Put the intermediate-outputs in a logical order (one step after the other).
6. Ask the farmers to identify the activities that need to be undertaken to reach the intermediate-outputs.
7. Order the activities in a chronological order and place them behind the intermediate outputs.
8. Write down on cards the party responsible for the different activities based on the outcome of Exercise 4C and place the cards behind the activities.
9. Decide on the timing of the activities and note these down as well.
10. Identify the materials required for each output. List them down.
11. Indicate behind each item who will provide the inputs and whether the items are provided in kind or cash.

**Small group discussions** (1 hour)

13. Ask the farmers discuss in small groups of 4-5 farmers for one of the intermediate-outputs (and only for the activities for which the farmers are responsible) the (a) quantities of materials required (b) estimated costs of the materials (c) labour requirements (d) where to find skilled labour if required (e) labour costs
14. Ask each group to fill in their estimates on a pre-prepared table (Exc. 1B).
Plenary discussions to finalize the Action Planning (1 hour)

15. Discuss the estimations of the different groups and try to conclude on realistic estimates.

16. Discuss responsibility for the organization and implementation of the different tasks and activities.

17. Appoint/elect sub-committees and responsible farmers for the different tasks and activities.


Guidelines for (technical) preparations / questions for discussion

For more technical information, see also:

- Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO, Chapter 4-7.

Examples of Action Planning formats

This table is an example of how to organize the intermediate-outputs and the activities that have to be undertaken to achieve the major output. Further, in this format the responsible party for each activity can be indicated as well as the timing of the various activities.

<table>
<thead>
<tr>
<th>Output: Subsurface pipe drainage system on 50 hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alignment and levels of drains set out.</td>
</tr>
<tr>
<td>1.1. Preparation of pegs</td>
</tr>
<tr>
<td>1.2. Surveying alignment and levels</td>
</tr>
<tr>
<td>1.3. Installation of pegs to indicate alignment and levels</td>
</tr>
<tr>
<td>Farmers</td>
</tr>
<tr>
<td>I&amp;D department</td>
</tr>
<tr>
<td>Farmers</td>
</tr>
<tr>
<td>2nd week May</td>
</tr>
<tr>
<td>2nd week May</td>
</tr>
<tr>
<td>1st week May</td>
</tr>
<tr>
<td>2nd week May</td>
</tr>
<tr>
<td>1st week May</td>
</tr>
<tr>
<td>2nd week May</td>
</tr>
<tr>
<td>1st week June</td>
</tr>
<tr>
<td>1st and 2nd week June</td>
</tr>
<tr>
<td>1st and 2nd week June</td>
</tr>
<tr>
<td>2. Alignment prepared for construction.</td>
</tr>
<tr>
<td>2.1. Cut large bushes and trees</td>
</tr>
<tr>
<td>Farmers</td>
</tr>
<tr>
<td>before end May</td>
</tr>
<tr>
<td>3. Collector drain dug</td>
</tr>
<tr>
<td>3.1. Excavation of collector drain</td>
</tr>
<tr>
<td>I&amp;D + farmers</td>
</tr>
<tr>
<td>1st week June</td>
</tr>
<tr>
<td>1st and 2nd week June</td>
</tr>
<tr>
<td>3.2. Removal of additional soil</td>
</tr>
<tr>
<td>Farmers</td>
</tr>
<tr>
<td>1st week June</td>
</tr>
<tr>
<td>1st and 2nd week June</td>
</tr>
<tr>
<td>4. etc.</td>
</tr>
<tr>
<td>3.3. etc.</td>
</tr>
<tr>
<td>etc.</td>
</tr>
<tr>
<td>etc.</td>
</tr>
</tbody>
</table>

This table shows how to organize the inputs/materials required to reach each of the intermediate-outputs. Further the responsible provider of the inputs and whether it will contributed in kind or cash can be indicated in this table.
### Other tasks and responsibilities to be undertaken by farmers

Besides the actual implementation work of the various activities there are a number of tasks and responsibilities that have to be undertaken to ensure smooth implementation. Examples of these tasks and responsibilities include:

- Co-ordination of various activities and time management.
- Ensure that all farmers contribute in kind and/or cash.
- Co-ordinate with the responsible governmental organization.
- Mobilize labour.

### Question related to Action Planning

1. What steps (intermediate-outputs) have to be taken to achieve the final output?
2. What intermediate-output has to be completed first before the next intermediate-output can be completed and so forth?
3. What activities have to be undertaken by the farmers or other organizations to finalize the intermediate-outputs?
4. Who is responsible for the implementation of the different activities?
5. When do the activities have to be undertaken to finalize drainage measures before the next (monsoon) season?
6. What materials/inputs are required to complete each intermediate-output?
7. Are the materials/inputs delivered in kind or cash?
8. Who is responsible to provide the various materials/inputs?

### Question related to finalizing the Action Planning

9. How much of each material is required?
10. What are the costs of the materials (unit prices)?
11. How much labour is required for each activity?
12. Is skilled labour required?
13. Does anybody within the farming community have these skills?
14. What are the costs for labour, both skilled and unskilled?
15. Besides the actual implementation work of the various activities what are other tasks that have to be undertaken to ensure smooth implementation?
16. Who will be responsible for the organization and implementation of the tasks and activities?
**EXERCISE 4F: FOLLOW-UP IMPLEMENTATION OF DRAINAGE MEASURES**

**Introduction**

Depending on the size and the type of drainage measures the implementation might take anywhere between a few weeks and several months. During the implementation work it is important to pay in the FST regular attention to the follow up of the Action Plan for implementation.

**Objectives**

- To monitor progress of implementation according to the Action Plan.

**Expected outputs**

- An assessment of the progress made on the implementation of the drainage measures according to the Action Plan.
- Corrective measures to be taken if deviations are observed from the Action Plan.

**Preparation required**

- None

<table>
<thead>
<tr>
<th>Materials required</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Action Plan as prepared during Exercise 4E.</td>
</tr>
<tr>
<td>• Empty Action Plan forms if major deviations have to be made.</td>
</tr>
<tr>
<td>• Progress report forms.</td>
</tr>
</tbody>
</table>

**Time required**

- One hour

**Timing**

- At regular intervals e.g. fortnightly after Exercise 4E during implementation.
Procedure (Steps)

**Plenary introduction** (10 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected outputs.

**Plenary discussion** (50 min)

4. Present the Progress Report forms.
5. Fill in the Progress Report Forms in discussion with the farmers. Pay attention to reasons for deviation from the initial Action Plan and discuss the corrective measures to be taken.
6. Discuss the functioning of the sub-committees and the participation of beneficiaries. If conflicts occur or Sub-committees do not function as required refer to exercises ...
7. Summarize the revised Action Plan for the following period.

**Guidelines for (technical) preparations / questions for discussions**

**Examples of Progress Report formats**

These tables show examples of how to organize the progress reports for activities, contribution of materials and contribution of labour. If deviations occur and corrective measures will entirely change the schedule of the Action Plan it might be wise to fill in new forms.
### Example Progress Report “Activities”

<table>
<thead>
<tr>
<th>Activities</th>
<th>Planned Timing</th>
<th>Progress</th>
<th>Reasons for deviation</th>
<th>Corrective measures to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Preparation of pegs</td>
<td>1st week May</td>
<td>Completed</td>
<td>Late start due to</td>
<td>Start after completion of</td>
</tr>
<tr>
<td>1.2. Surveying alignment and levels</td>
<td>2nd week May</td>
<td>In progress</td>
<td>involvement of</td>
<td>setting out alignment and levels</td>
</tr>
<tr>
<td>1.3. Installation of pegs to indicate</td>
<td>2nd week May</td>
<td>In progress</td>
<td>surveyors in another</td>
<td>Rescheduled in consultation</td>
</tr>
<tr>
<td>2.1. Cut large bushes and trees</td>
<td>before May</td>
<td>None</td>
<td>project</td>
<td>with the I&amp;D department</td>
</tr>
<tr>
<td>3.1. Excavation of collector drain</td>
<td>1-15 June</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2. Removal of additional soil</td>
<td>1-21 June</td>
<td>-</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Example Progress Report “Contribution of Materials”

<table>
<thead>
<tr>
<th>Activities</th>
<th>Planned contribution</th>
<th>Actual contribution</th>
<th>Reasons for deviation</th>
<th>Corrective measures to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Preparation of pegs</td>
<td>Wood for 250 pegs</td>
<td>Wood for 250 pegs</td>
<td>Sub-committee</td>
<td>Sub-committee should initiate</td>
</tr>
<tr>
<td></td>
<td>Rp. 1000 for 20</td>
<td>-</td>
<td>responsible for</td>
<td>collection of financial</td>
</tr>
<tr>
<td></td>
<td>liters of impregnator</td>
<td></td>
<td>financial contribution</td>
<td>contribution as soon as possible</td>
</tr>
<tr>
<td></td>
<td>10 axes</td>
<td>10 axes</td>
<td>not functioning yet</td>
<td></td>
</tr>
</tbody>
</table>

etc. | etc. | etc. | etc. | etc. | etc.
Example Progress Report “Contribution of Labour”

**Progress report “Contribution of labour”**

<table>
<thead>
<tr>
<th>Activities</th>
<th>Planned contribution</th>
<th>Actual contribution</th>
<th>Reasons for deviation</th>
<th>Corrective measures to be taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Preparation of pegs</td>
<td>10 farmers * 2 hours</td>
<td>10 farmers * 1.5 hours</td>
<td>less time was required</td>
<td>farmers can contribute more time in other tasks if required</td>
</tr>
<tr>
<td>1.2. Surveying alignment</td>
<td>2 farmers per day * 4 days</td>
<td>2 farmers per day * 4 days</td>
<td>etc.</td>
<td>etc.</td>
</tr>
</tbody>
</table>

For more technical information, see also:
- Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO, Chapter 4-7.

**Questions for discussion**

1. Were the planned activities for the past period implemented in due time?
2. What was the reason for any delay?
3. Was this delay due to - external factors?
   - non participation of farmers?
   - poor organization?
   - non or poor functioning of sub-committees?
4. What corrective measures can be taken to proceed with the implementation?
5. Do certain activities have to be rescheduled?
6. Does the rescheduling and corrective measures have major effects on the initial Action Plan?
7. What activities have to be undertaken in the following period?
8. Who is responsible for which tasks?
9. Are there any preventive measures that can be undertaken to prevent future delays?
EXERCISE 4G: OPERATION AND MAINTENANCE OF DRAINAGE

Introduction

Once the drainage system has been implemented the system needs to be operated and maintained. Depending on the type of drainage technology used and environmental conditions there are several tasks and activities that need to be undertaken for sound operation and maintenance (O&M).

Objectives

• To plan tasks and activities that have to be undertaken for sound O&M.

Expected outputs

• Action Plan for O&M defining the activities, responsibilities and a timeframe for operation and maintenance activities.

Preparations required

• Carry out a short assessment of all O&M activities.
• Make a short assessment of the cost and other inputs required for O&M.

Materials required

• Large sheets
• Small coloured cards
• Markers
• Pre-prepared tables

Time required

• Three hours.

Timing

• After Exercise 4E before actual O&M starts.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected outputs.

Small group exercise (50 min)

3. Divide the farmers in small groups of 4-5 farmers.
4. Ask each group to draw the cropping calendars for the main crops.
5. Ask farmers to indicate periods in which the different crops suffer from access of water and periods that crops suffer from water shortages.
6. Discuss the possibilities to alleviate these constraints through drainage operation management.

Plenary discussion (1 hour)

7. Ask each group to present the cropping calendars and options for drainage operation management.
8. Decide on the most promising drainage operation management.
9. Ask the farmers to identify the activities that need to be undertaken for sound O&M of the system. Note these down on a flip chart.
10. Decide on the timing of the activities and note these down as well.

Small group discussions (30 min)

11. Ask the farmers to go back to the same small groups.
12. Ask the farmers to discuss for the identified regular O&M activities the (a) quantities of materials required (b) estimated costs of the materials (c) labour requirements (d) where to find skilled labour if required (e) labour costs
13. Ask each group to fill in their estimates on a pre-prepared table (Exc. 1B).
Plenary discussions to finalize the Action Plan for O&M (30 min)

14. Discuss the estimations of the different groups and try to conclude on realistic estimates.

15. Discuss responsibility for the organization and implementation of the different tasks and activities.

16. Appoint/elect (new) sub-committees and responsible farmers for the different tasks and activities.

17. Note the names of subcommittee members and individual farmers down behind the respective activities on the flip charts.


Guidelines for (technical) preparations / questions for discussions

Considerations for drainage operation management

On the one hand, drainage is implemented to prevent crop damage due to excessive water. One the other hand, the worldwide continuous increase in water demand has increased the competition for water between industrial, agricultural, environmental and recreational needs. Increased competition for water requires intensive management of water resources. In the agricultural sector this has led to the necessity of conservation and recycling of the available water resources and sound water quality management.

Drainage management can contribute to these goals through:

- Conserving water and reducing drainage effluent through “water table management”.
- Recycling water resources by “reuse” of drainage water for irrigation.

Water table management is keeping the water table high through manipulating the drainage system operation so that plants can meet part of their evaporation needs directly from soil water. The permissible water table depth depends on the rooting depth of the crops grown, salinity of the shallow groundwater table and availability of leaching water. If both rice and dry land crops are grown in an area, rice should preferably be grown in independent operational drainage units that can be closed during the rice growing period.

Reuse of drainage water for irrigation can take place down stream of the drained area or within the area from where the drainage water is generated. It depends on the drainage water quantity, quality and the crops ‘how’ and ‘how much’ of the drainage effluent can be used for irrigation (Sub-module 4.4: Salinity management). Reuse might consist of direct reuse, blending, cyclic reuse of fresh and drainage water, or sequential reuse in which after each reuse cycle a more tolerant crop is grown. Often generation drainage effluent does not coincide with the demand for drainage water use for irrigation. Under these conditions storage of drainage water might be considered.
**Formats for Action Planning for O&M**

The same formats as presented in Exercise 4E can be used. In the column “responsibility” the names of the sub-committees or of individual farmers can be written down.

The formats for financial contribution, materials and labour as presented in Exercise 1B can be used.

**For more technical information, see also:**
- [Irrigation water management training manual No. 9, Drainage of irrigated lands, 1996, FAO, Chapter 8](#).

**Questions for discussion on drainage operation management**

1. What are the main crops in this area?
2. When are they planted and when are they harvested?
3. During which periods do they suffer from excessive water?
4. Do periods of water shortage occur?
5. During which period for which crops is drainage required?
6. Are there periods that it would be beneficial to keep the water table high?
7. Are there periods that you would like to use the drainage effluent for irrigation?
8. What are the consequences for the operation of the drainage system?

**Questions for discussion on the Action Plan for O&M**

9. What activities have to be undertaken by the farmers or other organizations for sound O&M of the drainage system?
10. Who is responsible for the implementation of the different activities?
11. When do the activities have to be undertaken?
12. What materials/inputs are required?
13. Should the materials/inputs be delivered in kind or cash?
14. Who is responsible to provide the various materials/inputs?
15. How much of each material is required?
16. What are the costs of the materials (unit prices)?
17. How much labour is required for each activity?
18. Is skilled labour required?
19. Does anybody within the farming community have these skills?
20. What are the costs for labour, both skilled and unskilled?
21. Besides these activities what are the other tasks that have to be undertaken to ensure smooth implementation?
22. Who will be responsible for the organization and implementation of the tasks and activities?
SUB–MODULE 4.3
FLOOD CONTROL

EXERCISE 4H: PLANNING OF FLOOD CONTROL MEASURES

Introduction

In case regular flooding inhibits further development of an area or early floods, flash floods or floods caused by torrential storms cause unacceptable levels of damage to an area, a flood control plan needs to be developed. In the first place, farmers need to decide whether flood control and protection measures are required and feasible. Secondly, it should be discussed what types of measures are desirable and at what scale these plans should be initiated. Finally, depending on the scale and works involved, farmers could look for co-operation in the planning and implementation from other farmers and government.

Objectives

- To prepare a flood control and prevention plan.

Expected outputs

- Decision on whether flood control/protection is desirable and feasible.
- Identified measures and scale of plans to reduce the damage caused by flooding.
- Identified partners for co-operation to carry out the identified activities.

Preparations required

- Discuss the flooding situation with the government officials to find out what has been done in the past and if the government is willing to co-operate in a better flood control.

Materials required

- Copies of the map prepared by the farmers in Exercise 4A.
- Small coloured cards and markers.
- Large sheets of paper and markers.

Time required

- Four hours.

Timing

- Well in advance of the flooding season.
- After Exercise 4A
Procedure (Steps)

**Plenary Introduction** (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected outputs.

**Small group discussions** (30 min)

3. Divide the farmers in small groups of three persons.
4. Ask farmers to discuss the origin and causes of floods and whether flood intensities, frequencies and heights have increased/decreased during the past.
5. Ask the groups to discuss the impact of floods on their farming systems and crop production.
6. The group should write positive impacts on green cards and negative impacts on red cards. Ask them to indicate whether impacts concern regular flooding or exceptional floods.

**Plenary discussion** (30 min)

7. Ask a representative of the groups to present their findings and stick the cards on a board.
8. Group similar impacts and summarize results.
9. Discuss positive and negative impact of flood control and protection measures.
10. Discuss whether flood control/protection works are desirable, what type of measures is required and at what scale they should be implemented.

**Group work - only to be done of flood control/protection is desirable** (1 hour)

11. Divide the farmers in the same groups again.
12. Provide each group with a copy the map prepared by the farmers during Exercise 4A. Ask the farmers to check the area(s) subject to flooding, sources of flooding and direction of flows.
13. Ask the farmers to discuss what they could do (maybe with the help of the government and other farmers) to prevent and control flooding.
Plenary discussion (1 hour 50 min)

14. One farmer should present their plan to prevent and control flooding.

15. Discuss the feasibility of the proposed plans.

16. Summarize the identified actions to prevent and control flooding and ask the farmers to select those actions they would like to be carried out.

17. On the basis of the selected actions ask the farmers to list down all the steps (activities) that have to be taken from planning/design until operation and maintenance.

18. Write the steps down in a chronological order grouping them under the headings planning & design, implementation, and operation & maintenance (see example under Exercise 4C, guidelines for (technical) preparation).

19. Discuss which activities can be solely done by the farmers and for which activities external help is required or which activities have to be completely done by an external organization.


Guidelines for (technical) preparations / questions for discussion

Impacts of floods

Flooding is a natural phenomenon in many parts of the world. Traditionally farmers’ cropping patterns are well suited to normal flooding. Flooding cause problems when they are unusually early, high or late, when water levels rise very quickly or when exceptionally heavy rainfall or cyclones occur.

Positive impacts
- Provides water for traditional cropping patterns;
- Replenishes soil moisture for post-monsoon crops;
- Fine-grained sediments increase fertility of the soil;
- Depressions, lakes and ponds will be refilled which is important for fisheries, irrigation and domestic water use.

Negative impacts
- Damage or destruction of established crops;
- Prevent farmers from planting in time or at all;
- Force farmers to plant alternative crops;
- Loss of land by river erosion;
- Loss of land fertility when buried in coarse sand or gravel;
- Salinisation of land when inundated with seawater;
• Damage or destruction of infrastructure and houses;
• Damage or destruction of farm equipment, stocks and livestock.

**Impacts of flood control and prevention measures**

In general terms the role of flood control and protection measures is to protect life and property against damage caused by floods. In agricultural terms the role of flood control and protection measures is to reduce the damage to crops and to increase agricultural potential. Implementation of flood control and protection measures in flood plains and deltaic zones will regulate the depth and timing of flooding. Where large areas are fully protected from floods by embankments, drainage of excess rainfall is normally obtained by gravity through sluices. Under this concept, excess rainfall is drained slowly through the monsoon season. If supplementary pumping is added, so changing to a polder-type of management, the area will be separated from the surrounding hydrological regime and independent water table control can be accomplished.

**Positive impacts**

• Crops are protected against damage from floods;
• Infrastructure, houses, farm equipment, stocks and livestock are protected against damage from floods;
• Opportunities for crop intensification and diversification;
• Improved farm management;
• Possibilities for farm mechanization.
• Prevention of damage to farm equipment, stocks, livestock, infrastructure and houses.

**Negative impacts**

• In general the flood level rises in areas unprotected by dikes or embankments and thus increasing the damage in these areas;
• Beds of rivers confined by embankments might experience a rise due to siltation causing drainage problems;
• If inadequate drainage measures are incorporated in flood protection works the area behind the embankments and dikes might suffer from drainage problems as rainwater will accumulate behind the flood protection work;
• Damage from floods caused by breaches in dikes and embankments are normally very destructive;
• Deltaic and tidal areas are often fragile ecosystems that are easily disturbed by development works.

**Type of flood control and protection measures**

Flood control and protection measures vary largely in scale, spatial coverage and technology. A distinction can be made between flood control measures that aim to reduce and delay the flow and thus the flood height, and measures that aim to protect certain areas from floods.

**Flood control measures**

These measures that aim prevent extreme flood events or to reduce the flood height and normally concern an entire river basin or a distributary. Flood control measures include:

• Stream channel improvement.
• Construction of storage reservoirs.
• Land treatment in the catchment area to reduce and delay run-off.
• Creation of storage capacity in lakes, marshes, and inundation polders.

**Flood protection measures**
Flood protection involves the construction of dikes and embankments to protect the area behind from flooding. Flood protection measures can range from regional large-scale to small local developments. Flood protection measures include:

• The construction of low submergible embankments to protect the harvest of dry season crops from early floods. The incorporation of surface drainage in this type of flood protection works would enhance early flood recession and create favourable conditions for early planting of dry season crops. However, when drainage is done by gravity, time and speed of recession depend entirely on the outer water level at the drainage outlet.
• Complete protection of areas from floods by embankments in which drainage of excess rainfall is obtained by gravity through gates or sluices. The time and speed of recession depend entirely on the outer water level at the drainage outlet.
• Construction of polders. In polders an area is completely protected from floods by embankments in combination with supplementary pumping. The advantage of polders over flood control in combination with drainage under gravity is that additional lands can be planted and planting can take place earlier in the season (crop intensification). The introduction of subsurface drainage in those lands protected from floods would help to increase paddy production, and in lands, which are suitable for crops other than rice, crop diversification could be obtained.

**Flood preparedness and warning systems**
Other non-engineering measures to reduce the damage from floods include flood forecasting and warning systems and flood plain zoning.

**Precaution measures**
There are further a number of precaution measures that can easily be implemented by individual farmers. These measures include:

• Construct raised seedbeds so that seedlings will not be submerged.
• In flood prone areas seedbeds should be resown after transplanting in case floods destroy the first planting.
• Keep a reserve seed stock.
• Plant woody crops that can stand flooding around fields to break the force of waves and keep out floating masses, e.g. dainchya (sesbenia).
• Avoid flood prone sites.
• Make a bund around fields, which is high enough to keep flash floods and early floods out.
• Plant early.
• Choose suitable crop varieties.

**Consideration for flood control measures**
Flood control and protection measures including polder developments are normally implemented in the context of the overall planning of a larger area, e.g. delta areas or river...
basins. Due to this reason, planning and implementation of flood control and protection measures are normally beyond the scope of a single group of farmers. This does not imply that farmers should not be involved in the development process. On the contrary, as implementation of flood protection and control measures will alter the hydrology of an area, farmers should be fully involved in the planning process and farmers needs and wishes should be incorporated in the designs whenever possible. The responsibility for planning of on-farm works, e.g. on-farm drainage as integral part of the flood control works, and small-scale flood protection and precaution measures, should be entirely with the farmers’ groups.

Similar to drainage development, the level of flood control and level of sophistication of the flood control works should suit the general development level of a region.

Questions for discussion on the impacts of floods

1. Are the crops and the cropping patterns adjusted to regular cropping events?
2. Do floods increase soil fertility?
3. For what purposes are lakes, ponds and depressions used?
4. What is the impact of floods on the function of the ponds, lakes and depressions?
5. Are there any other positive impacts of floods on crop production or livelihood of the community?
6. What is the impact of extreme flood events on crop production?
7. Do floods destroy soil productivity through e.g. deposition of stones, inundation with saline water?
8. Does riverbank erosion occur?
9. What other damage is caused by floods rather than damage to crop production?
10. How often do destructive floods occur?
11. Has the frequency, intensity, and/or depth of flooding increased/decreased over the past decades/years?

Questions for discussion on the impacts of floods control measures

12. What positive impacts do you expect from flood control and protection measures for crop production and farm management?
13. What other positive impacts do you expect for the local community?
14. What will be the impact in areas that are unprotected by dikes or embankments?
15. If beds of rivers confined by embankments might experience a rise due to siltation what would be the effect?
16. What would be the impact of embankments and dikes on the drainage situation?
17. What will happen when a dike or embankment breaks during a flood event?
18. What will be the impact of flood control and protection measures on the ecosystems?

Questions for discussion on the desirable type of floods control measures

19. Should measures aim to prevent extreme flood events or to reduce the flood height?
20. Is it feasible to aim at measures that include an entire river or distributary basin?
21. Should the measures aim at protecting a localized area?
22. What size is the smallest independent unit that can implement measures to protect itself from flood damage?
23. Is it desirable to protect an area completely from floods or is it sufficient if crops can be protected against early floods?
24. Is it sufficient to drain the protected area simultaneous with the flood regression?
25. Is additional pumping for drainage required?
26. Would it be beneficial to incorporate additional subsurface drainage measures?
27. What governmental agency and which farmers needs to be involved in planning and implementation of the proposed flood control and protection measures?

**Questions for discussion on the additional measures to reduce crop damage**

28. What can this group of farmers do independently to minimize flood damage?
29. What precaution measures can individual farmers implement?
EXERCISE 4I: IMPLEMENTATION OF FLOOD CONTROL MEASURES

Introduction

After plans and designs have been made and approved, the activities that need to be undertaken to implement the flood control, protection and precaution measures have to be scheduled. This exercise can be used for both the planning of implementation activities as well as for the planning of operation and maintenance activities, or use Exercise 4G steps 1, 8-16.

Objectives

- To plan activities that have to be implemented in order to realize the selected flood control, protection and precaution measures.

Expected outputs

- Action plan defining the activities, responsibilities and a timeframe for implementation of selected flood control, protection and precaution measures.

Preparations required

- Carry out a short assessment of all activities that need to be undertaken to implement the selected measures and the required resources.
- If designs were made by a governmental organization assure that farmers have approved the designs and agreed on the division of tasks and responsibilities between both parties.
- Make a short assessment of the cost of possible construction materials and other inputs required.

Materials required

- Large sheets
- Small coloured cards
- Markers
- Pre-prepared tables

Time required

- Three hours and 45 minutes.

Timing

- After Exercise 4E and after approval of designs for flood control and protection measures.
Procedure (Steps)

Plenary Introduction (20 min)

1. Review of previous training session (Exc. 1, Part C).
2. Review the plans and designs and discuss the tasks and responsibilities of the different parties involved.
3. Explain the specific objectives and expected outputs.

Plenary Action Planning (1 hour 30 min)

4. Discuss with the farmers that the planned flood control and protection measures can be regarded as the final output or goal for which the Action Planning will be made.
5. Ask farmers which intermediate-results or intermediate-outputs have to be achieved to reach the final output. Write the intermediate-outputs on cards.
6. Put the intermediate-outputs in a logical order (one step after the other).
7. Ask the farmers to identify the activities that need to be undertaken to reach the intermediate-outputs.
8. Order the activities in a chronological order and place them behind the intermediate outputs.
9. Identify the responsibility for the different activities based on the step-by-step plan made during exercise 4H.
10. Write the responsibilities on cards and place behind the activities.
11. Decide on the timing of the activities and note these down as well.
12. Identify the materials required for each output. List them down.
13. Indicate behind each item who will provide the inputs and whether the items are provided in kind or cash.
14. Copy the Action Plan in pre-prepared tables (see Exercise 4E).

Small group discussions (1 hour)

15. Ask the farmers discuss in small groups of 4-5 farmers for one of the intermediate-outputs (and only for the activities for which the farmers are responsible) the (a) quantities of materials required (b) estimated costs of the materials (c) labour requirements (d) where to find skilled labour if required (e) labour costs.
16. Ask each group to fill in their estimates on a pre-prepared table (Exc. 1B).

**Plenary discussions to finalize the Action Planning** (1 hour)

17. Discuss the estimations of the different groups and try to conclude on realistic estimates.

18. Discuss responsibility for the organization and implementation of the different tasks and activities.

19. Appoint/elect sub-committees and responsible farmers for the different tasks and activities.


**Guidelines for (technical) preparations / questions for discussion**

**Examples of Formats for Action Planning**

See Exercise 4E

**Questions for discussion**

See examples Exercise 4E replace drainage measure by flood control measure.
EXERCISE 4J: PLANNING OF SALINITY CONTROL MEASURES

Introduction

In case salinity causes unacceptable levels of damage to crop production, measures need to be developed to control salinity or to mitigate the ill effects of salinity on crop production. In Exercise 4A, farmers have identified the causes of salinity and briefly discussed potential solutions, in this exercise a detailed plan to cope with salinity problems will be established.

Objectives

- To prepare plan to control and mitigate the ill effects of salinity on crop production.

Expected outputs

- Identified measures to control and mitigate the effects of salinity on crop production.

Preparations required

- Chemical analysis of soil and water resources.
- Make short assessments of: 1) availability and cost of water soil amendments; and 2) locally available crop species and varieties and their tolerance to salinity.

Materials required

- A copy of the map and the “cause and effect diagram” prepared by the farmers in Exercise 4A.
- Small coloured cards and markers.
- Large sheets of paper and markers.

Time required

- Three hours.

Timing

- After Exercise 4A
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of the previous training session (Exc. 1, Part C).

2. Discuss briefly the outcome of Exercise 4A on the basis of the map and the “cause and effect diagram”.

3. Explain the specific objectives and expected outputs.

**Small group discussions** (30 min)

4. Divide the farmers in small groups of 4-5 persons.

5. Ask each group to discuss their experiences with or known practices for soil reclamation, measures to control or mitigate effects of salinity and/or irrigation with saline water.

6. Request each group to write down on green cards which measures worked and which measures failed.

7. Ask the groups to select those measures that they expect to work in this area.

**Plenary discussion** (30 min)

8. Ask each group to present the measures that they expect to work for this area.

9. Discuss with the farmers, based on the outcome of the soil and water analysis and knowledge of the physical conditions in the area, whether the measures could technically work and suggest additional measures that have not been suggested by the farmers.

**Small groups exercise** (1 hour 30 min)

10. Divide the farmers in the same groups again. Assign one measure to each group.

11. Explain the purpose of the Strengths, Weaknesses, Opportunities and Limitations (S.W.O.L.) analysis and distribute pre-prepared sheets for the S.W.O.L. analysis (see Guidelines for technical preparation).

12. Explain the four categories Strengths, Weaknesses, Opportunities, and Limitations (S.W.O.L.) to the farmers and explain that they should evaluate the measures on these four points (see Guidelines for (technical) preparation).
13. Ask each group to evaluate the selected measure on the four points and request them to write these down on the pre-prepared sheets.

**Plenary discussion** (30 min)

14. Ask each group to present their S.W.O.L. analysis.

15. Discuss the S.W.O.L. analysis and select a set of measures to be tried out in the field.


**Guidelines for (technical) preparation / questions for discussion**

**Reclamation of salt affected soils**

Whether it is attractive for farmers to reclaim soils and how reclamation will be attained depends on the salt concentration, type of salts, soil texture, availability of water and soil amendments, and the economic environment. Salt affected soils can be divided into saline, saline sodic, and sodic soils and accordingly reclamation techniques are advised.

**Saline soils**

The principle method for reclamation is leaching of salts by ponding water on the soil surface and allowing it to infiltrate. For effective leaching either sufficient natural drainage is required or an artificial subsurface drainage system to discharge the salty drainage water outside the area. As a rule of thumb a unit depth of water will remove about 80 percent of the salts from an equivalent unit of soil depth. Though if large-scale reclamation is planned more reliable estimates have to be made. This can be done through conducting leaching tests on a limited area and the preparation of leaching curves. Amendments are not required in saline non-sodic soils.

**Saline sodic soils**

As for saline soils the major method for reclamation is leaching of salts. Desalination is always accompanied by desodication although the rate of desodication is slower than the desalination process. Therefore, the application of amendments is not per se necessary. It will depend on the soil infiltration characteristics and the salinity of the leaching water whether the application of amendments is desirable. When soils susceptible to crusting or aggregate degradation are leached with low salinity water, application of an amendment might be desirable to enhance the reclamation process. The choice of amendment depends on soil characteristics, price and availability of the amendments and farmers resources.

**Sodic soils**

Basically the reclamation of sodic soils requires the replacement of most of the exchangeable sodium by calcium ions in the root zone. The way to accomplish this depends on the local conditions and local resources. If farmers do not have the resources to buy chemical amendments or they are not available reclamation can be obtained slowly by cultivating sodic tolerant crops and integration of organic residues in the soil. For a reasonably quick
reclamation process, application of chemical soil amendments followed by leaching is necessary. There are three groups of chemical amendments: soluble calcium salts (e.g. gypsum, calcium chloride), acid and acid forming substances (e.g. sulphuric acid, iron and aluminium sulphate, sulphur, and pyrite), and low soluble calcium salts (e.g. ground limestone). The applicability of the various groups of amendments depends on the soil conditions. Acids and acid forming substances are only suitable when the soil contains natural calcium carbonate. While ground limestone will only be effective to be applied to soils having a pH of about 7.0 or below.

**Strategies for the use of saline water for crop production**

The feasibility of using saline water for crop production depends on the quality, quantity, time of availability, and crops grown. Saline water can be used directly for irrigation or in conjunction with fresh water sources. If saline water is used in conjunction with fresh water the saline water can be either be blended with fresh water or used cyclic in which the fresh water and saline water are applied according to the different growth stages or in crop rotations between tolerant and sensitive crops.

**Direct application**

If the salinity concentration in the water does not affect the potential crop yields, or expected yield losses are acceptable, the water source can be used directly for irrigation (see attached tables). Care should be taken that salinity concentration does not build up in the root zone, therefore periodic leaching should be applied.

**Blending two water sources**

The blending strategy is normally applied when the saline water source is too saline for direct application and/or the fresh water source are insufficient. When blending two water sources the mixed water source should have such a salinity concentration and composition that it does not affect crop yields. Like in the direct application sufficient periodic leaching has to be ensured to prevent salinity levels building up in the root zone. Further, the final quality of the blended water should be such that other water uses e.g., domestic water use and use for environmental purposes, is not endangered.
Cyclic use

If two water sources are available the saline water can be used to irrigate salt tolerant crops or during salt tolerant growth stages. In general a pre-irrigation should be applied with the best quality irrigation water, as most crops are sensitive to salinity during germination. Later in the cropping season most crops become more tolerant to salinity. In cyclic application the tolerable salinity concentration in the irrigation water is in general higher than mentioned in most literature sources. As in the other two application strategies sufficient periodic leaching has to be ensured to prevent salinity levels building up in the root zone.

Use of sodic water

The presence of a high concentration of sodium in comparison to calcium plus magnesium and a relatively low total salt concentration, or the presence of bicarbonates in the irrigation water threatens the stability of soil aggregates and subsequently interferes with water infiltration and crop production. To mitigate such problems gypsum is normally added, either directly to the soil or dissolved in the water.

Additional management option to mitigate the effects of salinity on crop production

Selection of salt tolerant crops and varieties

A wide range of relatively salt tolerant crops exists and in many parts of the world salt tolerant varieties have been developed. Selecting more salt tolerant crops and varieties offer possibilities for utilization of saline water resources and saline lands for crop production.

Frequent irrigation application

Frequent irrigations maintain high higher soil water contents while maintaining lower concentrations of soluble salts. As salinity decreases the availability of soil water for plant uptake frequent irrigations will promote better crop growth.

Modify the irrigation method

Each irrigation method has certain advantages and disadvantages for salinity management. Sometimes it could be beneficial from a salinity-control point of view to shift to a different irrigation method. The most commonly recognized advantages and disadvantages of different methods are:

- With surface irrigation methods the infiltration is often not even which can result in isolated pockets of accumulated salts. Further, as the depth of applied irrigation water is quite high, an increase in irrigation frequency will often lead to deep percolation causing drainage and waterlogging problems. Though with basin irrigation large irrigation applications can be applied that will leach the salts over the entire field below the root zone.

- Sprinkler irrigation normally will apply water with a good uniformity. The frequency can be increased to maintain high soil water content. Also if well managed, adequate and uniform leaching can be obtained. The largest disadvantage of sprinkler irrigation is that
sprinklers can cause leaf burn if salts accumulate on the leaves between rotations of the sprinklers.

- With localized irrigation systems the soil moisture can be kept very close to field water-holding capacity. The irrigation can be given in such a quantity that a slight but nearly continuous downward movement of moisture and salts is maintained. When saline water is used for irrigation with localized irrigation the best yields can be obtained. During the season salts accumulate at the edges of the wetted area. When salts are moved by rain serious damage to crops might result. In this case periodic leaching through surface or sprinkler irrigation has to be done. The disadvantage is that this might require a second irrigation system and large quantities of additional water are required.

**Land preparation**

To permit uniform water distribution and leaching field needs to be sufficiently graded. Land smoothing also promotes uniform water distribution of water. Further, shortening of furrow and border length and reducing the size of basins will in general promote better and more uniform water distribution and leaching. The actual length of the furrow or border depends on soil type, slope and irrigation discharge. For optimal salinity control, land grading and smoothing is more crucial when surface irrigation is applied than when sprinkler or localized irrigation systems are used.

**Salinity control during germination**

Salinity reduces or slows down germination making it difficult to obtain a satisfactory crop stand. Therefore it is important to control salinity during the critical period of germination. Placement of seeds, bed shaping and irrigation management are important instruments to maintain low salt concentrations around the seeds during germination.
S.W.O.L. (Strengths, Weaknesses, Opportunities and Limitations) analysis

This tool recognizes that there are usually two different sides (positive and negative) to any given solution or measure. Further it also helps to identify the opportunities and the limitations for implementing certain measures in the field. It encourages discussion on all four aspects. In this way it helps to set the basis for selection of a set of measures and to identify action to be undertaken to enable implementation in the field.

Explanation of the four categories:

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunities</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths are those effects that are expected to have a positive impact on the agricultural production. Strengths are the best aspects of the measure under consideration.</td>
<td>Weaknesses are those effects (or secondary effects) that are actually unwanted.</td>
<td>Opportunities are all possibilities for positive implementation of the selected measures, given both the strengths and weaknesses. Opportunities are the chances to change things for the better.</td>
<td>Limitations are the things that prevent implementation of measures. It is those things that stop farmers from realizing the opportunities. Some limitations can be overcome, others cannot.</td>
</tr>
</tbody>
</table>

S.W.O.L. analysis format and example

<table>
<thead>
<tr>
<th>TOPIC Salinity control</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEASURE: Reclamation of sodic soils</td>
</tr>
</tbody>
</table>

**STRENGTHS**  | **WEAKNESSES**  | **OPPORTUNITIES**  | **LIMITATION**  |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• More land for crop production</td>
<td>• Loss of fuel wood</td>
<td>• Enough labour is available in the community</td>
<td>• Gypsum is expensive</td>
</tr>
<tr>
<td>• Less migration as land can be allocated to landless</td>
<td>• Loss of land which can be sold to brick factories</td>
<td>• Sodic wasteland is communal.</td>
<td>• Irrigation water has to be made available</td>
</tr>
</tbody>
</table>

For more technical information, see also:

Questions for discussion on identification of measures

1. Do you have experience in reclaiming saline/sodic soils?
2. What did you do to the reclaim the soil?
3. What was the end result?
4. Why did this measure work or why did it not work?
5. Would this measure work under different conditions?
6. If the measure did not work or if you did not try to reclaim saline soils what do you think is required to enable soil reclamation?
7. If you do not have experience in reclaiming saline/sodic soils, do you know if other farmers in the region have tried to reclaim soils?
8. What did they do to reclaimer the soil?
9. What was the end result?
10. Why did their measure(s) work or why did they not work?
11. Would their measure(s) work in this area?
12. Why do you expect the measures will (not) work?

13. If you irrigate with saline water, are there special measures that you take to prevent negative effects on soil quality or crop production?
14. What is the effect on the soil quality and crop production?
15. Are there any measures that could improve the crop yield and/or soil quality?
16. What is required to implement these improvements?
17. How are other farmers in the region using saline water?
18. What is the effect of their method on the soil quality and crop production?
19. If these methods work, could they also work in this area?
20. Why do you expect these measures (not) work here?

21. Do you select special crops or crop varieties?
22. Do you know if any salt tolerant crops or varieties exist?
23. Do they produce better yields?
24. If you have not tried any salt tolerant crop or variety why did you not do so?
25. Do you follow a different irrigation schedule for saline water sources or saline fields?
26. How does it differ and what is the effect?
27. Would it be beneficial to change to a different irrigation method?
28. Did you or farmers in the region try different irrigation methods?
29. What was the effect on the soil quality crop production?
30. What is the effect of land grading, furrow length and basin size on salinity control?
31. Are you aware of any methods that will increase the seedling emergence?

32. Which set of measures might be suitable to be tried out in this area?
33. What positive impacts do you expect from these measures on the agricultural production?
34. Are there any other positive impacts that might result from the measures?
35. Are there any negative side effects to be expected?
36. What are the possibilities and opportunities for implementing the measures?
37. What limitations do you so for implementing these measures?
38. Based on the positive and negative effects, and the identified opportunities and constraints what set of measures can be tried out in the field?
Module 5:
WATER USERS ASSOCIATION
MODULE 5

WATER USERS ASSOCIATION

Introduction

There are several reasons why farmers decide to strengthen their cooperation in the operation and maintenance of an common water control management system and there are several forms in which such cooperations can be organized. The complexity of the activities for which farmers decide to cooperate will determine the management and organizational requirements.

The exercises have been sub-divided in two sub-modules.

References

In the preparation of the exercises in the module use is made of the following publications:

- A guide to the transfer of irrigation management services, Irrigation and Drainage paper No. 58, 1998, FAO and International Water Management Institute, Rome – Colombo
- Irrigation water management training manual No. 10, Irrigation scheme operation and maintenance, 1996, FAO
- Socioeconomic and Gender Analysis (SEAGA) Sector Guide: Irrigation, 1998, FAO

Additional technical information can be obtained from the above mentioned publications.
Sub-module 5.1: Development of farmers’ cooperation

In exercise 5A (phase: planning) farmers will investigate in which water management activities better cooperation is required. Based on this they will decide to formalize cooperation in water management. In exercise 5B (phase: planning and construction) the farmers will develop the guidelines for the organizational structures, tasks and responsibilities, and rules and regulations. The finalization of the management and organizational requirements and endorsed by the farmers will take place in exercise 5C (phase: planning and construction).

Sub-module 5.2: Defining rules and regulations

The farmers will define the water fees and the operation and maintenance in exercise 5D (phases: operation) and 5E (phase: operation and maintenance). In Exercise 5F (phase: maintenance) farmers will play a role-play on how to deal with conflicts.
SUB-MODULE 5.1
DEVELOPMENT OF A FARMERS’ CO-OPERATION

EXERCISE 5A: NEED FOR FARMERS’ CO-OPERATION IN WATER MANAGEMENT

Introduction

Before starting discussing the establishment of a water user association, it is important to identify with the farmers for which activities better cooperation is required (for example, operation and maintenance) and if there is a need for more formalized farmers’ cooperation in water management. What could be the benefits of (formalized) farmers’ cooperation and what do farmers have to invest in time and money? What are the rights, and obligation, they will get? These are some of the questions that need to be answered first.

Objectives

- To identify joint activities for better water management

Expected outputs

- Identified water management related activities, where farmers’ cooperation needs to be improved.
- Identified what is needed to improve farmers’ cooperation.
- Assessment of the farmers’ interest in more formalized farmers’ cooperation (WUA or WUG)

Preparations required

- None.

Materials required

- Large sheets of paper and markers.

Time required

- Two and half-hours.

Timing

- Second half of the FST.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Brainstorming (30 min)

3. Ask the farmers to mention all water management related activities in which an increased farmers’ cooperation could have a positive impact. Recall the different previous exercises during which the use of a WUA has been considered (maintenance and/or operation of pump, canals, water distribution, etc.). Write the mentioned activities down on a large sheet of paper.
4. Discuss shortly the listed activities, take out the duplicates and decide on the final list.

Small group discussion (50 min)

5. Ask the farmers to discuss in small groups (4-5 persons) what kind of farmers’ cooperation is needed for each activity listed.
6. Ask the groups to present the results of their discussions.

Plenary discussion (1 hour)

7. Discuss the different farmers’ cooperations required.
8. Ask the farmers what is needed to obtain these required farmers’ cooperations.
9. Discuss what is expected of the farmers when they establish a more formalized farmers’ cooperation and what they can expect in return.
10. Summarize the advantages and disadvantages of establishing more formalized farmers’ cooperation (WUA) and ask the farmers if they are interested to establish one themselves.
Guidelines for (technical) preparations / questions for discussions

Formalized farmers’ cooperation

Benefits
- Farmers organized as a group can easier mention production problems towards government extension units. Quick and well-targeted interventions can be made to solve these problems.
- More efficient O&M of irrigation facilities can be organized.
- A farmer group stands stronger in negotiations with government and private sector (purchasing of inputs or selling of harvest).
- Agricultural inputs can be purchased in bulk at lower prices.
- Investments in the irrigation system are discussed and coordinated among group members.
- The group is a platform for conflict management between upstream and downstream farmers.

Expected inputs from the members
- Define and agree on a clear objective and organization structure for the group.
- Commitment to the group and it’s objectives.
- Contribution in the form of money and/or labour.
- Entrust the management to a small group of representatives.

For more information, see also:
- A guide to the transfer of irrigation management services, Irrigation and Drainage paper No. 58, 1998, FAO and International Water Management Institute, Rome – Colombo, Chapter 5

Questions for discussions
- What are the activities that can be carried out more effectively in a group?
- Who are the relevant stakeholders?
- Is it important that all relevant stakeholders are included in the formulation process of a WUA or WUG? And if yes: How can they be included in the process?
- Do you think you have sufficient skills to manage a WUA or WUG?
- Will the irrigation department support the formation of a WUA or WUG?
- Are there organizations or individuals, which do not like to see you getting organized in a WUA or WUG?
- How will you deal with that?
- What will be an acceptable WUA or WUG contribution and/or water-fee?
EXERCISE 5B: DEFINING ORGANIZATION

Introduction

After the farmers have identified the need to improve farmers’ cooperation through the establishment of farmers’ organization or, more specifics, a WUA or WUG, farmers have to decide on the organization objectives, structure, management, etc.

Objectives

- To define the WUA or WUG (farmers’ organization).

Expected outputs

- A draft proposal for the
  - Tasks and functions of the WUA or WUG,
  - Institutional aspects and organizational form,
  - Rules and regulation of the WUA or WUG,
  - Operation and maintenance procedures carried out under the WUA or WUG.

Preparations required

- Try to find out where close to the area a group of farmers have organized themselves in a WUA or WUG.
- Invite two representative farmers from the WUA to inform the group on how they have organized their WUA or WUG.
- Write on a large sheet of paper the keywords of the organizational characteristics of successful WUA or WUG.

Materials required

- Large sheets of paper and markers.

Time required

- Three and a half-hours.

Timing

- Second half FST.
**Procedure (Steps)**

**Plenary Introduction** (15 min)

1. Review of previous training session (Exc. 1, Part C).

2. Explain the specific objectives and expected output.

**Plenary discussion** (1 hour and 10 min)

3. Recall the activities that could be carried out more effectively if farmers would get formally organized in a WUA or WUG.

4. Discuss with the farmers what is needed to establish a WUA or WUG.

5. Introduce the Key organizational characteristics of successful WUA or WUG. Discuss with the farmers each point and decide on which of those points are important for the WUA they would like to establish. Mark them on the paper.

6. Introduce the guests and ask them what for their WUA or WUG the important organizational characteristics are, and what they think of what has been selected so far by the participating farmers.

7. Summarize the contribution(s) of the guests and discuss it with the farmers.

**Small group discussions** (1 hour)

8. Split the farmers in small groups of 4-5 persons. Divide the selected organizational characteristics among the groups (1 or 2 per group)

9. Ask each group to work out a draft proposal(s) on what needs to be organized to guarantee the organizational characteristic(s) that has been assigned to the group.

10. Ask each group to present the draft proposals they have prepared.

**Plenary discussion** (1 hour and 10 min)

11. Discuss with the farmers the proposals. Ask the guests to comment.

12. Try to reach decisions on the presented proposals and to integrate them in one proposal for the establishment of the WUA or WUG.

13. Ask the farmers to select among them self 3-4 volunteer to formulate; basic organizational structure, mission and basic policies, rules and sanctions for the
WUA or WUG (articles of association, or constitution, and the by-laws) based on the draft proposal prepared and agreed upon.

14. Ask the volunteers to present their work during the next training session for approval.


Guidelines for (technical) preparation / questions for discussions

Key organizational characteristics of successful WUA’s

The organization has:
1. a legal & political recognition to perform all its core functions,
2. a sustainable and measurable water right,
3. a clear definition of who are the members of the organization,
4. an agreed and measurable definition of its irrigation services,
5. means for excluding non-members and/or non-payers from receiving the services provided by the organization,
6. full control over O&M, financing and dispute resolution,
7. primary responsibility for financing O&M and rehabilitation and modernization,
8. a balance of full responsibility and authority for its key functions,
9. clear policies, rules and leaders which are subject to approval, rejection or removal from office by the majority of water users,
10. transparent administration, operations and performance,
11. full control over irrigation infrastructure and rights of eminent domain,
12. a service charge which is based upon actual service delivery and strict accounting practices,
13. financial and technical audits performed by the government or other independent entity,
14. power to impose strong incentives and sanctions to ensure:
   a) accountability of water users to agreed rules and policies,
   b) accountability of selected leaders to the assembly of water users,
   c) accountability of management staff to WUA leaders.

The above list can be considered as a vision of the ideal. But experience suggests that the more of these characteristics are present the more successful and sustainable the WUA is likely to be.

Definition of who are the members of the organization

A few basic principles which seem to be generally accepted world-wide:
• eligibility for membership should be determined through clear rules about who should have a right to receive the water service and have an obligation to pay for it,
• a member need not be a landowner but should have a relatively stable attachment to receiving and paying for the water service (how stable this should be can only be determined locally),
• both men and women should have rights to membership or at least participation in decision-making, even if they belong to the same household. Special arrangements should be sought to permit women, along with their husbands, to become voting members.

A **measurable service definition** should include the following elements:
• what is the service area for water delivery and disposal,
• what amount of water will be diverted and delivered,
• when will the water be delivered and removed,
• how water users will pay for the service.

**Basic documents that are normally prepared for the establishment of the WUA or WUG**

The basic documents that are normally prepared for the establishment of the WUA or WUG are the articles of association, or constitution, and the by-laws. The articles of association normally contain the following elements:

1. a mission statement, which describes the purpose of the organization,
2. a statement about what type of legal entity it is and its legal basis of authority,
3. definition of the service area,
4. description of the criteria for membership,
5. description of basic functions of the organization,
6. description of basic rights, powers and obligations of the organization,
7. description of basic rights, powers and obligations of members of the organization,
8. description of governance structure of the WUA or WUG, powers of leaders and their relationship to the service providing entity,
9. method for amending the articles of association

The by-laws are the accompanying descriptions of rules for how the articles of association are to be implemented. They generally include the following:

1. rules for receiving new members and expelling existing ones,
2. constitution of the governing board of officers, periods of tenure in office and rules for selection and removal of association leaders,
3. definition of the water service,
4. rules and sanctions related to the water service,
5. rules and sanctions related to support functions (maintenance and financing),
6. procedures for conflict resolution,
7. duties of the board of directors,
8. procedures for amending the by-laws.
For more information, see also:

- A guide to the transfer of irrigation management services, Irrigation and Drainage paper No. 58, 1998, FAO and International Water Management Institute, Rome – Colombo, Chapter 7

Questions for discussions

- Can all farmers in the command area automatically become members of the WUA or WUG?
- Can only landowners become member, or also renters, sharecroppers, squatters, sub-tenants and so on?
- Landowners with more than one field will they receive multiple membership?
- Should only one person per field or per household (men or women?) be permitted to be a member?
- What will be done to encourage the participation of women in the WUA or WUG?
- Should in this (development) stage of the WUA or WUG not already all relevant stakeholders be present? Or will this take place in a community meeting outside the FST?
- Who are presently responsible for the services that the WUA or WUG will start to provide?
- Will they give the WUA or WUG the rights to provide those services?
- How will the coordination between the previous service providers and the WUA or WUG be organized?
- Should the WUA or WUG be a single-purpose irrigation management entity or should it have rights to take on other functions as well? (Provision of agricultural service?)
- What would be the best timing for the establishment of the WUA?
EXERCISE 5C: FOLLOW-UP DEFINING ORGANIZATION

Introduction

A draft article of association, or constitution and the by-laws are prepared by 3-4 volunteers, but still need to be discussed and endorsed be the other farmers. But after that still a lot needs to be done. A board of directors needs to be chosen, contributions and water fees set, etc. When there is a basic concept for a WUA, a plan of action needs to be developed to take the WUA in operation.

Objectives

- To prepare a plan of action to take the WUA in operation.

Expected outputs

- Endorsement of the “draft article of association” and the “by-laws”.
- A plan of action to take the WUA in operation.

Preparations required

- Check if the volunteers have managed to finalize the preparation of the “draft article of association” and “by-laws”. If not, assist them in the finalization.

- Prepare with the volunteers a presentation of the “draft article of association” and “by-laws”.

Materials required

- Large sheets of paper and markers.

Time required

- One and half-hour.

Timing

- After the draft article of association” and the “by-laws” for the WUA have been completed.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Plenary discussion (1 hour and 20 min)

3. Ask the volunteers to present the “draft article of association” and the “by-laws” for the WUA or WUG.
4. Discuss the “draft article of association” and the “by-laws”. Make amendments where they are needed. Ask the farmers to endorse the “draft article of association” and the “by-laws” for the WUA or WUG.
5. Discuss with the farmers what needs to be done further before the WUA or WUG can start to operate. Some points to consider are:
   • To discuss the WUA or WUG initiative with the water department and local authorities.
   • Present and discuss the WUA or WUG initiative with the entire farmers’ community in the command area (community meetings).
   • Selection of a board of directors.
   • Define the WUA or WUG member contribution and/or water fees.
   • Selection of office location WUA.
   • Planning official opening/inauguration of the WUA or WUG.
6. Prepare with the farmers a plan of action (activities, who is responsible, time frame, inputs needed, expected outputs).
7. Decide with the farmers on when to meet again to discuss the progress made in establishing the WUA or WUG.

Guidelines for (technical) preparation / questions for discussions

For more information, see also:
• A guide to the transfer of irrigation management services, Irrigation and Drainage paper No. 58, 1998, FAO and International Water Management Institute, Rome – Colombo, Chapter 7 and 10
Questions for discussions

• Is it needed to officially register the WUA or WUG?
• Are there other WUAs or WUGs in the area you could work together with?
• Do you have all the skills to manage a WUA or WUG?
• Do you need additional training to manage the WUA or WUG?
• Is capital needed to establish the WUA or WUG? And how do you think you will get that?
• Should all major stakeholders be presented in the board of directors?
• What will be the tasks/responsibilities of the board of directors?
• How will the board of directors communicate with the members of the WUA or WUG?
• How often will the board meet? And, how often will be a meeting organized with the members?
SUB-MODULE-5.2
DEFINING RULES AND REGULATIONS

EXERCISE 5D: DEFINING WATER FEES

Introduction
Members of a WUA, or other kinds of farmers’ organization, have to develop policies how the organization will deal with all kinds of issues. As an example, defining water fees, is often an important issue for which the organization has to develop rules and regulations (policies). Member farmers have to decide on how much they are going to pay for the water, will members pay the same amount as none members, how will the water fee be collected, etc.

Objectives
- To define water fees
- To go through the process of formulating policies for the WUA.

Expected outputs
- Clear definitions of water services.
- Water fees for (non-) members of the WUA or WUG.
- Rules and regulations for water fee collection.

Preparations required
- None.

Materials required
- Large sheets of paper and markers.

Time required
- Two and A half-hours.

Timing
- During the planning of operation farmers’ organization (pump, WUA, etc.).
Procedure (Steps)

Plenary Introduction (10 min)

1. Review of the previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Brainstorming (20 min)

3. Ask the farmers to mention all the activities needed to supply water to the fields and list these down on a large sheet of paper.
4. Discuss the activities listed and add the once missing.

Small group discussions (30 min)

5. Ask the farmers to discuss in small groups of 4-5 persons the costs involved to carry out all the activities mentioned to supply irrigation water (50 m³) to a Paddy field (1000 m²). Ask the groups to write their calculations on a large sheet of paper.
6. Ask the groups to present their calculations and compare the results.

Plenary discussion (1 hour and 30 min)

7. Ask the farmers what they are used to pay for irrigation water and list this down on a large sheet of paper.
8. Compare the previous price and expected water supply costs. Identify the minimum possible water fee (to cover only the supply costs) and the maximum fee farmers are maybe prepared to pay.
9. Try to identify a water fee level acceptable for all members and high enough to cover the operation, management and investment costs.
10. Discuss if non-members will get the possibility of receiving water as well and if they will have to pay the same water fee or more.
11. Discuss with the farmers how the payments of the water fee will be collected.
12. Ask the farmers what they will do with non-payers, what will be the procedures in dealing with and penalties for non-payers.
13. Summarize the discussions and ask the farmers to endorse the decisions taken.
Guidelines for (technical) preparation / questions for discussions

Activities to supply irrigation water

- Operating the distribution structures (gates).
- Measuring the amount of water supplied.
- Administration of the water request, and planning of the supply schedule.
- Operation of the pump (in case of water supply from a pump).
- Fuel use of the pump.
- Use of the pump (writing of pump investments and distribution system).

For more information, see also:
- Irrigation water management training manual No. 10, Irrigation scheme operation and maintenance, 1996, FAO, Chapter 5

Questions for discussions

- What did the water department charged you for the irrigation water?
- How do you measure the amount of water supplied to a farmer?
- What are the overhead-costs in supplying the water? Who is going to pay for that?
- Where is the water coming from and does the WUA has to pay for that water?
- Who will operate the water distribution system of channeling the water to the fields?
- If on demand, when has the farmer has to ask for the water?
- How many days in advance has he or she have to make the request?
- How and where?
- Has he or she have to pay when the farmer makes the request?
- What will happen if the farmer does not pay or too late?
- Will there be a maximum of water that the farmer can request for?
EXERCISE 5E: DEFINING OPERATION AND MAINTENANCE

Introduction

Members of a WUA, or other kinds of farmers’ organization, have to develop policies how the WUA will deal with all kinds of issues. Defining operation and maintenance, is an other important issue for which the organization has to develop rules and regulations (policies). Member farmers have to decide on who will be responsible of the operation and maintenance of, for example, the pump and water distribution system of the WUA or WUG. What to do when parts need to be repaired or even replaced.

Objectives

- To define Operation and maintenance of pump and irrigation distribution system.
- To go through the process of formulating policies for the WUA or WUG.

Expected outputs

- Rule and regulations for the operation of the pump and irrigation distribution system.
- Appointments of persons who will be responsible for the operation and/or maintenance of the pump and irrigation distribution system.
- A time frame when all maintenance activities will be carried out.

Preparations required

- Invite the irrigation officer to the session.
- Layout map of the area prepared by the farmers.

Materials required

- Large sheets of paper and markers.

Time required

- Two hours.

Timing

- During the planning of operation farmers’ organization (pump, WUA or WUG, etc.)
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of previous training session (Exc. 1, Part C).
2. Explain the specific objectives and expected output.

Plenary discussion (40 min)

3. Present the layout map of the area prepared by the farmers and asks the farmers to indicate the entire infrastructure and equipment under the control of the WUA or WUG. Write them down on a large sheet of paper.
4. Ask the farmers to indicate, which of the listed items only need to be maintained and which do need to be operated as well (pump, gates, etc.).
5. Ask the farmers to indicate for each of the items that needs to be operated, how it should be done and for how long. Add this to the list.

Small group discussions (30 min)

6. Ask the farmers to discuss in small groups of 4-5 persons, for each of the listed items what the maintenance activities are. Ask each group to write the results of their discussions on a large sheet of paper.
7. Ask the groups to present the results of their discussions.

Plenary discussion (40 min)

8. Compare and discuss the maintenance activities reported by the groups. Try to reach a conclusion on the needed maintenance activities.
9. Discuss who will be responsible for the operation and maintenance of pump and the different elements of the irrigation system.
10. Summarize the decisions taken and ask the farmers to endorse the decisions.
Check lists / questions for discussions

For more information, see also:
• Irrigation water management training manual No. 10, Irrigation scheme operation and maintenance, 1996, FAO, Chapter 3 and 4

Questions for discussions

• During the sessions in which the irrigation system and equipment was discussed, what were the important activities identified in operation and maintenance?
• Do you have the skills and time to carry out the identified operation activities?
• If not, who will you ask to carry out those activities?
• How will you pay for operation and maintenance?
• Is there a need for additional training to carry out the O&M?
EXERCISE 5F: CONFLICT MANAGEMENT

Introduction

Organizations, including WUAs and WUGs have to deal sometimes with conflict situations. Conflicts among the members of the organization or with other organization. In solving a conflict it is important that everybody understand the different sides of the conflict. A way of doing this is by playing similar situation in a role-play. The persons involved in the conflict can play a different role in the play or be an observer. A common conflict in a WUA or WUG is the unequal off take of water by farmers at the beginning of the canal and those situated at the end of the canal.

Objectives

- To define ways in solving conflicts.

Expected outputs

- Different ways on how to deal with a conflict.

Preparations required

- Prepare a role play (description of the situation and roles) conform an actual conflict present.

Materials required

- Materials needed to play the role-play.

Time required

- One and A half-hours.

Timing

- When there is a problem to be solved.
Procedure (Steps)

Plenary Introduction (15 min)

1. Review of the previous training session (Exc. 1, Part C).

2. Explain the specific objectives and expected output.

Role-play (50 min)

3. Introduce a (possible) conflict in the organization (for example: farmers at the beginning of the canal take all the water and not enough water is left over for the farmers at the end of the canal).

4. Explain the role-play to the farmers. Select the players and assign the roles (2-3 farmers situated at the beginning of the canal, 2-3 farmers situated at the end of the canal, 2-3 management members of the WUA or WUG to solve the problem, rest are the observers).

5. Select a suitable setting for the role-play. Introduce the role players and ask the players to start the role-play, manage the time.

6. After the role-play ask each of the players how it was to play that role and what he or she though about his or her role in solving the conflict.

7. Ask comments from the observers on the role-play.

Plenary discussion (30 min)

8. Summarize the comments and observation made during the role-play. Discuss what can been learnt from it about the different sites of the conflicts.

9. Discuss how the player, responsible for solving the conflict, (management members of the WUA or WUG) solved the problem and what can been learnt from it on how such a conflict should (not) be solved?

10. Ask the farmers if they know of other ways in solving the conflict. Compare and discuss the different suggestions on how to solve the conflict.

Guidelines for (technical) preparation/ questions for discussions

For more information, see also:


Questions for discussions

- Where all different aspects of the conflict discussed in the role-play? Which not?
- Where all players interested in solving the conflict? How is that real life?
- Is it always possible to find solutions in which everybody feels happy with?
- What are the important conditions for solving the conflict in the role-play?
- Are these also the conditions for solving a problem or conflict in general?
- What are the capacities needed to solve a conflict?
PART C

EXERCISES FOR FEEDBACK AND MONITORING & EVALUATION
FEEDBACK AND MONITORING & EVALUATION
FEEDBACK AND MONITORING
AND EVALUATION

Introduction

The use of feedback exercises and summaries informs the facilitator and participants on how the training is progressing, from the point of view of the participants. The summary of the feedback informs as to how participants are reacting to the training. It enables the facilitator to stay abreast of participants’ feelings as well as their learning. Future plans for the training can be adjusted in line with the responses to the participants’ feedback. Daily feedback strengthens training design and increases feelings of ownership.

This part of the manual also contains exercises that can be used to evaluate the success of the training. The evaluation should consider the improvement that occurs during one season of training. These methods mostly consider changes in knowledge and field skills between the beginning and the end of the training—changes assumed to have taken place as a result of the training activities during one season.

Perhaps most importantly, evaluation should check for the impact of the training. Farmers may improve their basic skills and knowledge, but this may not always lead to a change in action or may not lead to a desirable change such as improved water application methods, improved yields or reduced water losses. The goal of PT&E-FWM is to have a long-term impact. Evaluation will help us know when we arrive where we think we are going.

Annex 2 and 3 give more information about Feedback and Monitoring & Evaluation of training sessions and training programs.

Exercises

The related exercises are the following:

Feedback

1. Review of the previous training session
2. Summary and Closure
3. Words remembered
4. Feedback cards
5. Feedback Fishbowl
6. Likes and Dislikes - Statements
7. Likes and Dislikes – Cards
Monitoring & Evaluation

8  T chart
9  Applicability of the training
10  Attainment of learning objectives
11  Field Walks
12  Questionnaire

For every feedback or evaluation session, another exercise may be used, to give some variation in the methods used. Exercise 1 is very useful for the start of every training session, and exercise 2 for closing every training session.
EXERCISE 1: REVIEW OF THE PREVIOUS TRAINING SESSION

Introduction

Each meeting of a training session, participants start with a summary of what occurred the previous training session. This will help to bring attention back to the training topics and to refresh memories on what has been discussed, achieved and agreed during the previous training session.

Objectives

• To recall the content and outcome of the previous training session.

Expected Output

• Participants will refresh their memories of what has been discussed, achieved and agreed during the previous training session.

Materials required

• none

Time required

• 15 minutes

Timing

• At the start of every new training session
**Procedure (Steps)**

**Plenary Introduction** (5 min)

1. Explain the specific objectives and expected output.

**Plenary Activity** (10-15 min)

2. Ask a selected farmer to summarize for the participants what was achieved and discussed during the previous training session.

3. Extend and explain the summary when needed.

4. Before the end of the day’s session, identify the farmer who will summarize findings at the next training session so that he can prepare notes.

**Questions for discussion**

- Where did each group go?
- Which (water management) practice/technology was observed and discussed?
- What were the participants' main observations/comments on the observed/discussed practice/technology?
- Which tests were executed?
- What were the participants’ main observations/comments on the indicators/measurements?
- Did the group reach any significant conclusion or agreement?
- Which other water management practice or topic of special interest was observed, demonstrated and discussed?
EXERCISE 2: SUMMARY AND CLOSURE

Introduction

Each training session ends with a summary of what has occurred during the day. This will help participants to recall and remember what has been discussed, achieved and agreed during the day’s training session.

Objectives

• To recall the content and outcome of the today’s training session.

Expected Output

• Participants will recall what has been discussed, achieved and agreed during today’s training session.

Preparations required

• none

Materials required

• none

Time required

• 15 minutes

Timing

• At the closure of every training session
Procedure (Steps)

Plenary Introduction (5 min)

1. Explain the specific objectives and expected output.

Plenary Activity (10-15 min)

2. Summarize the topics discussed and the main findings of the day’s session. Remind farmers of the assignment given for the week (if any).

3. Remind a selected farmer that at the beginning of the next training session he will summarize the topics discussed and the main findings of today’s session.

4. Close the session reminding farmers of the next training date.
EXERCISE 3:  DAILY FEEDBACK, WORDS REMEMBERED

Introduction

The use of feedback exercises and summaries informs the facilitator and participants on how the training is progressing, from the point of view of the participants. The summary of the feedback informs us how participants are reacting to the training. It enables the facilitator to stay abreast of participants’ feelings as well as their learning. Future plans for the training can be adjusted in line with the responses to the participants’ feedback. Daily feedback strengthens training design and increases feelings of ownership.

Objectives

- To enable farmers to give accurate feedback on today’s training session.
- To collect comments, from the point of view of the participants, about today’s training session.

Expected Output

- Comments, suggestions for improvement about today’s training session from the point of view of the participants.

Preparations required

- none

Materials required

- cards, markers, pencils

Time required

- 20 minutes

Timing:

- At the end of every training session
**Procedure (Steps)**

**Plenary Introduction** (5 min)

1. Explain the specific objectives and expected output of this exercise.

**Plenary Activity** (15 min)

2. Ask participants to write down words which, for example:
   - best describe what you have learned today, or
   - represent the experience you had today.

3. Promote discussion by asking questions about these words, for example:
   - why did you choose these words?
   - can you say more about the words you have chosen?

4. Keep records of the words and comments for possible future use.
EXERCISE 4: DAILY FEEDBACK, FEEDBACK CARDS

Introduction

The use of feedback exercises and summaries informs the facilitator and participants on how the training is progressing, from the point of view of the participants. The summary of the feedback informs as to how participants are reacting to the training. It enables the facilitator to stay abreast of participants’ feelings as well as their learning. Future plans for the training can be adjusted in line with the responses to the participants’ feedback. Daily feedback strengthens training design and increases feelings of ownership.

Objectives

- To enable farmers to give accurate feedback on today’s training session.
- To collect comments, from the point of view of the participants, about today’s training session.

Expected Output

- Comments, suggestions for improvement about today’s training session from the point of view of the participants.

Preparations required

- Write down the questions on a large sheet of paper.

Materials required

- Cards, markers, pencils, pins, tape.

Time required

- 20 minutes

Timing

- At the end of every training session
**Procedure (Steps)**

**Plenary Introduction** (5 min)

1. Explain the specific objectives and expected output of this exercise.

**Plenary Activity** (15 min)

2. Distribute note cards (two colours).

3. Ask participants to write a brief answer to each of the following questions on one of the coloured cards:
   - Either:
     - What was the most helpful today? followed by Why?,
     - or What was most useful, interesting? followed by Why?

4. Ask participants to write a brief answer to the following questions on a second coloured card:
   - What was least helpful, less useful? followed by either What could have been improved? or Why?

5. Collect cards.

6. Summarize the responses before the next meeting (overnight). Count the number of responses related to each aspect of the day mentioned then summarize the responses. The count, or number of responses, tell facilitators and participants which aspects were of great interest to participants and the summary of comments tells what the participants were saying.

7. Discuss the feedback with the participants.

**Alternatively**

1. Ask a couple of participants to collect the comments/cards, then cluster and post them on the board for all to see.
2. Discuss the posted and clustered cards.
3. Keep records of the words and comments for your use.

**Alternatively**

4. If there is time, redistribute and have one person read aloud all the cards with one colour. Discuss.
5. Have another person read the cards of the other colour. Discuss.
6. Keep records of the words and comments for your use.
Questions for discussion

- What was most helpful/useful/interesting today?/ Why?
- What did you like most/ Why?
- What was most difficult today?/ Why?
- What was least helpful today?/ Why?
- What did you not like?/ Why?
- What could have been improved
EXERCISE 5: DAILY FEEDBACK, FEEDBACK FISHBOWL

Introduction

The use of feedback exercises and summaries informs the facilitator and participants on how the training is progressing, from the point of view of the participants. The summary of the feedback informs as to how participants are reacting to the training. It enables the facilitator to stay abreast of participants’ feelings as well as their learning. Future plans for the training can be adjusted in line with the responses to the participants’ feedback. Daily feedback strengthens training design and increases feelings of ownership.

Objectives

- To enable farmers to give accurate feedback on today’s training session.
- To collect comments, from the point of view of the participants, about today’s training session.

Expected Output

- Comments, suggestions for improvement about today’s training session from the point of view of the participants.

Preparations required

- none

Materials required

- none

Time required

- 30 minutes

Timing

- At the end of every training session
Procedure (Steps)

**Plenary Introduction** (5 min)

1. Explain the specific objectives and expected output of this exercise.

**Plenary Activity** (25 min)

2. Ask participants to divide into two groups.

3. One group sits in an inner circle facing each other and the second group is on the outside.

4. Give them a question related to learning from the day’s training session to discuss. For example:
   - What were the most helpful parts of the training today?
   - Why?

5. Only those in the inner circle can speak. Those on the outer circle listen.

6. After a few minutes, have them change places (inner go to the outer and the outer go to the inner).

7. Ask the inner group the same questions (you may also change questions being asked).

8. Keep records of the answers and comments.

9. Discuss the answers and comments with the participants.
EXERCISE 6: DAILY FEEDBACK, LIKES AND DISLIKES - STATEMENTS

Introduction

The use of feedback exercises and summaries informs the facilitator and participants on how the training is progressing, from the point of view of the participants. The summary of the feedback informs as to how participants are reacting to the training. It enables the facilitator to stay abreast of participants’ feelings as well as their learning. Future plans for the training can be adjusted in line with the responses to the participants’ feedback. Daily feedback strengthens training design and increases feelings of ownership.

Objectives

- To enable farmers to give accurate feedback on today’s training session.
- To collect comments, from the point of view of the participants, about today’s training session.

Expected Output

- Comments, suggestions for improvement about today’s training session from the point of view of the participants.

Preparations required

- none

Materials required

- none

Time required

- 10-20 minutes

Timing

- At the end of every training session
Procedure (Steps)

Plenary Introduction (5 min)

1. Explain the specific objectives and expected output of this exercise.

Plenary Activity (10-15 min)

2. There are two parts to this exercise. Arrange participants in a circle or hollow U, so that all have eye contact with each other. In turn each participant completes the sentence:

“I didn’t like it when............ because................”

This may refer to anything that happened during the training of today. Each person may choose to say nothing or complete the sentence as many times as necessary. No one should pass judgement on what others say.

3. After everybody has answered this question, the procedure is repeated for what they appreciated. This time complete the sentence:

“I liked it when.............because...............”

4. Keep records of the answers and comments and discuss with the farmers.

Note

- The exercise finishes with what was liked, so participants finish on a positive note.
- You can also end by asking participants to mention one good thing they feel they have personally contributed to the group. This helps to build self-esteem.
- You can also end by asking for “suggestions”. Participants comment on what they would like to see changed.
EXERCISE 7: DAILY FEEDBACK, LIKES AND DISLIKES - CARDS

Introduction

The use of feedback exercises and summaries informs the facilitator and participants on how the training is progressing, from the point of view of the participants. The summary of the feedback informs as to how participants are reacting to the training. It enables the facilitator to stay abreast of participants’ feelings as well as their learning. Future plans for the training can be adjusted in line with the responses to the participants’ feedback. Daily feedback strengthens training design and increases feelings of ownership.

Objectives

- To enable farmers to give accurate feedback on today’s training session.
- To collect comments, from the point of view of the participants, about today’s training session.

Expected Output

- Comments, suggestions for improvement about today’s training session from the point of view of the participants.

Preparations required

- none

Materials required

- cards, markers, pencils, pins, tape

Time required

- 20 minutes

Timing

- At the end of every training session
Procedure (Steps)

Plenary Introduction (5 min)

1. Explain the specific objectives and expected output of this exercise.

Plenary Activity (15 min)

2. Distribute coloured cards, one to each person.

3. Ask each participant to write on one card “what they did not like” during the training session (each card one comment only). This may refer to anything that happened. Each person may choose to write nothing or to write on as many cards as necessary.

4. The cards are pinned to a board or stuck to a piece of paper for all to see. The authors should remain anonymous.

5. After everybody has written the answers to the first question, ask each participant to write on a second card “what they did like” during the session or day.

   This may refer to anything that happened. Each person may choose to write nothing or to write on as many cards as necessary.

6. After everybody has written the answers to the second question, ask a participant to collect all the cards and pin them to a board or stuck to a piece of paper for all to see.

7. Discuss the feedback with the participants.

Suggestion

A third card can be distributed for “suggestions” and participants asked to comment on what they would like to see happen in future sessions.
EXERCISE 8: EVALUATION, T-CHART

Introduction

To be able to further improve the training curriculum, the schedule and the facilitation process, the training should be evaluated at the end of the training season.

Objectives

- To evaluate the training schedule, curriculum and impact.

Expected Output

- A complete list, made by facilitators and participants, with suggestions for the improvement/adjustment of the training schedule and curriculum and facilitation techniques used.

Preparations required

- None

Materials required

- Large sheets of paper or board, pencils, markers

Time required

- One and a half-hours.

Timing

- At the end of the training season
Procedure (Steps)

Plenary Introduction (10 min)

1. Explain the specific objectives and expected output of this exercise.

Plenary Activity (80 min)

2. On a large piece of paper, draw one line down the middle and one across the top to form a “T”. On the top of one column, write “Needs to be improved”. On the top of the second column, write “It is good”.

3. Now ask the group to make a list of items in the training that fit under each title. Each point can be considered as it is given, or you may use it like a brainstorming session in which only phrases are written with no comments.

4. Then go back and ask for clarification of each point with further discussion.

5. The points under “Needs to be improved” should be discussed with the aim of finding solutions.

6. Wrap-up, summarizing the main points discussed.

Note: This exercise can be conducted in plenary sessions or by forming sub-groups.

Questions for discussion

- Was the duration of the training appropriate?
- Was the length of each meeting appropriate?
- Was the time of each meeting appropriate?
- Was the meeting place appropriate?
- Was the time of each meeting suitable, for both men and women?
- Was the field practice appropriate?
- What do you think about working in groups?
- Did you find the plenary discussion appropriate and useful?
- Where the learning objectives appropriate?
- Was each selected topic adequately studied?
- Where the on-farm tests useful for identifying solutions to the farmers’ water management problems?
- Was the language used by the facilitator (or resource person) clear?
EXERCISE 9: APPLICABILITY OF THE TRAINING

Introduction

To be able to further improve the training curriculum, the schedule and the facilitation process, the training should be evaluated at the end of the training season.

Objectives

• To evaluate the training schedule, curriculum and impact.

Expected Output

• Farmers and facilitator will have evaluated the applicability of the knowledge and learning skills incorporated in the training sessions.

Preparations required

• none

Materials required

• paper, pencils, markers

Time required

• 2 hours

Timing

• At the end of the training season
Procedure (Steps)

Plenary Introduction (10 min)

1. Explain the specific objectives and expected output of this exercise.

Small Group Activity (80 min)

2. Ask the participants to form small groups of 3-4 persons and to think about:
   • what they have learned from the training and
   • what they have used/adopted/applied from their attendance during the training.

3. Ask them to divide a blank sheet of paper into sections with each section sized to show the relative importance of an aspect of the training as it appeared to them. They should label each section to show the learning/knowledge they gained.

   The size of each section of the page should be proportionate to the usefulness of that aspect of their learning. For example: if a technique has been particularly important, it may occupy 1/3 of a page, while another remembered aspect of a session may only occupy 1/8 of a page.

   In essence, participants are making a simple visual collage (or drawing) showing which aspect of the training proved to be the most important/useful.

   ![Blank Sheet of Paper](image)

4. Repeat the above exercise asking participants to indicate what they have used/adopted or applied from what they have learned during the training.

Plenary Activity (30 min)

5. After all drawings have been presented summarize the results and promote a plenary discussion.

6. Keep records of the answers to help you to improve the next training.

7. Wrap-up, summarizing the main points discussed.
Questions for discussion

- Which topic or session of the training did you find important?
- Why did you find this techniques useful (or not)?
- Was farmer-to-farmer sharing of experience/information important?
- Do you have sufficient confidence to adopt what you have learned on your own farm/in your own fields?
EXERCISE 10: ATTAINMENT OF LEARNING OBJECTIVES

Introduction
To be able to further improve the training curriculum, the schedule and the facilitation process, the training should be evaluated at the end of the training season.

Objectives
- To evaluate the training schedule, curriculum and impact.

Expected Output
- Farmers and facilitator will have evaluated the training in terms of suitability of the learning objectives

Preparations required
- make a list of the training learning objectives you want farmers to evaluate
- make as many card sets as groups you want to work with. A card set consists of cards with one learning objective that was the focus of one of the training sessions. Each group receives the same set of cards.

Materials required
- cards, markers, pins, tape

Time required
- 1,5 hours

Timing
- At the end of the training season
Procedure (Steps)

Plenary Introduction (10 min)
1. Explain the specific objectives and expected output of this exercise.

Small Group Activity (50 min)
2. Make groups of 3-4 persons and distribute the set of cards to each sub-group.
3. Ask the groups to sort the cards containing the learning objectives according to learning, use, usefulness (I have learned it, I have used it, It was useful).
4. Paste the cards according to the sorting on the board or large paper for all to see.

<table>
<thead>
<tr>
<th>I have learned</th>
<th>I have used</th>
<th>It was useful</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Plenary Activity
5. Explain the resulting ranking through plenary discussion.
6. Keep records of the answers to help you to improve the next training.
7. Wrap-up, summarizing the main points discussed.

Note: this exercise could alternatively be done in a plenary session.
EXERCISE 11: FIELD WALKS

Introduction

Field walks are a good evaluation method because there is time to clarify questions and answers. Field walks basically involve walking in the field in pairs (facilitator and farmer) with a predetermined list of questions.

Objectives

- To evaluate the training schedule, curriculum and impact.

Expected Output

- Farmers and facilitator will have evaluated the training in terms of the suitability of the knowledge and attitudes that were the focus of the training.

<table>
<thead>
<tr>
<th>Preparations required</th>
</tr>
</thead>
<tbody>
<tr>
<td>- make a list of questions you want to ask to the farmers during the walk.</td>
</tr>
<tr>
<td>- Familiarize yourself with the parts of the field where the questions can be used.</td>
</tr>
</tbody>
</table>

Materials required

- list of questions

Time required

- 1 hour per person

Timing

- At the end of the training season
Procedure (Steps)

Individual Introduction (5 min)

1. Explain the specific objectives and expected output of this exercise to the farmer.

Individual Activity (50 min)

2. Walk with the farmer to the field and ask your questions. Discuss and elaborate on the farmer’s answers.

3. Take note of the answers for your records and summarize your impression of the farmer’s improved knowledge and skills.

Note: This method is also useful for testing farmers after some seasons in relation to retention of information, and also for determining the kind of knowledge and skills that farmers in one group may be lacking.

Suggestions for questions to be asked
The same questions as for the Ballot Box exercise can be used, see Annex 4.
EXERCISE 12: QUESTIONNAIRE

Introduction

When using a questionnaire for evaluation, it is important to consider the literacy level of the group and their knowledge of technical terms. The terms used in one village may not be the official names used nationally and this can lead to confusion. Written questions must be tested for clarity beforehand and checked to ensure local applicability. Remember not to be academic about names or definitions. Be practical and keep the questionnaire focused on real issues, skills and knowledge.

Objectives

• To evaluate the training schedule, curriculum and impact.

Expected Output

• Farmers and facilitator will have evaluated the training in terms of suitability of the knowledge, skills and attitudes that were the focus of the training.

Preparations required

• prepare the questionnaire in advance

Materials required

• list of questions, paper, pencils

Time required

• 1 hour

Timing

• At the end of the training season
Procedure (Steps)

Plenary Introduction (10 min)

1. Explain the specific objectives and expected output of this exercise.

Group Activity (50 min)

2. Distribute the questionnaire to each farmer and allow time for clarification.

3. Collect the results and analyze them overnight.

4. Present the farmers with your observations and promote discussion so as to clarify and reach a consensus on each reply that they gave in the questionnaire.

5. Alternatively (from step 2) you may also form sub-groups and ask each group to discuss and reply to the questions. Then ask each group to present their answers and promote discussion so as to clarify and reach a consensus on each question answered.

6. Keep the questionnaire for your records. This will help to improve your next training.

Suggestions for questions

• In the manual look at the objectives and expected output of each exercise and ask questions to learn if the farmers were able to acquire the knowledge, skills or attitude specified by the objectives.

Related to training curriculum and schedule:
• What did you like most about the training?
• What did you not like?
• Which was the most important lesson you learned?
• What did you find difficult to understand?
• What main obstacle do you anticipate in applying what you have just learned?
• What are your suggestions for improvement?
• What do you consider was the most valuable experience you had at the school?
• Why is that?
• What aspects of the school could have been strengthened?
• How could that be done?
• What other comments do you have?
ANNEXES
ANNEX 1: THE ADULT LEARNING PROCESS

The adult learning process

Adults differ from children in the way they learn. For learning to be effective it has to be relevant to their daily lives. They need to see immediate results to validate the information based on their experiences and because of their numerous experiences it sometimes becomes difficult to present new ideas and viewpoints.

Adult learners normally go through some phases of a learning cycle. These phases are experiencing, analyzing, processing and generalizing.

Adults have a wide experience and have learned much from life. Learning something new (experiencing) is not just achieved in an instant. The adult learner will have to go back to his old knowledge/skills. It may sometimes be necessary to break apart and review the existing knowledge/skill (analyzing) as well as test the new ideas. The new learning will have to be internalized (processing) by making it relevant to one’s self. It may have to be shared with other people as part of the process. Only after this can the learning be applied when confronted with a similar situation (generalizing).

How do adults learn?

- Adults are voluntary learners. They perform best when they have decided to attend the training for a particular reason
- Adults have experiences and can help each other to learn. They need to share that experience.
- Adults learn best in an atmosphere of active involvement and participation.
- Adults learn best when it is clear that the context of the training is close to their own tasks or jobs. Therefore a real-world approach is often best.

Each learner goes through the learning cycle in a unique way. One may spend more time in a particular stage of the cycle. Another may just go quickly through all stages.

Knowing this and following some basic principles, training can help adults learn more effectively.
Discovery-based exercises

The challenge in designing exercises for Farmers Training is to make the exercises discovery based. The aim of the ‘discovery-based’ exercises is to help participants to remember more of what they are learning.

People remember:  
20% of what they HEAR  
40% of what they SEE  
80% of what they DISCOVER FOR THEMSELVES.

A condition of discovery-based is that the facilitator should not start the exercise with the assumption that there will be a correct answer or outcome. If he or she does this, then we can not expect participants to learn from what they have observed. Instead, they will just tell the facilitator what they think he or she wants to hear, based on what the facilitator told them to say.

By discovering information themselves and then evaluating if and how it could be useful, the participants can start to look more critically at what they observe or hear. Participants are starting to build skills in analyzing what they observe and can base their decisions on their own experiences and understanding.

One important method is to ask questions that allow the participants to develop their own analysis and understanding. The facilitator is stealing an opportunity for education if he or she reply a question directly with an answer. Ask questions! Lead the participant to the answer by asking questions (what is this?, why is it not functioning?, what has changed?, etc.).

ANSWER QUESTIONS WITH QUESTIONS!!
ANNEX 2: FEEDBACK

Daily Feedback

What is daily feedback?

Ending each day with a short anonymous feedback activity informs facilitators as to how the training is progressing, according to the participant. Giving an analysis of the feedback to the participants the following session (feedback on feedback) enables them to assess how other participants are reacting to the training.

Why bother?

Such feedback enables the facilitators to get an impression of the participants’ feeling as well as learning. Facilitators can then adjust the present and future training program to the extent possible in response to participant feedback. Such daily feedback also helps participants to feel that their opinions and suggestions are important and that they are being “heard” by the facilitators and planners. Daily feedback strengthens training design and increases feelings of ownership.

Who will collect, analyze and report the feedback?

The daily review can be run by facilitators or trainers but also by the participants themselves. The last is especially appropriate in training-for-trainers situations.

How to collect the feedback?

There are many different ways of collecting the feedback, and determining the degree of participation, interaction and level of detail. The choice will depend on the purpose, the group, the available time, etc. The daily feedback activity takes at least 10 minutes at the end and at the beginning of the session, but can easily go up to half an hour if you like to do the feedback orally or discuss how to adjust the training on the basis of feedback.

Encourage the participants to be specific about “what” and analytic about “why”. At the start of the training the participants may be very unfamiliar with daily feedback, but as you go along and they gain more experience in reflecting on and expressing feelings they will become more analytic. Therefore, start with the “more easy to respond to” their feedback questions and gradually move to the “more analytical” questions.

How to analyze the feedback?

A simple way to do this is to count the number of responses related to particular aspects of the day then summarize the responses. The number of responses tells both the facilitator and the participants which aspects were of greatest interest to the participants and the summary of the comments tells more about the reasons.
**How to give feedback back?**

At the beginning of the next session present a summary of the responses and comments. Invite people to react. If the outcome includes suggestions it is important to explain whether the facilitators propose any changes on the basis of the feedback and why (or why not).

Do not include particularly negative or embarrassing comments directed at particular persons (participants, resource persons, or facilitators). If there are a number of comments about a particular person, you may wish to discuss the issue privately with the person involved.

**At the end of each daily feedback**

- you have encouraged open reflection by the participants;
- you are able to adjust future program plans to the extent possible in response to participants’ feedback;
- participants were enabled to express their feelings and make suggestions for changes;
- participants feel that their opinions are important and that they are being “heard”.
ANNEX 3: MONITORING AND EVALUATION

Monitoring and Evaluation

Monitoring is a surveillance system, used by those responsible for a project or a (training) programme to see that everything goes as nearly as possible according to plan, that learning objectives are achieved, that field trials are correctly implemented, and that changes in On Farm Water Management (in our case) are observed, recorded and evaluated.

Participatory monitoring involves the participants of a Programme/project in measuring, recording, collecting, processing and communicating information to assist both the group members and facilitators in decision-making. It is a continuous feedback system, on going throughout the life of the project/programme and involves the overseeing or periodic review of each activity and experiment to ensure that:

- constraints and bottlenecks can be foreseen, and timely solutions found
- people who need to know, are kept informed
- inputs are ready on time
- adjustments can be made, and corrective action taken when necessary
- resources, technology and practices tested are used efficiently and effectively

Participatory Monitoring and Evaluation (PME)

PME belongs to the people the project/programme is designed to help. It is self-help oriented, and an effective means of increasing self-reliance while increasing people’s control over their own destiny. PME requires the involvement of people in:

- deciding what areas to monitor and evaluate
- selecting indicators for M and E
- designing data collection systems
- collating and tabulating data
- analyzing the results
- using PME information for their own purposes.

Evaluation is not the same as monitoring. Participatory evaluation is the systematic analysis of the process by the group members and facilitators to enable them to analyze experimentation results, make adjustments, redefine objectives if and when and reorganize. Data collected while monitoring provides the basis for evaluation analysis, which concerns both the assessment of the effects of the agricultural practices and technologies tested and the effectiveness of the Participatory Extension Programme as a learning methodology for the intended beneficiaries.

The benefits looked for may be medium term, and in the case of an evaluation carried out ex-post (long after the test of program completion), the full impact of the activities and inputs may be assessed. Negative results are included in evaluation assessments.

It is often desirable when developing a participatory monitoring and evaluation system to develop a two-level system, which provides the information, needed by the respective parties-farmers, facilitators and scientists.
In a PT&E-FWM Programme it is usual to monitor and evaluate the progress or results achieved during the field tests, the resources used, and the overall impact of farmers’ water management practices on crop production. Analysis may include productivity, improved water control characteristics, local utilization of external or internal resources, levels of technology and whether tested solution were able to solve farmers’ problems.

Qualitative social aspects should also be monitored. These could include levels or degree of people’s participation, the performance of those involved, gender equity, changing attitudes and values, access to information and advisory services and also the suitability of the Program curriculum and schedule.

**Participatory Methods in PME**

Where participatory research has been used to engage group members, self-help action frequently follows, and ME then forms part of the management strategy employed to help reach goals in development.

Participatory research can initiate the first steps toward group action by using data collection and generation of information within a small reasonably homogeneous group of trusted people. The group collects data on key elements of their research, which then provides the baseline against which change can be measured, and assessments can be made to establish a PME system.

Participatory research differs from conventional research in that the objects of the study, the target beneficiaries, actually take part in all aspects of the study of their own situation. As researchers, and the primary objective of the research, the data collected or generated is mainly for their own use.

**PME in action**

Traditional monitoring and evaluation systems are initiated from the top, carried out for the people and professionals outside the village use the results. Participatory monitoring and evaluation is carried out by the people the project is meant to help. It is the people’s management tool, and their teacher. With the help of a suitable facilitator, PME provides the data to help people analyze and interpret their own progress. After a suitable period of time, group facilitators should be in a position to phase out their support, so that the people fully implement and further develop the system themselves.

The use of data collected or generated in the M and E process is in turn used by a group to help identify and anticipate problems, and to plan their own steps to avoid or solve these problems. It also comprises a learning process in which data is used to analyze, assess and draw conclusions from field test activities involving technologies and practices development.

In this way a deep understanding of the activities, processes and systems is promoted, so that the final conclusion is likely to be constructive, realistic and action-oriented. The results provide the information needed for good decision-making, which leads to good planning and implementation of the PT&E-FWM.
Encouraging Participation

The essential element of participation requires that everyone understands, supports and is willing to join actively in, the process. This requires much teaching and learning. There are many ways to increase participation and some of whose which are most useful for developing a PME system follow:

1. **Involve everyone in active learning.** Use active rather than passive, practical rather than theoretical, methods. Involve everyone- assign tasks that ensure everyone is involved or has a chance.

2. **Of interest to all.** Begin with an activity that is of interest to all. Provide a simple outline.

3. **Use small groups.** A large group intimidates the less bold, makes consensus more difficult, and inhibits spontaneity. Small, homogeneous groups where there is mutual trust and concern are more co-operative and supportive, at least initially.

4. **Meaningful and simple.** Provide meaningful data and information. For those with no or little formal education, statistics and academic information cannot be interpreted. Simple graphics, models, numbers and charts should be used.

5. **Gathering information.** Facilitate access to more information. Take the group on field trips where they can increase their knowledge base and teach them where to go for information in the future.

6. **Awareness.** Empower the group! Only when participants’ awareness and confidence in experimentation has been raised, are they willing and mentally able to help themselves. Participation is the way to collective action.

The next three documents are examples from Zambia of Reporting Formats for three different levels of the PT&E-FWM (extension officer, district irrigation engineer and provincial irrigation engineer). These forms have to be filled in directly after the last training session and forwarded to the person responsible on the next level. The terminology used in these formats is the terminology of the Smallholder Irrigation and Water Use Programme (SIWUP), a programme similar to the PT&E-FWM.
SMALLHOLDER IRRIGATION AND WATER USE PROGRAMME

Report Format for extension officers on The Farmer Training Programme.

This document has to be forwarded to the district irrigation engineer (or other responsible officer involved in the SIWUP programme) approximately 1 week after the last training takes place.
# CAMP/BLOCK REPORT FORMAT ON FARMER TRAINING

## IDENTIFICATION

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<th>Year:</th>
<th>Period:</th>
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## LOGISTICAL ASPECTS

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Were there any problems during the organization of the FT? E.g. transport, fuel, stationery, lack of farmers interest etc.

Give a short programme of the visits from the different resource persons.

## PROGRAMME OF RESOURCE PERSONS (Visits to your FT sessions)

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## FARMERS PARTICIPATION IN TRAINING PROGRAMME

Provide table for each group separately

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<th>Attendance in FT sessions</th>
<th>Former FT</th>
<th>Observations / remarks</th>
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1 Former FT: Did the farmer participate on former FT sessions f.i. last year?  **Yes/No**
# FARMERS PARTICIPATION GROUP B

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<th>No</th>
<th>Name</th>
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\(^1\) Former FT: Did the farmer participate on former FT sessions f.i. last year? **Yes/No**
TOPICS OF THIS FARMING TRAINING SESSION.

Technical message: Give a short summary of the subjects discussed
Outcomes: Give a short summary on the expected outcomes
Constraints: What are the major constraints concerning this topic

If more space is required, add an extra paper.

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<td>Outcomes:</td>
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<p>| <strong>Session 2</strong> | Topic: | A: | B: |
| Extension / facilitation method used: | |
| Technical message: | |
| Outcomes: | |
| Constraints: | |</p>
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<td>Technical message:</td>
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<th>A:</th>
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<tbody>
<tr>
<td></td>
<td>Extension / facilitation method used:</td>
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<td>Technical message:</td>
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<td>Constraints:</td>
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</tbody>
</table>
FARMERS EVALUATION

Let the farmers evaluate the training at the end of each session. Write the results, one of the positive elements and one of the negative elements mentioned in the following tables.

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Positive</th>
<th>Negative</th>
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</thead>
<tbody>
<tr>
<td>Group A</td>
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<tbody>
<tr>
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<td>Group B</td>
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<thead>
<tr>
<th>Session 4</th>
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<th>Negative</th>
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<tbody>
<tr>
<td>Group A</td>
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<tr>
<td>Group B</td>
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<table>
<thead>
<tr>
<th>Session 5</th>
<th>Positive</th>
<th>Negative</th>
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<tbody>
<tr>
<td>Group A</td>
<td></td>
<td></td>
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<tr>
<td>Group B</td>
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</tbody>
</table>
EVALUATION ASPECTS

Answer the following questions (if applicable). Use a separate paper if needed or the backside of the papers. Add other information if you think that it is important to evaluate the impact of your training sessions. Try to be as exact as possible, i.e. give figures.

Farmer training programme
1. Since when have FT’s been taking place in your camp?
2. Are the participants the same as last year, partly the same, or are the all new?
3. Which criteria were used to select farmers for the training sessions?
4. Do the topics, selected during the EST, cover the specific needs of the farmers in your camp?
5. Are their visible effects in the field of the topics covered during this or former training sessions (i.e. better construction of nursery, use of organic fertilizer etc. If possible give figures)
6. Do you have enough knowledge to deal with the problems you encounter in the field?

Irrigation practices
7. What type of irrigation is practiced?
8. How many farmers of the training group use treadle pumps, how many farmers use a bucket to irrigate and are there other lifting devices used?
9. Are farmers outside the training groups starting to use irrigation? How do they get their information?
10. For farmers involved in this training programme, but not practicing irrigation, what are their major constraints?

Problems and constraints for irrigated agriculture.
11. What are the major constraints farmers face with regard to irrigation?
12. Are their improvements on these problems since the last FT?
13. What is necessary to improve the situation according to the farmers?
14. What is necessary to improve the situation according to you?

SIWUP Activities.
15. Give any kind of remarks and/or suggestions with regards to SIWUP activities in your camp.
MINISTRY OF AGRICULTURE, FOOD AND FISHERIES

TECHNICAL SERVICES BRANCH, IRRIGATION.

SMALLHOLDER IRRIGATION AND WATER USE PROGRAMME

Report Format for district officers on
The Farmer Training Programme.

This document has to be forwarded to the provincial irrigation engineer not later than 2-3 weeks after the last training session takes place.
DISTRICT REPORT FORMAT ON FARMER TRAINING

IDENTIFICATION

<table>
<thead>
<tr>
<th>Farmer Training No:</th>
<th>Year:</th>
<th>Period:</th>
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<th>Reporting officer:</th>
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<tr>
<th>District:</th>
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LOGISTICAL ASPECTS

<table>
<thead>
<tr>
<th>How much fuel did you receive?</th>
<th>Distribution of fuel (give a the total Qty)</th>
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</thead>
<tbody>
<tr>
<td>Diesel:</td>
<td>District:</td>
</tr>
<tr>
<td>Petrol:</td>
<td>Camps:</td>
</tr>
</tbody>
</table>

What were the other inputs you received in all the camps in your district?
- Stationery:
- Others:

Where there any problems (constraints) during the organization of the FT? E.g. transport, fuel, stationery, lack of farmers interest etc.

DISTRIBUTION OF THE INPUTS

<table>
<thead>
<tr>
<th>CAMPS / BLOCKS</th>
<th>Fuel (l)</th>
<th>Stationery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Petrol</td>
<td>Diesel</td>
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</tbody>
</table>

xix
Give a short programme of the visits made (to your extension officers in the SIWUP districts) by the different resource persons (including yourself).

**PROGRAMME OF RESOURCE PERSONS (Visits to FT sessions)**

<table>
<thead>
<tr>
<th>DATE</th>
<th>NAME</th>
<th>RANK</th>
<th>CAMP visited</th>
<th>Kind of assistance given:</th>
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**ALLOWANCES REQUIREMENTS**

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<th>Name</th>
<th>Rank</th>
<th>Days</th>
<th>Rate/day</th>
<th>Total</th>
<th>Station</th>
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**TOTAL:**

Comments on this subject:
Summarize the farmers' participation in the training programmes in your district:

<table>
<thead>
<tr>
<th>No</th>
<th>Camp</th>
<th>Group A</th>
<th>Group B</th>
<th>Total</th>
<th>Observations / remarks</th>
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The figures above are averages. How irregular was the distribution over the different training sessions:

Were there many differences between the programmed and the real dates the FT sessions took place. Give comments:

Other observations, remarks, comments, suggestions, etc. concerning farmers participation:
Summarize the comments of the CEO/BEO and give your own comments (field observations, constraints, outcomes, suggestions, etc.) on the topics selected during the EST and the facilitation methods used by the extension officers. If more space is required, add an extra paper.

<table>
<thead>
<tr>
<th>TOPICS OF THE FARMER TRAINING SESSION:</th>
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<p>| 2 | Topic: |
|   | Extension / facilitation methods used: |
|   | Comments: |
|   | Outcomes: |
|   | Constraints: |</p>
<table>
<thead>
<tr>
<th>Topic:</th>
<th>Extension / facilitation methods used:</th>
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</table>

Constraints:
FARMERS EVALUATION

The farmers were asked to evaluate at the end of each session the training. Summarize the results, the positive elements and the negative elements mentioned in the following tables.

<table>
<thead>
<tr>
<th>Session</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td></td>
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<tr>
<td>Session 2</td>
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<td>Session 4</td>
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<tr>
<td>Session 5</td>
<td></td>
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</tbody>
</table>
EVALUATION ASPECTS

The extension officers were asked to answer the following questions (if applicable). Give a short summary on the results of these answers and add your own comments, observations etc. Add other information if you think that it is important to evaluate the impact of the training sessions. Try to be as exact as possible, i.e. give figures.

Farmer training programme
1. Since when have FT’s been taking place in your camp?
2. Are the participants the same as last year, partly the same, or are the all new?
3. Which criteria were used to select farmers for the training sessions?
4. Do the topics, selected during the EST, cover the specific needs of the farmers in your camp?
5. Are their visible effects in the field of the topics covered during this or former training sessions (i.e. better construction of nursery, use of organic fertilizer etc. If possible give figures)
6. Do you have enough knowledge to deal with the problems you encounter in the field?

Irrigation practices
7. What type of irrigation is practiced?
8. How many farmers of the training group use treadle pumps, how many farmers use a bucket to irrigate and are there other lifting devices used?
9. Are farmers outside the training groups starting to use irrigation? How do they get their information?
10. For farmers involved in this training programme, but not practicing irrigation, what are their major constraints?

Problems and constraints for irrigated agriculture.
11. What are the major constraints farmers face with regard to irrigation?
12. Are their improvements on these problems since the last FT?
13. What is necessary to improve the situation according to the farmers?
14. What is necessary to improve the situation according to you?

SIWUP Activities.
15. Give any kind of remarks and/or suggestions with regards to SIWUP activities in your camp.

ATTACH ALL THE REPORTS FROM THE CAMPS AND BLOCKS.
Smallholder Irrigation and Water Use Programme

Provincial Report Format on
The Farmer Training Programme.

This report has to be forwarded to SIWUP in Lusaka approximately 1 month after the last training session takes place.
PROVINCIAL REPORT FORMAT ON FARMER TRAINING

I. Identification

<table>
<thead>
<tr>
<th>Farmer Training No:</th>
<th>Year:</th>
<th>Period:</th>
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<table>
<thead>
<tr>
<th>Province:</th>
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</table>

II. Introduction

A short introduction with information on the global aspects of the FT can be given (general information and conclusions, major constraints etc.).

III. Logistics

<table>
<thead>
<tr>
<th>District</th>
<th>Camp</th>
<th>Report received:</th>
<th>Distribution of Fuel from province:</th>
<th>Use of fuel in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>District</td>
<td>Camps</td>
<td>District</td>
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</table>

Problems/constraints reported with the distribution of inputs (fuel and stationary)

IV. Visits of resource persons

- A short programme of the visits made (to extension officers in the SIWUP districts) by the different resource persons

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Rank</th>
<th>Camp visited</th>
<th>Kind of assistance given</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

ALLOWANCES REQUIREMENTS

<table>
<thead>
<tr>
<th>Name</th>
<th>Rank</th>
<th>Days</th>
<th>Rate/day</th>
<th>Total</th>
<th>Station</th>
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| TOTAL: |

Comments on this subject:
V. Farmers participation

<table>
<thead>
<tr>
<th>District</th>
<th>Camp</th>
<th>FT No:</th>
<th>Year:</th>
<th>Group A</th>
<th>Group B</th>
<th>Total</th>
<th>Observations / remarks</th>
</tr>
</thead>
<tbody>
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TOTAL

- The figures above are averages. How irregular was the distribution over the different training sessions:

- Were there many differences between the programmed and the real dates the FT sessions took place. Give comments:

- Other analyses, observations, remarks, comments, suggestions, etc. concerning farmers participation:
VI. **Topics of the farmer training sessions**

During the EST the following topics were prioritized for the farmer’s courses:

The following table gives a global description of the technical message transferred and the comments from the field and your fieldtrips on expected outcomes and constraints.

<table>
<thead>
<tr>
<th></th>
<th>Topic:</th>
<th>Extension / facilitation methods used:</th>
<th>Comments:</th>
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<tbody>
<tr>
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</table>
VII Evaluation aspects:

The extension- and district officers were asked to answer the following questions (if applicable). The last chapter presents a short summary on the results of these answers and also your own comments, observations etc. Add other information if you think that it is important to evaluate the impact of the training sessions. Try to be as exact as possible, i.e. give figures.

Farmer training programme
1. Since when have FT’s been taking place in your camp?
2. Are the participants the same as last year, partly the same, or are the all new?
3. Which criteria were used to select farmers for the training sessions?
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9. Are farmers outside the training groups starting to use irrigation? How do they get their information?
10. For farmers involved in this training programme, but not practicing irrigation, what are their major constraints?

Problems and constraints for irrigated agriculture.
11. What are the major constraints farmers face with regard to irrigation?
12. Are their improvements on these problems since the last FT?
13. What is necessary to improve the situation according to the farmers?
14. What is necessary to improve the situation according to you?

SIWUP Activities.
15. Give any kind of remarks and/or suggestions with regards to SIWUP activities in your camp.

ATTACH ALL THE REPORTS FROM THE CAMPS, BLOCKS AND DISTRICTS.

xxx
ANNEX 4: BALLOT-BOX QUESTIONS

Canal design

The size of this distribution canal is?
   A. too small
   B. just right
   C. too large

The construction bund is?
   A. too wide
   B. too low
   C. not sufficiently strong
   D. will require frequent maintenance
   E. all right as it is

The discharge of canal is too small because?
   A. too narrow cross-section
   B. not deep enough
   C. intake weir insufficient

The problem in this canal section is?
   A. no maintenance
   B. there is no problem
   C. soil erosion

This quarterly canal is needed for?
   A. irrigation
   B. drainage
   C. to separate two fields
   D. is unnecessary and takes-up only space

The situation in this quarterly canal causes?
   A. erosion
   B. unequal water distribution
   C. no problem at all

Collapsing banks

What is needed to repair/prevent landslide in this canal?
   A. slope needs to be flattened
   B. canal bank needs to be widened
   C. canal lining is required

To repair/prevent sliding of this part of the canal, it needs?
   A. Canal bank should be constructed with a slope or have some supporting device
   B. Canal bank should be vertical
   C. Canal is to be widened
The collapsing sides?
A. Can be repaired by reshaping canal sides
B. Require canal lining
C. Does not matter

Unstable sides?
A. Does not matter as water will carry away earth
B. Can be repaired by putting soil in the sides
C. Can be repaired by bamboo matting

Is there a problem with this part of the dike or bund?
A. Is good, satisfactory
B. Will require regular maintenance
C. Original = solution
D. Will cause water leakage’s
E. Will frequently block the canal

This part of the canal often gets damaged, so that?
A. It needs to be repaired
B. Needs to be hardened or to be made permanent
C. No matter

Seeing this type of canal, it needs to?
A. Be made permanent
B. Be repaired and returned to its original form
C. Be planted with grasses

**Leaking of lining**

Seepage through stonewalls?
A. No problem
B. Causes seepage and water losses
C. Inadequate design/construction stonewall

**Structures – causes of broken structures**

Why is this sidewall collapsed?
A. Cement not strong enough
B. Design inadequate
C. Broken on purpose by somebody
D. Broken without intention by somebody/cattle

**Steep canal section**

What can you do to prevent the too steep slope erosion in this section?
A. More water will pass, leave as it is
B. Fill up with earth to higher water level
C. Make drop structure
The condition of this canal can be improved by?
A. Building a division structure
B. Construction of a drop and canal lining
C. Lining of canal only

This part of the canal will cause?
A. Flooding
B. Canal erosion
C. More water flow

Erosion in canal will cause?
A. Reduce water flow downstream
B. Silt will be carried away by flow
C. Destroys canal

**Overtopping canal**

Over topping of this canal is caused by?
A. Too much grasses and weeds
B. Too low
C. Too much water

What is the problem at this location?
A. There is no problem
B. Water flows too fast
C. There is too much water in the canal

Overtopping canal section?
A. Too much sand/vegetation in the canal
B. Canal too low
C. Too much water in the canal

**Canal damage**

Damage in canal is caused by?
A. Too much water
B. No maintenance by farmer
C. Animals
D. Fast flow of water

Canal is damaged because of?
A. Rain
B. bad construction
C. Washing of animals

Maintenance and repair should be done by?
A. All farmers of that block
B. Owner of the animal
C. A+B is right
Crabs / Rats

What do you think of the leaks because of crab holes?
A. Few holes will not matter
B. May cause collapse of canal banks
C. Caused by rats

Crab holes seen here?
A. Cause severe water leakages
B. Are no problem
C. Damage bund

What problems do cause the holes on the other side of the canal?
A. Cause water losses
B. Cause undermining by water and erosion
C. Are not a problem

Canal blockage - stones

Will the stones form a bottleneck in this fast running water?
A. Much water will pass as water is flowing fast here
B. Does not matter, has no effect on water supply
C. Canal requires to be made deeper here

Stone in canal?
A. Cause water to flow faster
B. Block flow of water, reduces debit of canal
C. No problem at all or use full for washing

Such canal condition will result in?
A. Canal will be stronger
B. Water flow will be better
C. Water flow will be hampered

Canal blockage – vegetation

The grasses and weeds in this canal will cause?
A. Dirty water
B. Reduced water flow
C. No problem

The waste and leaves around this structure and in the canal?
A. Are not a problem
B. Hampers the water flow
C. Lowers the discharge

What is the effect of all this vegetation in the canal?
A. Plant restrict water flow
B. Plants keep the water in the canal
C. Does not effect water availability
What will be the influence of this heavy vegetation in the canal?
   A. Plant restrict water flow
   B. Plants keep water in the canal
   C. Does not effect water availability

**Sedimentation**

The sedimentation in this canal is caused by?
   A. Water is not clear
   B. Need to have division gate
   C. Canal is too dirty, flow is hampered

**Low number of offtake structure**

Why are there only a few offtake structures?
   A. No. of offtakes sufficient
   B. more canals required to serve total plots and all blocks
   C. not enough boxes

**Irregular offtakes**

What is needed in this canal section?
   A. a bamboo inlet is needed
   B. a gate of cement should be build
   C. no improvement is needed

What is the situation of this brushwood offtake?
   A. require frequent repairs
   B. allows accurate distribution of water
   C. needs to be replaced with a concrete box

What needs to be done with this offtake to quartair?
   A. need to be equipped with box
   B. water intake need to be controlled
   C. it is acceptable as it is

What kind of irrigation structure is needed at this part of the canal?
   A. Drop structure
   B. Division box
   C. Intake structure

**Water management**

Which of the following irrigation structures would be needed here?
   A. Drop structure
   B. Diversion structure / quartenary canal
   C. Intake
Why does this canal receive little water?
   A. Not enough water available for the whole scheme
   B. Canal too high
   C. Canal blocked
   D. Not a good distribution of water among the canals
   E. too many leakages

Illegal offtakes

Water theft on this canal can cause?
   A. Neighbour plot will have shortage of water
   B. Downstream plot will have shortage of water
   C. Water distribution is in equity

What is the situation here related to illegal offtake?
   A. Each farmer is allowed to take water as required
   B. Causes water shortage with farmers downstream
   C. Intake gate should be installed

Drop structures

Is there a problem with this drop structure?
   A. There is no problem
   B. Weir is needed
   C. One is not enough

This drop structure is?
   A. Okay
   B. Needs maintenance
   C. Is constructed wrong

What is needed at this part of the canal?
   A. Permanent canal
   B. Drop structure
   C. Leave it like it is

Functioning of a box

If supply is continuous?
   A. Gate B and A should have the same width
   B. Gate A should be 2X larger than gate B
   C. Gate B should be larger

What would happen if no box were constructed here?
   A. Much problems in dividing water equally to the different blocks
   B. Not needed here
   C. More water would pass to block 1
Where are the gates used for in the box?

A. Gates are normally open and are closed only when water is too little
B. To regulate flow of water
C. Gates normally closed, only when water is needed to they are opened.

How does this box function?

A. It functions okay
B. It functions a bit
C. Must have higher embankments

How does this big diversion structure work?

A. Wider gates are needed
B. A gate needed
C. no problem at all

How does this big diversion structure gate work?

A. No problem
B. Is leaking
C. Too small

**Damaged structures**

Leakage of this big diversion structure is caused by?

A. Water flows too fast
B. Damage by farmers
C. Bad construction

Erosion behind this structure is caused by?

A. Too much water is passing
B. Canal should be lined
C. Stilling basin should be deepened

Damage of this structure is caused by?

A. Its time (age)
B. Leakage/small damage that is repaired on time
C. Using for bathing

Collapse of the wing or the wall of this structure is caused by?

A. Bad quality mixture of materials used
B. Poor structure design/plan
C. Flood is out of estimate

Gates are worn out due to?

A. Old
B. Too much water flowing through
C. Lack of maintenance
What should be done with this broken gate?
A. This gate is not needed  
B. Farmers should removed the gate in order to increase water supply  
C. A new gate is needed and it should be made stronger

**Distribution of water to the fields**

Water distribution to these fields should take place?
A. From quarternary canal to the (paddy) field  
B. From one (paddy) field to another  
C. Directly from the main canal to the (paddy) field

How is the flow of water from one field to the other?
A. Its to much, the flow needs to be reduced  
B. Flow needs to be increased for better aeration  
C. It should be stopped in order to save water upstream  
D. Flows alright

Should this form of field to field irrigation be replaced?
A. Better be replaced by canal with separate intakes to each field  
B. Always OK. Already old. Its an tradition  
C. Acceptable, but water flow need to be controlled, preferable by bamboo poles

The outlet for drainage of this field is?
A. Just how it should be  
B. Too high  
C. Too low

**Basin irrigation**

What is needed to irrigate the whole field?
A. More water  
B. Better land leveling  
C. Steeper slope  
D. Smaller fields

**Furrow Irrigation**

What is needed to irrigated the whole field?
A. More water  
B. Better land leveling  
C. Steeper furrow slope  
D. Reduction of distance between furrows
Flooding

What kind of measurements is needed here?

A. Less rainfall  
B. River protection  
C. More drainage infrastructure  
D. Maintenance of drainage canals

Salinization

The white spots in this field are caused by:

A. Poor land preparation  
B. Poor quality of irrigation water  
C. Lack of drainage infrastructure
### ANNEX 5: POSSIBLE PROBLEMS, CAUSES AND SOLUTIONS

#### Problems in the Irrigation system.

The problems mentioned for this category are often directly visible (indicated in the problem-box) in the field through the problem itself or by observing the underlying cause(s). The problems related to the irrigation system that are not directly visible, may be expressed in interviews or discussions.

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<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solutions</th>
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</thead>
<tbody>
<tr>
<td><strong>1. Collapsing canal banks</strong>&lt;br&gt;(visible)</td>
<td>• erosion by fast flowing water&lt;br&gt;• unstable embankments because of unsuitable soil&lt;br&gt;• erosion by leaking lining&lt;br&gt;• cattle activity&lt;br&gt;• overtopping canals</td>
<td>• introduce drop structures&lt;br&gt;• line canal embankment&lt;br&gt;• stabilizing the embankments&lt;br&gt;• eradicate crabs and other digging animals&lt;br&gt;• fill up the holes&lt;br&gt;• construct cattle crossings&lt;br&gt;• construct cow bathing areas&lt;br&gt;• see problem 2</td>
</tr>
<tr>
<td><strong>2. Overtopping canals</strong>&lt;br&gt;(visible)</td>
<td>• low embankments&lt;br&gt;• canal dimension too small&lt;br&gt;• obstruction of canal&lt;br&gt;• canal depression</td>
<td>• raise &amp; strengthen canal embankments&lt;br&gt;• construct canal lining&lt;br&gt;• realignment of canal&lt;br&gt;• construct canal lining&lt;br&gt;• see problem 3&lt;br&gt;• realignment of canal after canal survey</td>
</tr>
<tr>
<td><strong>3. Obstruction of canal</strong>&lt;br&gt;(visible)</td>
<td>• excessive vegetation in canal&lt;br&gt;• silt/sediment in canal&lt;br&gt;• obstruction for water diversion (increase water level)</td>
<td>• regular cleaning of canals&lt;br&gt;• remove sediment&lt;br&gt;• improve field inlets&lt;br&gt;• improve water distribution among farmers&lt;br&gt;• realignment of canal to raise water level</td>
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<tr>
<td><strong>4. High water losses in canal</strong>&lt;br&gt;(visible)</td>
<td>• high percolation losses &amp; seepage&lt;br&gt;• (frequent) collapsing of canal banks&lt;br&gt;• overtopping canals&lt;br&gt;• leaking lining&lt;br&gt;• illegal &amp; uncontrolled offtakes</td>
<td>• canal lining&lt;br&gt;• see problem 1&lt;br&gt;• see problem 2&lt;br&gt;• improve lining&lt;br&gt;• see problem 7</td>
</tr>
<tr>
<td><strong>5. Some canals receive no or little water</strong>&lt;br&gt;(visible)</td>
<td>• not enough water available&lt;br&gt;• insufficient canal capacity&lt;br&gt;• canal too high&lt;br&gt;• canal blocked&lt;br&gt;• too many leakages&lt;br&gt;• no farmers or no farmers interested&lt;br&gt;• lack of a good distribution scheme</td>
<td>• see problem 8&lt;br&gt;• realign after canal survey&lt;br&gt;• realign after canal survey&lt;br&gt;• see problem 3&lt;br&gt;• see problem 4&lt;br&gt;• WUA to assess interest of farmers&lt;br&gt;• WUA to introduce water distribution among canals/farmers</td>
</tr>
<tr>
<td><strong>6. Inadequate coverage of canal layout system</strong>&lt;br&gt;(in some cases visible)</td>
<td>• no field channels or quarteries&lt;br&gt;• difficult terrain conditions&lt;br&gt;• land allocation problems</td>
<td>• extend canal network&lt;br&gt;• conveyance structures&lt;br&gt;• settle land allocation constraints</td>
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<td><strong>7. Illegal &amp; uncontrolled inlets</strong>&lt;br&gt;(visible)</td>
<td>• lack of adequate offtakes&lt;br&gt;• strong competition for water&lt;br&gt;• no regulations or penalties on water offtake&lt;br&gt;• ignorance of farmers</td>
<td>• construct simple intake structures&lt;br&gt;• WUA to introduce water rotational schedule&lt;br&gt;• WUA to introduce regulations for water offtakes and introduce control systems&lt;br&gt;• WUA &amp; PEP to train farmers</td>
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<tr>
<td>Problem</td>
<td>Causes</td>
<td>Solutions</td>
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<tr>
<td><strong>8. Insufficient water to irrigate the total area</strong>&lt;br&gt;(in some cases visible)</td>
<td>• insufficient water in canal/river&lt;br&gt;• frequent pump breakdown or pump has too little capacity&lt;br&gt;• canal has limited capacity&lt;br&gt;• too much water taken by some farmers&lt;br&gt;• inadequate water distribution&lt;br&gt;• unequal water distribution</td>
<td>• explore possibilities for groundwater pumps or other technologies&lt;br&gt;• see problem 12&lt;br&gt;• see problem 1-5&lt;br&gt;• WUA to impose equal water distribution and sanctions for illegal water offtake&lt;br&gt;• see problem 11&lt;br&gt;• see problem 9</td>
</tr>
<tr>
<td><strong>9. Unequal water distribution</strong>&lt;br&gt;(in some cases visible)</td>
<td>• poor canal layout&lt;br&gt;• inadequate canal capacity&lt;br&gt;• inadequate water distribution&lt;br&gt;• too much water taken by certain farmers&lt;br&gt;• no schedule for water distribution&lt;br&gt;• poor cooperation of farmers&lt;br&gt;• insufficient water</td>
<td>• realign canals after canal survey&lt;br&gt;• enlarge and realign canal&lt;br&gt;• see problem 11&lt;br&gt;• reduce offtake by smaller intakes and better &amp; timely closure, use sanctions&lt;br&gt;• WUA to arrange proper schedule for water distribution&lt;br&gt;• see problem 24&lt;br&gt;• see problem 8</td>
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<tr>
<td><strong>10. Damaged &amp; inadequate structures</strong>&lt;br&gt;(visible)</td>
<td>• inadequate design (location, elevation, material)&lt;br&gt;• erosion and insufficient maintenance&lt;br&gt;• lack of funds&lt;br&gt;• poor farmer skills</td>
<td>• adjust or redesign the structure&lt;br&gt;• establish repairs and maintenance schedule and responsibilities&lt;br&gt;• establish maintenance fees &amp; contributions&lt;br&gt;• train farmers in simple construction techniques</td>
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<tr>
<td><strong>11. Inadequate water distribution</strong>&lt;br&gt;(in some cases visible)</td>
<td>• width of canal sections disproportional to areas served&lt;br&gt;• damaged &amp; inadequate structures&lt;br&gt;• lack of guidelines &amp; criteria for water distribution&lt;br&gt;• poor functioning of WUA&lt;br&gt;• irregular water level in supply sections</td>
<td>• proportional water division structures&lt;br&gt;• see problem 10&lt;br&gt;• through training &amp; WUA, establish guidelines &amp; criteria for improved water distribution&lt;br&gt;• see problems 21-30&lt;br&gt;• improve, install adequate water level control structures to regulate flow in supply canal</td>
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<td><strong>12. Frequent pump breakdown</strong></td>
<td>• unreliable electricity supply&lt;br&gt;• old pump&lt;br&gt;• poor repairs and maintenance&lt;br&gt;• unskilled pump operator</td>
<td>• WUA to approach Electricity Cy. to discuss improvement elect. supply&lt;br&gt;• WUA to prepare proposal for overhaul or replacement pump&lt;br&gt;• WUA to review maintenance procedures&lt;br&gt;• training for pump operator</td>
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<tr>
<td><strong>13. Basin Irrigation</strong>&lt;br&gt;Wild flooding or uneven flooding of basin&lt;br&gt;(visible)</td>
<td>• poor land leveling&lt;br&gt;• too large fields&lt;br&gt;• too sandy soils&lt;br&gt;• too steep sloops</td>
<td>• introduce appropriate leveling techniques&lt;br&gt;Redesign field layout:&lt;br&gt;• contour strips&lt;br&gt;• bunding&lt;br&gt;• reduce field size</td>
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<tr>
<td><strong>14. Basin Irrigation</strong>&lt;br&gt;Long time required to irrigate basin</td>
<td>• too small discharge&lt;br&gt;• too high infiltration rate&lt;br&gt;• too large basins&lt;br&gt;• farmers not familiar with water control/field layout</td>
<td>• increase flow rate&lt;br&gt;• decrease field size&lt;br&gt;• train farmers</td>
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<tr>
<td>Problem</td>
<td>Causes</td>
<td>Solutions</td>
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<td>15. Long furrows with slope (some visible, some not)</td>
<td>flow too fast</td>
<td>• slope too steep</td>
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<td></td>
<td>erosion patterns</td>
<td>• furrow too short</td>
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<td></td>
<td>insufficient infiltration</td>
<td>• flow too large</td>
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<td></td>
<td>excessive runoff</td>
<td>• reduce slope by diagonal furrows</td>
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<td></td>
<td>flow does not reach end furrow</td>
<td>• furrow length too long</td>
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<td></td>
<td>high infiltration at head border</td>
<td>• reduce flow</td>
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<td></td>
<td>lateral wetting inadequate</td>
<td>• redesign in small basins</td>
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<td></td>
<td>dry, salty on top furrow</td>
<td>• flow control devices</td>
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<td></td>
<td>sandy soil with high infiltration</td>
<td>• reduce length of slope</td>
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<td></td>
<td>furrow too short</td>
<td>• increase flow</td>
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<td></td>
<td>flow too large</td>
<td>• redesign in small basins</td>
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<td></td>
<td>distance between furrows too large</td>
<td>• decrease flow rate</td>
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<tr>
<td></td>
<td>sandy soils</td>
<td>• flow control devices</td>
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<td></td>
<td>farmers not familiar with furrow irrigation and furrow constructions</td>
<td>• train farmers</td>
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<tr>
<td>16. Short furrows without slope (some visible, some not)</td>
<td>heavy ponding at end or head of furrow</td>
<td>• inadequate furrow sloping</td>
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<tr>
<td></td>
<td>excessive time to fill furrow</td>
<td>• too long/wide furrow</td>
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<td></td>
<td>lateral wetting inadequate</td>
<td>• too sandy soil</td>
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<td>• distance between furrows too large</td>
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<td></td>
<td>• inadequate leveling</td>
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<td>• furrow depth or ridges inadequate</td>
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<td></td>
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<td>• improper furrowing tools</td>
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<td></td>
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<td>• unstable soils</td>
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<td></td>
<td></td>
<td>• farmers not familiar with furrow irrigation &amp; construction</td>
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<td>• precision land leveling</td>
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<td>• improve furrow shape</td>
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<td>• introduce improved implements for leveling &amp; furrowing</td>
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<td></td>
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<td>• land leveling</td>
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<td>• reduce furrow length</td>
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<td>• increase furrow width</td>
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<td></td>
<td></td>
<td>• train farmers</td>
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<td>17. Floods (visible)</td>
<td>natural recurring phenomena</td>
<td>• adjust farming system; implement flood control, protection, and/or precaution measures</td>
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<td></td>
<td>extreme flood events</td>
<td>• integrated river basin management</td>
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<td></td>
<td>farming in flood prone areas</td>
<td>• adjust farming system; implement flood control, protection, and/or precaution measures</td>
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<td></td>
<td>blocking of natural drainage flows</td>
<td>• integrated river basin management</td>
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<td></td>
<td>flood protection in other areas</td>
<td>• adjust farming system; implement flood control, protection, and/or precaution measures</td>
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<td></td>
<td>deforestation</td>
<td>• integrated river basin management</td>
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<td></td>
<td>canalization of streams</td>
<td>• adjust farming system; implement flood control, protection, and/or precaution measures</td>
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<td></td>
<td>disappearance of wetlands</td>
<td>• integrated river basin management</td>
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<tr>
<td>Problem</td>
<td>Causes</td>
<td>Solutions</td>
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</table>
| **18. Prolonged surface ponding** *(surface drainage problem)* *(visible)* | • excessive rainfall  
• flooding  
• excessive irrigation  
• insufficient natural drainage  
• blockage of natural drainage flow  
• soil crusting  
• soil compaction  
• poor land leveling  
• waterlogging (soil saturated already)  
• inadequate drainage capacity  
• blocked or overgrown drainage canals | • no remedy  
• see 17  
• WUA to impose rules to reduce excessive water use and propose improvements on irrigation system  
• improve natural drainage or implement artificial surface drainage system  
• improve natural drainage by removing blockages  
• increase soil stability and/or change irrigation application  
• improve farm operations  
• grade land to enhance surface runoff to (natural) drains  
• see waterlogging (subsurface drainage problems)  
• remodel drains and structures  
• undertake drainage maintenance works |
| **19. Waterlogging (subsurface drainage problem)** *(not always visible)* | • insufficient hydraulic gradient to evacuate deep percolation  
• excessive recharge arriving from losses from the irrigation system  
• excessive deep percolation from irrigated fields  
• shallow impermeable layer | • construction of subsurface drainage system  
• improve irrigation system and management  
• improve timing of irrigation, adjust depth, level fields, change cropping patterns  
• deep ploughing |
| **20. Salinity and problems** *(not always visible)* | • waterlogging  
• irrigation with poor quality water  
• weathering of parent material  
• seawater intrusion | • implement subsurface drainage and leach the salts (apply amendments in case of threat of soil degradation as a result of high sodicity levels)  
• apply soil or water amendment in case of high sodicity levels  
• control build up of high salinity levels through leaching  
• conjunctive use of saline water and fresh water  
• shift to more salt tolerant crop  
• irrigation and cultivation practices to mitigate the effects of salinity on crop production  
• leaching  
• integrated river basin management |
## Problems with the Water Users Association

These problems are not directly visible in the field, but can be mentioned in interviews and discussions.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solutions</th>
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</table>
| 21. No Water Users Activities | • lack of information on WUA purpose  
• low participation of farmers  
• fear for extra costs and fees to be paid  
• lack of leadership  
• lack of competent support from Irrigation Agency/extension staff | • organize meeting with WUA and provide training where needed  
• see problem 24  
• through WUA better water supply and fair charge to everyone  
• see problem 22  
• arrange meeting with support staff and train them when needed |
| 22. No leadership | • nobody interested to take lead  
• low prestige linked to WUA  
• social contrast in village/community  
• mistrust among villagers  
• no support from village head  
• no good people available  
• farmers too busy with other activities | • in consultation with local leaders, identify potential candidates  
• convince farmers of benefits WUA  
• analyze social contrasts and discuss with local leaders for solutions  
• investigate reasons for mistrust  
• discuss reasons, consider mediation from district head  
• delegate authority of WUA to village head |
| 23. Low interest farmers in WUA | • unfamiliar with the WAU purpose  
• irrigation low priority  
• fear for enforcement of extra payments  
• mistrust among villagers  
• lack of adequate information  
• bad experiences with previous/other groups activities  
• farmers too busy with other activities | • inform farmers on benefits of WAU  
• consider to abolish irrigation scheme  
• explain fairness of water fees  
• investigate reasons for mistrust  
• arrange information meetings, use local leaders to disseminate information  
• investigate reasons for previous failures  
• 1) investigate other ways of participation, 2) delegate authority of WUA to village head |
| 24. Poor participation farmers | • not well informed on the purpose of the WAU  
• irrigation not considered high priority  
• fear for enforcement of extra payments  
• farmers too busy with other activities | • inform farmers on purpose and benefits  
• organize training for farmers on the potential benefits of irrigation for rice production, horticultural crops, etc  
• through WUA, better water supply and fair charge to everyone  
• arrange meeting/training at convenient time and invite key farmers |
| 25. Low payment of fees | • Farmers too poor  
• low profitability of irrigation  
• no or poorly supplied with water  
• attitude: "others don't pay, so why should I pay?"  
• mistrust in fee calculation  
• no penalties for non-payment | • waterfees adapted to income from irrigated agriculture  
• in training explain potential benefits of irrigation and reliable water supply  
• see problem 8, 9 or 11  
• WUA need to impose fair payment by everyone  
• WUA to explain basis of fee calculation  
• WUA to establish rules and penalties for non-payment of fees to facilitate payment |
<table>
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<th>Solutions</th>
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</table>
| 26. Poor participation in Maintenance Works | • Farmers not motivated  
• Farmers don't see benefits in maintenance works  
• Farmers have no time as employed elsewhere  
• Attitude: “Others don't participate, so why should I work?”  
• Conflict among farmers  
• Lack of adequate penalties for non-participation | • WUA and local leaders to investigate reasons for low motivation and explain importance of maintenance  
• WUA to arrange payment in cash for labour in maintenance works  
• Adequate control and penalties on non-participation  
• See problem 27  
• WUA to agree on penalty system for non-participation |
| 27. Conflicts among members | • Mislusses of water by certain farmers  
• Unequal water distribution among blocks  
• Unequal distribution of maintenance tasks  
• Social contrasts in village  
• Misuse of trusted funds | • WUA to impose proper control and penalties on misuse of water  
• WAU to establish fair and equal water distribution system  
• WUA to establish fair assignment of maintenance tasks, quality control and penalties  
• Analyze social relationships and divide according social lines  
• Ensure an adequate control and complete transparency in WUA expenditures |
| 28. Lack of rules and regulations | • Unclear about purpose of WUA  
• No need felt for rules and regulation  
• Unfamiliar with drawing up rules and regulations  
• Afraid for too heavy commitment | • Explain necessity of rules and regulation to ensure fair contribution and cooperation from all members  
• Assist in drawing up regulations based on example elsewhere  
• No enforcement, but gradual development of regulations |
| 29. No book keeping and records | • No need felt for keeping records  
• Nobody capable or willing to keep records  
• Require special training in bookkeeping | • To ensure fair and adequate accounting of fees and expenditures, some basic bookkeeping is essential  
• Discuss with village head possibilities for assistance village administration  
• Arrange special training for WUA |
| 30. No WUA meetings to explain or agree | • No need felt or organize WUA meeting  
• No leadership in WUA  
• No WUA  
• Farmers not interested to attend  
• No confidence in benefits of WUA  
• Farmers insufficiently informed | • Evaluate reasons for low interest, identify issues for information  
• See problem 22  
• Establish interest and willingness for WUA  
• Arrange meeting/training on convenient time and invite key farmers  
• Inform and discuss with farmers benefits of WUA  
• In consultation with local leaders, arrange information meeting |
## Problems in Agricultural Production

These problems in agricultural production may be caused by shortcomings of the irrigation system and irrigation management. If this is the case, possible solutions are mentioned. In case the underlying causes are related to another discipline, solutions are not given and the problem is not dealt with in this manual. In case this problem is prioritized to be solved, input from specialists of other disciplines is needed and should be searched for.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solutions</th>
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</thead>
</table>
| 31. **Limited area irrigated** | • insufficient water for irrigation  
• frequent pump breakdown  
• inadequate coverage of canal layout system  
• inadequate and unequal water distribution | • see problem 8  
• see problem 12  
• see problem 6  
• see problem 11 and 9 |
| 32. **Late planting** | • late start rainy season and no irrigation used for land preparation  
• shortage of irrigation water for land preparation  
• unequal water distribution among blocks  
• shortage of power-tillers for land preparations  
• shortage of seeds  
• failure nursery | • train/inform farmers about land preparation irrigation requirements  
• see problem 8  
• see problem 9 |
| 33. **Low yield of irrigated crops** | • insufficient irrigation water  
• low inputs  
• inadequate low performing varieties  
• late planting  
• low soil fertility  
• pest and diseases  
• weeding problems  
• inappropriate production techniques | • see problem 8  
• see problem 38  
• see problem 32  
• see problem 37  
• see problem 34 |
| 34. **Inadequate cultural practices** | • limited skills and tradition of farmers in irrigated agriculture  
• low inputs  
• insufficient information and extension on appropriate production techniques | • train farmers in irrigated agriculture  
• train farmers on production techniques |
| 35. **Low use of fertilizers** | • soils sufficiently fertile  
• unfamiliar with use and appropriate types of fertilizers  
• too expensive  
• no timely credit available  
• not available at the right time | |
| 36. **Low interest of farmers** | • land ownership conditions  
• absent land owners  
• unfamiliar with good cultural practices  
• agriculture not main source of employment  
• social constraints | |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Causes</th>
<th>Solutions</th>
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</thead>
<tbody>
<tr>
<td>37. Pest and diseases</td>
<td>• new and sever of pests previously less persistent&lt;br&gt;• unfamiliar with appropriate pest control techniques&lt;br&gt;• low or inadequate use of pesticides</td>
<td></td>
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<tr>
<td>38. Lack of good varieties</td>
<td>• unavailability of good varieties&lt;br&gt;• unfamiliar with new high performing varieties&lt;br&gt;• poor selection and seed production methods by local farmers&lt;br&gt;• low performance of new varieties due to problems in diseases, fertility or shortage of irrigation</td>
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<tr>
<td>39. Unfamiliarity with other crops under irrigation</td>
<td>• unavailability of good alternative non-rice crops&lt;br&gt;• unfamiliar with new high performing varieties&lt;br&gt;• unfamiliar with appropriate cultivation techniques&lt;br&gt;• poor marketing and risky benefits&lt;br&gt;• low performance of crops due to problems in diseases, fertility&lt;br&gt;• unfamiliar with irrigation of non-rice crops</td>
<td>• see problem 34&lt;br&gt;• see problem 37</td>
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