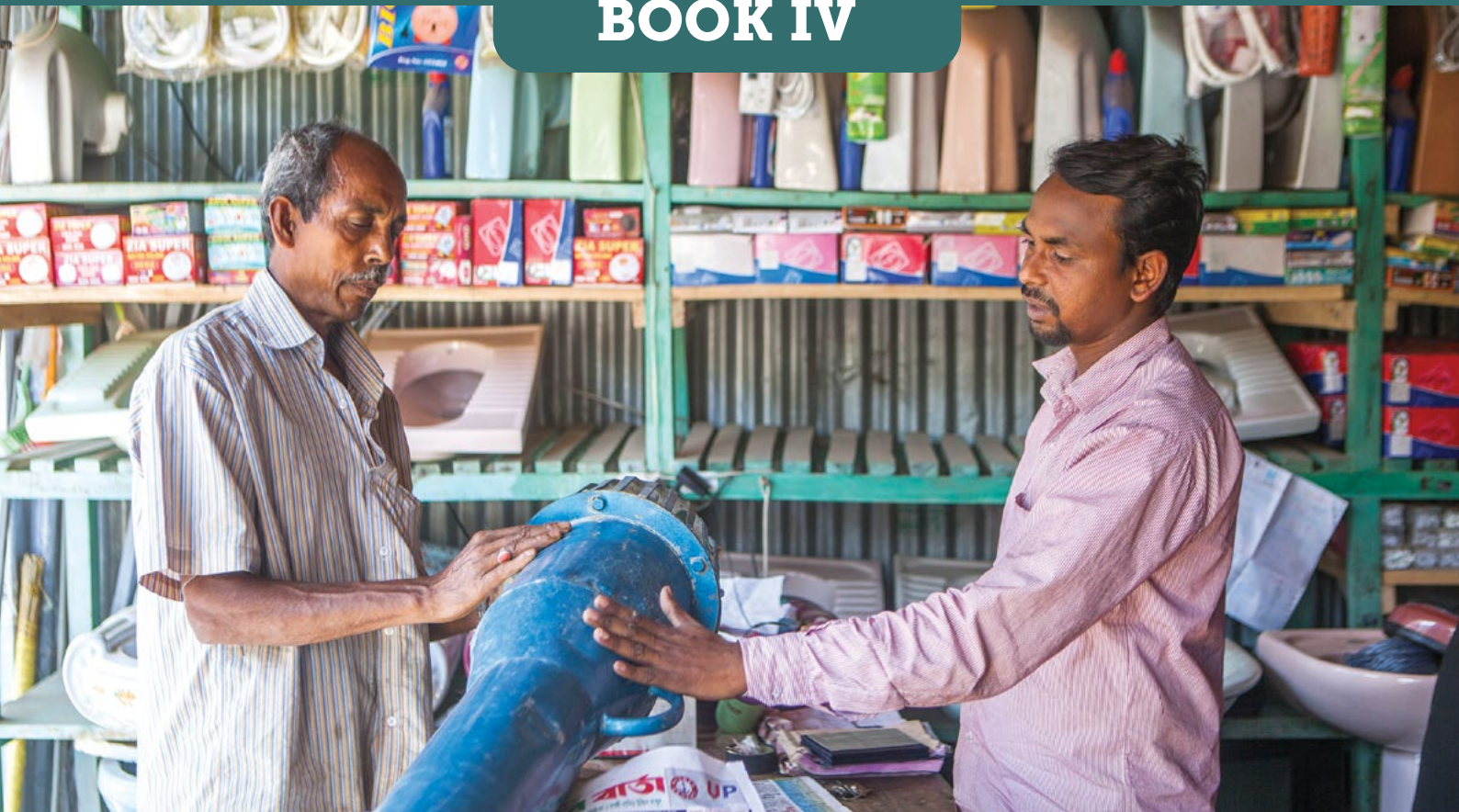


# Axial flow pumps and mixed flow pumps for mechanics

*Experiential learning modules for sustainable  
intensification and agricultural service provision*

## BOOK IV



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# Cereal Systems Initiative for South Asia


## AXIAL FLOW PUMPS AND MIXED FLOW PUMPS FOR MECHANICS

*Experiential learning modules for sustainable intensification and agricultural service provision (IV).*

Timothy J. Krupnik<sup>1</sup>, Kamrun Naher<sup>2</sup>, Kh. Shafiq Islam<sup>1</sup>, Md. Abdul Matin<sup>3</sup>, Syed Mahmudul Huq<sup>1</sup>, Shamim Ara Begum<sup>1</sup>, Muhammad Arshadul Hoque<sup>3</sup>, Sheikh Md. Nazim Uddin<sup>4</sup>, Scott Justice<sup>5,6</sup>, Khondker Murshed-E-Jahan<sup>7</sup>, and Md. Israil Hossain<sup>8</sup>

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CIMMYT – the International Maize and Wheat Improvement Center (CIMMYT) is the global leader in publicly-funded maize and wheat research and related farming systems. Headquartered near Mexico City, CIMMYT works with hundreds of partners throughout the developing world to sustainably increase the productivity of maize and wheat cropping systems, thus improving global food security and reducing poverty. CIMMYT is a member of the CGIAR Consortium and leads the CGIAR Research Programs on MAIZE and WHEAT. The Center receives support from national governments, foundations, development banks and other public and private agencies.

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CSISA was established in 2009 with the goal of benefiting more than eight million farmers by the end of 2020. The project is led by the International Maize and Wheat Improvement Center (CIMMYT) and implemented jointly with the International Food Policy Research Institute (IFPRI) and the International Rice Research Institute (IRRI). Operating in rural 'innovation hubs' in Bangladesh, India and Nepal, CSISA works to increase the adoption of various resource-conserving and climate-resilient technologies, and improve farmers' access to market information and enterprise development. CSISA supports women farmers by improving their access and exposure to modern and improved technological innovations, knowledge and entrepreneurial skills. CSISA works in synergy with regional and national efforts, collaborating with myriad public, civil society and private sector partners.

CSISA's goals are to:

- Promote widespread adoption of resource-conserving practices, technologies and services which increase yields with lower water, labor and input costs.
- Support mainstreaming innovations in national-, state- and district-level government programs to improve long-term impacts achieved through investments in the agricultural sector.
- Generate and disseminate new knowledge on cropping system management practices which can withstand the impacts of climate change in South Asia.
- Improve the policy environment to facilitate the adoption of sustainable intensification technologies.
- Build strategic partnerships that can sustain and enhance the scale of benefits accrued through improving cereal system productivity.

CSISA-MI emerged out of CSISA's ongoing efforts in the USAID/Bangladesh Mission-funded CSISA expansion project (2010-2015), and during CSISA Phase II. It continues to be strategically aligned with the broader CSISA Phase III program in Bangladesh, and is led by CIMMYT in partnership with International Development Enterprises (iDE). CSISA-MI is a five-year project (July 2013 – September 2018) that focuses on unlocking agricultural productivity through increased adoption of agricultural mechanization technologies and services.



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\* PowerPoint files of the flip charts in 'ready to present' format can be downloaded from here (for English language: <https://bit.ly/2MwQ2Ep>) or here (for Bangla language: [https://csisa.org/wp-content/uploads/sites/2/2019/12/191204-\\_AFP-mechanics-smh.pdf](https://csisa.org/wp-content/uploads/sites/2/2019/12/191204-_AFP-mechanics-smh.pdf)).

## Introduction

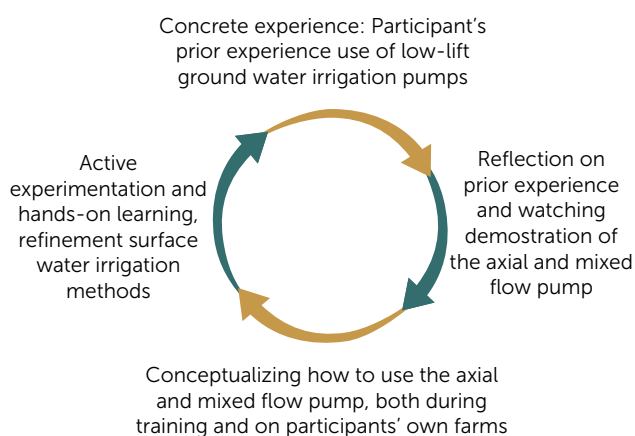
This set of training modules focuses on ensuring that mechanics are able to make repairs to axial flow pumps and mixed flow pumps efficiently and correctly. It builds on other books in this series, and is designed so that anybody who uses these materials can easily conduct training – even those with a limited background in and understanding of agricultural engineering or machinery. By the conclusion of the training module (which can be completed in a single day of intensive training or in a multi-day, multi-session format), participant mechanics will be well equipped to repair axial and mixed flow pumps as part of their ongoing agricultural machinery servicing business. However, users of this book should carefully read all the instructions on how to implement the training effectively in order to ensure the best learning experience possible for the participants. A key aspect of this is ensuring that the training is experiential and interactive, as discussed in the next section.

## Experiential education and training format

This training uses an experiential and hands-on modular format. It is based on a foundation of experiential and hands-on work, combined with discussion and reflection among participants. This means that although the facilitator is instructed on how to carry out the training and how to present materials, the format in which this is done should be horizontal and participatory, with room for adaptation and modification. We also underscore that farmers and agricultural machinery service providers – who are the target of this training – are experts in their own fields. They work daily on farms and have considerably more experience than most university educated technicians, researchers or extension agents. Attentively listening to their opinions and working with them to respond to their needs and experiences will facilitate improved learning and enhance the quality of any given training session. In this sense, it is the responsibility of the training facilitator to elicit the participants' input, opinions and ideas, and to use these interactively to shape discussion and learning. Each facilitator therefore should think of him or herself as a guide whose goal is to elicit insight and ideas from the trainees, in order to enhance their learning process. The technical materials included in this document should therefore be seen as a guide to supplement the in-depth knowledge that the trainee farmers and agricultural machinery service providers already have.

The training format presented in these modules is loosely based on the experiential learning cycle described by Kolb (1984)<sup>1</sup>, who posited that adults learn differently from children, with learning based on cycles involving concrete experience, learners reflecting on this experience, conceptualizing their experiences, and then doing experimentation. After this, the learning cycle is repeated. He further hypothesized that there are generally four types of adult learners and learning styles which should be accommodated. In the production of this manual, we have tried to account for these types of learners, including those who learn by taking part in demonstration activities and critically thinking about them (whom Kolb called divergers), those who learn by thinking, reading and watching (assimilators), those who learn by hands-on thinking and doing (convergers), and those who learn by doing (accommodators).

Well-designed training should accommodate each participant's individual learning style by providing a mixture of lectures and discussions, reading or visual material, hands-on experiential and experimental opportunities, and opportunities to watch demonstrations and to learn. The challenge thus given to training facilitators when using these modules is to accommodate different types of learners in an active learning process. Kolb's theories have been widely researched and validated in a number of contexts, and provide a solid foundation for educational programs aimed at experienced farmers and agricultural service providers, as well as farmer field, school-oriented and action learning. In this training, we loosely attempt to formulate Kolb's learning styles as shown below.



Kolb's (1986) experiential learning cycle as loosely applied to these training modules.

<sup>1</sup> Kolb, D.A. 1984. *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall, Englewood Cliffs, NJ.

Therefore, at every step of the process, facilitators should work to generate discussion and hands-on learning through practical activities, to demonstrate the axial and mixed flow pumps and show participants how to use them, and to encourage critical but constructive reflection among the training participants. There is a certain art to this process, so beforehand, facilitators should practice with their peers different techniques for eliciting discussion among participants. Here are some examples of how to ask questions of the training participants in a way that will encourage them to think and critically reflect on the training materials:

- 1. Arrange seating in a circle, not like in a classroom.** Circular seating arrangements encourage participants and facilitators to interact as equals, and improve the potential for discussion.
- 2. Rather than ask closed questions, ask open ones.** For example, rather than ask "What are the financial advantages to farmers using an axial or mixed flow pump?", ask "How can an axial or mixed flow pump help farmers to sow and harvest more crops from the same plot of land within one year?" Participants may require some additional encouragement to discuss this question, but gently push them towards realizing the answer.
- 3. Prompt questions that have open and multiple answers.** For example, rather than asking training participants "What happens if water gets into the bearing?", ask "If water gets into the bearing, what are the implications for water leakage from the pump, and how might this cause reduced profits for farmers and service providers?"
- 4. Pick a particular participant to give an answer.** Rotate among students, picking different ones and asking them individually or as a group to answer a question. It may take time for them to answer, but allow them to work through the process of reflection and come up with a response. Engage with them and discuss their response, and ask others for their thoughts on the response. However, if a particular participant is naturally quiet or reserved, avoid asking him/her too many questions. The goal is to encourage an active learning atmosphere, but not to make participants feel uncomfortable.
- 5. Most importantly, ask logical questions based on the training materials.** This seems like a simple point, but it is important to stay on topic and make sure that participants are equipped to respond to questions. The ultimate goal is not to make training participants identify what they do not know; rather, our goal is to engage training participants with the training materials so they can succeed at mastering mechanical reaping by applying a combination of what they already know and what they will learn.

- 6. Provide space for under-represented students to speak.** In many training sessions, men speak over women or dominate the conversation. Members of a particular economic or religious group or caste may also speak over those who are not part of their group. Facilitators are encouraged to recognize this, and work to give space to under-represented groups to enable them to learn and speak out equally. This may require giving individuals an opportunity to contribute by asking other participants to wait to reply.

## The field is the best classroom for farmers and service providers

Training sessions are to be held primarily outside and in the field, where participants are encouraged to learn with their own hands how to operate the pumps safely and effectively. It is only by setting up the pumps safely and operating them that trainees can learn how to benefit from them. To facilitate this, the flipchart material provided in this book can be printed on large paper and taken out into farmers' fields, where electricity for PowerPoint presentations or other learning formats may not be available (downloaded <https://bit.ly/2MwQ2Ep>).

Emphasis should be given to these participatory activities throughout the training. Last but not least, training and education does not end at the conclusion of the day. Participants should be encouraged to experiment with, learn from, modify and adapt the techniques they learn for using axial or mixed flow pumps on their own farm, emulating the cycle of continual learning articulated by Kolb, as discussed above. For this reason, training facilitators should share their contact information with participants so they can backstop and assist with technical matters when needed over time. Similarly, trainers may wish to supply contact information of experienced extension agents with knowledge of axial flow and mixed flow pumps.





## Organization of this book

This book is organized as follows: after a general introduction to the training format and style, and materials needed for one day's training, five independent learning sessions are presented. Each session covers a different topic, as follows:

1. Introduction, training objectives and pre-training evaluation
2. Introduction to the axial flow pump and mixed flow pump
3. Main parts of the axial and mixed flow pumps and their functions
4. Common causes of axial and mixed flow pump failure and breakdown – possible solutions
5. Common causes of axial and mixed flow pump failure and breakdown – practical troubleshooting
6. Review of key points, post-training evaluation and close of training

The individuals who are facilitating the training are then instructed on how to implement each training session. This includes a review of the learning objectives, key messages, required materials, and step-by-step instructions on how to conduct the session from start to finish. At each step of the process, training facilitators are expected to encourage experiential learning as articulated above. Most sessions include a component during which the facilitator will give a brief presentation on the topic. Presentations are intended to be discussion oriented, and the facilitator should allow time for participants to ask questions, and in turn elicit questions and feedback, especially if few participants are speaking.

Flipchart materials are provided to guide the technical content of each of these presentations. Facilitators should simply follow the flipcharts and use the materials presented to initiate discussion and ensure that all technical points are covered. Care should be taken to allow all participants to speak, and to make space for under-represented participants, specifically women, to speak and ask questions.

The pages of this book can be printed out on large poster-sized paper and used as flipcharts. The same flipcharts are also intended to be printed on normal-sized paper, stapled together and provided as hand-outs and reference material for participants. In many countries, training facilitators may also choose to use the flipcharts as projected PowerPoint slides, which is encouraged here as long as a reliable electricity source can be supplied, and participants are able to easily view the slides. Some trainers even prefer to use the flipchart materials as a base for PowerPoint slides, modifying them and adding relevant material as they see fit. We fully encourage this approach.

Lastly, training begins with a pre-training evaluation of participants' knowledge, and ends with a post-training evaluation of their knowledge at the end of the day. The change in participants' scores provides an indication of their progress in learning. Ready-made pre- and post-training test questionnaires and their answers are provided in Annex 1. Simply print them on regular sized paper for use. Some training facilitators also like to conduct post-training evaluations a second time, a week or more after the training, to gauge how much information participants have retained over time. We also encourage this, as it can be instructive for training facilitators to learn how to improve and emphasize particular parts of the training that some participants may forget as time passes.

## Training aims and objectives: The axial and mixed flow pumps

The aims of this training are to: (1) increase participants' knowledge of the common causes of axial/mixed flow pump failure and breakdown experienced by farmers and service providers, and (2) improve their ability to repair the machine effectively and efficiently.

By the end of the training, participants should be able to:

- identify the major mechanical parts of axial and mixed flow pumps and understand their functions;
- identify the causes of major failures and breakdown associated with axial and mixed flow pumps, and find solutions to fix them;
- select appropriate spare parts and tools/workshop facilities required to make repairs to the pump;
- demonstrate awareness of where to purchase spare parts; and
- demonstrate that they can repair the pump(s) effectively and efficiently.

## Whom is this training designed for?

This training is designed for mechanics, either (1) with experience repairing irrigation pumps, or (2) who are already running a business and have an interest in repairing axial and mixed flow pumps. This training is also suitable for farmers and irrigation service providers, but only if they have advanced knowledge of machinery repair. Gender balance should be maintained when selecting participants – the ideal is to have an equal mix of women and men.

## Key considerations for training

Key considerations for planning, preparing and organizing the training are given below. The facilitator(s) should prepare well in advance, reading each section carefully to ensure the training is implemented effectively and efficiently. The information presented here can be generalized for each training day in this series of books. More specific information pertaining to individual training days is also presented at the beginning of each module; be sure that you also review this material.

### Participants

The number of participants per batch should not exceed six. They should be mechanics who have experience (or who are interested in) providing mechanical repair services for the users of axial and mixed flow pumps. Contact participants well ahead of the training date (at least one week) to allow them time to prepare.

### Venue

Select the training venue carefully. It should be next to a mechanic's workshop, preferably with an open shady place –for example, under a tree. This outdoor area should be no more than a five-minute walk away from where participants meet at the start of the day. The space should be free from outside distractions, and should be close to a surface water source (e.g., a pond, canal or river, from which water can be lifted). Note that the water should be no more than 2.5 m from the edge of the canal. In other words, the canal should be relatively full, with no more than 2.5 m of vertical height between the water and the soil surface. There should also be accessible restroom/toilet facilities nearby.

### Training aids

At least one month before the training is due to start, please review the detailed list of training aids on the next page and make sure you get together all the materials needed well before the training starts.

### Facilitator(s)

An experienced local mechanic with the competence to train others should be selected to facilitate the training. However, if help is not available locally, the facilitator should arrange support from other research or extension institutes, or from machinery manufacturers. Allow enough time to arrange this in advance. If resource people such as these are not available, the facilitator(s) should carefully study all the

points in this book and make sure they can repair a AFP easily, without having to refer to printed instructions. The key point is that the person who facilitates the training should be well versed on how to lead effective interactive and experiential learning-based training, in addition to being a knowledgeable mechanic.

### Facilitator's preparation

Well ahead of the training start date, the facilitator(s) should go through each module and its respective topics, and practice the implementation techniques as per the allocated time. Since each session contains different topics, implementation techniques and time allocation, facilitators need to read each module minutely and practice their delivery following the PowerPoint presentation/flipcharts to ensure a lively presentation that keeps to schedule.

### Date of training

The date of the training should be decided following discussion and agreement with trainees to ensure their participation. It should preferably be during their weekly day off to avoid any financial loss to their business.

### Registration

Participants should reach the training venue on time. On arrival, each participant should register his/her name and take a seat in the classroom or similar covered area allocated for training. They will later move to the nearby crop field for practical exercises. Registration should be completed before training begins, after which no new participant can be allowed to join. Registration of participants should be completed before the training session begins. No more than six participants should be allowed after the registration period.

### Group formation

As part of the introduction, the facilitator should divide participants into three groups. Ideally there should be five participants per group; however, the number of groups or number of participants per group may vary depending on (1) the total number of participants, and (2) the number of axial or mixed flow pumps available. Working in smaller groups ensures a more action-oriented, hands-on approach to learning. Generally, four to five people should be assigned to one pump. Arrange any seating so these small groups can sit with one another. Participants should remain in the same group throughout the day, to take part in discussions, question and answer sessions, demonstrations and exercises. Do not set up the seats in classroom style; circular seating should always be used.

## Participatory, experiential and hands-on learning

The training approach should be participatory, with an emphasis on hands-on and experiential learning, and actual operation of the AFP/MFP. This is why it is important to limit participant numbers relative to how many pumps are available, as each participant should have the opportunity to have hands-on experience operating the machine. The facilitator should have been trained in these methods, and should utilize techniques that aim to motivate participants to get involved in the training – for example, question and answer sessions, experience sharing, group exercises, group discussions, and group presentations. This guide explains how to do that.

## Effective and enjoyable training

The training should be facilitated in such a way that participants understand the key messages and information clearly, and find it useful and valuable, rather than a waste of their time. To achieve this, the facilitator should work to ensure that the training is enjoyable (using fun games, quizzes, sing-along sessions and other techniques to get trainees motivated and involved). One-way lecture formats are not acceptable and are discouraged – hands-on training is always more effective. The facilitator should arrange a short break (about two minutes) after each ten minutes of presentation, discussion and exercise, during which they should ask questions to check whether participants are understanding the training well, and if necessary, adapt their teaching style.

## Use of mobile phones

Use of mobile phones causes distraction and reduces the effectiveness of the learning experience. All participants, including the facilitator(s), should keep their mobile phones switched off during the training session. If they receive an urgent call, they should excuse themselves from the group to answer it.

A pre-training evaluation questionnaire at the start of the training and post-training evaluation at the end are important and necessary to judge whether and to what degree the learning has been effective. These questionnaires are provided in Annex 1.

## Course preparation, duration, materials and setting

This course is designed for one day's training of approximately 7 hours of instruction, comprising about 2 hours and 20 minutes of discussion and review plus 5 hours of demonstrations and practical exercises. This

excludes lunch and breaks. This is an intensive course; sessions are held in the field and not in a classroom. The facilitator(s) can decide the best time to take tea and lunch breaks (these times are not included in the estimates below and so should be accounted for when planning the training). It is important to keep times flexible, depending on the needs of the participants – some sessions may be faster than allowed for, others may be slower.

The content is divided into an introductory session plus five instructional sessions, as follows:

Session	Topic	Approximate duration (minutes)
1	Introduction, training objectives and pre-training evaluation	30
2	Introduction to the axial and mixed flow pumps	30
3	Main parts of an axial and mixed flow pumps and their functions	30
4	Common causes of failure and breakdown – possible solutions	60
5	Common causes of failure and breakdown – practical troubleshooting	240
6	Review of key messages, post-training evaluation and close of training	50

## Planning and preparing for the training

Please review the 'Key considerations for training' section above. Note that the training requires a body of water with a level of water suitable for pumping, a safe and flat area next to it on which to set the pump and where the training will take place, and next to it, land suitable for demonstrating irrigation. Several weeks of advanced preparation are therefore required.

## Training venue

Provide space with adequate cover for six participants, and a water body nearby (ideally no more than five minutes' walk from where the participants meet) with water at the appropriate level for demonstrating the axial/mixed flow pump. Note: water levels change throughout the year and affect the timing of the training; it is therefore the facilitator's responsibility to check the suitability of the location in advance but also

close to the time scheduled for the training to take place. The venue should be easily accessible and safe for any vulnerable or non-able-bodied participants. Bathroom facilities with appropriate privacy (particularly for women participants) should be provided.

## Required training aids

- ✓ two sets of toolboxes, each containing: 1 x dual wrench set, 1 x adjustable wrench set, 1 pair of pliers, at least 1 x Phillips head screwdriver, 1 x flathead screwdriver, 1 x measuring tape, 1 x Allen key (hex key) wrench set, hammer and other common hand tools, 1 x 3-jaw puller (10"), oil, 1 x grease gun, files, cloth, common sizes of nuts and bolts, chalk (see Annex 3 for more details).
- ✓ diesel (2 L), gasoline (2 L), grease (0.25 kg), lube oil (1 L)
- ✓ rugs (jrhuts) to sit on and work from, and to catch spilled oil
- ✓ printed flipcharts for sessions 1-3 and 5

- ✓ blank flipchart paper for group feedback (approximately 10 sheets)
- ✓ whiteboard and flipchart/whiteboard stand
- ✓ two or three whiteboard (dry erase) pens; two or three flipchart markers
- ✓ a notebook, pencil and spare paper for each participant
- ✓ two used axial flow pumps
- ✓ faulty or broken parts from an axial flow or mixed flow pump (if available)
- ✓ pre-arrangement with a workshop to provide necessary mechanical support

**Note:** the facilitator should explain to participants that axial flow and mixed flow pumps are different, although they are the same in their basic operation, shape and size. Axial flow pumps are usually slightly less powerful than mixed flow pumps; mixed flow pumps have a 'bell' shaped water intake area, and an impeller larger than the pipe conduit diameter.

# Session 1

## Introduction, training objectives and pre-training evaluation

### Learning objectives

At the end of this session, participants should be able to:

- state the names of the trainer(s) and other participants
- understand and state the course contents and training objectives
- understand the training guidelines about learning and cooperation, including the participatory
- approach and their expected contribution
- assess their pre-existing knowledge level in terms of the content of the training

### Key messages to convey to participants throughout this session

1. The training day is composed of an introductory session plus five instructional sessions and will take about seven hours excluding lunch, tea and other breaks. Get ready to learn plenty of new things – and please be patient: there is a lot of material to complete.
2. This training is participatory and fun – trainers and trainees will learn from each other.
3. The training is mostly hands-on: participants should learn by working with the pumps, rather than just listening. Active participation works best.
4. There is a pre-training and post-training evaluation process, which is an essential part of the day.
5. Participants should be attentive during the training and participate actively – either individually or as part of their group – in each task/assignment/exercise given to them.
6. The facilitator and participants should keep their mobile phone switched off or on silence. If they receive an urgent call, they should excuse themselves from the group and go elsewhere to answer it.

### How to conduct the session on *Introduction, training objectives and pre-training evaluation*

For this session, you will need the following resources and materials:

- the participant registration form
- the flipchart Session 1: Introduction, training objectives and pre-training evaluation
- A4 printed copies of the flipchart for each participant
- a notebook and pen for each participant
- a copy of the pre-training evaluation questionnaire for each participant (see Annex 1)
- several sheets of blank poster paper or a whiteboard, whiteboard stand and dry marker/whiteboard pens

### Step 1 – Form groups (5 minutes)

Most adults learn best when they work in groups. Participants in a small group can interact and share ideas with each other, which allows peer-to-peer learning and stimulates more entertaining and rich learning experiences.



An ideal size is a total of six participants, divided into two groups of three.

Divide the participants into groups of three by asking them to number themselves 1, 2, 3 recurring and asking those with the same number to rearrange their seats and sit together (all the 1s together in one group, 2s in another and so on). This splits up participants who are sitting with people they already know.

Next, ask each group to select a leader and choose a fun name for their group. It is helpful if the group leader can read and write, which is something the training facilitator can assess during the registration period.

Ask each group to find five things group members have in common with every other person in the group, and that have nothing to do with work. Please, no body parts, as we all have legs and arms! Also, no clothing, as we all wear clothes. Focus on more interesting commonalities; examples may include having worked as a mechanic for more than three years, working to repair motors for motorcycles or tractors, or being interested in sports like cricket. This activity helps the group explore shared interests more broadly – it should be fun and anything of relevance can be included!

Ask the group leaders to take notes and be ready to read their list to the whole group at the end of the session. This should generate discussion, and a lot of laughter and fun, while encouraging each group to think more like a team. .

## Step 2 – What are the participants' expectations? (10 minutes)

This is one of the most effective tools for breaking the ice and enabling a new group of trainees to get to know each other. Each group member is an important source of knowledge. Each participant also has his or her own style of thinking and learning. This means that for effective learning it is important for the trainers to understand each participant's expectations of the training module. It will also help the facilitator(s) be better equipped to deliver a successful learning experience during the training.



Use an icebreaker approach during which participants can state what their learning expectations are at the beginning of the day. This will provide feedback from each participant about what they expect – and want – to get out of the training.

During the introduction of the training module, when it is time for participants to introduce themselves following group formation, the facilitator should explain that participants' expectations are very important, and that understanding them will be crucial for ensuring quality outcomes from the training. These expectations can later be compared with the module outline, and modifications and changes can be made where necessary.

Ask participants to:

- introduce themselves individually;
- share their expectations of the training course (which should be summarized and presented by the group leader after 2-3 minutes of discussion).

Here is an example:

"Hi, my name is Sudhanshu. Our group wants to know how to solve major problems with axial and mixed flow pumps, what type of pump is best to use with which types of water bodies, and how we can make money providing a pump repair service to farmers. Will we learn how to do that?"

At the end of this session, review the list of expectations that the groups made. Discuss any points not covered in the course and explain whether their expectations will be met, and if not, why.

## Step 3 – Introducing the training (10 minutes)

Use flipchart *Session 1: Introduction, training objectives and pre-training evaluation* to present a brief overview of the training course, the training methods the course uses, the rules, and the responsibilities of the participants. Allow time for both the trainer(s) and participants to ask questions.

## Step 4 – Pre-training evaluation questionnaire (20 minutes)

Distribute the 'Pre-training evaluation questionnaire' (see Annex 1) to each participant and allow 20 minutes or so to complete it. If necessary, helpless literate participants understand and answer the questions. The questionnaire can also be printed and put up on flipchart paper. Collect the answers; they will be compared with the post-test evaluation answers at the conclusion of the training. They should be corrected before the end of the day, prior to the closing session, during which the evaluation scores will be given to all participants.

# Session 2

## Introduction to the axial flow pump and mixed flow pump

### Learning objectives

At the end of this session, participants should be able to:

- demonstrate awareness of the different types of irrigation pumps available on the market;
- understand and explain the functions of the different pumps and their usefulness; and
- explain the comparative advantages and disadvantages of the axial and mixed flow pumps compared to conventional centrifugal pumps for lifting surface water from canals, ponds and rivers.

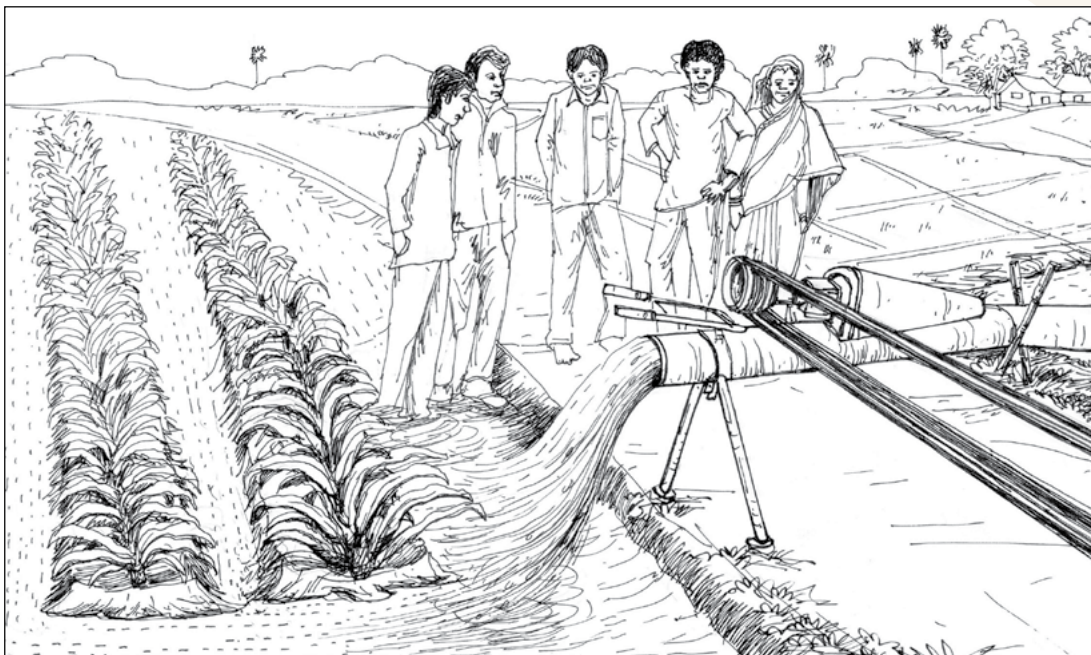
### Key messages to convey to participants during this session

1. The axial flow pump consists of a propeller (called an 'impeller') mounted on a shaft inside a long pipe. The pump is powered by a diesel engine or electric motor, enabling it to pump water from a surface source. It has been in common use in Thailand and other Southeast

Asian countries since the 1960s; it is only now emerging in Bangladesh.

2. Mixed flow pumps differ from axial flow pumps in that the impeller is usually larger than the diameter of the pipe in which the shaft is encased; this provides extra water pumping power.
3. Axial and mixed flow pumps are available in different sizes and capacities.
4. Tests in Bangladesh have shown that when low lifting (less than 3 m in height), the axial flow pump's fuel consumption is much lower (21-50%) than that of the traditional centrifugal pump, saving money for irrigation service providers<sup>1</sup>.

<sup>2</sup> See Krupnik, T.J., Santos Valle, S., Islam, M.S., Hossain, M.A., Gathala, M.K., and A.S. Qureshi. 2015. Energetic, hydraulic, and economic efficiency of axial flow and centrifugal pumps for surface water irrigation in Bangladesh. Irrigation and Drainage. DOI: 10.1002/ird.1940.



Demonstrating the axial flow pump.

## How to conduct the session on *Introduction to the axial flow pump and mixed flow pump*

For this session, you will need the following resources and materials:

- the flipchart Session 2: Introduction to the axial flow pump and mixed flow pump
- A4 printed copies of the flipchart as a handout for each participant
- several sheets of blank poster paper/whiteboard, flipchart stand, whiteboard stand, dry markers/whiteboard pens

### Step 1 – Prepare participants for the DVD (5 minutes)

Display the following questions and ask participants to note down any answers they learn during the screening of the DVD, *Axial Flow Pump*. Before starting the DVD, ask the participants to read through the questions and ask for clarification if there is anything they would like to be explained. Encourage them to take notes during the screening of DVD, and to aim to have answers ready for discussion at the end.

- What is an axial flow pump?
- What two possible power sources can be used to operate the AFP/MFP?

- What are the power requirements of these power sources?
- What are the different types of AFPs available on the market?
- Why is the AFP/MFP useful?
- What are the differences between the AFP/MFP and the conventional centrifugal pump?
- How does a mixed flow pump differ from an axial flow pump?

### Step 2: (15 minutes)

Show the DVD/AFP video.

### Step 3: (10 minutes)

Lead a discussion on the axial and mixed flow pumps, focusing on the points listed on the poster paper or whiteboard.

### Step 3: (10 minutes)

Lead a discussion on the AFP, focusing on the points listed on the poster paper or whiteboard.



# Session 3

## Main parts of the axial and mixed flow pumps and their functions

### Learning objectives

At the end of this introductory session, participants should be able to:

- identify the main parts of the axial and mixed flow pumps
- understand and state the functions of each part

### How to conduct the session on *Introduction to the axial and mixed flow pumps and their functions*

For this session, you will need the following resources and materials:

- the flipchart Session 3: Main parts of the axial and mixed flow pumps and their functions
- A4 printed copies of the flipchart for each participant
- several sheets of blank poster paper or a whiteboard, whiteboard stand and dry marker/whiteboard pens

### Step 1 – Raise participant awareness and generate discussion (20 minutes)

Show the participants some used or old axial and mixed flow pumps. Then initiate the session, warming up participants with an ice-breaking question-and-answer session.

**Ask:** Can anyone name the main parts of the axial and mixed flow pumps? What are their functions? Encourage one or two participants to answer the questions. Listen carefully and list the parts they mention on blank poster paper or the whiteboard.

### Step 2 – Generate discussion and learning (10 minutes)

Lead a discussion on the AFP/MFP, using the flipchart Session 3: *Introduction to the axial and mixed flow pumps* to ensure that trainees can identify and state the functions of the main pump parts as follows:

Name of part	Functions
Inlet screen	Blocks dirt and other stray materials from getting into the pump from the canal, pond or river from where water is pumped
Impeller	Pumps/pushes water upwards through the pipe or conduit
Driving shaft	Drives the impeller, which pushes water up the pump
Pipe or conduit	Holds the water pumped by the impeller until delivery
Bearing housing	Holds the bearings
Bushing	Works like a bearing and holds the shaft in place
Pulley	Drives the shaft (powered by an engine)
Diffuser vane	Straightens the water flow and reduces turbulence



# Session 4

## Common causes of axial and mixed flow pump failure or breakdown – possible solutions

### Learning objectives

At the end of the session, participants should be able to:

- understand and state the common causes of failure and breakdown of the axial and mixed flow pumps, and
- repair and adjust a range of failures and breakdowns efficiently.

### How to conduct the session on Common causes of failure and breakdown and possible solutions

For this session, you will need the following resources and materials:

- flipchart Session 4: Common causes of axial and mixed flow pump failure or breakdown and possible solutions
- A4 printed copies of the flipcharts as a hand-out for each participant
- several sheets of blank poster paper/whiteboard, flipchart stand, whiteboard stand, dry markers/whiteboard pens
- faulty/broken parts of axial and mixed flow pumps (if available)
- spare parts (if available)
- blank poster paper/whiteboard, whiteboard stand, white board pens

### Step 1 – Raise participant awareness and generate discussion (15 minutes)

Show the participants a used or old axial and/or mixed flow pump. Then initiate the session, warming up participants using an ice-breaking question-and-answer session.

**Ask:** What are the common causes of failure and breakdown in an axial or mixed flow pump? What type of failure and breakdown do service providers and

farmers usually complain about to you?

Encourage one or two participants to answer the questions. Listen carefully and list the causes of failure and breakdown on the whiteboard or flipchart. Rank the problems based on the consensus of the trainees, focusing on participants who are hesitant to speak up or appear unconfident about providing a solution to the problems.

Next, encourage participants to contribute their experience solving each of the problems. Check whether the solution to each problem is on the flipchart. If not, make a note of it, return to this topic and discuss it with the group during the next session. Finally, check whether any common cause of failure or breakdown listed on the flipchart has not been encountered by any of the participants. If prompted, a participant may recall and be able to talk about it. If not, be prepared to talk about it yourself.

### Step 2 – Demonstration by a skilled mechanic (30 minutes)

Next, if available, an experienced mechanic talks about: (1) the faulty parts of the axial and mixed flow pumps and how to repair or replace them, and (2) the maintenance and storage of the machines. If a mechanic is not available, an experienced service provider should be engaged; if this is not possible, the facilitator should complete this part of the training.

### Quick review (15 minutes)

At the end of Session 4, bring participants together in their groups. Ask each group five to ten questions, encouraging each participant to answer 1 or 2 questions based on the information given during this session. If a participant is unable to answer a question, invite other members of their group to answer. If no one in that group can answer, pass the question over to the next group.



# Session 5

## Common causes of axial and mixed flow pump failure and breakdown and possible solutions – practical troubleshooting

### Learning objectives

At the end of the session, participants should:

- be equipped to carry out repairs and be aware of essential safety measures;
- be able to put together and dismantle the main parts (those which most commonly fail/breakdown) of axial and mixed flow pumps;
- be able to resolve common failures/breakdowns by repairing the relevant parts or replacing them efficiently.

### How to conduct the session on *How to set up and use the axial and mixed flow pumps safely and effectively*

For this session, you will need the following resources and materials:

- used axial and mixed flow pumps
- faulty/broken parts of axial and mixed flow pumps (if available)
- spare axial and mixed flow pump parts (if available)
- blank poster paper/whiteboard, flipchart stand, whiteboard stand, dry markers/whiteboard pens
- the assistance of an experienced mechanic

Please note: there are no flipcharts for this session.

### Step 1 – Demonstration by a skilled mechanic (or if not available, an appropriate expert) (75 minutes)

The skilled mechanic demonstrates: (1) all the parts (putting together and dismantling) of both pumps, and (2) the common issues as ranked below, along with ways to fix them:

1. the pump shaft bends or breaks
2. water leaks from the pipe or pump
3. the transmission belt rips
4. the pump impeller breaks
5. the pulleys overheat, stretch or break
6. the bushing jams or fails due to sand getting into the bushing casing

### Step 2 – Information sharing about spare parts and where to get them (15 minutes)

Next, present information about the prices of the different spare parts of axial and mixed flow pumps and where to get them. If possible, use actual spare parts to illustrate the discussion.

### Step 1 – Consolidation of learning (150 minutes)

Encourage each participant to demonstrate his/her ability to identify solutions to each of the problems listed on the whiteboard, and address each of the points below for each problem.

**Step 1:** Identify the most significant problem and state its cause(s).

**Step 2:** Dismantle the relevant part and inspect it for the cause of the failure.

**Step 3:** Identify the appropriate spare part(s) needed or repair the faulty part.

**Step 4:** Replace the repaired/new part on the machine appropriately.

Repeat the above steps with the second and third most significant problem, and so on.

# Session 6

## Review of key messages, post-training evaluation and close of training

How to conduct the session on Review of key messages, post-training evaluation and close of training

For this session, you will need the following resources and materials:

- flipchart Session 5: Review of key messages, post-training evaluation and close of training
- A4 printed copies of the flipcharts as a hand-out for each participant
- several sheets of blank poster paper/whiteboard, flipchart stand, whiteboard stand, dry markers/whiteboard pens
- a copy of the post-evaluation questionnaire for each participant (see Annex 1)
- hand-outs or other materials (e.g., leaflets, brochures, if available) for participants

### **Step 1: Generate discussion to recap and reflect on the key messages of the day (30 minutes)**

Review each of the day's sessions by asking the participants the questions listed on the Session 5 flipchart, 'Review of key messages'. This will provide a good indication of whether all the participants have learned from the training, and to what extent.

Use the following questions to stimulate discussion and make sure that everyone understands the essential messages:

- What are main parts of an axial/mixed flow pump? What are their functions?
- What are major causes of failure and breakdown of the axial/mixed flow pumps?
- What should you do if the pump shaft breaks or bends?
- Where can you get a new impeller?
- How would you address water leakage from the pipe or pump?
- What should you do if the transmission belt rips?

Next, ask participants directly if there is anything that needs further clarification. If the facilitator has been successful in making the day's training really participatory, trainees should have the confidence to speak up if they think some aspect was not covered during the day. As throughout the day, encourage any reticent trainee to speak (without making them feel awkward or self-conscious). Note down any issue that was not covered in the training – this will enhance the next training day for a new batch of trainees.

### **Step 2: Participants complete the post-training evaluation questionnaire (10 minutes)**

Distribute the post-training evaluation questionnaire to participants and allow them 10 minutes to complete it. Be ready to answer questions and assist anyone who may need it. In particular, look out for any less confident participant who might need more help or who lacks the confidence to ask for it.

### **Step 3: Distribution of hand-outs, tool bags and any additional materials (5 minutes)**

Distribute hand-outs, leaflets, brochures and other materials to participants.

### **Step 4: Acknowledgments and close of training: (5 minutes)**

Thank the participants and any guests, and close the training with concluding remarks. Inform participants that there are other training sessions for mechanics which they may find useful, such as the training on self-propelled multi-crop reapers, the PTOS and the bed planter. Make sure participants know whom to contact if they have any follow-up queries, and how to do so.



# Flipcharts and handout materials\*

\* PowerPoint files of the flip charts in 'ready to present' format can be downloaded from here (for English language: <https://bit.ly/2MwQ2Ep>) or here (for Bangla language: [https://csisa.org/wp-content/uploads/sites/2/2019/12/191204-\\_AFP-mechanics-smh.pdf](https://csisa.org/wp-content/uploads/sites/2/2019/12/191204-_AFP-mechanics-smh.pdf)).





# Session 1

## Introduction, training objectives and pre-training evaluation

**Axial and mixed flow pumps  
one-day training flipchart**



# What do you expect to learn from this training?



- ◆ In groups, discuss what you think you'll learn today.
- ◆ Choose someone from each group to speak for the group.
- ◆ Take notes.

# Today's sessions

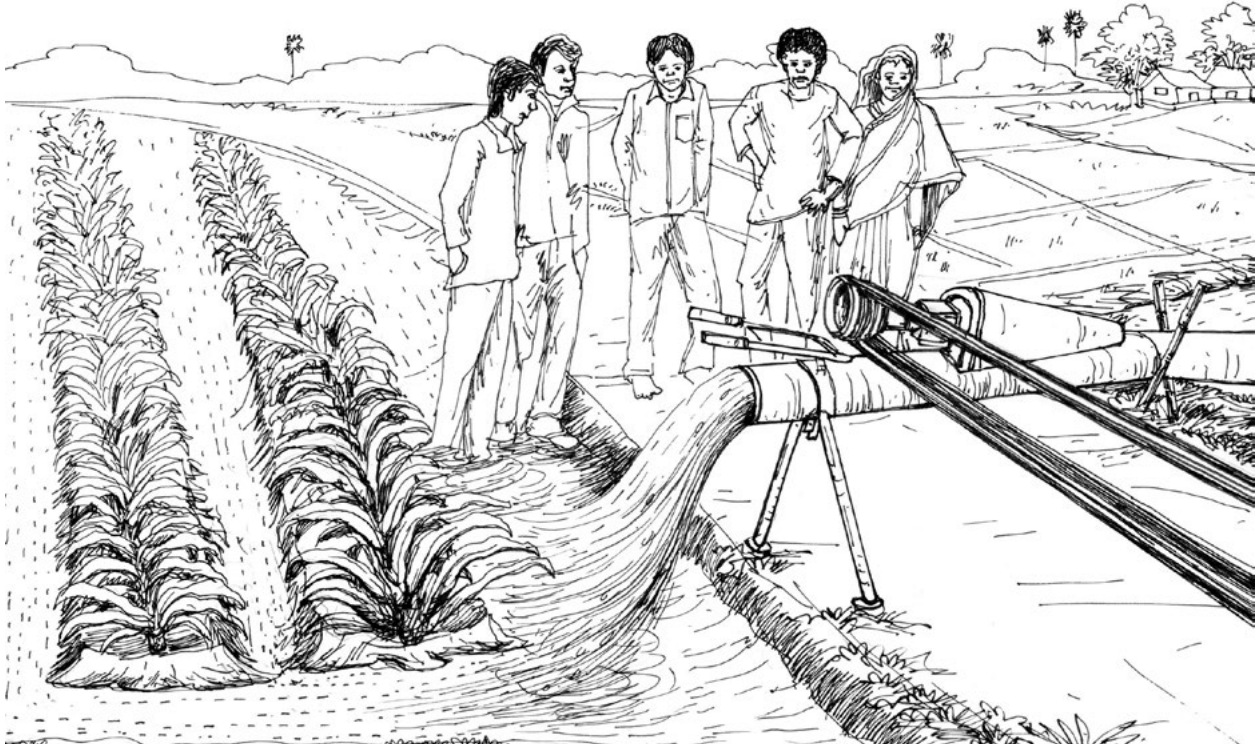
- 1. Introduction, training objectives and pre-training evaluation**
- 2. Introduction to the axial flow pump and mixed flow pump**
- 3. Main parts of the axial and mixed flow pumps**
- 4. Common causes of axial and mixed flow pump failure and breakdown and their potential solutions**
- 5. Common causes of axial and mixed flow**
- 5. Common causes of axial and mixed flow pump failure and breakdown – practical troubleshooting**
- 6. Starting an axial or mixed flow pump service business**
- 7. Review of key messages, post training evaluation and close of training**

## What kind of training is this?

This is *participatory* training, so:

- ◆ Ask questions and speak up.
  - ◆ Learn by experience – run irrigation pumps yourself and learn how to operate them.
- ◆ Learn by discussing each topic with your group.
  - ◆ Speak up when the facilitator asks questions – and ask questions yourself. This way we can learn from each other.

# Please enjoy this training!

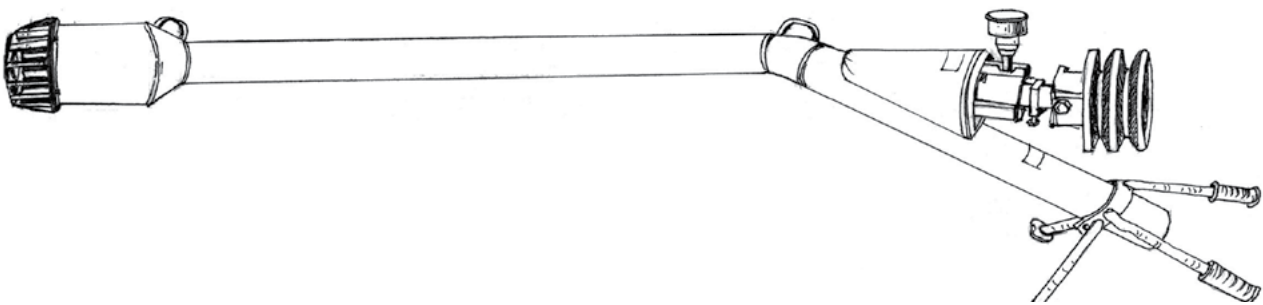


- ◆ **Feel free to ask questions and to contribute your knowledge.**
- ◆ **Make sure you get time to practice how to set up and operate the pump.**
- ◆ **Have fun!**

# Session 2

## Introduction to the axial flow pump and mixed flow pump

Axial and mixed flow pumps  
one-day training flipchart





## What are the axial flow pump and mixed flow pump?

- ◆ An axial or mixed flow pump (AFP/MFP) is driven by (1) a shaft encased in a long pipe, and (2) an impeller (this is a reverse directed propeller – like on a boat – which operates using power from a diesel engine or electric motor).
  - ◆ The mixed flow pump impeller is usually larger than the pipe in which the shaft is encased, which provides extra power to lift water.
- ◆ AFPs can be traced back to Vietnam and Thailand in the 1960s, where they were developed by innovative farmers. They are now common throughout Southeast Asia.

## **What are the axial flow pump and mixed flow pump?** *(continued)*

- ◆ Both pumps are also known as 'propeller pumps' because the impeller works much like a boat propeller.
  - ◆ To run an AFP, a two-wheeled tractor or a 12-16 HP diesel engine is necessary (unless engines are directly coupled). However, these are rare in South Asia.
- ◆ Using a AFP to irrigate farmers' fields can be profitable – both for the pump owner and for the farmer!

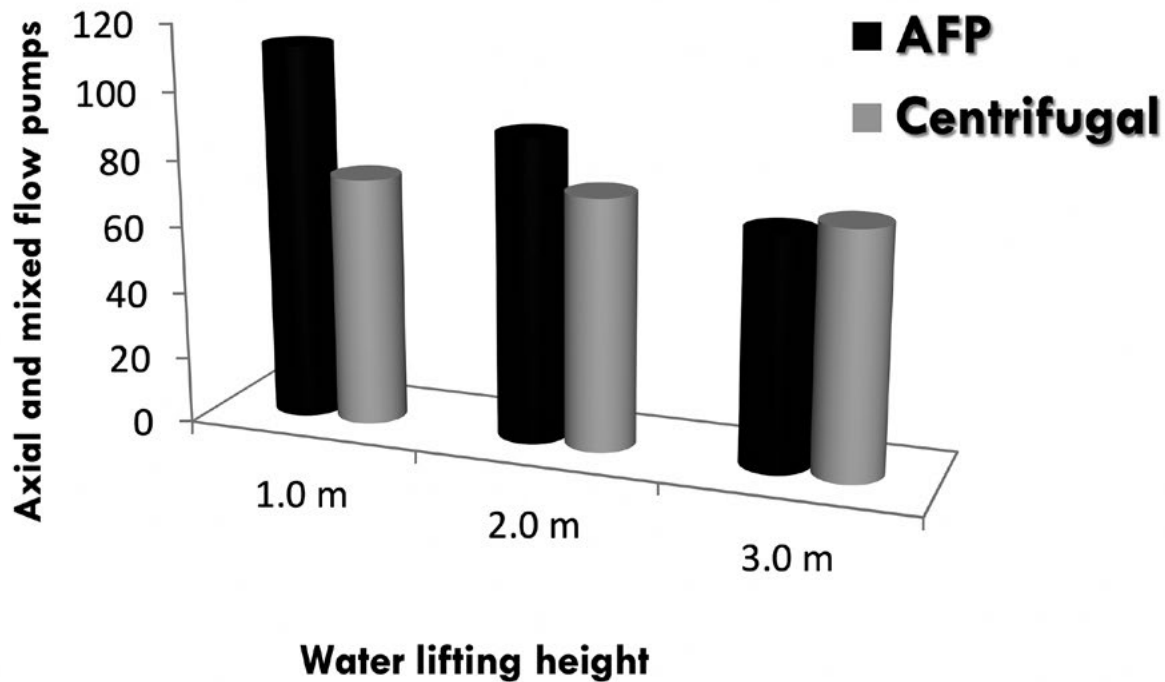




## Differences between the AFP/ MFP and the centrifugal pump

Criteria	AFP/MFP	Centrifugal pump
Capacity	high	low
Frictional loss	low	high
Operating cost	low	high
Power transmission	high efficiency	low efficiency
Operating time required	less	more
Manufacture	easy to fabricate	difficult to fabricate
Fuel consumption	low	high
Water lifting height	up to about 3 m (and fuel efficient)	over 3 m (but with low fuel efficiency when lifting < 3m)

## Advantages of the AFP



Early experiments show that:

- ◆ At 1-m lift, the AFP is 51% more fuel efficient than the centrifugal pump.
- ◆ At 2-m lift, the AFP is 21% more fuel efficient than the centrifugal pump.



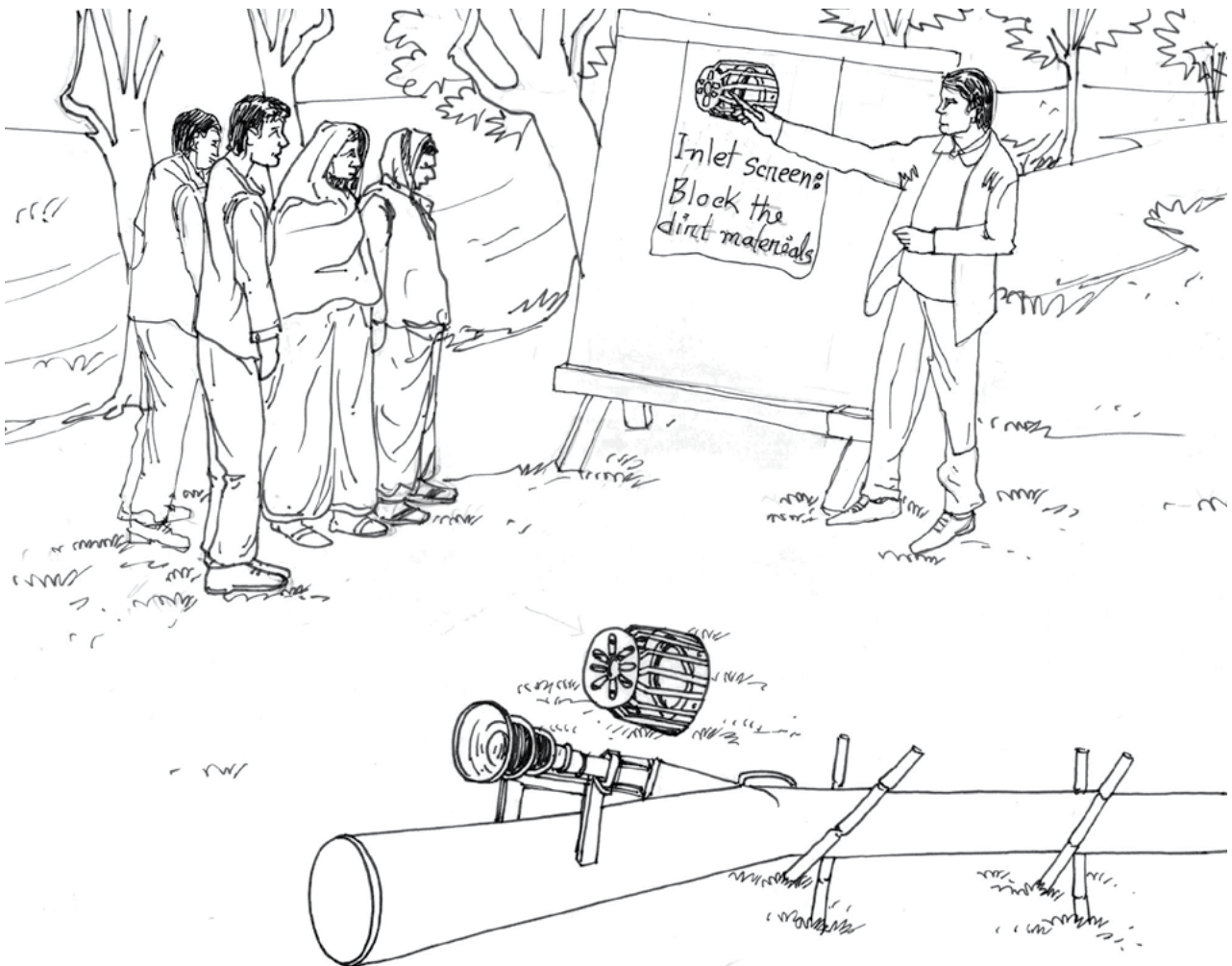
◆ At 3-m lift, the AFP discharges more water but the fuel cost is higher.

Mixed flow pumps can provide increased lift height. Experiments are under way to determine the best engineering approach to developing highly fuel efficient MFPs.

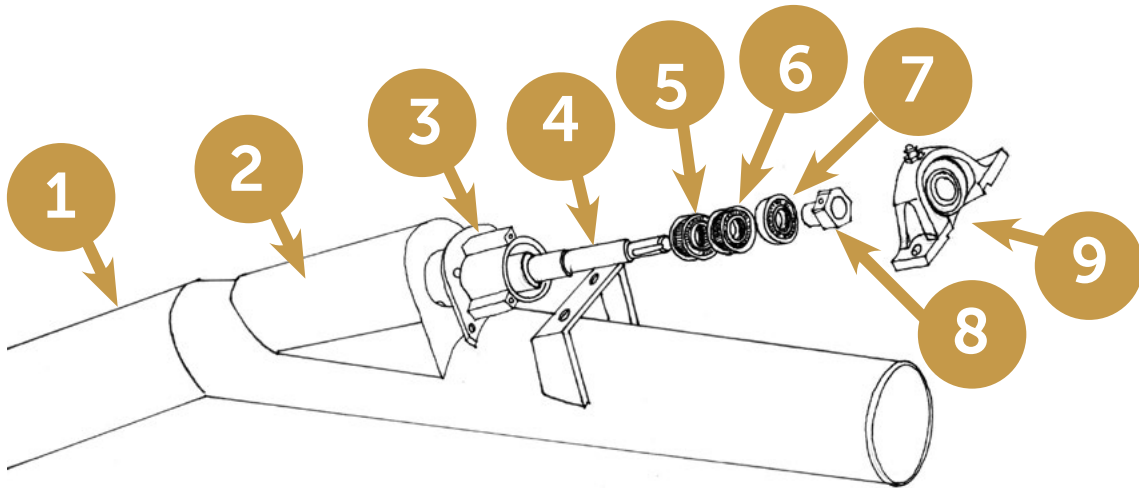
# Session 3

## Main parts of the axial or mixed flow pump and their functions

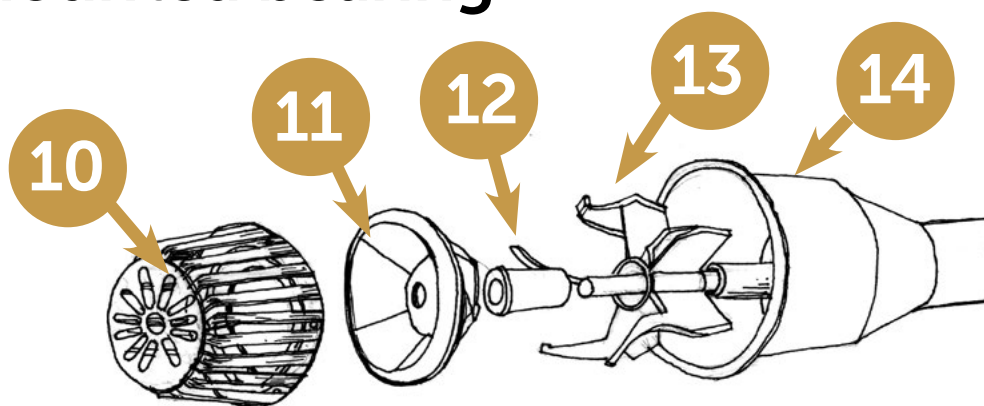
Axial and mixed flow pumps  
one-day training flipchart



## Main parts of the axial flow pump and their functions (1)



1. pipe column, 2. bearing house mount
3. bearing housing, 4. inlet side drive shaft, 5. thrust bearing, 6. ball bearing
7. additional ball bearing, 8. shaft collar, 9. mounted bearing

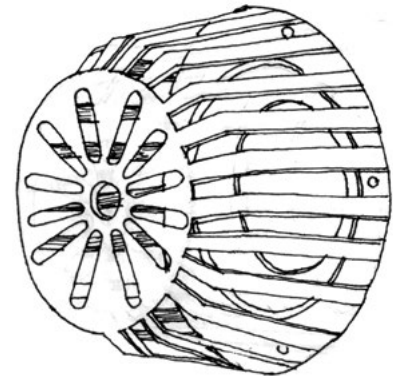


10. inlet screen, 11. impeller, 12. suction end bushing, 13. suction end stator, 14. suction bell

## Main parts of the axial flow pump and their functions (2)

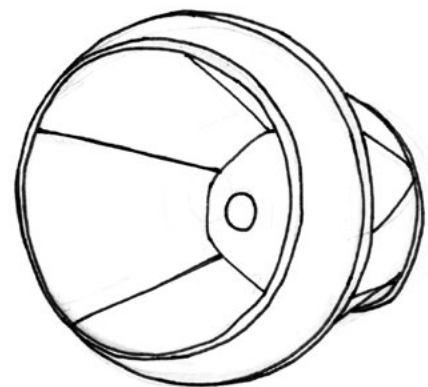
### The inlet screen

Prevents dirt and other stray materials from getting into the pump from the canal, pond or river that the water is pumped from



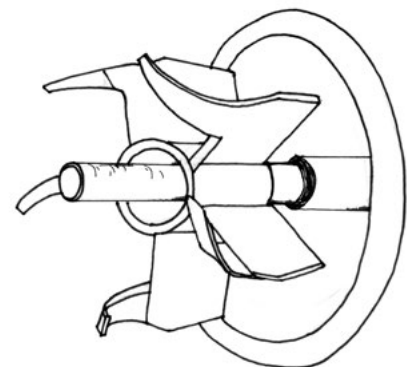
### The impeller

Pumps/pushes water upward through the pipe or conduit



### The suction end stator

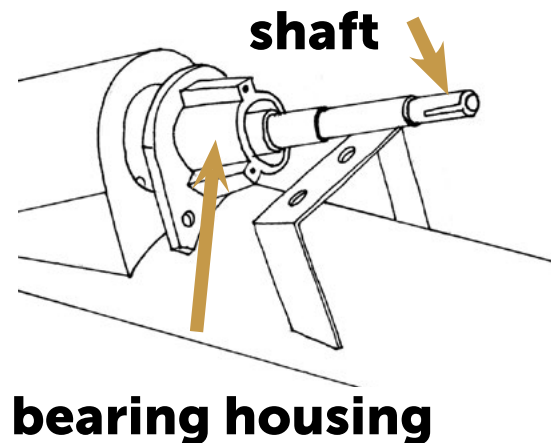
Straightens water flow and reduces turbulence



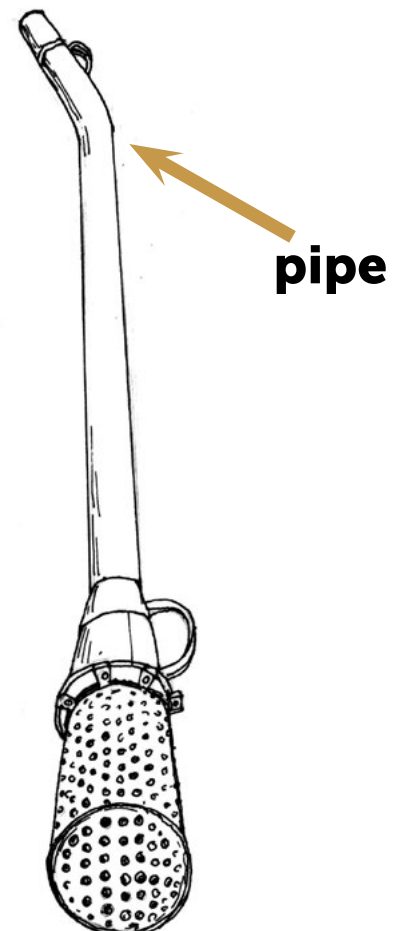
## Main parts of the axial flow pump and their functions (3)

**The driving shaft**  
Drives the impeller

**The bearing housing**  
Holds the bearings



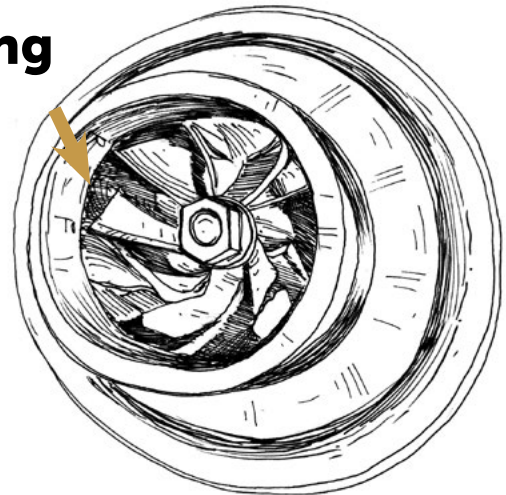
**The pipe/conduit**  
Transfers the water pumped by the impeller until delivery. Note: This pump is an AFP (not an MFP) because it does not have a 'bell' shape at the end of the pump from where water is drawn.



# Main parts of the axial flow pump and their functions (4)

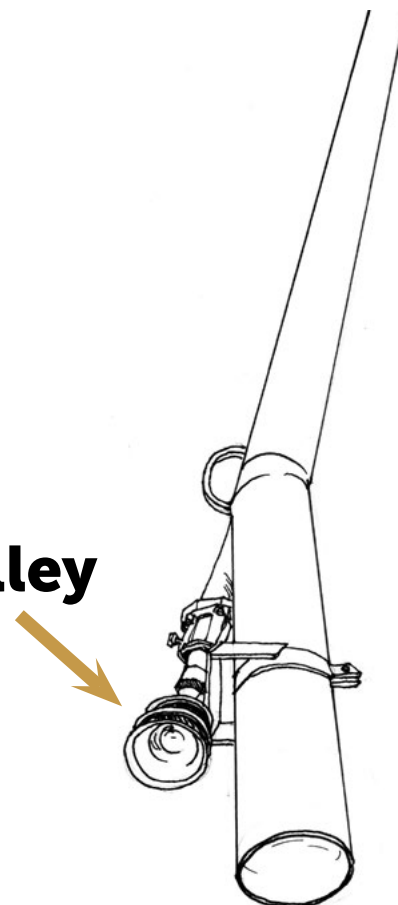
**The bushing**  
Holds the impeller and shaft in place

bushing



**The pulley**  
Drives the shaft to rotate the impeller  
(powered by an engine)

pulley

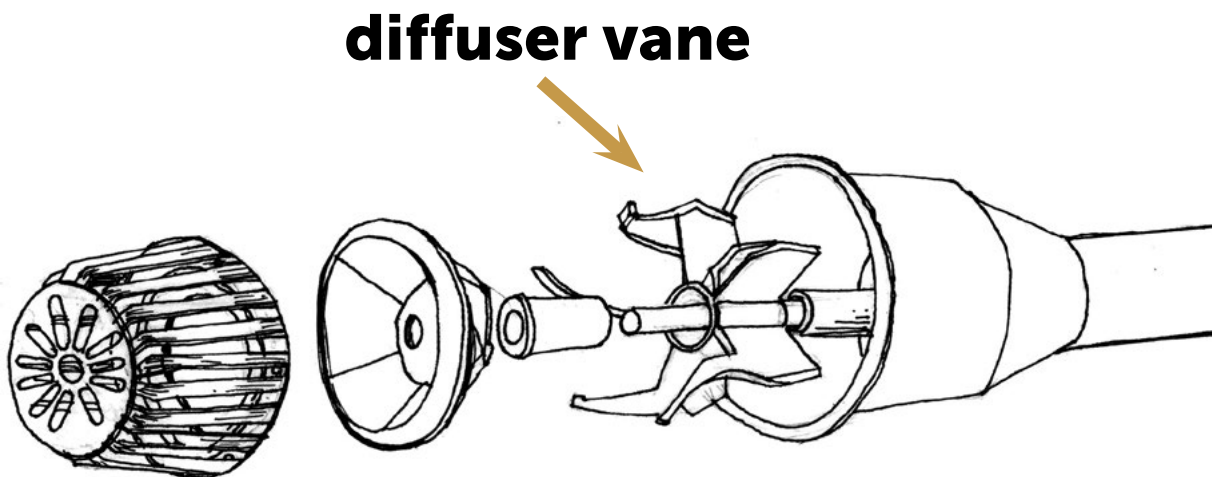




# Main parts of the axial flow pump and their functions (5)

## The diffuser vane

Straightens the water after it is transferred by the impeller into the conduit pipe



## Review of key messages

- ◆ The axial pump and the mixed flow pump are very similar.
  - ◆ Axial flow pumps have smaller impellers that fit inside the conduit pipe.
- ◆ Mixed flow pumps have larger impellers that are wider than the conduit pipe. They deliver more water than an axial flow pump.



## The main parts of both pumps are:

Name of part	Function
Inlet screen	Stops dirt and other stray materials from getting into the pump from the canal, pond or river from where the water is pumped
Impeller	Pumps/pushes water upward through the pipe or conduit
Driving shaft	Drives the impeller, which pushes water up the pump
Pipe or conduit	Holds the water pumped by the impeller until delivery
Bearing housing	Holds the bearings
Bushing	Works like a bearing and holds the shaft in place
Pulley	Drives the shaft (powered by an engine)
Diffuser vane	Straightens the water flow and reduces turbulence

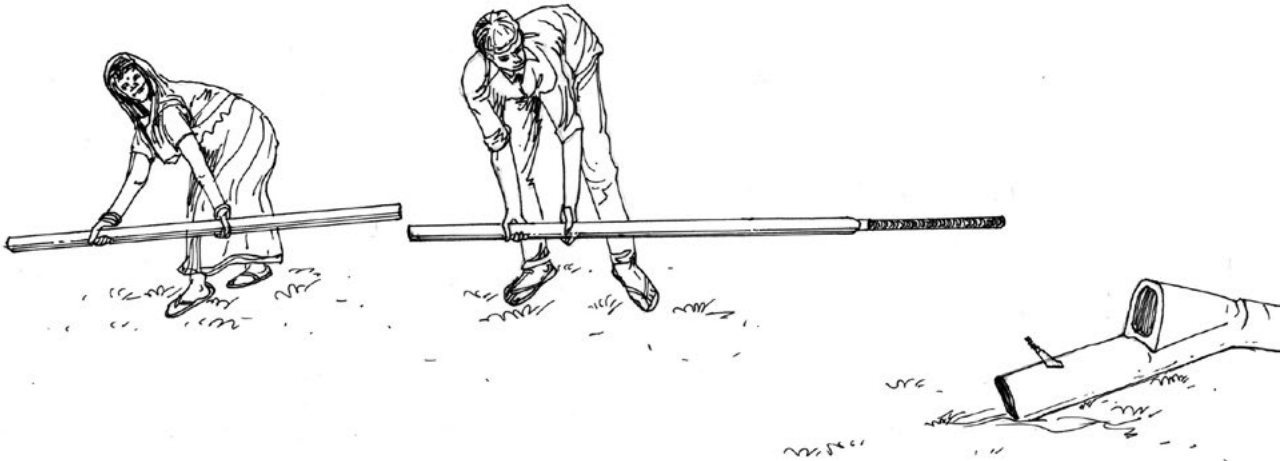
# Session 4

## Common causes of failure and breakdown of the axial flow pump and mixed flow pump (and potential solutions)

Axial and mixed flow pumps  
one-day training flipchart



# Problem 1: The pump shaft breaks



## Symptoms:

The pump produces abnormal sounds or there is no water discharge

## Causes:

(1) Over-running the pump, (2) excessively high water lift height, (3) faulty shaft

## **Effects:**

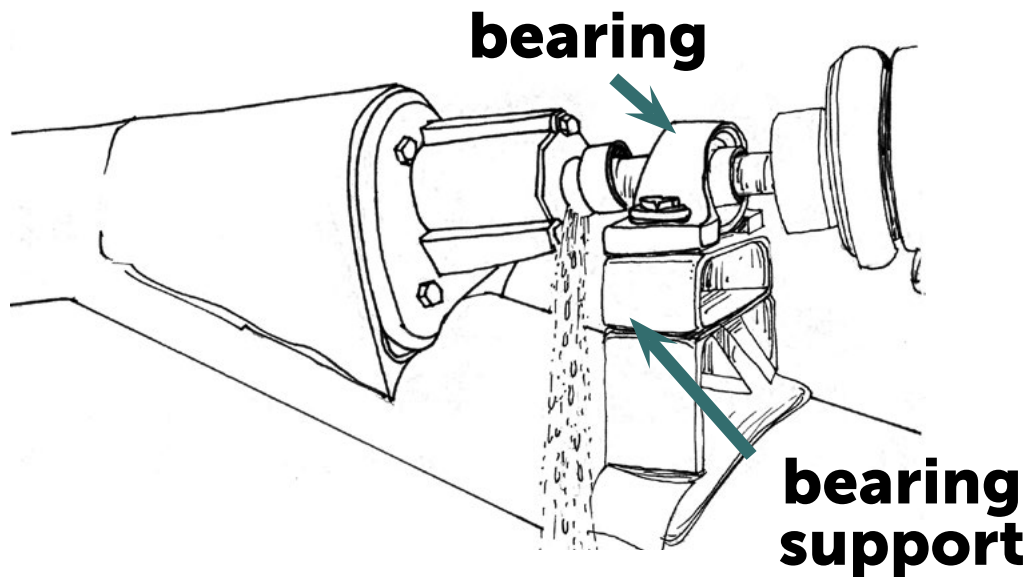
**Complete pump failure (meaning that the pump cannot be used)**

**Spare parts required:  
shaft**

**Where to get or make/repair spare parts: obtain a new one from a dealer or make another one with a new pipe.**

**Tools required:  
dual wrench, adjustable wrench,  
screwdriver, hammer and puller**

## Problem 2: Water leakage during pumping due to faulty oil seal



### Symptoms:

Water leakage from the base of oil seal

### Causes:

(1) tearing or loosening of the oil seal, (2) loosening of nuts and bolts, (3) bent shaft

## **Effects:**

**(1) water gets into the bearing and causes bearing damage, (2) reduced water discharge/efficiency, (3) increased fuel cost**

## **Spare parts required:**

**oil seal, bearings**

## **Where to get spare parts:**

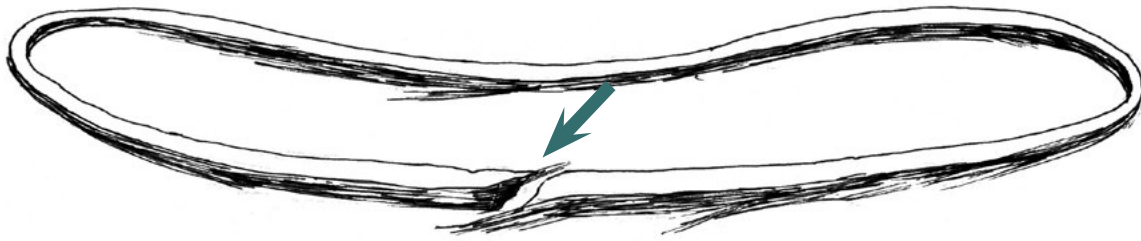
**shop dealing with pump/engine spare parts**

## **Tools required:**

**dual wrench, adjustable wrench, screwdriver**



## Problem 3: The transmission V-belt rips



### **Symptoms:**

The V-belt connecting the engine to the pump cracks or tears

### **Causes:**

(1) misalignment of the engine and pump and pulleys, (2) engine speed too high, (3) the pump pulley is too close to the engine, (4) the surface of the pulley is rough, wearing away the belt, (5) the V-belt is old

## **Effects:**

(1) belt slippage, (2) reduction of discharge, (3) increased cost, (4) pump failure

## **Prevention:**

(1) align the pulley correctly in a straight line with the pump, (2) use a large belt if water level is too low, (3) file the pulley until smooth

## **Solution:**

replace the belt (full set)

## **Spare parts required:**

V-belt

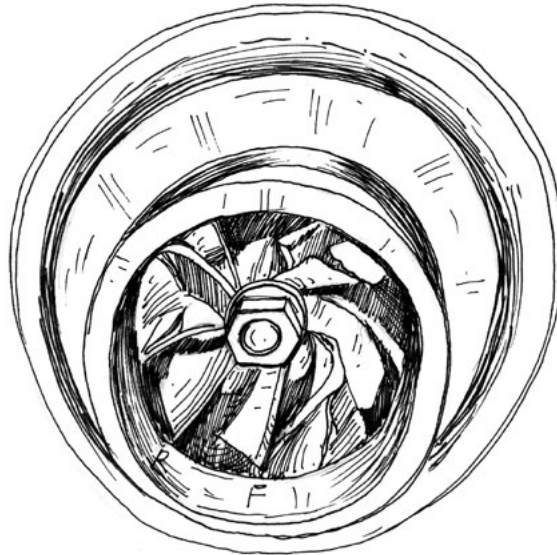
## **Where to get spare parts:**

shop dealing in pump/engine spare parts

## **Tools required:**

file or sand/glass paper

## Problem 4: Pump impeller breaks



### **Symptoms:**

Low discharge of water, abnormal vibration of the pump, lack of water flow

### **Cause:**

Foreign objects or dirt are sucked into the pump, breaking the blades or causing their disruption

## **Effects:**

(1) reduced discharge due to partial break of the blade(s), (2) zero discharge due to complete break of the blade(s)

## **Solution:**

(1) repair the blade(s), and/or  
(2) replace the impeller

**Spare parts required:**  
impeller

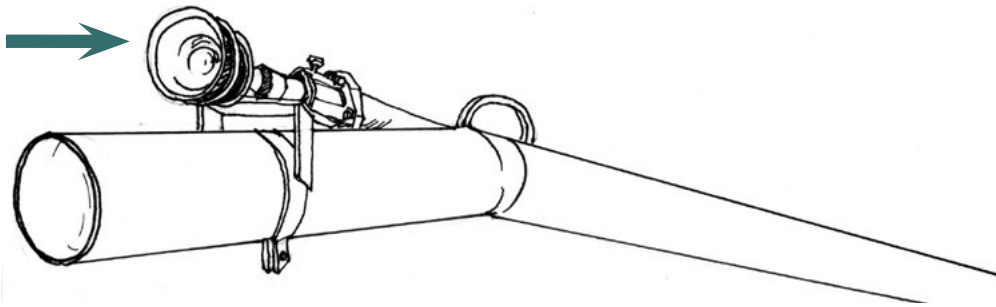
**Where to get or make/repair spare parts:**

purchase a new impeller from a dealer or repair/have new blade(s) made at a local workshop

**Tools required:**

dual wrench and adjustable wrench

## Problem 5: Pump pulley worn out



### Symptoms:

symptoms can be felt by touching the pulley – it will be out of shape, or show gouges or similar defects

### Causes:

(1) loose V-belt, (2) rough surface of pulley

### Effects:

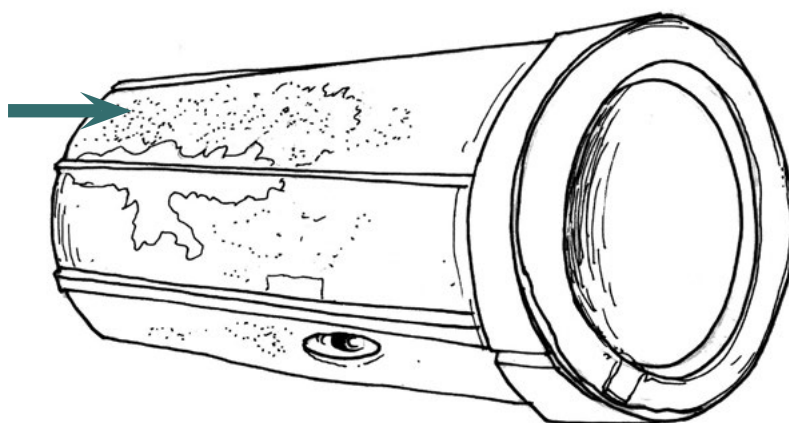
the V-belt tears

**Spare parts required:**  
a new V-belt, or a new pulley (if  
the pulley is severely deteriorated)

**Where to get spare parts:**  
at a shop dealing in pump/engine  
spare parts

**Tools required:**  
file or sand/glass paper, wrenches

## Problem 6: Damage to shaft bushing due to deposition of sand in the pump (1)



**Symptoms:**  
excessive vibration of the pump,  
faulty shaft

**Causes:**  
(1) the impeller is too close (less than 0.6 m) to the bottom of the canal, pond or river, and/or (2) running the pump in muddy or sandy water

## **Effects:**

**(1) the shaft bends/breaks, and/or (2) the bushing rips**

## **Prevention:**

**(1) always place the impeller at least 0.2 m (and never less than 0.3 m) above the bottom of the water body you are pumping from, (2) never run the pump in muddy or sandy water**

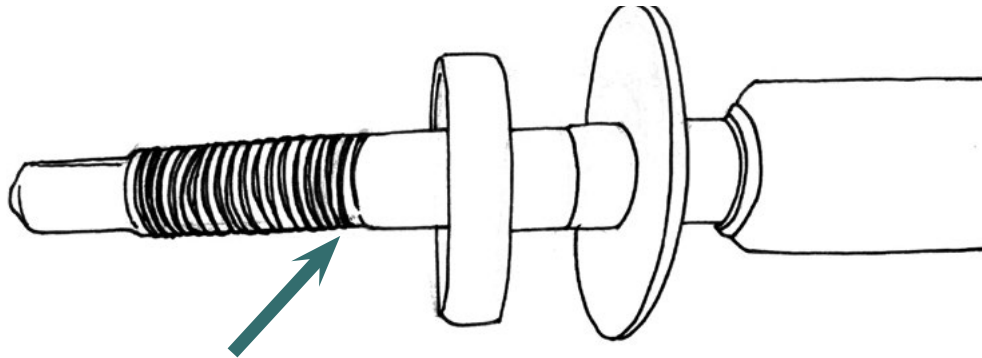
**Spare parts required:  
bushing**

**Where to get or make/repair spare parts: purchase new ones from a dealer or repair/have new ones made at a local workshop**

**Tools required:  
dual wrench, adjustable wrench**



## Problem 7: Shaft bearing(s) fail



### **Symptoms:**

Noise, overheating bearing(s)

### **Causes:**

(1) misalignment of the shaft, (2) old bearing(s)

### **Effects:**

(1) power loss, (2) reduced discharge

### **Solution:**

Replace faulty bearing(s)

## **Spare parts required:**

bearing(s)

## **Where to get spare parts:**

at a shop dealing with pump/engine  
spare parts

## **Tools required:**

dual wrench, adjustable wrench,  
screwdriver, hammer, puller and  
chisel

## Problem 8: Too much black smoke in the exhaust (1)



**Symptom:**  
black smoke comes from the engine  
during operation

**Causes:**  
(1) engine speed is too high, (2)  
water lift height is too high,

**(3) engine size/horse power is too small for the AFP/MFP being used,  
(4) engine is old or overloaded**

**Effect:**

**damage can be caused to the engine**

**Solution:**

**(1) reduce engine speed, (2) pump water within the suggested range of water lift heights, (3) select correct engine or pump**

# Session 5

## Review of key messages, post-training evaluation and close of training

**Axial and mixed flow pumps  
one-day training flipchart**



# Review of key messages, post-training evaluation and close of training

- ◆ What are the main parts of an axial or mixed flow pump and their functions?
- ◆ What are main causes of failure and breakdown of the axial/mixed flow pumps?
- ◆ What is the solution if the pump shaft breaks or bends?
- ◆ Where can you obtain new impellers?



## **Review of key messages, post-training evaluation and close of training**

- ◆ **What is the best solution if there is water leakage from the pipe or pump?**
- ◆ **How do you keep the transmission belt from ripping? How do you deal with it when it rips?**

# Annexes

## Annex 1

### Evaluation questionnaires and answers

### Pre-training evaluation questionnaire

**Venue:**  
(to be completed by the facilitator)

**Batch:**

**Date:**

**Name:** \_\_\_\_\_

Please check (√) or circle the correct answer **Total time: 10 minutes**

Question	Answer		
<b>1. In which year was AFP traced to Southeast Asia?</b>	1955	1960	1970
<b>2. Why are both AFP/MFP called propeller pumps?</b>	Because the impeller works much like a boat propeller	Because the impeller works much like an airplane propeller	Because the impeller works much like a car propeller
<b>3. What kind of tractor or diesel engine is needed to run an AFP?</b>	A 4-wheeled tractor or a 16-24 HP diesel engine is necessary	A 2 wheeled tractor or a 12-16 HP diesel engine is necessary	Both answers are correct
<b>4. What is the function of an impeller?</b>	Impeller pushes water up the pump	Blocks dirt and other stray materials from getting into the pump from the canal, pond or river from which the water is pumped	Pumps/pushes water upward through the pipe or conduit
<b>5. What is the function of a bushing?</b>	Holds the impeller and shaft in place	Drives the shaft to rotate the impeller (powered by an engine)	Straightens the water after it is transferred by the impeller into the conduit pipe
<b>6. What are the operating costs and manufacturing system compared to the centrifugal pump?</b>	High cost and difficult to fabricate	Low cost and easy to fabricate	Very high cost and difficult to fabricate
<b>7. What should be considered when setting the inlet of the pump?</b>	The inlet needs to be at least 0.1 m below the water surface and at least 0.4 m above the bottom of the river, pond or canal	The inlet needs to be at least 0.2 m below the water surface and at least 0.5 m above the bottom of the river, pond or canal.	The inlet needs to be at least 0.3 m below the water surface and at least 0.6 m above the bottom of the river, pond or canal.
<b>8. What are the causes of water leaking during pumping due to a faulty oil seal?</b>	-Tearing or loosening of the oil seal -Loosening of nuts and bolts -Bent shaft	- Water leakage from the base of the oil seal	-Water gets into the bearing and causes bearing damage -Reduced water discharge/efficiency -Increased fuel cost

(Continued on page 59)



(continued from page 58)

Question	Answer		
<b>9. What is the cause of too much black smoke coming out of the exhaust?</b>	The engine produces black smoke during operation	-Reduce engine speed -Select correct engine or pump	-Engine speed is too high -Engine is old or overloaded
<b>10. What will be the effect if the transmission V-belt rips?</b>	-Belt slippage, - Reduced discharge - Increased cost - Pump failure	-Misalignment of the engine and pump and pulleys -Engine speed too high	-Pump pulley close to the engine -Rough surface of the pulley -Old belts

# Post-training evaluation questionnaire

Venue:  
(to be completed by the facilitator)

Batch:

Date:

Name: \_\_\_\_\_

Please check (√) or circle the correct answer Total time: 10 minutes

Question	Answer		
1. In which year was AFP traced to Southeast Asia?	1955	1960	1970
2. Why are both AFP/MFP called propeller pumps?	Because the impeller works much like a boat propeller	Because the impeller works much like an airplane propeller	Because the impeller works much like a car propeller
3. What kind of tractor or diesel engine is needed to run an AFP?	A 4-wheeled tractor or a 16-24 HP diesel engine is necessary	A 2-wheeled tractor or a 12-16 HP diesel engine is necessary	Both Both types of tractor
4. What is the function of an impeller?	Impeller pushes water up the pump	Keeps dirt and other stray materials from getting into the pump from the canal, pond or river that the water is pumped from	Pumps/pushes water upward through the pipe or conduit
5. What is the function of a bushing?	Holds the impeller and shaft in place	Drives the shaft to rotate the impeller (powered by an engine)	Straightens the water after it is transferred by the impeller into the conduit pipe
6. What are the operating costs and manufacturing system compared to the centrifugal pump?	High cost and difficult to fabricate	Low cost and easy to fabricate	Very High cost and difficult to fabricate
7. What should be considered when setting the inlet of the pump?	The inlet needs to be at least 0.1 m below the water surface and at least 0.4 m above the bottom of the river, pond or canal.	The inlet needs to be at least 0.2 m below the water surface and at least 0.5 m above the bottom of the river, pond or canal.	The inlet needs to be at least 0.3 m below the water surface and at least 0.6 m above the bottom of the river, pond or canal.
8. What are the causes of water leaking during pumping due to a faulty oil seal?	-Tearing or loosening of the oil seal -Loosening of nuts and bolts -Bent shaft	- Water leakage from the base of the oil seal	-Water gets into the bearing and causes bearing damage -Reduced water discharge/efficiency -Increased fuel cost
9. What is the cause of too much black smoke coming out of the exhaust?	The engine produces black smoke during operation	-Reduce engine speed -Select correct engine or pump	-Engine speed is too high -Engine is old or overloaded
10. What will be the effect if the transmission V-belt rips?	-Belt slippage, - Reduced discharge - Increased cost - Pump failure	-Misalignment of the engine and pump and pulleys -Engine speed too high	-Pump pulley close to the engine -Rough surface of the pulley -Old belts
<b>Overall training feedback from the participants</b>			
Did you understand all the messages delivered by the facilitator(s)?	Yes/No	Partly	Fully
How do you rate the training?	Not very useful	Useful	Very useful
Do you feel confident that you can use the AFP/MFP profitably while also saving money for your farmer-clients?	Yes	Partially	Unsure

# **Answers to questions 1 to 10**

- 1. 1960**
- 2. Because the impeller works much like a boat propeller**
- 3. A 2-wheeled tractor or a 12-16 HP diesel engine is necessary**
- 4. Pumps/pushes water upward through the pipe or conduit**
- 5. Holds the impeller and shaft in place**
- 6. Low cost and easy to fabricate**
- 7. The inlet needs to be at least 0.3 m below the water surface and at least 0.6 m above the bottom of the river, pond or canal.**
- 8. Tearing or loosening of the oil seal, loosening of nuts and bolts, bent shaft**
- 9. Reduce engine speed, select correct engine or pump**
- 10. Belt slippage, reduced discharge, increased cost, pump failure**

## Annex 2

### Video resources

Several training videos are included in this compendium of experiential learning and modular training resources. We encourage their use as an audiovisual learning aid to improve the quality of training. The appropriate video for a specific module is indicated in each chapter and module. Descriptions of the videos can be found below.

<https://www.youtube.com/watch?v=VnV79S9ROTg>

## Annex 3

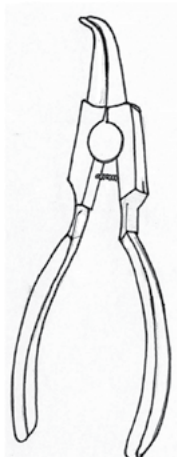
### Common tools used to repair the axial and flow pumps (1)



**Adjustable wrench:** An adjustable tool for gripping hexagonal nuts with an adjusting screw.



**Hammer:** A hand tool with a heavy head used for striking objects.

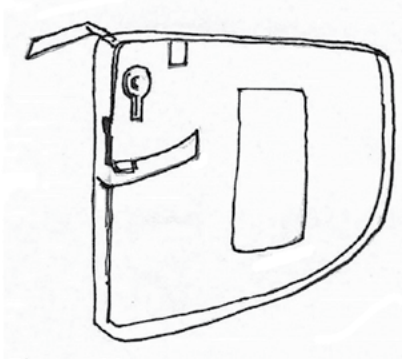


**Pliers/cutting pliers:** Used to grasp small objects, and to insert/extract or turn them. Pliers often have small cutting blades that can also be used to cut wire or other materials.



**Grease gun:** A common workshop and garage tool used to apply lubricant to machinery.

# Common tools used to repair axial and mixed flow pumps (2)



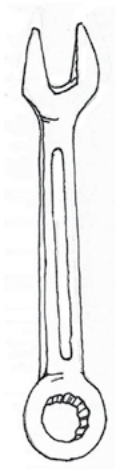
**Measuring tape:** A flexible scale used as a common measuring tool.



**Screwdriver (star/Phillips head):** Used to screw in or out screws with a + shape at the head of the screw.



**Screwdriver (flat head):** used to screw in or out screws with a – shape at the head of the screw.



**Dull wrench:** Used to turn bolt heads to the left or right. This one has two ends, the circular one has the best grip.

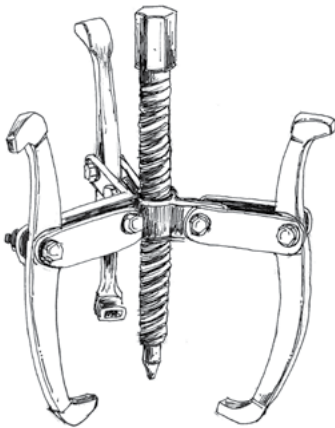
# Common tools used to repair axial and mixed flow pumps (3)



**L-dull wrench:** Used to grip bolt heads. This one has two gripping areas at each end.



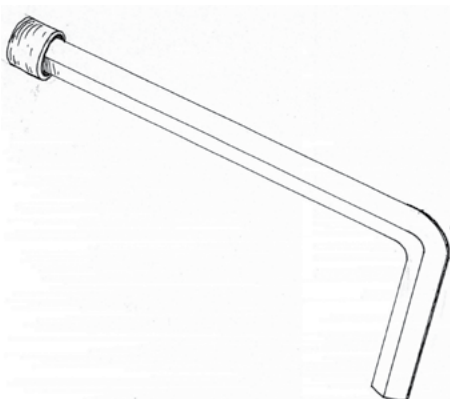
**Ratchet:** Used to turn the head of a bolt in one direction but not the other. It makes it easy to tighten or loosen bolts without having to take off the tool each time (as with pliers or wrenches).



**Three-jaw puller:** Useful for removing components such as a gears, pulleys or bearings from a shaft.



**Files (flat and round):** Used to grind or file different metal parts to the shape required. They can be useful in difficult repair jobs.



**Allen key (hex key) wrench set:** Used to tighten or loosen bolts that have an 8-sided hex shape at the head of the bolt.





This set of training modules focuses on ensuring that mechanics are able to make repairs to axial flow pumps and mixed flow pumps efficiently and correctly. This booklet is designed so that anybody who uses these materials can easily conduct training – even those with a limited background in and understanding of agricultural engineering or machinery. This training uses an experiential and hands-on modular format. It is based on a foundation of experiential and hands-on work, combined with discussion and reflection among participants.

This means that although the facilitator is instructed on how to carry out the training and how to present materials, the format in which this is done should be horizontal and participatory, with room for adaptation and modification. The technical materials included in this document should therefore be seen as a guide to supplement the already in-depth knowledge of the trainee mechanics. By the conclusion of the training module, participant mechanics will be well-equipped to repair axial flow pumps and mixed flow pumps as part of their ongoing agricultural machinery service providing business. Nonetheless, users of this booklet should carefully read all the instructions on how to implement the training effectively in order to ensure the best learning experience possible for participants.

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