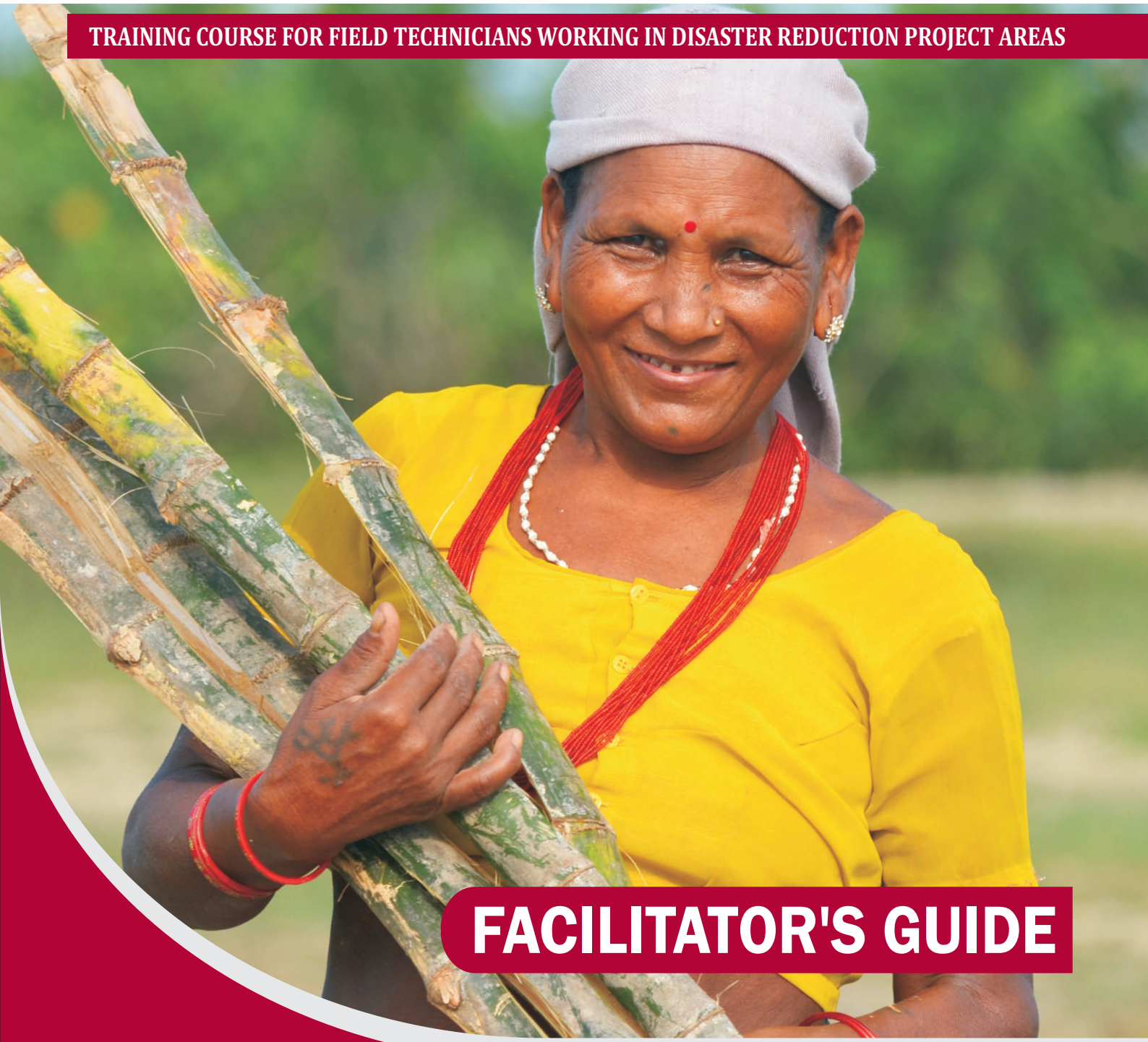
BIO-ENGINEERING FOR RIVER TRAINING AND SLOPE PROTECTION WORKS

TRAINING COURSE FOR FIELD TECHNICIANS WORKING IN DISASTER REDUCTION PROJECT AREAS



FACILITATOR'S GUIDE

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Federation of Community Forestry Users Nepal (FECOFUN)

TRUST FOR NATURE CONSERVATION NEPAL 1982

MercyCorps

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Acknowledgement

Serious problems of flash floods and landslides have long negatively affected communities across Nepal, leading to significant loss of lives, houses, productive assets and livelihoods, often for the most vulnerable, who have little margin to bear these losses. These hazards also introduce debilitating stressors in the form of uncertainty and thus a reticence to invest in longer-term improvements, thereby holding back potential development initiatives at the community level.

Mercy Corps - Nepal (MC) has, over the past several years, been working in the Far West of Nepal to help vulnerable communities mitigate these hazards and risk through a series of programs focusing on disaster risk reduction (DRR) and economic. Particularly around DRR, MC has sought to address disaster mitigation as well as preventive measures as protective functions, though also seeking to impact more positively on the investment and technological sides. MC has been implementing, studying and iterating around low cost, indigenous and small-scale technology to help communities better address these problems. With several years of solid experience, MC seeks to share its findings with the broader community of practitioners in government, private and civil sectors in the hopes of contributing to the enhancement of the technical capacity of those working in such at-risk areas through training on planning, design, implementation and maintenance aspects of bioengineering. To that end, this Facilitator's Guide has been prepared and is the result of the experiences gained throughout the project activities of MC and similar activities in the road, disaster prevention, soil conservation and forestry sectors. This guide has been written with the close collaboration of MC and is hereby submitted to MC as a part of a consulting service.

Many people have been involved in this project, so it is quite impossible to acknowledge all of them here. Nothing could have been achieved without the full support of MC. Generally, many institutions place emphasis on hard-core engineering works, rather than the dissemination of appropriate knowledge and skills, awareness generation and capacity building initiatives for those to whom it should be most relevant. In contrast, MC has been giving a high priority on orienting field staff to be better able to solve problems on the site. This is a praiseworthy action of MC. In this regard, the consultant, first and foremost, would like to acknowledge Mercy Corps Nepal.

The consultant wants to acknowledge Mr. Sanjay Karki, the Country Director, and Mr. Sagar Pokharel, the Program Advisor, for their efforts on the incorporation of the consultant to the assigned job and every support they have given to help bring this consultancy and this guide to a successful conclusion. Likewise, the consultant acknowledges Mr. Chet Bahadur Tamang, Program Manager M-RED Program, Mr. Keshab Pokharel, Program Manager SAFER Project, Eng. Mr. Deepak Jung Singh and Eng. Ms. Kabita Gyawali for their active, valuable, and tireless supports, cooperation and participation.

A draft of the Facilitators' Guide was prepared and validated with a short training program for the participants from the Hariyo Ban Program. The consultant would like to thank the staff of Hariyo Ban, as well as its implementing partners including World Wildlife Fund (WWF), Nepal Trust for Nature Conservation, Practical Action, Nepal and Care Nepal. The participants of the orientation program are a source of inspiration in their commitment to applying the knowledge gained in the orientation program. We are very thankful for their active participation and encouragement. The service of Mr. Lal Bahadur Chand was praiseworthy as the driver, who made the travel very safe and successful.

The consultant is grateful to the donor of the project, without the support of which this work would have been completely impossible.

Content

Forward

With this training manual – "Bioengineering for River Training and Slope Protection Works: Training Course for Field Technicians Working in Disaster Reduction Project Areas" – Mercy Corps hopes to present a technically detailed overview of the practice of bioengineering in both theory and practice, focusing more on the needs of the skilled and semi-skilled practitioner, since you are the ones working to protect productive land, households, prevent destruction and save lives. This manual seeks to provide you with the background, thinking and the practical tools you will need to assess, analyze, design, implement and evaluate sound bioengineering infrastructure in areas of high risk of landslides, riverbank cutting and, to an extent, flooding.

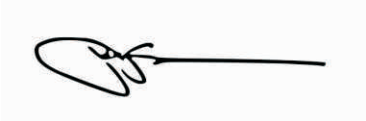
The manual seeks to present a best-case scenario, while also realizing that every situation is different and complex in its own way, very often requiring difficult decision-making on the part of the practitioner as to whether one shouldinvest in longer-term, more comprehensive sub-basin or basin-oriented interventions or if one should instead implement more immediate short-term life or property saving interventions. This question is, unfortunately, often partially answered by limitations of budget, donor priorities, limitations of local or national government and capacity of the implementing organization, as well as 'moral' priorities of immediate need. However, the practitioner must be aware of that trade off between the short-term and the long-term and answer her/his own questions honestly, transparently and together with the community at risk.

This manual does not attempt to present, nor does Mercy Corps support, the idea of bioengineering as a panacea, of being able to address all situations of riverbank erosion or landslide risk. We instead consider bioengineering as one tool – a very effective and cost effective tool – in a wider collection of hardware and software approaches, techniques and solutions. We have found many situations in which bioengineering, when properly assessed, designed and implemented, has been the best and sole solution to serious risks to communities' safety, property, lives, livelihoods and productive agricultural land. We have also found many situations in which bioengineering is only part of the solution in considered combination with larger scale, more expensive check dams, gabion walls and other infrastructure, and cases in which bioengineering is inappropriate and insufficient. We are also keenly aware that badly assessed, designed or implemented bioengineering infrastructure (typically carried out with only a superficial knowledge or understanding of what bioengineering is) can lead to yet greater disaster risk, a false sense of community security and ultimate loss and disappointment on the part of affected communities. Bioengineering is not a simple matter of establishing bamboo baskets and establishing plants along a riverbank, but is rather a serious consideration of water flow, speed, impact points, variability of water levels, soil type, local plant varieties and root systems, community capacity and sociological context, contextual analysis, market or livelihood assessments, land ownership and much more.

Mercy Corps began the practice of landslide mitigation bioengineering in hilly areas of Nepal's Far Western Development Region with some good degree of success. When programs shifted to the more riverine areas, we were faced with the challenge of adapting that learning to the challenge of riverbank erosion. Working with communities, local government officials, technical experts and our own engineering teams, we were able to iterate and develop a model that we believe is workable, affordable, effective and innovative. We continue to iterate on our model with greater efforts toward local government and community capacity building, integration of disaster risk reduction activities like flood early warning systemestablishment and the direct causal in-building of economic development (as opposed to more limited income generation or livelihood enhancement) and fully intend to share our findings and best learning experiences as open source, hoping other organizations and DRR actors can build and improve upon our findings.

We see this manual as a technical introduction, which cannot hope to be comprehensive to include all conditions for all situations faced across Nepal. Feedback from readers, practitioners and others are very welcome.

We hope this manual will be useful, educational, illuminating and challenging, spurring more interest in our bioengineering approach, tempered with a caution against overenthusiasm for it as The Solution.



Jeffrey Shannon,
Director of Programs
Mercy Corps Nepal
November 2014

Purpose of the Course

Regular landslides and floods cause displacement of local people every year on the Siwalik Range and along the rivers in Kailali, Kanchanpur, Dadeldhura and Baitadi districts and the related tributaries respectively. Mercy Corps has been engaged in water-induced disaster mitigation activities in different parts of these districts for the past 6 years. Bioengineering is one of the activities under different sub-projects implemented in the project area. In many sites, the bank erosion was completely halted, landslides have been stabilized and the flow has been maintained on the natural path. Although bioengineering is not a new technique for Nepal, Mercy Corps - Nepal has introduced very special and site-specific unique solutions for riverbank protection in several cases.

Districts of Far Western region of the project areas under Mercy Corps are relatively underdeveloped and under served in relation to the rest of the country. The local people are illiterate and poor. They tend to have little knowledge on flood risk and few solid, technically feasible solutions for mitigation measures. This led to their accepting all the anomalies, risks and impacts that occurred due to the flood in their areas. But Mercy Corps - Nepal has been trying to raise awareness amongst local people to help make them better prepared to mitigate these risks. Nowadays, the bioengineering approach is getting a wide range of utilization for that purpose.

A branch of engineering, in which living plants are used in engineered combinations as building material for erosion control, controlling shallow seated instability and landscape restoration, is called bioengineering. It aims at protecting and stabilizing the riverbanks by preventing erosion and reducing shallow seated mass movement. Vegetation is carefully selected for the functions, which can serve in stabilizing the slopes and its suitability to the sites. It operates in the same way as civil engineering structures. It can also be used in combination with small-scale civil engineering structure.

Firstly, in this connection, it is essential to compile and consolidate experiences as a technical document and disseminate these ideas to the people of those areas with the same type of vulnerabilities. Secondly, it is important to pass on the correct method of implementation and choice of the correct techniques. Therefore, it is necessary to train the technical persons working in the project areas as well as the local people by implementing the proposed techniques. Mercy Corps - Nepal has therefore undertaken to publish, with the kind support of Hariyo Ban and WWF, a bioengineering training manual and facilitator's guide detailing the experience of Mercy Corps in implementing its disaster risk management and economic development projects in the Far West of Nepal.

This is a facilitator's guide based on the experience of projects for the flash flood- and landslide-affected communities under Mercy Corps' implemented disaster risk reduction and economic development projects.

This course has been designed to provide the basic knowledge and skills in bioengineering required by technicians in the project and staff engaged in other works on unstable slopes .It does not seek to provide them all the answers, but to give them a basic knowledge of bioengineering, which can enable them to carry out their work more effectively. During the course, a range of reference materials will be provided and further references will be delivered. This material will enable them to investigate bioengineering further.

Structure of the Course

The course has been designed as one-week training course.

Outline of the Course

The course develops from the context in which bio-engineering is applied through its own principles for designing, implementing and maintaining the works. It contains the components like an introduction to bio-engineering, geology, geomorphology, water and bio-engineering principles, bio-engineering plants, bio-engineering design, nursery design, bio-engineering site implementation, bio-engineering management, bio-engineering maintenance etc.

The contents of the scientific background topics are purely dictated by the needs of staffs for applying bio-engineering effectively with understanding. As trainer, one must avoid the temptation to go into unnecessary details of these topics. Although these components have been identified separately, they are considered sequentially and the content of the components is designed to build work that has been considered earlier in the course. The sessions should not be considered as free-standing units.

Course Approach

Staff attending this training should all be mature adults. Therefore, the emphasis on this course is placed on using participatory training methods, which recognize and utilize the experience that they bring with them. Through this approach, you will find that you are able to make use of their natural potential to learn. They will be more motivated and the effects of the course will be much longer lasting.

You should avoid any tendency to adopt a traditional lecturing approach.This may be the approach that the participants are expecting. Your experience of training, and that of many of them, may have been through this method.But this approach has been shown to be less effective as compared to the participatory method with adult learners and with training which needs to be applied at work.Throughout the course, you should encourage their active participation.

If the participants are going to become very actively involved in the sessions, you need to develop an atmosphere in which they are willing to contribute and are not afraid of making mistakes.

The course includes a range of practical activities and extensive use is made of a structured program of site visits.

Some staff may be reluctant to become involved fully in the practical work and the site exercises.In order to break down this barrier, you need to demonstrate that you as trainers should participate fully in all these activities. All of you should normally take part in these sessions, not just the trainers who are responsible for running them.

Group Work

Many of the sessions include group work. In order to provide a wide variety of ideas in each group, you need to form groups which mix the background and experience of the participants. You can consider their qualifications, seniority, length of service and the divisions in which they have worked. You can get this information from the questionnaire they complete in Session 2.At intervals, you may like to re-form the groups so that each participant works with a range of other participants during group work.

Group work can be a very effective method of training but it often fails.In order to avoid the risk of failure, you need to plan and manage the group work carefully. Write out the full instructions that you will give. Make sure that they are clear and complete and if they are lengthy or complicated, prepare a handout or write them on the board. Include any points on group leadership, reporting arrangements and the time limit. You may not always want formal feedback, but if you do, indicate whether it is to be verbal or supported by visual aids, as well as time available. Make sure that you have allowed adequate time for the discussion and reporting back.

There will generallybe five participants in each group.This means you should ask some of the participants to move their chairs inside the line of tables to face the other group members so that everybody can become easily involved in the discussion. Do not interfere while the groups are working unless they are clearly missing the point of the exercise. Walk around quietly, giving needed encouragement and requested guidance. Make sure that you give full attention to each group.

Warn the groups as the time is almost up and stop them on time. At this stage, you may want them to stay in their groups or return to the normal training room arrangement. Manage any feedback carefully. This means that you have to tell them how much time each group has and be strict to that time. If all the groups have looked at the same topic, you may prefer to get one response from each group in turn; otherwise the last group to report may not have anything new to contribute. Encourage discussion but make sure that you, and the participants, accept all the comments positively even if you have to say that they are false. Do not allow a longer discussion for the single point. You will need to keep firm control over the discussions in general, but their length in particular. Make sure that all of the key points have been raised and conclusions reached. Finally, thank all the participants for their meaningful contributions.

Training Room Organization

You need to elicit contributions from the participants and develop discussion. This means that you need to arrange the training room to encourage the involvement of the participants. In most of the sessions, a shape will be most effective as you sit or stand at the open end. You also need to be ready to move the chairs and tables to facilitate the small group discussions.

Make sure that the whiteboard and overhead projection screen are clearly visible from every seat. Check this at different times of the day because the change in lighting during the day may make them less easy to read at certain times.

Safety

It is a general principle that staff are responsible for their own safety and for the safety of others, which means you are responsible for your own safety and that of the other participants. They in turn have similar responsibilities.

Most of the sites will likely be examined off-road where the participants have to work. Some of the time, they must be warned to take care and you must keep a watch out. If along a road, you might consider placing warning pylons or other signals to warn vehicles. These should be placed each side of the site, at a distance, which gives adequate, but not excessive, advance warning that staff are working on the road.

Many of the slopes are clearly unstable and you must take care to ensure that the trainees are reminded that they need to be careful. Other slopes may appear to be stable, but again care must be taken on them. Do not allow the trainees to work above each other on these slopes. Make sure that they take their safety helmets on site visits and instruct them to wear them whenever this is advisable.

A small first aid kit should be provided. You should make sure that this kit is taken out on the field visits and practical sessions. Replace anything that is used.

Make sure that medical problems are attended adequately. If needed, arrange transport for the participant to receive medical attention.

Evaluation

At the end of the course, the participants are required to complete an evaluation of the course. The evaluation forms are included in Sessions 27.

Evaluation is an important aspect of the management of the training. Encourage the participants to undertake this work carefully. This will enable them to monitor the courses and make any changes that become necessary. Spare copies of the evaluation form are provided for you to use when you summerize the results.

Assessment

Participants will be assessed in the process of training. However, you should not give too much emphasis to this assessment. As outlined in the second session, this course has been designed to provide the knowledge and skills required for understanding and implementing basic bioengineering. It is not planned as a method of providing a qualification or certification.

Course aims and objectives

The overall purpose of this course is to equip the participants with the knowledge and skills they require for carrying out site appraisal and designing, implementing and managing of bioengineering works.

In order to achieve these goals, the following aims and objectives motivate the course.

Course Aims

The aims of the course are to teach the participants:

- ✓ The geological and Geo-morphological context of slope instability.
- ✓ The causes and mechanisms of slope failure and its mapping.
- ✓ The engineering functions of bio-engineering systems.
- ✓ Designing small civil engineering and vegetative engineering structures for the protection of slopes.
- ✓ Plant selection for bio-engineering purposes.
- ✓ The basic aspect of plant nurseries.
- ✓ The organization and planning of civil engineering and bio-engineering works.
  The programming and cost estimation of bio-engineering works.

Course Objectives

At the end of the course the participants will be able to:

- ✓ Describe the geological and Geo-morphological context of slope instability.
- ✓ Examine an unstable slope and identify the causes and components of instability as part of instability assessment.
- ✓ Map landslides and establish repair priorities;
- ✓ Establish the engineering functions required of bio-engineering systems on specific sites.
- ✓ Design and evaluate small civil engineering and vegetative engineering structures and integrate the two for slope protection;
- ✓ Plan the development of plant communities for bio-engineering purposes.
- ✓ Select plants for bio-engineering applications;
- ✓ Supervise the establishment of plant nurseries and manage these nurseries.
- ✓ Evaluate the performance of nursery staff carrying out nursery techniques related to the production of plants for bio-engineering purposes.
- ✓ Plan the implementation of civil engineering and bio-engineering works.
- ✓ Manage and supervise the preparation of sites and the implementation of small civil engineering works.
- ✓ Prepare bio-engineering works programs and manage the implementation of these works.
- ✓ Manage the maintenance of bio-engineering works.

Although the aims and objectives are described as a series of individual items, the participants will be able to integrate them in order to satisfy the general purposes of the course.

Using the manual

You need to become fully familiar with the manual. To be clear, you need to read it carefully, including all the introductory sections and the sessions that will be taught by your colleagues.

Preparation

In order to run an effective course, you need to commence your preparations in good time. Before the course actually starts, you need to be confident that all the preparations have been completed. During the course, you will be busy, either teaching and supporting or assisting your colleagues. Carefully work through the section on planning the course and try to keep to the recommended time schedule. Make sure that you keep all the other people who will be involved in organizing and running the course fully aware of the preparations that are taking place and their contributions to the program.

Session Plans

There is a plan for each session of the course. This commences with the aims and objectives of the session and these are followed by an outline of the content. There is a list of all the resources that you require. However, in advance of the session, you need to check that they are all available.

Timing

The suggested time for each part of the session is given to the left of the plan. This is followed by the total time from the start of the session (in brackets).The time is given as a guide to how long you probably need for each part of the session in order to cover everything without rushing any single part .You may have to vary this timing as you work through the session .Most plans indicate a time of five minutes for the introduction section .You should consider this an absolute maximum with introduction often taking much less time, thus leaving more time for the following sections. The break times are only fixed when they are in between sessions .If there is a two or three-hour session, the break should be taken at a suitable stage. A suggested time for this is often indicated in the plan.

Facilitator's notes

The main part of the plan consists of full facilitators' notes, which will give you guidance on how you can teach the session effectively. This material has been tested and proved to work. You must be responsive to the participants, but you also need to ensure that the material contained in the session is covered effectively .In order to achieve this, you must be very familiar with the training notes. You may find that adding your own notes and highlighting points in them makes it easier to use the training notes during the class .Do not simply read through them in the class. If you do that you will not establish good communication with the participants. As a result, their participation will become reduced.

In the facilitator's notes you will find the headings ,introduction, development and conclusion. Do not read these words out. They are there to help you use the notes in the training room. The titles for each section of the session are given in bold. You do not have to read these out, but may find that the words are useful as you introduce the next section of the session. If there is specific information for you to write on the board, it is recommended to do so.

Training resources

Following these notes, you will find details of all the handouts, PowerPoint presentation slides and charts you require. In some cases, there are also notes on the sites being visited. There are handouts for most of the sessions. These are given out during the course. But at the end of the course, you should arrange to bind them together with any other notes the individual participants want to include.

Planning the course

Throughout the planning, you should involve the concerned organizations in the design, logistics and delivery.

Timing

The timing of the course will be decided by Mercy Corps, Nepal in collaboration with the participants, so that it fits in with the workload and commitments of project technicians. It will also have to be coordinated with other training commitments in the project(s).

Trainers

Two or three trainers are required for this course. If there are fewer trainers, they will be insufficient for the effective management of the site exercises and practical work. As a result, the workload will be excessive and the training quality may suffer. More than four trainers should be avoided, because you should be developing a close relationship between the trainers and the participants, and this is not as easy with a larger group.

Do not bring any specialist to teach individual sessions. They will not be part of the team of staff and participants and may not understand the participatory nature of the course in depth. The contributions of these specialists may not fit the coordinated requirements of the whole course. Specialists are often tempted to go into unnecessary details on their areas of specialty.

You need to select one of your members who will act as the course coordinator. The course coordinator ensures that each member of the team is aware of her/hisresponsibilities and that the team works together effectively. The course coordinator should also maintain liaison with other people involved in running the program. Either the Course Coordinator or another member of the team will need to co-ordinate the domestic arrangements.

Participants
The participants will have been nominated in response to an invitation from Mercy Corps, Nepal. There should not be more than twenty participants. This is important for the participatory nature of the course to be maintained and for the effective operation of the site exercises.

TIME SCHEDULE FOR PLANNING
TWO MONTHS BEFORE THE COURSE

Initial Meeting of Training
You need to have a meeting to discuss the allocation of sessions and other responsibilities for the purpose of running the course.

Training Facilities
Although many of the sessions take place in the training room, the most important facilities are the field sites. The course has typically been planned in Kailali where there is a range of suitable sites. These sites are described in the manual. If the course is to be run elsewhere, you have to identify suitable alternatives. Wherever the training will take place, you need to organize a visit to these sites in advance of the course, so that you are thoroughly familiar with them. You should also make arrangements for other visits in the program.

At this stage you need to check whether the training room is ready or not.

Accommodation and catering
Make contact with the staff responsible for the residential accommodation. Advise them how many trainers and participants will be attending the course and check if the accommodations are ready. Check what things are provided and what the participants have to bring. You need to ensure that the catering arrangements, including costs, have been agreed.

Transport
Throughout the course you need transportation to take the participants on the site visits. This is the time to check the suitability of vehicles and a budget for fuel. Since many of the field exercises involve groups working on different sites at the same time, several smaller vehicles are better than large ones.

Handouts
Most of the sessions are supported by handouts. These build up into a reference source for the participants when the course is completed.

Training aids
If these are not already available, start preparing the PowerPoint presentations and charts. You can prepare them by copying the pages from the manual.

Equipment and materials
Arrange all the equipment and materials required for the course to be made available or purchased. There is a complete checklist of these items later in the manual.

Opening and closing ceremonies
The course includes an opening ceremony at the start and a closing ceremony at the end. You need to choose senior officials to take part in each of these ceremonies. By obtaining individuals who are recognized for their importance, you are helping to emphasize the importance of this training, while also gaining a degree of buy-in from these officials.

Having identified your choice of officials, you need to arrange letters of invitation to be sent to them in good time. In these letters, you should give an outline description of the course and explain that it will be attended by about twenty staff. If you would like the speaker to mention any particular point, you should suggest them in the letter.

Advance information to participants

This is the time to plan the information that you want to give the participants in advance of the course.

Certificates

You need to start organizing the printing of certificates for the course participants.

One month before the course

By now, the general preparations should be well advanced and this is the time to check if all the preparations have been made and nothing has been overlooked. In particular, you should confirm that the advance information has been sent to the participants and that the facilities and resources are being prepared. Make sure that all of the equipment and materials are being obtained.

One week before the course

You should now be traveling to the training center, so that you know everything is ready before the participants arrive.

You need to make a final check on the following items:

- ✓ The training room layout and equipment.
- ✓ Training resources - handouts, Power Point presentations, charts, real material.
- ✓ Equipment and materials for the course.
- ✓ The field sites, to make sure that there have been no recent changes.
- ✓ Visit arrangements.
- ✓ Accommodation and catering arrangements.
- ✓ Transport and fuel.
- ✓ Officials for the opening and closing ceremonies.

The day before the course

Be ready to welcome the participants and make sure that they know where and when the course will start.

Prepare stationery packs for the participants, so that you do not waste time in the session when these are to be given out.

Make a final check that the training room is ready.

Advance information to participants

The following is a draft letter that provides the information needed by the participants in advance of the course. You can use this as a basis for the information that you send out, but you should ensure that all the details are correct.

Date: .....

Dear Participant,

Bio-engineering **Training for Field Technicians,**

We are pleased to inform you that you have been selected for the bioengineering course and look forward to meeting you during the course.

We hope that the following information will help you to be prepare for the course and will answer all your questions.

Location and dates

The course will take place at the …….training Venue

The training will run from 08:30 to 16:30 on each day from ……to ……

Please arrange to arrive on the day before the actual start of the course. Staff will be ready to meet you after lunch on that day.

Travel to and from the training suite

You are responsible for your own travel to the training venue. You will be reimbursed for any costs from your own office, according to standard Mercy Corps policy. Transport will be provided for all course-related travel during the sessions.

Accommodation and meals

You will be staying in shared rooms at the training location or nearby. All meals will be provided, from the evening before the course starts to the morning after it finishes. You should claim subsistence/per diem allowances from your own office, according to Mercy Corps policy.

Purpose of the Course

This course has been designed to give you a clear understanding about bioengineering and its design and implementation. You need to study background topics to the extent that they are necessary to support the bioengineering topics to be covered. The course covers an Introduction to bioengineering, Geology, Geomorphology, water and bioengineering principles, bioengineering plants, bioengineering design, nursery design, bioengineering management and bioengineering maintenance.

The nature of the course

We describe this as a participatory course. By this, we want you to contribute actively in the course and will not simply be placing you in a training room and giving you lectures. You will be invited, and expected, to take part in the sessions and will be encouraged to enter into discussions so that you get maximum benefit from them. We expect that the atmosphere will be lively and informal. The amount you get out of the course will depend on how much you are prepared to put into it.

You will be spending almost half of the time infield exercises and practical work related to bioengineering. The exercises on sites involve going off the road and up hillsides.

What to bring

We recommend that you bring the following things with you:

- ✓ Bed sheet
- ✓ Towel
- ✓ Toiletries
- ✓ Suitable clothes and stout footwear for examining field sites
- ✓ Water bottle
- ✓ Calculator

Certification

At the end of the course you will be given a certificate saying that you have undertaken the full training.

We are pleased to be able to work with you on this course,

Yours sincerely,

Course Trainer,

Course time table
The course timetable is given on the next page.
This is based on the following basic structure:

- ✓ 08:30 - 09:30 Session 1
- ✓ 09:30 - 09:40 Break
- ✓ 09:40 - 10:40 Session 2
- ✓ 10:40 - 11:00 Tea break
- ✓ 11:00 - 12:00 Session 3
- ✓ 12:00 - 13:00 Lunch
- ✓ 13:00 - 14:00 Session 4
- ✓ 14:00 - 14:10 Break
- ✓ 14:10 - 15:10 Session 5
- ✓ 15:10 - 15:30 Tea break
- ✓ 15:30 - 16:30 Session 6

Adjustments are made to these times in order to accommodate the visits and some sessions will run over into a second period.

Although you can change the start and finish times and the length of breaks, the length of the sessions should not be changed.
Because of the developmental nature of the course, you should not change the sequence of sessions if at all avoidable. If you have to make changes, you must check that the links between sessions are maintained.

Equipment and materials

Training room resources

- ✓ Whiteboard -1
- ✓ LCD projector -1
- ✓ Screen -1
- ✓ Chart stands -2
- ✓ Chairs -24
- ✓ Set tables for 20 participants -1
- ✓ Table for trainers -1
- ✓ Comb binder -1

Stationery and equipment for trainees

- ✓ Bags with shoulder straps -24
- ✓ Caps -24
- ✓ File covers -24
- ✓ A4 clipboards -24
- ✓ Field notebooks (approximately A6) -24
- ✓ Black ball-point pens -24
- ✓ Clutch pencils with spare leads or pencils and sharpeners -24

- ✓ Erasers -24
- ✓ Rulers -24
- ✓ Name cards -24
- ✓ Name badges -24
- ✓ Comb binding spines -20
- ✓ Paired cover for bound notes -20
- ✓ Reams plain A4 paper -5
- ✓ Includes material for four trainers *

Stationery and equipment for trainers (based on recommended team of four trainers)

- ✓ Set handouts -1
- ✓ Sets of four colours permanent OHP pens -4
- ✓ Sets of four colours non-permanent OHP pens -2
- ✓ Box ordinary OHP transparencies -1
- ✓ Sets of four colours whiteboard pens -4
- ✓ Sheets A1 chart paper -100
- ✓ Sets of four colours chart pens -8
- ✓ Roll of masking tape -1
- ✓ Box drawing pins with coloured heads -1
- ✓ Hole punch with guide bar -1
- ✓ Stapler -1
- ✓ Box staples -1
- ✓ Box paper clips -1

Equipment and materials for training sessions in Block 1 [Sessions in which required]

- ✓ Map of Nepal -1
- ✓ Cline-compasses -12
- ✓ Map of South Asia -1
- ✓ Glass -1
- ✓ Rock -1
- ✓ First aid kit [all field sessions] -1

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: The aim of the session is to open the training course and introduce the participants to the course, the trainers and each other so that they will clearly appreciate the nature of the course and get to know the other people with whom they are working.

Session Objective:

The participants will be able to:

- ✓ Realize the importance given by Mercy Corps to bio-engineering for disaster risk reduction in Nepal.
- ✓ Establish working relationships with the fellow participants.

Content

Introduction	**Timing**
Welcoming remarks	5 (5)
Development	
1. Personal self-introductions	
a. Guests and trainers	5 (10)
b. Participants	25 (35)
2. Opening program	
a. Comments on the need of the training from the project side	5 (40)
b. Comments on expectation from the participants side	5 (45)
c. Opening remarks by Chief Guest	10 (55)
Conclusion	
Vote of thanks	5 (60)

1.1 Facilitator's notes

This is the first step toward the training program. Therefore, it is an important session because it needs to set a good atmosphere for the training. There are project manager(s) of the project(s), technicians working in the project area, concerned authorities and stakeholders. So it is necessary to address the expectations from all these sides. For this purpose, guests are invited to deliver very short speeches to demonstrate the importance placed on this training by Mercy Corps.

The participants are invited half an hour before the session begins. They are registered and given the package of stationery materials. A banner (B 01-1) similar to PPS 01-2 is hung on the wall and a welcome banner (PPS 01-1) is demonstrated on the screen. The training coordinator serves as the master of ceremony.

The training coordinator invites all the participants and the guests to the training room and requests them to take their seats. S/he starts the session with a warm welcome and distributes the program sheet (H 01-1). S/he invites the prescribed person to give a short welcome speech on behalf of the organizer. The speakers have to be reminded of the time constraint.

Announce that you are looking forward to working very closely with them over the whole week. It is the time for formal introductions. Introduce the trainers and the guests by name only. Distribute the blank name cards, name tags and chart pens and ask them to write the name they wish to be known by on the cards. Show them your name cards, which you have prepared in advance.

1.1.1 Personal self-introductions

Explain that you want everybody to get to know everybody else and you will start this process by self-introductions.

a. Trainers

You need to take turns to introduce yourselves. Keep strictly to a time limit of one minute each. If one of you acts as a timekeeper and stops the speaker on time, this shows the participants how much they can expect to cover and will add to their enjoyment.

b. Participants

When you have completed your introductions, explain that it is now their turn, but that you are giving them just two minutes to prepare. When this time is up, ask for participants to start the introductions. Keep control over the time, otherwise this exercise will take far too long. While they are speaking, you may find they make some points that will help you relate to them during the course. Ask them to put a pin in the map to show where they are now working.

c. Guests

Now, it is the turn of the guests to introduce themselves. As they introduce themselves turn by turn, make possible arrangements for photography.

It is now time for the formal opening of the program. For this purpose, request the chief guest to open the program by clicking on the 'enter' key of the computer. After the opening activity, one of the participants is allowed to express the expectations from the participants' point of view. Likewise, the senior manager of the project is invited to highlight the importance of the training program and emphasize the practical implementation in the real field. Finally, the chief guest is requested to deliver her/his remarks on and wishes for the success of the training.

The program given is an example. It might differ from case to case. The actual program for any course depends on the guests who are available. The time allocated for this session may not be sufficient depending on the number of guests. In this case, there will be more pressure on time for the following sessions. Lastly, one of the organizers or the training coordinators thanks the guests for providing the time and the participants for being punctual. Show slide PPS 01-3 to close the session and invite the guest(s) for refreshments.

1.2 Training resources

Handouts

- ✓ H01-1 Opening Session Program 20

Facilitation aids

- ✓ B01-1 Banner for the opening session 1
- ✓ PPS 01-1 Power Point Slide of welcome banner 1
- ✓ PPS 01-2 Power Point Slide of opening banner 1
- ✓ PPS 01-3 Power Point Slide of 'Vote of Thanks' banner 1

Equipment and materials

- ✓ Name cards 20
- ✓ Name badges 20
- ✓ Chart pens 8
- ✓ Map of Nepal and project area on chart stand 1
- ✓ Drawing pins with coloured heads 20
- ✓ Sets of stationery for participants 20

- ✓ Black ball-point pen
- ✓ Clutch pencil with spare leads or pencil and sharpener
- ✓ Eraser
- ✓ Ruler
- ✓ 10 sheets of A4 paper
- ✓ Field notebook (approximately A6)
- ✓ File cover
- ✓ A4 Clipboard

Notes

Make sure that you have prepared your own name cards before the session. Only include the short name you wish to be known by and print it in large, clear letters. Make sure that there is continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To introduce the participants to the training course so that they will clearly appreciate the nature of the course.

Session Objective:

The participants will be able to:

- ✓ Describe the approaches to training which will be used.
- ✓ Discuss the objectives of the course.
- ✓ Use the safety discipline in their activities.

Session content

Introduction	**Timing**
Review of opening session and orientation to training program.	5(5)
Development	
1. Course aims, objectives, timetable, handouts and assessment.	15(20)
2. Training approaches and safety .	5(25)
3. Pre-course questionnaire and participants' bio- data forms.	30(55)
Conclusion	
Key point - Importance of participation	5(60)
Domestic arrangements	

2.1 Facilitator's notes

2.1.1 Introduction

Remind the participants that they have already been welcomed formally through the opening ceremony. Welcome them again in a more humorous way by showing a series of slides through major languages and culture. Show slides PPS 02-1to12. Now tell them that there is a huge expectation both from the organizer and the participants' sides. Therefore, there is a big challenge to cope with these expectations. Recap the views of the speakers in the opening ceremony. Do not spend much time on this stage. Just remind them that the training is organized because of its significance in the context of Nepal. Lead the session toward the introduction of the training course.

2.2.1 Development

2.2.1.1 Glimpses of natural beauties and disasters in Nepal

Start the session by asking a question about how we describe the country to introduce it to others. They may answer that Nepal is beautiful, peaceful and great. Reiterate their answers and show some slides (PPS 02-13 to 67) related with the beauties of Nepal. Do not explain the scene and scenario. Ask the participants whether these scenes prove their answer that Nepal is beautiful, or peaceful, or great. They will certainly be satisfied.

Now show them some slides (PPS 02-68 to 79) leading to the slope failures, riverbank erosion and floods. Ask them whether our country remains as beautiful, peaceful or great if such situations continue to affect it regularly. The answer will be negative. Then lead them to the significance of the training.

2.2.1.2 Training Course's aims, objectives, timetable, handouts and assessment

Show the slide (PPS 02-80 & 81) and briefly outline the aims and objectives of the course. Then show slide (PPS 02-82) and work through the timetable to show how the sessions will enable you to achieve these aims and objectives. Finally, in this section, tell the participants that they will receive handouts with most of the sessions. At the end of the course, you will arrange for these to be bound as a course book, together with any notes they want to keep.

Distribute handout H 02-1 and explain that it has incorporated more information for their reference as well. Distribute handout H 02-2 and request them to fill out the pre-questionnaire. Explain to them that it is just for reference purposes and is not used for an assessment of their knowledge. Remind them the time constraint for this purpose and control it. When time is up, collect the questionnaires. Emphasize the importance of good time keeping. Explain that you will try to keep to the set times and would like them to do the same.

2.2.1.3 Training approaches and safety

Explain that this is planned as a participatory course and you want them all to be very actively involved. Their involvement may vary between different sessions, but it is important for them to participate. Part of their participation will be through group discussions.

Quickly identify the different types of sessions in the timetable. These include practical, field classes and field exercises. Explain that there will be several sessions based on exercises on a range of sites. Emphasize the fact that bioengineering sites are frequently hazardous. Explain that each participant is responsible for her/hisown safety and that of others. Distribute handout H 02-3 and ask them to read it carefully.

2.3.1 Conclusion

Commence the conclusion by reinforcing the importance of their participation in the sessions. Explain the domestic arrangements such as meals, cleaning, etc. and answer any questions. Outline the possible visits on Saturday (or appropriate day) and ask them to think about their preferences. Finally, explain that they will start to think about bioengineering and some of the background topics related to it in the afternoon. Thank them with slide PPS 02-83.

2.2 Training resources

Handouts

- ✓ H 2-1 Introduction to training course 20
- ✓ H 2-2 Pre-Training course questionnaires 20
- ✓ H 2-3 Safety 20

Facilitation aids

- ✓ PS 02-1 Power Point Slide on 'welcome' 1 Set
- ✓ PS 02-2 Power Point Slide on 'natural beauties' 1 Set
- ✓ PS 02-2 Power Point Slide on 'instabilities' 1 Set
- ✓ PS 02-3 Power Point slide of objective of training course 1 Set
- ✓ PS 02-4 Power Point slide of training schedule 1 Set

Equipment and materials

Notes

Make sure that there is provision of LCD projector and the computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To introduce the capacity of plants as an engineering structure and meaning of bio-engineering as well as to establish its importance, so that the participants understand the idea of bio-engineering, and are motivated to learn about it and will be apply it in their work.

Session Objective:

The participants will be able to:

- ✓ Enlist the scenario of erosion.
- ✓ Describe the six engineering functions which may be performed by plants.
- ✓ Define the term 'Bioengineering'
- ✓ Explain the adverse and beneficial effects of plants under Nepalese conditions.
- ✓ Enlist the field and scope of bioengineering.
- ✓ Justify the general use of bioengineering .

Session content

Introduction	**Timing**
Importance of use of living plants	5(5)
Development	
1. Glimpses on the erosion in Nepal	5(10)
2. Engineering function	10(25)
3. Definition of bioengineering	5(30)
4. Advantages of bioengineering	10(40)
5. Scope and field of bioengineering	10(50
6. Criteria for justifying use of bioengineering	5(55)

Conclusion

Key point ✓ Bioengineering is applied with, not in place of, traditional civil engineering. 5 (60)

✓ Bioengineering has clear purposes and methods, but the benefits are not easily quantifiable and at present are mainly qualitative.

Link to Session 4, start on importance of site investigation.

3.1 Facilitator's notes

3.1.1 Introduction

Remind the participants that they are now aware of the over all training course. It is the beginning session. Just read the understandings of some of the participants about bioengineering and tell them that they are very close to its definition. Explain that in this session, they will develop a definition of bioengineering and discuss its advantages and disadvantages. This helps them see how the use of bioengineering can be justified. Tell them that they will learn the actual reality of bioengineering in the field of erosion control and reducing shallow seated instability.

3.2.1 Development

3.2.1.1 Glimpses of soil erosion in Nepal

Start the session asking a question how water should be seen in color. They will likely answer that it should be blue or something similar. Show the first slide (PPS 03-1 to 7), which passes the message that soil is being eroded from the slopes of Nepal in huge quantities. Now ask the participants what other problems there are on the slopes. They will indicate some of the problems. Now show slide (PPS 03-8), which describes the problems of the slope. Conclude this section with the understanding that there are problems on the slope and it has to be addressed to reduce the disaster.

3.2.1.2 Engineering function

Show the slide (PPS 03-8) again and ask how these problems can be solved. They will give some example of structures. Now ask: "How does it achieve its purpose?"You may need to give some prompting, but you should lead to the answer: "It performs an engineering function".Add on the board: engineering function.

Explain that they will be considering the engineering functions of bioengineering systems. They will also see how bioengineering and civil engineering systems work together. But direct them to the function. Tell them that we are dealing with six basic engineering functions: catch; armor; reinforce; support; anchor and drain. Introduce them turn-by-turn in relation to the problem of the slope with slide (PPS 03-9). Now ask the participants whether plants can perform the functions described now or not. They should agree with the theme. Now show slide (PPS 03-10) to prove that the vegetation is actually and really beneficial for the purpose of slope protection work. End this portion with the understanding that the proper engineering function has to be performed to solve the specific problem. Show slides (PPS 03-11 to 22) to demonstrate the bioengineering application in Nepal.

3.2.1.3 Definition of bio-engineering

Ask the participants the following questions and write the three key phrases in italics on the board, as you receive the answers.

Ask the question, "What do we use in bioengineering, but not in civil engineering?"They should have no problem with the fact that it is plants, but you may need to help them see that these plants must be living. If they have difficulty with this, you could ask if a wooden fence is a bioengineering structure since it contains plant material.

Write on the board: living plants
Now ask, "Does bioengineering only involve the use of plants?"The answer you want is that this is not necessarily the case. Explain that strictly speaking, bioengineering only relates to using plants. In practice, we use the term to include both plants and small civil engineering structures. Therefore plants can be used alone, but are normally used in combination with civil engineering techniques. Write: in combination with civil engineering structures, then ask the question, "What are we trying to achieve through using bioengineering?"The answer is: "To produce stability on eroding slopes." Then ask, "What sorts of slopes can we stabilize with bioengineering?" In this case the answer is: "Shallow-seated instability and erosion." Write on the board: reduction of shallow instability and erosion.

Explain that you have not attempted to define the depth meant by 'shallow'.This varies, but in practice, it relates to a number of factors including: mechanisms of instability, climate and available plants.

Explain that the elements on the board are the three fundamental aspects of bioengineering.

Show the participants the definition of bioengineering on slide (PPT 03-23 to 25), stating: "Bioengineering is the use of living vegetation, either alone or in conjunction with civil engineering structures and non-living plant material, to reduce shallow-seated instability and erosion on slopes."

3.2.1.4 Scope and field of bio-engineering

Explain that the definition has been developed from a number of sources in order to fit the use of bioengineering in stabilizing slopes, riverbanks, water purification and soil conservation. Now ask them what in other fields can bioengineering be used. Show slide (PPS 03-26 to 27) dealing with the

scope and fields of bioengineering applications. Tell them that they will be concentrating on bioengineering for erosion control and slope stabilization.

3.2.2 Justification for use of bioengineering

3.2.2.1 Criteria for justifying use of bioengineering

Now explain that if bioengineering is to be a normal part of engineering, we must be able to justify its use. Ask the participants to produce lists of reasons and purposes through which bioengineering could be justified. They should be thinking about answers to the question, "Why should we use bioengineering in Nepal?"Write this on the board. Emphasize that you are not asking them to justify bioengineering, but to identify criteria against which its use could be evaluated. Divide the participants into 4 groups with chart paper and pens, then tell the groups to write up their lists. Ask each group in turn to hold up its chart and tick the point on their list, matching with the points in the slides. Now show slide (PPS 03-28to29) stating the benefits.

3.2.2.2 Evaluation of the criteria

Working with the list of criteria, ask how we can evaluate these items in order to justify the use of bioengineering. Show the slide PPS 02-30.Tell the participants that, in many cases, we cannot easily quantify the benefits from bioengineering. Now explain that we need to balance the advantages against the disadvantages. Therefore we need to think about the disadvantages. Now show slide (PPS 03-31 stating the limitations of the plants.

3.3.1 Conclusion

Explain the key point of the session. It is that bioengineering has a clear purpose to reduce instability and a clear means of achieving this through performing an engineering function. It does this by the use of plants in combination with normal civil engineering methods. However, the benefits of bioengineering are not easily quantifiable. At present, they are mainly qualitative End the conclusion by emphasizing the engineering functions performed by vegetation structures and that vegetation has adverse as well as beneficial effects on slope stability. On balance, we believe that the benefits outweigh the disadvantages, but in individual cases, we cannot always be sure.

Finally, distribute the handout (H 03-1) and tell the participants that they will start to look at the background to bioengineering in the next session.

3.2 Training resources

Handout

- ✓ H 20-1 Introduction to Bio-engineering 20

Facilitation aids

✓ PPS 03-1 to 7	Glimpses of soil loss in Nepal
✓ PPS 03-8	Problems on the slope
✓ PPS 03-9	Engineering functions
✓ PPS 03-10	Plant to perform engineering functions
✓ PPS 03-11 to 22	Examples of bio-engineering application in Nepal
✓ PPS 03-23 to 25	Definition of bio-engineering
✓ PPS 03-26 to 27	Scope and application of bio-engineering
✓ PPS 03-28 to 29	Advantages of bio-engineering
✓ PPS 03-30	Justification of bio-engineering
✓ PPS 03-31	Limitation of bio-engineering

Equipment and materials

✓ Non-permanent OHP pen	1
✓ Chart paper	8 Sheets
✓ Chart pens	4

Notes

Make sure that there is provision of LCD projector and the computer with continuous source of power.

Session Plan

Location: Training suite **Duration**: 1 hour

Session aim: To teach the participants about the land form and the incidence of slope formation. Participants will use this skill as a background for landslide appraisal.

Session Objective:

The participants will be able to:

- ✓ Realize the formation of Himalaya of Nepal.
- ✓ Identify the slope formation process.
- ✓ Identify the physiographic zones of Nepal .
- ✓ Identify main land forms.
- ✓ Describe the potential failure zone based on the landforms.

Session content

Introduction	**Timing**
Importance of knowledge on the geomorphology and landforms	5(5)
Development	
1. Geological formation of Himalaya of Nepal	5(10)
2. Physiographic zones of Nepal	20(30)
3. Landforms of Nepal	15(45)
4. Potential of failure	10(55)
Conclusion	
Key points	
✓ Landform determines the susceptibility to failure	5(60)
✓ Terai is susceptible to flooding whereas mountains are susceptible to mas movements	
Link to Session 5, start on importance of site investigation	

4.1 Facilitator's notes

4.1.1 Introduction

Just before the break, the participants had learnt about the problems on the slope. Ask the participants to recall them and the functions to be performed. Remind them that to identify the problems, we have to study the slope and landforms. Therefore, the study of the slope and its forms are the main issues of this session. Ask the participants to identify the differences between the landforms in Terai and hills. Keep this discussion rather short and move onto the main part of the session.

4.2.1 Development

4.2.1.1 Formation of Himalaya of Nepal

Ask the participants what the rock type in Mt. Everest is. If they are unable to answer, tell them that it is composed of limestone. Remind them that it is sedimentary rock and generally formed at the bottom of the sea. Ask them how it is possible. Lead them to answer that the territory of Nepal was once at the bottom of the sea and it is in today's' position due to its shift.Now show the slides (PPS 04-1 to 6), which demonstrate how Nepal's Himalaya range was formed. Compare it with the collision of a moving car with a giant lorry and describe the ups and downs of the slope surfaces.

4.2.1.2 Physiographic zones of Nepal

Ask the participants to name the different physiographic zones of Nepal. Add them on the board. Show the slide (PPS 04-7), which demonstrates the block diagram of Nepal's Himalaya. Introduce the concept of thrusts. Now, gradually demonstrate all the physiographic zones and thrusts. Explain the general stability problems in each zone. Explain that the problems in each zone can be categorized for identifying the solutions specifically.

4.2.1.3 Landform classification

Generally, infrastructure development activities are centered on specific sites. Therefore, it is important to study the small landform. Ask the participants where apower house is constructed. They will answer that it will be on the riverbank on the foothill. Then ask what type of site is appropriate for abridge site in Terai. Address their answer and explain the importance of identifying the landforms. Now, show slides (PPS 04-8 to 46) and explain different types of landforms both in the hills and Terai. While dealing with the landforms, ask the participants what the problems of instability are there in those landforms.

4.2.1.4 Potential to failure

Remind them that they correctly indicated the problems on each of the landforms. Now show the slides (PPS 04-47) and explain the susceptibility of slope angles to slope failure.

4.3.1 Conclusion

In your conclusion, tell the participants that these are the principal land forms of the lower and middle Himalayas which they need to be able to recognize.

Explain the key point that each land form has a different degree of susceptibility to instability.

Finally, distribute the handout (H 04-1) and ask them to read it in the leisure period.

4.2 Training resources

Handout

- ✓ H 04-1 Geomorphology and landforms of Himalaya of Nepal 20

Facilitation aids

- ✓ PPS 04-1 to 6 How Himalayas are formed
- ✓ PPS 04-7 Block diagram of Nepal's Himalaya
- ✓ PPS 04-8 to 31 Physiographic zones of Nepal
- ✓ PPS 04-32 to 46 Landforms
- ✓ PPS 04-47 Potential analysis of failure

Equipment and materials

- ✓ Non-permanent OHP pen 1
- ✓ Chart paper 8 Sheets
- ✓ Chart pens 4

Notes

Make sure that there is provision of LCD projector and the computer with continuous source of power.

■ ■ ■

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: The aim is to introduce the participants to the characteristics of rainfall in Nepal, important features of infiltration of water into the soil and its percolation through it as a basis for investigating water movement and types of slope instability. Another aim is to introduce the physical conditions controlling water movement over and beneath the ground and the instability situations arising from this. This is so that they can relate bioengineering planning and implementation requirements to rainfall regimes. The session also aims to introduce the participants to the river morphology and the drainage pattern.

Session Objective:

The participants will be able to:

- ✓ Describe the general patterns of rainfall across the country.
- ✓ Describe the local factors affecting rainfall.
- ✓ Identify broad local variations in rainfall distribution.
- ✓ Describe the general situation with regard to the infiltration of water into soil.
- ✓ Explain how infiltration and percolation take place.
- ✓ Explain how these affect the use of bioengineering measures.
- ✓ State the conditions that lead to overland flow and the resulting erosion effects.
- ✓ State the conditions that are conducive to sub-surface movement of water and the resulting. erosion and instability effects.
- ✓ State the conditions that control movement of water through rocks.
- ✓ Analyze the river morphology and map it.

Content

Introduction	**Timing**
Importance of understanding rainfall patterns, their effect and river morphology	5(5)
Development	
1. General description of the rains	10(15)
2. Effect of water	15(30)
3. River morphology	10(40)
4. Mapping of river banks	15(55)
Conclusion	
Possible applications of bioengineering in controlling effects of water movement	5(60)

Nepalese soil and rocks are generally very permeable, allowing water in to various depths and serving as a cause of instability.

5.1 Facilitator's notes

5.1.1 Introduction

Commence the session by saying that rock is very hard. Drop a rock on the floor. Then ask, "What is stronger?"Show the participants the glass of water and again ask, "What is stronger?"Establish that water is stronger. They have to look at water and then see how slope and water interact. Lead in to the fact that in this session, they are going to look at two other processes, which are very important for the amount of water, how it enters the soil and the mechanism by which it moves through the material. Show the slides PPS 05-1 to 3 and demonstrate water-induced disaster.

Describe how this involves discussion of the movement of water over the surface, through the surface to a depth of a few centimeters, further down into the soil profile, and deep into rocks. Each situation will be dealt with in turn and their relevance to bioengineering considered.

5.2.1 Development

5.2.1.1 General description of the rains

5.2.1.1.1 Summer monsoon rains

Introduce the water balance cycle in short, showing the slide PPS 05-4 and general pattern of summer monsoon rainfall in Nepal. There is no need to go into detail on subjects such as the bi-annual changes in the jet stream or other reasons behind the existence of a seasonal rainfall pattern. Show the slide PPS 05-5 to 6 'the map of South Asia' to show how the monsoon rain approaches from the south-east, off the Bay of Bengal, and moves westwards, across the southern front of the Himalayas. Emphasize the regularity of this movement, which occurs in June every year. Then use the map of Nepal to show this progression in more detail. Explain that as air rises over mountains, it becomes cool and it rains. Pick out the main topographical barriers which give rise to higher rainfall. These include: large Mahabharat ridges, higher middle mountain ridges, and the southern flanks of the Annapurna Himal. Identify examples of where the lower rainfall areas are most pronounced; i.e., where the differences can be seen most clearly.

5.2.1.1.2 Rains outside the monsoon

Briefly describe the incidence of rains outside the monsoon.

i. Pre-monsoon thunderstorms: These occur from March onwards, as a result of the increasing temperatures in the sub-continent.They are usually strongest in the Terai, but can also be significant in the hills. They give appreciable amounts of rain in short periods and can ease the drought temporarily at the hottest time of year.

ii. Tropical cyclones:
In the spring and autumn, Nepal can be affected by the tail of cyclones generated over the Indian Ocean and which reach Nepal following along the Bay of Bengal. These give several days of heavy rain. An example occurred in November 1995, giving rise to an avalanche in the Khumbu Valley and a debris flow in Manang, both causing heavy loss of life.

iii. Winter rains::

Low pressure and atmospheric instability give rise to other bursts of rain during the colder winter months. In western Nepal, these are more common, but they are still infrequent events. In cooler and higher altitude areas, however, it can be enough in some years to allow winter tree planting.

iv. Other pre- and post-monsoon rains:
These occur during unsettled climatic conditions just before and after the true monsoon. They serve to extend the wet period by a month or more in some years.

5.3.1 Infiltration

5.3.1.1 Factors affecting infiltration

Divide the participants into four groups of five and ask them to discuss the main factors that they think will affect infiltration in Nepal. Allow them a maximum of five minutes for this activity.
Now ask each group in turn to provide a factor. Summarize their ideas and compare it with the list in slide (PPS 05-11).

5.3.1.2 Rate of infiltration

Show the participants slides(PPS05-12to14) that relate expected infiltration rates to soil textural classes. Emphasize the difference between infiltration rates on sandy and clayey soils.

5.3.2 Percolation

Remind them of the definition of percolation. Show slide PPS 05-15 and point out that in most areas of Nepal, there are steep slopes, so percolation is almost entirely downward. Explain that the percolation of water through a soil is related to the texture and structure of the material, because these have an effect on the porosity. Tell them that the rate of percolation can be measured as the hydraulic conductivity, or the passage of water through the soil.

5.3.3 Water retained in soil

Explain that not all of the water drains out of soils through percolation. A portion is retained, for example, in pores and against clay particles. This is held at various pressures, depending on the physical or chemical bonds, but may be available to plants, even when the soil appears to be quite dry.

5.3.4 Percolation through clay soils

In clay soils, the rate of percolation is so slow that they rarely lose their moisture through drainage. Instead, they tend to lose it by evapotranspiration, especially when they have plant cover. As this happens, the clay particles lose their films of water and are drawn together. This causes shrinkage of the soil and results in cracking. When the soil is first re-wetted, water can enter quickly through the cracks. Hence, there is a high initial rate of infiltration and percolation through very dry clay soils, but this rapidly slows once the soil becomes saturated. As a result, clay soils often do not have the same behavior as coarser materials.

5.3.5 Surface water movement

5.3.5.1 Ground conditions leading to overland flow of water

Commence this part of the development by asking: "What conditions lead to overland flow of water?"Write 'conditions leading to overland flow of water' on the board. As you receive responses, show the slide (PPS 05-16) and compare with the given points.
You may need to lead them to the idea of soil capping. Explain that a soil cap may lead to surface flow, even if the underlying material is sand.

5.3.6 Effect of surface water movement

5.3.6.1 Erosion resulting from surface water movement

Then ask, "When water flows over the surface what may be the results?" Write 'Results' on the board and add the following points in this order: *sheet erosion and rill erosion*
Then ask if we always get erosion and add: *gentle flow.*

Ask them to think of the differences between sheet erosion and rill erosion. Through guided discussion, lead to these definitions:

-Sheet erosion is the removal of soil, mineral or rock particles evenly over the whole surface.

Explain that there is physical damage to the whole surface; it is not concentrated in channels. If the erosion results from water concentrated in channels, we see rill erosion.

- Rill erosion is the removal of soil, mineral or rock particles along water channels.

Explain that this is by far the most common form of erosion. As rills become larger and deeper, they develop into gullies.

Finally explain that gentle flow is not really a technical term. We simply use it to indicate that no erosion is taking place.

Now explain that we are most likely to see sheet erosion when there are extremely shallow soils produced on soft and weathering rock. Rain constantly removes the weathering skin of soil from the surface. The rock itself is sufficiently strong to resist rill erosion.

Then consider the soil conditions most likely to lead to rill erosion. Rills are seen in soils that have fine, cohesion-less particles that are very easily detached by water and carried in suspension. Fine, sandy soils will also rill, but not as much.

If anyone mentions gullies, explain that these are simply extensions of rills. They are often taken as rills, which are over 3 m deep. Show the slides PPS 05- 17 to23 to recap this part.

5.3.7 Sub-surface movement of water

Explain that soil pore pressure refers to the pressure exerted on the soil particles by water in the pores.It becomes positive when all the pores are filled with water and a hydrostatic head develops.The pressure results in the soil grains moving apart and the soil behaving as a liquid rather than as a solid. Ask them, "What happens to the soil pore water pressure when the soil surface becomes saturated?"The answer is that the pore water pressure will begin to rise.Check that they have understood this effect by asking, "What form of instability results?" Make sure that you get the answer, "Liquefaction and flow of the soil." Now ask, "What is the result if pore water pressure becomes positive along the walls of a fissure underground?"They may know that a pipe develops,but you may have to explain that an enlarged fissure forms underground in the soil and that we call this a pipe.Fissure enlargement takes place as the water flowing along the fissure detaches soil particles and carries them away in suspension. Progressively show slides (PPS 05-24 to 30) as you explain the effect of subsurface water.

5.3.8 Drainage pattern and river morphology

Show the slide (PPS 05-31 to 55) and briefly inform the drainage pattern and the river morphology.

5.3.9 Mapping of riverside

Show the slide (PPS 05-56) and illustrate the mapping technique of the river bank.

5.3.10 Conclusion

Summarise the general points made during the lecture:

Finally explain that Nepalese soils and rocks are generally very permeable, allowing water in to various depths, all of which can cause instability.

5.2 Training resources

Handout

- ✓ H 05-1 Rainfall and water movement 20

Facilitation aids

- ✓ PPS 05-1 to 3 Power Point slide of rainfall pattern 1 Set
- ✓ PPS 05-4 Power Point slide on Water cycle 1 Set
- ✓ PPS 05-5 to 10 Power Point slide on rainfall pattern 1 Set
- ✓ PPS 05-11 to 15 Power Point slide on infiltration of surface water 1 Set
- ✓ PPS 05- 16 Power Point slide on condition of overland flow 1 Set
- ✓ PPS 05-17 to 23 Power Point slide on effect of surface water 1 Set
- ✓ PPS 05- 24 to 30 Power Point slide on effect of subsurface water 1 Set
- ✓ PPS 05-31 to 55 Power Point slide of river morphology and drainage pattern 1 Set
- ✓ PPS 05-56 Power Point slide on mapping

Equipment and materials

- ✓ Map of South Asia
- ✓ Map of Nepal
- ✓ Piece of rock
- ✓ Glass of water

Notes

Make sure that you have LCD projector and computer with continuous source of power.

■ ■ ■

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the origin and characteristics of common soils and materials occurring in the Sub Himalaya and Lesser Himalaya of Nepal and their significance in general engineering terms, so the participants can use this information in analyzing sites.

Session Objective:

The participants will be able to:

- ✓ Identify the main slope type.
- ✓ Identify the slope forming materials.
- ✓ Identify the main constituents of colluvial and alluvial materials.
- ✓ Distinguish between colluvial and alluvial materials.
- ✓ State the reason for the high permeability and low plasticity of soils.
- ✓ State the engineering uses and limitations of river-borne materials.
- ✓ Identify the stability condition of rocky slopes of Himalayan Nepal.

Content

Introduction	**Timing**
The range of soil types and materials in Sub Himalaya and Lesser Himalaya are limited from an engineering point of view.	5(5)
Development	
1. Type of slope.	5(10)
2. Materials forming the original slope.	20(30)
3. Geological characteristics which affect engineering.	5(35)
4. Stability analysis of rocky slope.	20(55)
Conclusion	
✓ Colluvial material is susceptible to mud flow and liquefaction.	5(60)
✓ Weathered material is unsuitable for road construction.	

6.1 Facilitator's notes

6.1.1 Introduction

Remind the participants how the Himalayas of Nepal were formed. Describe to them that the process of uplifting is a continuous process. The mountains are rising gradually. Describe how the range of soil types in the Sub Himalaya and Lesser Himalaya is limited from an engineering point of view. Explain that in this session the participants will be introduced to the common types of soils and materials found in the Sub Himalaya and Lesser Himalaya of Nepal and how they originated. Tell them that they will be considering their characteristics in relation to slope instability. Explain that these materials are typical to the valley side situations. Explain that, although the Himalayas are very complex, there are relatively few soil types which are of concern. Relate this to the fact that the soils on hill slopes are constantly being mixed by gravity and water movement.

6.2.1 Development

6.2.1.1 General description of the rains

Ask the participants where bioengineering can be implemented. They will indicate the field of bioengineering application. Now show the slide (PPS 06-1) to demonstrate the types of slopes where bioengineering can be implemented. Now tell them that they have to identify the slope types before assessing the site and recommending the protection measures.

6.2.1.2 Slope forming materials

Ask the participants to write down in their notebooks what materials are available in those slopes. Ask them to give their responses and note them down. Again, show the slide (PPS 06-2 to 45), which displays the types of materials on the slope. Ask the participants how the materials on the slope are formed. They will give some points. Emphasize their points and inform them that weathering is the main process of material formation. Transporting phenomena differentiate the different types of soil types. Then ask them what material is accumulated on the base of a landslide and establish the term colluvium. Likewise, introduce the concept of materials formation by transportation, such as river, air, glacier or lake deposited soil. Ask them the general properties of each material type. Remind them that these are the important features to identify the slope materials. Tell them that there are basically two methods of material investigation: Field investigation and laboratory investigation. Let them know that for bioengineering application, field investigation is the major method of investigation. Therefore, it is important to follow the rules of hands-on practice exercises.

6.2.1.3 Geological characteristics which affect engineering

Ask them to think about large cobbles, which are weathered so that when they are hit with a hammer, they break into fine particles. Ask what they can conclude about these particles. Lead them to the fact that these particles have not travailed far. If they had been carried much farther, they would have broken up. Explain that this is most clearly seen with phyllite, which breaks up very easily with weathering. Cobbles of quartzite do not provide as clear information, because the material is chemically more resistant and contains fewer fracture planes.

Ask them, "What mechanical problems do large rounded pebbles from river beds present when they are used as aggregate?" Establish the fact that they have poor mechanical interlock and are mechanically unstable because they are spherical. In order to re-introduce angularity to the pebbles, they need to be crushed.

Remind them that alluvial sand from river valleys does not contain organic matter or clay. Ask, "What is the main limitation of the sand component of the terrace gravel as a source of construction material?"The answer is that it has a high content of mica, which weakens concrete. Ask them what action can be done to this material to overcome the problem; establish that it can be washed to remove the mica. This is necessary for high strength concrete ,which can be used in bridge works.

6.2.2 Stability analysis of rocky slope

Ask the participants how to identify stable slopes. Establish the idea that the slope that is composed of strong rock is strong and vice-versa. Therefore, it is essential to identify the slope forming rocks. Now, show the slides PPS 06- 46 to 81 and describe how the slope is analyzed on the basis of mineral type, weathering grade, lithological characteristics and presence of discontinuities. Briefly describe the method of analyzing the minerals and consequently explain the type of slope on the basis of mineral type. Likewise, introduce the concept of weathering and its significance on the strength of the rock slope. The stability of the slope depends widely upon the lithological characteristics that are on the rock type. Then give them the idea of how the rock mass affects the slope stability and potentially to its failure. Briefly tell them the methods of analyzing the slope based on its discontinuities: fractures, joints, faults, folds, bedding planes, etc. planes, etc.

6.3.1 Conclusion

In your conclusion, remind them that the slopes are stable if they are composed of the strong minerals with no visible signs of weathering and the counter dip slope.

Distribute the handout (H 06-1) and remind them the key ideas.

6.2 Training resources

Handout

- ✓ H 06-1 Cause and mechanism of failure 20

Facilitation aids

- ✓ PPS 06-1 Power Point slide types of slopes 1
- ✓ PPS 06-2 to 45 Power Point slides on slope forming materials 1
- ✓ PS 06-46 to 81 Power Point slides on stability analysis 1

Equipment and materiels

Notes

Make sure that you have LCD projector and computer with continuous source of power.

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Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the geomorphologic processes, underlying and leading to slope failure. Participants can use this information as a first step in instability assessment and as a basis for specifying appropriate remedial measures.

Session Objective:

The participants will be able to:

- ✓ Name the causes of and conditions leading to slope failure.
- ✓ Name the mechanisms by which strength in a slope is lost, and by which failure occurs.
- ✓ State the relationship between these two sets of principles.

Content

Introduction	**Timing**
Importance of assessing the causes and mechanism of failure	5(5)
Development	
1. Definitions of 'cause' and 'mechanism'	5(10)
2. Causes of instability	20(30)
a. Surface water	
b. Ground water	
c. Weathering	
d. Differential weathering	
e. Undercutting	
f. Added weight	
3. Mechanisms of instability	25(55)
a. Erosion	
b. Shear failure	
c. Disintegration	
d. Fall	
e. Plane failure	
f. Complex	
Conclusion	
✓ Colluvial material is susceptible to mud flow and liquefaction.	5(70)
✓ Weathered material is unsuitable for road construction.	

7.1 Facilitator's notes

7.1.1 Introduction

Tell the participants that they have now entered into the stage of assessment of the site. This is one of the most important sessions in this aspect. Explain that this is the first out of three sessions introducing the process of assessing instability of the slope. In this session, they will discuss the factors giving rise to instability. In the second session, they will look at the basics of instability and in the third consider the mapping procedure. The scheme introduced in this session has been developed for Nepalese conditions with the experience of different projects.

7.2.1 Development

7.2.1.1 Definitions

Ask the participants to define the cause. They may be confused with the factors leading to failure. Now, explain that the 'causes' of slope failure mean the condition(s) that generates or starts failure. Show the slide (PPS 07-2), which gives this definition. Similarly, show the slide (PPS 07-3) with the definition of the mechanism of failure.

7.2.1.2 Cause of Instability

Explain that we can identify six underlying causes of slope failure. Tell participants that they have already seen some of them so far. In the next part of this session, they are going to identify all these causes. Show the series of slides (PPS 07-4 to 15) gradually and briefly discussing the causes of failure. The first set of causes include rainfall, earthquake and volcanoes, which are natural causes and they should be addressed for preparedness and post-event rehabilitation.

7.2.1.3 Surface Water

Ask them to think about water falling on the ground. Ask what may happen to this water on a sloping surface. Explain that this may be a cause of instability.

7.2.1.4 Ground water

Follow this by asking what happens to the water if it does not simply run off the surface. Establish that the water may enter the ground, where it may become a second cause of instability.

7.2.1.5 Weathering

Remind them of Session 6.Ask them, "What is a cause of rocks becoming soft?"They may answer directly that it is weathering or they may give you three factors leading to weathering. Whichever response you receive, establish the idea that weathering leads to softening of rock and that this can then lead to instability.

7.2.1.6 Differential weathering

Remind them about the rock type with alternating bands of hard and soft rocks. Now ask them how the weathering process takes place in such rocks. They should answer that there will be differential weathering. Establish this terminology. Do not start to discuss disintegration atthis stage, as it will be dealt with in the section on mechanism of failure.

7.2.1.7 Undercutting

Now ask them whether they are aware of an incident in which an engineer in Rasuwa recently died during road construction. Follow this by asking why it fell and lead to the idea of toe undercutting. Remind them that roads and rivers are examples of undercutting.

7.2.1.8 Added weight

Ask, "What may happen when spoil is dumped on a slope?"Through discussion, establish that it may slide off. If it does not simply slide off, it may even cause a deeper slope failure by its weight or influence on the local hydrology. Remind them that the added weight may be caused by man, as in the case of spoil, or it may result naturally from landslide debris. Explain that weight added to the top of a slope may be dangerous.

7.2.1.9 Mechanisms of instability

Show the slides (PPS 07-16 to 26) gradually reminding the participants of the mechanisms of instability. Explain that you want them to move on from thinking about the causes of instability to how the loss of strength and stability occurs.

7.2.1.10 Erosion

Ask them what may result from the movement of surface water. They should easily be able to tell you that it is erosion. Then ask if anything else can cause erosion. If necessary, explain that nothing else can cause it. Tell them that we define erosion as only affecting particles on the soil surface down to a depth of 25 mm. Explain that this is an arbitrary depth, but it has a practical implication for bioengineering, too.

7.2.1.11 Shear failure

Now encourage them to start to think about soft material on a slope. Ask what may happen to it and develop the idea that it may slide, slump or flow. Check that they understand the differences between these. Explain that this movement may result from any number of causes. Tell them that we call this shear failure. Explain that it may result in a wide range of forms of instability.

7.2.1.12 Disintegration

Ask what happens to a rock that weathers and loses its strength throughout the mass. They should be able to answer that it breaks up into a pile of loose debris and completely loses its structure. Explain that this is the reason we distinguish it from a fall of hard rock. Introduce the idea of disintegration. Check that they can see the difference between a fall of hard rock, which comes under the heading of plane failure, and disintegration. Add that, strictly speaking, the mechanism is a 'fall', but the form of failure is distinctive.

7.2.1.13 Fall

Ask them to imagine the effect of weathering on alternating hard and soft rock layers. Ask, "What happens to the soft rock layers?"The answer is that they will weather back from the face of the rock. Then ask, "What will happen to the hard rock layers?" Guide them to the fact that as the soft rocks weather back from the face, the hard rocks are left sticking out. Eventually, the hard rocks overhang so far that they break off along vertical fractures. Explain that the cause is a combination of weathering of the soft rock layers and plane failure of the hard rock layers. Tell them that the process then starts again and the whole face retreats. This mechanism is very common in Nepal. Explain that this is called fall.

7.2.1.14 Plane failure

Ask them if we see the same effect in hard rock. Explain that failure takes place along fractures, which are distinct planes of weakness, which is why we call it plane failure. Add plane failure to your list. Establish that we see this as a rockslide or a rock fall.

7.3.1 Conclusion

Show the slides PPS 07 27 to 31 and emphasize the key point that learning to recognize the cause and mechanism of a landslide is a key factor in assessing its severity and in finding an appropriate solution. Finally distribute handout H 07-1.

7.2 Training resources

Handout

- ✓ H 07-1 Causes and Mechanism of failure 20

Facilitation aids

- ✓ PPS 07-2 Power Point slide on definition of causes of failure 1 Set
- ✓ PPS 07-3 Power Point slide on mechanism of failure 1 Set
- ✓ PPS 07-4 to 15 Power Point Slides on causes of failure 1 Set
- ✓ PPS 07-16 to 26 Power Point slides on mechanism of failure 1 Set
- ✓ PPS 07-27 to 31 Power Point slides on conclusion on cause and mechanism of failure 1Set

Equipment and materiels

Notes
Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To identify the type of instability and the general characteristics of an unstable slope. Participants will use this information as part of the process of the assessment of instability. Similarly, the second aim is to teach the factors that help to determine the degree of severity posed by the instability, so that the participants will be able to use this information in setting priorities for repair and in justifying designs for remedial works.

Session Objective:

The participants will be able to:

- ✓ Identify the type of instability.
- ✓ Describe the zones of a landslide.
- ✓ State classes of landslide severity and describe their significance in relation to the use of resources available for repair.
- ✓ Describe classes of failure depth zone and their significance in bioengineering designs.
- ✓ Describe the principal phases of landslide development and decay over a number of years and the significance of these phases for planning a program of bioengineering remedial works.

Content

Introduction	**Timing**
An assessment of an unstable slope helps in understanding the instabilities.	5(5)
Development	
1. Types of slope failure	10(15)
2. Zonation of unstable slopes	5(20)
3. Instability severity ratings related to scale of remedial works	10(15)
4. Depth zones of failure and their relevance to bioengineering design	20(35)
5. The life of a landslide	20(55)
a. History of a landslide	
b. Life progression of a landslide	
Conclusion	
✓ Key point - establishing the general character of the instability is the second stage in slope appraisal.	5(60)

8.1 Facilitator's notes

8.1.1 Introduction

Commence this session by saying that the participants are now going to turn their attention to the instabilities on the slope as a whole. Explain that not all the failures on the slope are landslides, so it has to be well defined. Tell them that, in this session, they will deal with different types of mass movement and landslides in particular. Recognizing and assessing these individually helps us understand the character of the landslide and, in particular, its severity. As a consequence, we are better able to decide what, if any, action should be taken.

8.2.1 Development

8.2.1.1 Type of mass movements

Begin the session with slide presentation (PPS 08-1to 8) demonstrating the examples of instabilities. Now ask the participants why they should study the instabilities. Establish the necessity of the study for its mitigation and rehabilitation. Therefore, the treatment differs from site to site and case to case. In this connection, it is important to analyze the type of failure or mass movement. Ask the participants what they understand by landslide. Establish the fact that there are different types of mass movement. One of them is a landslide. Now show the slide (PPS 08-9 to 49) and describe the term landslide. Gradually show all types of failures and describe them.

8.2.1.2 Landslide and its component parts

Show the diagram of a failed slope on slide (PPS 08-5o to 55) and ask the participants how many zones they can see. You may need to prompt them to the fact that there are four zones.

Ask the participants to identify the zones. Now explain that we can describe the stability of a slope in terms of the factor of safety. A factor of safety of 1 means the slope is at the dividing line between being stable or unstable. If the factor of safety is more than 1, the slope is stable. But if it falls below 1, it will be unstable.

Starting at the bottom of the slope, ask what the factor of safety will be in the zone of deposition. Since material is being deposited here and not moving, it must be >1.

Then move on to the zone of transport. Ask if it has failed. Explain that since it has not failed, the factor of safety must be >1.While material was being added to it from the zone of failure and this was being transported to the zone of deposition, the factor of safety will have been below 1.

Now consider the zone of failure. Since it has already failed, it will also be above 1.Explain that unless the landslide is still actively moving, both the zone of failure and the zone of transport will have returned to at least 1.

Finally, discuss the zone of cracking. It has not yet failed, but it is critical, therefore, the factor must be ~1.

Ask which zones can be seen most clearly and which are least obvious. Probably, all but the zone of cracking will be visible. As a result, you can point out that the factors of safety are the reverse of what appears to be the case. Debris usually seems to be least stable, but it can be easily solved by clearing it from the road and building a toe wall. Therefore, we need to look above the debris.

Explain that from a distance the whole of the zone of failure and the zone of transport appear to be the landslide scar. In fact, the zone of failure is the landslide scar.

The zone of transport may have been scraped bare of vegetation but is still stable .If no new material travels over it, it may "green over" and become a stable established slope. Before this occurs, there may be an erosion risk on the bare surface, but not a sliding failure. Therefore, there may be no need to do anything other than to encourage protection from erosion.

Now ask them to consider another common situation when the zone of transport is missing and the

landslide appears to be less important than it really is. Identifying the zone of transport is justas important, because, otherwise, the landslide may appear more severe than is the case.

8.2.1.3 Instability severity ratings related to scale of remedial works

Ask, "What is the simplest form of repair following a landslide?"If necessary, remind them that they are on a bioengineering course. Establish that it is the use of vegetation, plus some light engineering, to protect the young plants. Explain that this is the lowest severity level in terms of the scale of remedial works. Now show the slides (PPS 08-56 to 62) and gradually differentiate the types of slopes based on the applicability of the bioengineering systems.

Explain that one of the main factors relating to severity is the depth to the main failure plane. People often talk about 'deep' or 'shallow' failure, but they generally are not able to define what this means. Ask the participants to state what they consider to be the difference between a 'shallow' failure and a 'deep' one. They will probably say 2 or 3 meters.

Ask them if they think that bioengineering works can stabilize failures up to 1 m deep. Explain that 60% of tree roots are found in the top 0.5 m of soil; therefore, we cannot expect bioengineering to work below this level. Explain the significance of the choice of these depths.

Finally, in this section of the session, reinforce the fact that in bioengineering we consider shallow failure to be down to 250 mm. This is the depth to which we can use vegetation for stabilization.

8.2.1 The life of a landslide

8.2.1.1 History of a landslide

Explain that 'history' relates to the past activity of the landslide. There may be some records, but for fuller details, we need to talk to local people. They will know when there were minor slippages. Ask them how long we need to wait before we can consider a landslide stable and no longer a cause for concern. You may get varying estimates, but they should say that we can never rely on a landslide being completely stable.
Show the slides(PPS 08-56to62) and discuss the significance of these time periods.

8.2.1.2 Life progression of a landslide

Explain that they have looked at describing the recent past history of landslides and now need to consider the life progression of landslides. This relates to a landslide's future activity. We can make some predictions, but, obviously, only experience can help improve their accuracy.

8.3.1 Conclusion

In conclusion, discuss the fact that they have been looking at the zones of an unstable slope, the materials involved and the possible influence of road construction on instability. These all are factors which need to be considered carefully before any planning for remedial action is undertaken. Establishing the general characteristics of the instability is the second stage in slope appraisal. Explain that these features put the instability into perspective and help us set priorities.

8.2 Training resources

Handout

- ✓ H08-1 Slope instabilities 20

Facilitation aids

- ✓ PPS 08-1 to 8 Power Point slides on examples of slope failures 1 Set
- ✓ PPS 08-9 to 49 Power Point slides on types of instabilities 1 Set
- ✓ PPS 08-50 to 55 Power Point slides on features of instabilities 1 Set
- ✓ PPS 08-56 to 62 Power Point slides on severity analysis 1 Set
- ✓ PPS 08-63 to 66 Power Point slides on history and life progression 1 Set

Equipment and materiels

Notes

Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the participants a simple procedure for examining and recording the features of an unstable site, and for estimating its severity so that they are able perform a complete site investigation and set priorities for planning remedial works.

Session Objective:

The participants will be able to:

- ✓ State the order in which an unstable site should be examined.
- ✓ Use the scheme for appraisal of slope instability in Nepal as a guide.
- ✓ Use the check list for assessing the severity of a landslide as a guide for setting priorities for landslide repair.

Content

Introduction	**Timing**
Application of geological and geo-morphological background information Importance of methodical approach to landslide mapping	5(5)
Development	
1. Site record	5(10)
2. Procedure for mapping a landslide	45(55)
a. Mapping the instability	
b. Severity of instability	
Conclusion	
✓ Results in knowledge and general record of nature of the slide	5(60)
✓ Scheme only deals with one kind of failure at a time; practice enables them to deal with more complicated situations.	

9.1 Facilitator's notes

9.1.1 Introduction

Explain that in the previous sessions, participants have learned to understand the geological and geomorphologic background to instability and its component parts .In this session, they will learn a procedure that helps them map an unstable site and observe all its significant features. The procedure is given in a logical order, but you do not have to follow this order in every case. An advantage of observing the site in a methodical way is that there will be less chance of missing an important feature.

Tell them that they will apply this work in the field in the afternoon. Explain that the suggestions for a procedure are given in brief, because the individual activities have all been covered in previous sessions.

9.2.1 Development

9.2.1.1 Site record

Tell the participants that the basis of the site record is a drawing of the site. A simple sketch will do; it does not have to be to scale. Its purpose is to help them understand the geometric relationships between features of the landslide. It also enables them to record concisely their measurements and from where they took them. Any notes they make can also go on the drawing, but if they are lengthy, or if they wish to describe some detail of the slide by additional drawings and notes, these are best recorded separately in a notebook.

Point out that they cannot complete a sketch from a single viewpoint because they cannot see all the site details until they have inspected the site. They should start with an outline of the site's main features as they appear from the initial viewpoint. They should then build up the drawing as they go over the site. They may find it easier to walk around the site first and produce a drawing only after they have seen the site's general layout.

Explain that a large or more complex site might have to be described by several drawings. These drawings should be built up as the inspection proceeds.

In the practical session, a sheet of paper will be provided for them to make their drawings, but in practice it is good to get used to making all of the drawings and notes in one notebook. In this way, pages do not get lost and records are kept in sequence.

9.3.1 Procedure for mapping a landslide

9.3.1.1 Mapping the slide

Explain to the participants that there are sixteen steps in the procedure. Although this may make it sound complicated, in practice, they will find that it is not difficult. Tell them that each step concentrates on one aspect of the landslide site. They have covered all these aspects in previous sessions and are now bringing them together.

Distribute copies of handout H 09-1. They show how to map a landslide and work through this with the participants. After this, show the slides PPS 09-1 to 17 and gradually go through all steps.

Explain that they should start by examining the geomorphic situation. This includes the general locality and situation of the site. They should then record the exact location of the site, so that they can direct other people to it. They should then consider:

- ✓ It is in a part of the landscape where instability would be expected.
- ✓ The orientations of the rocks, outcropping on the hillside around the site, indicate that the cause of the failure may be due to rock structure, planes of weakness or movement of water along fractures.

Explain that they may get further clues by examining other sites in the area. These may have similar geomorphic situations and may have had similar life progressions.

Now tell them that they should sketch the site from the road or some other good observation point. When they are sketching they should:

- ✓ Concentrate on getting the general proportions correct.
- ✓ Estimate the length from top to bottom.
- ✓ Estimate the width across the base.

Ask them to recall the landslide zones and if all these zones will be present. They should remember that some of the zones might be missing. This means that they need to look for the landslide zones. Remind them that at this stage, they will not be able to see whether there is a zone of cracking above the scar or not.

Now explain that they should identify the material forming the original hill slope. This may be:

- ✓ Debris
- ✓ Soft rock
- ✓ Hard rock
- ✓ Alternating hard and soft rocks.

Now tell them that they need to record more details on the slope profile of the site, the surface water drainage and areas of rock outcrop. This information is best recorded by sketches, but these can be augmented with more detail, such as slope measurements. Remind them that they need to obtain a general idea of slope steepness as a guide to general stability. Tell them that slopes steeper than 35° tend to be unstable unless they are made of sound rock. They should measure the slope angles, but when they sketch, the slopes of the angles do not have to be exact, but should indicate the relative steepness.

Advise them to note any obvious landmarks on the site, such as a prominent tree. This will help them keep their bearings when high up on the site. These should be included in the drawings.

Now they are ready to start a walkover survey. Tell them they should walk up the center of the slide to the crown or head of scar. As they do this, they should measure the angles of major slope units. In some cases, it will not be safe to walk up the center of the slide, and they should instead walk around the edge looking into the scar.

Explain that the next step is to visit each rock out crop. They should measure any relevant rock planes and observe how the planes relate to the slope and the failure planes. Point out that they should make sure that the rocks they observe are true outcrops, i.e., they are attached to the solid rock underneath, and not simply large boulders lying half buried in the slope. As they do this they should note:

- ✓ The uniformity of the rock units.
- ✓ The degree of weathering or hardness of the rocks.
- ✓ The degree of fracturing, especially any open fractures.
- ✓ Signs of water movement along fractures.

Explain that they should follow this by examining the nature of the debris and the slope. This can be best recorded by written notes and drawings.

Now they need to examine the margins of the slide. Remind them that an important sign of failure related to stress is seen in the cracks. Although cracks are most frequent above the head of a slide, they also often occur around the sides. Since the presence of cracks shows that the ground is under tension and will probably fail, they are important clues in the likely development of the landslide. By examining the location, dimensions and orientation of the cracks, they will obtain information about the areas and direction of tension and, from this, the area over which failure is about to take place.

Remind them that water is a major cause of instability. Ask them which features related to water they should look for. The items you want are:

- ✓ Streams
- ✓ Springs
- ✓ Irrigation canals
- ✓ Drainage structures, especially masonry drainage ditches.

The first two may be sending water naturally into the slide. Failure of the second two will add water to the slope. Explain that all of them may either have caused the failure in the first place, or they may be contributing to further failure. They should inspect irrigation canals and masonry drainage ditches closely for any signs of cracking and leakage.

Now explain that irregular topography which is not due to rock outcrops may indicate the presence of an old landslide. They will see several sites where this has occurred. Although the old landslide may now appear stable, they should still survey the whole of the slide area.

In order to be fairly sure that they have collected all the relevant information, they must continue up the slope above the landslide until there is no further evidence of instability. They may have to walk at least fifty meters higher than the landslide scar and, in some cases, they may have to go much farther.

9.3.2 Severity of instability

Explain that the final item in the procedure for mapping a landslide is to assess its severity. Just remind them of the scoring system devised in the previous session and the importance of its use.

Explain that the checking system enables them to compare the severity of a number of landslides. They will follow this idea up in the next session.

9.3.4 Conclusion

In the conclusion, remind them that if they follow these steps, they will have gained a good knowledge of the general nature of the slide. They will also have produced a sensible record of it that can be understood by someone else - perhaps someone whose opinion they would like to seek in deciding upon an appropriate course of action for the site.

Finally, remind them that most landslides have more than one cause and mechanism of failure operating at different points on the slope. Practice will enable them to recognize the individual processes on a slope and how they are related. Separate parts of a landslide have to be given different treatments, appropriate to the mechanism of failure.

9.2 Training resources

Handout

- ✓ H09-1 Slope instabilities mapping techniques 20

Facilitation aids

- ✓ PPS 09-1 to 17 Power Point slide on steps for mapping techniques 1 Set

Equipment and materiels

Notes

Make sure that the LCD projector and computer with continuous source of power.

■ ■ ■

Session Plan

Location: Field site **Duration**: 3 hours

Session aim: To teach the participants how to map a landslide under guidance so that they are able to make a map of this kind when assessing landslides in the future.

Session Objective:
The participants will be able to:

- ✓ Draw a sketch map of a site and mark the instability features on it.
- ✓ Identify features during a walkover survey and mark these on the map.
- ✓ Explain the relationships between the features marked.
- ✓ Explain the significance of these features to instability occurring within the site, and to the instability of the site within the landscape.
- ✓ Apply the information provided in previous sessions on site mapping and appraisal of severity.

Content

Travel to site	30(30)
Introduction	**Timing**
Session brings together all the work so far in a guided mapping exercise. It involves producing site map and discussing remedial works safety.	5(35)
Development	
1. Site sketch	10(45)
2. Mapping exercise	60 (105)
3. Group discussion of site characteristics	40 (145)
Conclusion	
✓ Mapping is a painstaking process.	5(150)
✓ Visible scar not full extent of landslide. Should now be able to map in a methodical way and produce document as basis for discussing and planning remedial works.	
✓ Return to training center.	30(180)

10.1 Facilitator's notes

10.1.1 Introduction

Assemble the participants in a safe place, in a position from where they can get a clear view of the site. Tell them that during the course of this exercise, they are expected to put together all the knowledge of geology, site observation and mapping that they have learned up to now. Do not tell them anything about the site at this stage.

Explain that they are going to produce a sketch map of this landslide, including all the slopes, rocky outcrops, debris and waterways they can observe. They are expected to make use of the notes on landslide mapping provided in previous sessions.

Explain that towards the end of the mapping period, you want them to make an assessment of the severity of the landslide and to consider a program of remedial works. Tell them that you will be asking for their opinions in the group discussion at the end.

Divide them into four groups and tell them to remain in their groups and work as a team. The teams should not break up during the course of the mapping; neither should they communicate with other teams. Tell them that after they have completed the initial site sketch, they may begin from where they like on the site. Explain that the trainers will be on hand to help with queries during the course of the exercise.

Finally, emphasize site safety. Remind them that the site is steep and loose, and potentially very dangerous. Tell them that they should observe the following safety rules:

- ✓ Nobody should venture onto a part of the site where they do not feel safe.
- ✓ Be very aware of loose and slippery ground underfoot.
- ✓ Never move about on the slope above other people, especially if people are separated by a long distance.
- ✓ Falling rocks present a very serious hazard to personal safety.

During the session, you should constantly be aware of the danger that people working above others can present and you should direct groups away from each other if necessary. Remember that a group may be unaware that it is positioned above another far below.

10.1.2 Development

10.1.2.1 Site sketch

Indicate the site boundaries and make sure that all the participants are clear on this.

Ask them to begin by making a general sketch of the site before they move on to it and when they can see it clearly. Help each individual to produce a reasonable-looking sketch. Make sure that landmarks such as big trees are included in their drawings, so that the participants can relate to these when they are working on the slope.

10.1.3 Mapping exercise

10.1.3.1 Mapping of site

Move between the groups, prompting them to observe features relevant to slope stability. Make sure that these are recorded in the drawings. Point out any features elsewhere on the slope that relate to the feature currently under discussion, e.g., that the planes they see in a rock outcrop are reflected in the shape of the whole hillside. If possible, do not answer their questions directly, but prompt them into working out the answers for themselves.

Make sure that the groups are recording all the features of interest, i.e., that they are not concentrating too much on some features, such as rock outcrops, at the expense of other work, such as observations on water flow.

Do not spend time longer than necessary with any one group.

10.1.3.2 Assessment of severity and plan for a remedial program

Towards the end of the mapping period, ask the groups to turn their attention to an assessment of the severity of the landslide by referring them to the handout on this. You can also ask them to think about a program of remedial works for the slide. Tell them that you will be asking for their opinions at the end of the sessions with a general discussion on those matters.

10.1.3.3 Group discussion of site characteristics and severity of landslide

About twenty minutes before the end of session, bring the teams together at an assembly point on the road from where they can see the whole site.

Commence a general discussion on the character of the site. Describe it broadly and make sure that everyone is in agreement by asking questions of the group at intervals. The questions should concentrate on the inter-relationships between features on the slope. It must have the aim to enable the participants to understand the landslide in the context of its situation as part of the slope.

Discuss the history and life progression of the slide and try to get the participants' agreement on these important aspects of landslide assessment. Discuss the severity of the landslide. Try to obtain agreement on the points on the checklist for assessing severity of slope instability. Make sure that everyone is involved in these discussions.

10.2 Training resources

Handout

- ✓ H10-1 Instability mapping techniques 20

Facilitation aids

Equipment and materiels

- ✓ Cline-compasses 10
- ✓ A4 paper 20 Sheet

Notes

A suitable site for this exercise should be identified well, in advance, so that it could be easier to arrange the transportation and collect the information.

Arrange transport.

Arrange refreshments for a suitable point in the session.

Session Plan

Location: Training room **Duration**: 2 hours

Session aim: To revise engineering structures, with their functions, construction and uses, so that the participants are able to plan the integration of civil and vegetative structures.

Session Objective:

The participants will be able to:

- ✓ Identify suitable structures for given sites.
- ✓ Justify their choices.
- ✓ Design their construction.

Content

Introduction	**Timing**
Session based on participants knowledge of small-scale engineering structures	5(5)
Definition of small-scale civil engineering structures	
Development	
1. Examples of small-scale civil engineering structures	50(55)
2. Introduction to small-scale civil engineering structures	60(115)
Conclusion	
✓ Participants may not have studied every system, but they have looked at an example of each type and compared this with other structures.	5(120)
✓ Handout provides reference for use on the job.	

11.1 Facilitator's notes

11.1.1 Introduction

In this session, inform the participants that they will use their knowledge of small-scale engineering structures to devise a list of structures. They will then use their knowledge of engineering functions in an exercise on the applications of the structures they have identified.

Tell the participants that we make a clear distinction between civil engineering structures and bioengineering structures. We define civil engineering structures as consisting entirely of non-living material. This means we include bamboo wattle fences in civil engineering structures. Although wattle fences are made of organic material, they cannot grow and therefore must decay. The distinction between living and non-living structures is useful when we are considering civil engineering systems and bioengineering systems in combination. The bioengineering component is the living part and the civil engineering component is the non-living part. The distinction is also important while considering the length of life of the structure and the need to plan a hand-over from a decaying civil engineering structure to a maturing vegetative one.

Explain that 'small-scale' is really an arbitrary term. Most of the techniques used by bio-engineers are of relatively small size as compared to normal engineering structures, but there is a good deal of overlap. We regard anything up to about a 2 m high gabion wall as a small structure. Show the slide (PPS 11-2) and establish the concept of small scale.

11.2.1 Development

11.2.1.1 Examples of small-scale civil engineering structures

Remind the participants that in the previous sessions they were introduced to the six main structural functions of engineering systems. Quickly show the slides (PPS 11-3) that display the functions of engineering structures to remind them what these are. Explain that the small-scale engineering structures do not include structures for reinforcement or anchoring. So, the number that they will be dealing with in this session comes down to four.

Tell the participants that you are going to ask them to think of as many kinds of small-scale engineering structures as they can. Divide them into four groups with five people each. Give each group a piece of chart paper and a pen, and tell them to lay out their list of structures under the headings of the engineering functions. Show the slides (PPS 11-3) again, but remind them to leave out reinforcement and anchoring. Explain that they should concentrate on the main intended function of each structure. Although many systems perform additional functions, these are not their main purpose. Tell them they have five minutes for the exercise.

After five minutes, collect the charts and pen them on the chart stand. Check their lists against the available structures by showing the slides (PPS 11-4).They probably will not have thought about all the structures. You also need to check that they have correctly classified the systems they have identified. If there are any errors, correct them and make sure that everybody has understood the mistake. You may need to remind them that we are interested inthe main purpose of each system, not inthe additional functions that a system may perform.
Now show the slides (PPS 11-5 to 95) and describe every type of structure, method of its application and limitations.

11.3.1 Conclusion

You need to explain that, although some civil engineering structures have been under study, everyone has not looked at every system. However, they have all had an opportunity to look at examples for each function and to see their own structures compared with another system with different applications, but performing the same engineering function. Highlight the positive aspects of the presentations and suggest that they should try to copy them in the future presentations.

Give each participant the handout H 11-1 - applications of small-scale civil engineering structures. Explain that this is a summary sheet with all the engineering structures on it with their applications. The participants can compare their own answers with those on the handout. The handout also forms a reference for their use on the job. Finally, tell them that they will be inspecting examples of several of these structures in the afternoon session.

11.2 Training resources

Handout

- ✓ H11-1 Applications of small-scale civil engineering structures 20

Facilitation aids

- ✓ PPS 11-2 Power Point slide on the definition of small scale civil engineering structure. 1 Set
- ✓ PPS 11-3 Power Point slide on recall of engineering function. 1 Set
- ✓ PPS 11-4 Power Point slide on list of civil engineering structures. 1 Set
- ✓ PPS 11-5 Power Point slide on application of structures. 1 Set
- ✓ PPS 11-6-95 Power Point slides on different structures. 1 Set

Equipment and materiels

- ✓ Chart paper 4 Sheets
- ✓ Chart pens 4
- ✓ Drawing pins 8

Notes

Make sure that the LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the participants how to incorporate the principles of design in determining the requirements for bioengineering systems for slope surface, sub-surface drainage and the application of design principles related to gully protection works, including civil and vegetative engineering, so that they can use this procedure as a basis for bioengineering for any site.

Session Objective:
The participants will be able to:

- ✓ Apply a logical procedure describing the site circumstances for which slope surface drainage measures are appropriate.
- ✓ Apply a logical procedure to determine a set of bioengineering remedial measures that are suited to those site circumstances.
- ✓ Explain how check dams prevent gully erosion.
- ✓ State where check dams should be located in a gully and justify these decisions.
- ✓ Plan check dams for the stabilization of gullies and gully heads.
- ✓ Plan vegetative works for use in schemes for stabilizing gully sides and heads.

Content

Introduction	**Timing**
Consideration of surface and sub-surface drainage system and gullies	5(5)
Development	
1. Definition of surface and sub-surface drainage	5(10)
2. Design aspects of bioengineering for surface and sub-surface drainage	15(25)
3. Surface and sub-surface water drainage design requirements	5(30)
4. Definition of gully protection measures	5(35)
5. Civil engineering aspects of design	10(45)
a. Purpose and location of check dams	
b. Proposals for civil engineering works	
6. Vegetative engineering design for gully stabilization	5(50)
7. Gully stabilization design requirements	5(55)
Conclusion	
✓ Participants have now considered surface and sub-surface drainage on slopes.	5(60)
✓ Water is the main cause of slope instability and therefore it must be managed effectively.	
✓ All gullies are different and therefore need individual solutions.	
✓ Proposals must be based on careful examination of site.	

12.1 Facilitator's notes

12.1.1 Introduction

Remind the participants that they have already learnt the design of both vegetative components and civil engineering components of bioengineering systems, which must be considered in respect of function, physical relationships and time. In this session, they will look at the design aspect of a surface and sub-surface drainage system. As they complete it, they will look at the third aspect, which is the design of bioengineering systems applied to gully protection measures in the same section .In this session, they will examine the civil engineering component as well as the vegetative engineering component of bioengineering systems.

12.2.1 Development

12.2.1.1 Definition of slope surface drainage

Ask the participants what ground water is. Remind them that surface water is water on the ground surface. Thus, ground water is water that has entered into the slope and is stored there. The two areas of water occurrence must be kept separate: surface and the ground water. Of course, in practice, it is often necessary to accommodate both surface water and sub-surface water within one design scheme. Show the slide (PPS 12-2) for the effect of surface and sub-surface water.

12.2.1.2 Application of design aspects of bioengineering for surface water drainage

Divide the participants into four groups. Ask each group to fill in the form, working towards designs for bioengineering systems that are appropriate to surface water drainage. Ask the first two groups to list out the civil engineering systems used as a surface and sub-surface drainage system and the other group to list out the vegetative system for these systems.

Tell the participants they have only 5 minutes to discuss and agree on a set of systems that are compatible with the geographical circumstances. Now collect their findings.

12.2.1.3 Installation of cut-off ditches or catch drains above cuttings

Show the participants the slide (PPS-12-3), which shows a clogged surface drain. Ask them what other problems we encounter in such drains. They will tell you some of the points. In this part of the session, give a warning about the use of cut-off ditches, otherwise known as cut-off drains or catch drains. Explain that they are:

- ✓ Almost certain to become blocked
- ✓ Very likely to suffer from settlement of the foundations and crack as a result
- ✓ Often difficult to inspect because they are above the road.

Tell the participants that there are many situations in Nepal where a cut-off ditch has become blocked or cracked and has been the cause of a landslide or severe erosion of a cutting. In fact, damage to a cutting can be considered as the usual outcome of the installation of a cut-off ditch.

Explain that this warning applies to all surface ditches. They are best avoided. Water should be brought down the slope along its natural course, protected with vegetation, and, if possible, carried into the nearest roadside ditch by a cascade. Then, localized damage can be seen and repaired as soon as it occurs. Now show the slides(PPS 12-4to 6) to illustrate the proper method of drainage systems.

12.2.2 Definition of gully protection measures

Remind the participants that gullies are defined as stream courses more than 2 m deep, whereas rills are stream courses shallower than this. Gully sides are, for practical purposes, hill slopes, and can be treated with normal slope protection measures. Show the slides PPS 12-7 to 8 to illustrate the gully protection measures.

12.2.3 Civil engineering aspects of design

12.2.3.1 Purpose and location of check dams

Ask the participants what structures can be constructed at gullies. They will likely answer the 'check dam'. Now ask them why and what the check dam does. They may answer some of the points. Now establish the idea that there will be a tendency of deepening, widening and aggravation of the gully. So, check dams are constructed across the gully to prevent these phenomena.

Now ask the participants to recall the physical features that should be considered in check dam construction. They should be able to answer the necessity of keying, weep holes, apron, etc. Ask the participants where the check dams should be located. Introduce the terminology of 'nick point,' which refers to the points of change of behavior, like materials, gradient, direction, size, etc. Tell them that it is located at the key point. In a gully without distinct nick points, they should be located at the points as per calculation. Show the slide (PPS 12-9) and describe how to identify the location.

12.2.3.2 Vegetative engineering design for gully stabilization

Show the participants a cross section of a gully (PPS12-13) and tell them to design the vegetative system. After 5 min., show the cross section with the solution. Now tell them to compare with their work. Discuss why it is so for 5 minutes.

12.2.4 Conclusion

Commence the conclusion by distributing handout H 12-1 with the suggested answers to the problems set in this session. Explain that they have now considered both surface and sub-surface drainage on slopes. This means that they have looked at most of the problems related to water on slopes. The major area is the protection of gullies, and they have now considered this in this session.

Remind them that water is the main cause of slope instability and therefore its management is a major consideration in slope stabilization, whether by civil or vegetative methods. The process they have worked through in this session should help them plan more effective schemes for managing surface and sub-surface drainage and gully protection work.

12.2 Training resources

Handout

- ✓ H12-1 water management and gully protection work. 20

Facilitation aids

- ✓ PPS 12-2 Power Point slide on effect of surface and subsurface water 1
- ✓ PPS 12-3 Power Point slide on catch drain 1
- ✓ PPS 12-4 to 6 Power Point slides on drainage system 1
- ✓ PPS 12-7 to 8 Power Point slides on gully protection work 1
- ✓ PPS 12-9 Power Point slide on location of check dam 1
- ✓ PPS 12-10 Power Point slide on gully bed protection work 1
- ✓ PPS 12-13 Power Point slide on gully side protection work 1

Equipment and materiels

Notes

Make sure that you have LCD projector and computer with continuous source of power.

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Session Plan

Location: Field site **Duration**: 3 hours

Session aim: To teach the participants to apply their work on small-scale civil engineering structures and their principles, identifying and evaluating existing systems in the field so that they can use this knowledge in the selection, design and implementation of small-scale civil engineering (inert) works.

Session Objective:

The participants will be able to:

- ✓ Identify small-scale civil engineering structures on sites.
- ✓ Identify the slope materials, types of instability and cause that these structures are designed to control.
- ✓ Explain the method of operation of these structures.
- ✓ Explain the principles that are involved.
- ✓ Evaluate existing systems and propose alternatives.

Content

Introduction	**Timing**
Session links theory of small-scale civil engineering structures to work on Instability and applies this to sites.	5(5)
Travel to first site	30 (35)
Development	
1. Site assessment for the performance evaluation of catch drain	30(65)
2. Site assessment for the performance evaluation of spurs	30(95)
3. Site assessment for the performance evaluation of bamboo structures	30(125)
Conclusion	
✓ Summary of the field work.	5130)
✓ Travel between sites.	20(150)
✓ Return to training center.	30(180)
✓ Arrange the tea break in between travel.	

13.1 Facilitator's notes

13.1.1 Introduction

Introduce the session by reminding the participants that they have spent some time examining the background to instability and site investigation. In the last sessions, they have started to think about engineering functions and have discussed small-scale civil engineering structures. This session is an opportunity for them to link the work on instability to the sessions on engineering and apply them to field sites.

Explain that they will be examining small-scale civil engineering applications on three sites. In a later session, they will return to these sites and examine the bioengineering systems on these sites and the way the two interact.

Explain that they will be working in four groups. At each site, they will work through the same procedure.

Distribute handout H 13-1 and briefly explain what they have to do. Divide the participants into four groups and then arrange a site section for each group.

Get the participants into the vehicles and take them to the first site.

13.2.1 Development

At each site, emphasize that they are not looking at the vegetation, only at the small civil engineering systems. Make sure the participants know the limits of the site and the features that they should be examining. Arrange for one group to start at each end of the site and work to the opposite end. This will limit the amount of time they are working near each other, without making the procedure too complicated.

Tell them that they have 20 minutes and ask them to start working. While they are investigating the site, you should walk between the groups, giving any guidance they require. Make sure that they are concentrating on the site material, instability and small-scale civil engineering structures. Do not let them spend time examining the bioengineering. If needed, remind them that they will be doing this in a later session.

Do not answer the questions on the handout. They have to collect this information themselves through observation. If needed, you can ask some questions to guide them in the right direction.

When the time is up, bring the groups together and ask them to share their conclusions. Use the series of points on the handout as a basis for managing the discussion. Try to get as much as possible out of the group without supplying the information yourself. Get agreement on the material that forms the site and the instabilities present. When they have identified the structures, make them think why the different ones have been used. If they are mistaken or confused, lead them to the right answers.

You have ten minutes for this discussion and, just before the end, you should make sure that they have covered all the main points related to small-scale civil engineering on the site.

As soon as the discussion is completed, move on to the next site and repeat the same procedure. Remember that you have just 30 minutes per site.

(i) Site assessment for the performance evaluation of catch drain

This site is composed of a landslide, which is treated with a catch drain. It is totally clogged, uneven and depressed.

(ii) Site assessment for the performance evaluation of spurs

This site is composed of alluvium. Most of the spurs are damaged due to under-cutting, shifting the bank and discontinuity.

(iii) Site assessment for the performance evaluation of bamboo structures

Emphasize safety on this site, which is on a bend on a hill.

This is a cut slope on an alluvial terrace deposit. The site has been jute netted. Much of the jute has now failed, but it does not need replacement.

13.3.1 Conclusion

In conclusion, make the point that they have seen a variety of different systems and combinations of systems. Relate these to the site conditions and the types of instability. Emphasize that instability is a complicated problem and there is no single solution. The approaches used on these sites have been chosen after careful examination.

Remind them that you stopped them from examining the bioengineering on the sites. Tell them that they will be examining the design aspects of vegetative engineering structures in the morning. This will

be followed by a session on the interactions between small-scale civil engineering and bioengineering and they will then use this information in the next field exercise.

13.2 Training resources

Handout

- ✓ H13-1 Field exercise on small scale civil engineering structures 20

Facilitation aids

Equipment and materiels

- ✓ Chart paper 24 Sheets
- ✓ Roll of masking tape 1 role
- ✓ Markers 8

Notes

Arrange transport for this session to enable the participants to travel with trainers. You may have just one bus and one *'gadi'*. At a suitable stage of the session, take the refreshment break. This is probably most easily managed when groups are passing through city junction.

You need two trainers for this session so that one trainer can work with each group. Make sure that both of you are fully familiar with these sites before the session. Make your own notes on them to help you as you lead the discussions.

■ ■ ■

Session Plan

Location: Training room **Duration**: 2 hours

Session aim: To teach the range of vegetative engineering systems and their design principles so that the participants can analyze the different systems and correctly apply them.

Session Objective:

The participants will be able to:

- ✓ Describe the main vegetative engineering systems.
- ✓ Explain each system's functions and operations.
- ✓ Select suitable systems for different site conditions.
- ✓ Describe their limitations.
- ✓ Group the systems according to time of functioning.

Content

Introduction	**Timing**
Recall definition of bioengineering Identify vegetative engineering systems	10(10)
Development	
1. Identification of different bioengineering systems	60 (70)
2. Applications, site requirements, time to maturity and limitations	30 (100)
3. Time of functioning	10(110)
Conclusion	
✓ Key point - importance of understanding the systems for correct use Link to future work on plant interactions	1(120)

14.1 Facilitator's notes

14.1.1 Introduction

Remind the participants the definition of bioengineering that was established at the start of the course. By definition, bioengineering means the use of living vegetation, either alone or in conjunction with civil engineering structures and non-living plant material, to reduce shallow-seated instability and erosion. Now, show the slide (PPS 14-1) and ask the question. There might be both types of answers. Tell them that the plantation is not the bioengineering. Now show the slide (PPS 14-2) to redefine the bioengineering. Show again (PPS 14-3 to 6) to justify the definition of Bio-engineering.

Explain that in this session they will examine the functions, methods of operation, applications and site requirements, time to maturity and limitations of bio-engineering systems.

14.2.1 Development

14.2.1.1 Introduction to bioengineering systems

As already mentioned, simply the plantation is not the bio-engineering. So tell them that the structures should be studied in the system. Now ask the question what the systems might be using different parts of the plant itself. They might be confused with the question. Then ask directly how plants can be grown using its plants. Show the slide (PPS 14-7to8) and establish the systems.

Now show the slide (PPS 14-9 to 17) for seeding, (PPS 14-18 to 68) for planting, (PPS 14-69 to 115) for structures from cuttings and (PPS 14-116 to 128) for bamboo crib wall, (PPS 14-129 to 134) for structures from rhizomes and (PPS 14-135 to 139) for bamboo plantation. Gradually show the slides and explain the method of operation. Meanwhile, ask them the limitations of the systems.

14.3.1 Time of functioning

Ask the participants how long trees will perform bioengineering functions. You should receive the answer that they are effective for a long time. Then ask them how soon a tree begins to perform its function. This time, you need to have the answer that it does not begin to work immediately. Then ask them if they can think of a system that does begin its work immediately. Ask if this system also has a longer-term effect. You can now establish that we can group the systems into those with just a longer-term effect and those which begin to function immediately and continue into the longer-term.

Ask the groups to classify the nine systems on this basis. Allow them just five minutes for this activity. While they are doing this write the following on the board:

- ✓ Immediate and longer term effect.
- ✓ longer term effect.

Now ask which of the systems fit into each group and add this to the board:

- ✓ immediate and longer term effect: fascines, palisades and brush layering;
- ✓ longer term effect: grass seeding and planting, tree, shrub and bamboo planting.

14.4.1 Conclusion

In your conclusion, remind them that there are nine types of bio-engineering systems. They cover a wide range of functions and suit a variety of sites. We need to understand them clearly if we are going to make the best choice.

Distribute the handout as a summary of the session.

14.2 Training resources

Handout

- ✓ H14-1 Design aspects of vegetative engineering structures 20

Facilitation aids

- ✓ PPS 14-1 Power Point slide on question of definition 1 Set
- ✓ PPS 14-2 Power Point slide on definition of bio-engineering 1 Set
- ✓ PPS 14-3 to 6 Power Point slides on systems to perform functions 1 Set
- ✓ PPS 14-7 to 8 Power Point slides on vegetative systems 1 Set
- ✓ PPS 14-9 to 17 Power Point slides on vegetative systems from seeds 1 Set
- ✓ PPS 14-18 to 68 Power Point slides on vegetative systems from seedlings 1 Set
- ✓ PPS 14-69 to 115 Power Point slides on vegetative systems from cuttings 1 Set
- ✓ PPS 14-116 to 128 Power Point slides on vegetative systems from rhizomes 1 Set
- ✓ PPS 14-129 to 134 Power Point slides on crib wall 1 Set
- ✓ PPS 14-135 to 139 Power Point slides on bamboo plantation 1 Set

Equipment and materiels

Set of slides illustrating the vegetative engineering systems

- ✓ Chart paper 8 Sheets
- ✓ Chart pens 4
- ✓ Masking tape 1 Role

Notes

Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the participants the changes in the relative strength of civil engineering, and vegetative engineering structures over time and the relationship between the two types of structure so that they are able to use this information in planning fully integrated bioengineering works. It is aimed at building the capacity of the participants in the selection of optimum solution.

Session Objectives

The participants will be able to:

- ✓ Describe the changes in the relative strength of civil engineering and bioengineering structures.
- ✓ Explain how civil engineering and vegetative engineering structures may be integrated to increase their effectiveness .
- ✓ Explain how an engineering function may be handed over from one type of structure to another type and the need for the two structures to be compatible.
- ✓ Select the optimum system based on the physical features.

Content

Introduction	**Timing**
Link to engineering functions of bioengineering Functions may be met by civil engineering and vegetative engineering	5(5)
Development	
✓ Relative strength of structures over time	20(25)
✓ Life span of civil engineering structures	
✓ Life span of vegetative structures	
✓ Combined life spans	
✓ Physical relationships between civil and vegetative engineering structures	5(30)
✓ Compatibility of engineering structures	5(35)
✓ Selection of optimum system	20(55)
Conclusion	
Need to consider both types of structure in planning bioengineering.	5(60)

15.1 Facilitator's notes

15.1.1 Introduction

Ask the participants for some of the engineering functions that they have considered so far. Just spend some time on this to obtain three or four suggestions. Now ask if each of these functions can be achieved with civil engineering structures. Then ask if they can also be achieved with vegetative engineering structures. Use this to illustrate the fact that the majority of engineering functions can be met by civil engineering systems and bioengineering systems.

Explain that this means we may have a choice whether to use:

- ✓ Civil engineering on its own.
- ✓ Vegetative engineering alone.
- ✓ A combination of the two.

Tell the participants that in this session they will consider the important principles underlying the relationship between vegetative engineering systems and civil engineering systems.

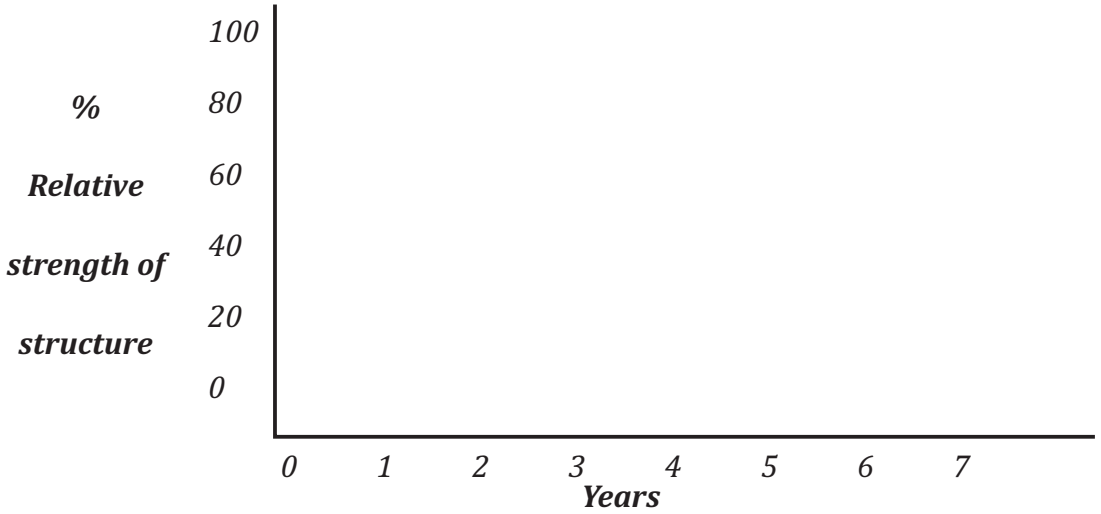
15.2.1 Development

15.2.1.1 Relative strength of structures over time

Explain that we can compare the strength of a structure at different stages of its life to its maximum strength. We can describe the strength at different stages as a percentage of the maximum strength.

15.2.1.2 Life span of small civil engineering structures

Draw the following graph on the board:



Tell the participants not to copy this graph until the discussion has been completed.

Ask them to think about the strength of a masonry wall as soon as it has been completed. Ask, "Will it be at full strength?"They should answer, "Yes." Then ask if its expected life is above seven years; they should again agree. Explain that its relative strength should remain at 100% over the period shown on the graph. Draw a horizontal line at 100% and label this *"Masonry wall".*

Now discuss the strength of a galvanized wire fence .Make sure that the participants realize that you are not comparing the strength of these two structures, but how the strength of each of them changes over time. Establish that the galvanized wire fence retains its full strength until it begins to rust. It gradually loses strength until it reaches a point when it will quite quickly fail. You can show by drawing a line that stays at almost 100%, until it fails at about six years. Label this line "Galvanized wire".Repeat this with bituminized jute netting, wooden check dam, wattle fence and un-bituminized jute netting. Each of these lines should start at 100%, but decline more rapidly than the previous one until the un-bituminized jute netting fails at two or three years. When you have added the last lines given, show the slide (PPS 15-2).

Use this exercise to establish that the strength of all civil engineering structures declines although the time scale for this decline varies between the different structures.

15.2.1.3 Life span of vegetative structures

Remove the lines for the six structures and use the graph to demonstrate the pattern of strength of vegetative engineering structures.

Ask the participants how long grass takes to become established. This varies depending on whether it is planted or sown. However, it is within the first year. Through the discussion, establish that it will have little strength up to this time. Then ask what its relative strength will be when it is mature. The participants should be able to tell you that this is the time for its full strength. Draw a line on the graph on the board that builds up rapidly from no strength during the first year and reaches full strength in the second year. Label the line. Repeat this exercise for shrubs and trees, but show the shrubs reaching 100% in about four years and the trees taking six years. Now let the participants add this information to their handouts.

Conclude this part of the session by showing (PPS 15-3), a generalized graph of the life span of vegetative structures.

15.2.1.4 Combined life spans

Now show the slide (PPS 15-4) and explain that this shows the decreasing relative strength of the engineering systems and increasing relative strength of the plants. Remind the participants that these graphs relate to the performance of each type of structure separately and that the combined graph does not show the strength of the civil engineering structures compared with the strength of the vegetative engineering structures.

Take the example of the catching function of the jute net and grass. Explain that at the beginning, the fine soil retaining capacity of the jute net is very high, and each small square behaves as a mini check dam. But with time, the jute decays, which weakens the net and consequently its soil retaining capacity decreases. Ultimately, the net will fail to carry out any retaining function. On the other hand, grass slips grow up with time and start to retain soil on the slope due to the development of root and shoot systems. When grass is fully grown, it stays at 100% relative strength. Link this to the field visit to civil engineering systems.

Use the graph to show the fact that, as the relative strength of the jute net declines, the relative strength of the grass increases. The soil retaining function of the jute net is handed over to the grass. Explain that this function of handing over from one system to another system is very important in the design of bioengineering works and is called the handover principle.

15.2.1.5 Physical relationships between civil & vegetative engineering structures

Introduce the idea of the relationships which may exist between the functions of civil and vegetative engineering structures. Show the following combinations on the slide (PPS 15-7):

- ✓ Toe wall below bamboo.
- ✓ Plants around end of toe wall.
- ✓ Trees above toe wall.
- ✓ Wattle fence with young plants below.

Ask the participants to look at each pair in turn and suggest how one of the pair supports the function of the other. Add the following explanations to the right of the four examples:

- ✓ Structure protects plant.
- ✓ Plant protects structure.
- ✓ Plant improves performance of structure.
- ✓ Plant replaces structure.

Explain these four ways in which civil and vegetative engineering structures can be used together.

15.2.1.6 Compatibility of engineering structures

Now ask the participants to think about the last example, in which plants take over the function of a civil engineering structure. Remind them this relates to the handover principle. Explain that if this is to happen, the engineering functions of the two structures must be the same.

Show the following table on the slide (PPS 15-9):

Civil engineering structure	Engineering function	Vegetative engineering strucutre	Engineering function	Compatibilty

Write Bituminized jute net in the first column and ask what engineering function it performs. Enter Catch in the second column. Now write Trees in the third column. As you receive the correct answer, write Support in the fourth column. Ask if these two structures are compatible, so that one can take over from the other. You should receive a clear 'No', which you can enter in the final column.

On the next line of the table, write Un-bituminized jute net in Column 1 and Horizontal grass lines in Column 2.Ask the participants to supply the missing information and enter Catch and Yes in the remaining columns. Then give the example of Un-bituminized jute net and Shrubs. This time, you may have to explain that the jute net will catch fine debris. Although the shrubs have a catching function, they are designed to catch larger debris. Therefore, the functions are not compatible. Finally, ask them to compare a wooden check dam and a shrub barrier. Since both catch and support larger debris, they are compatible.

15.2.1.7 Selection of optimum technique

Although they have learnt a lot to prescribe the systems, it is difficult to select the appropriate technique at the beginning. That is why, a simple guideline has been developed to identify the problems and recommend the solutions. Ask the participants whether they can measure the slope parameters. They should answer that they can. Then lead them on how to use the guideline based on the parameters of the slope.

15.3.1 Examining a site

15.3.1.1 Slope segments

Explain that a slope segment can be defined as a length of slope with a uniform angle and homogeneous material that is likely to erode in a uniform manner. The most straightforward way to approach the choice of stabilization technique is by splitting sites into segments of slopes.

15.3.1.2 Guidelines for applying bio-engineering techniques to all slopes

15.3.1.2.1 The guidelines

Show the slide PPS 15-10 to12 and establish the flowchart to use the guideline.

15.3.1.2.2 Slope angle

Point to the first column and explain that this is the primary distinction as it is used to identify the sites which need only mild soil conservation treatment, i.e. those less than 45°. A slope steeper than 45° has a seriously steep angle and creates greater erosion problems.

Ask them to look at the last line on the diagram and note that any rocky material, where normal planting techniques cannot be applied, is treated as one category, regardless of slope angle and length.

15.3.1.2.3 Slope length

Explain that the length of 15 meters is partly arbitrary but represents a good dividing figure between 'big' and 'small' sites. Slope segments longer than 15 meters are open to greater risks in terms of both gullying and deep-seated failures.

15.3.1.2.4 Aspect

Tell the participants that this, in fact, relates to more than just aspect. It also covers the environmental dryness of each individual site. The categories are based on the fact that the N and NE slopes are generally wettest and the S and SW slopes driest.

15.3.1.2.5 Material drainage

Tell them that the previous column is related to the addition of water to the site. This column is related to the internal porosity of soils and the likelihood of their reaching saturation and losing cohesion, thereby starting to flow (i.e., material liquefaction).Those materials which have poor internal drainage tend to have a high content of clay relative to sand and silt in the fine fraction. They tend to be prone to shallow slumping if too much moisture accumulates. Stabilization requires some kind of drainage in addition to protection.

You should relate this to sites that they have already seen on the course, but add that they can inspect additional sites during the field work.

15.3.1.2.6 Optimal technique

Explain that one or more techniques are given that are known to be successful on general sites of each type. However, the general picture may not cover every case, and so they should not consider the diagram fully comprehensive. Some local variation may be needed, and this is for the technician to determine on site. Now show the slide (PPS 15-13) and ask the participants to identify the possible mitigation measure.

15.4.1 Conclusion

In the conclusion, remind the participants that designing bioengineering works involve considering civil and vegetative engineering structures and planning how the roles of these two relate to each other. Stress the point that in assessing sites for their bioengineering requirements, the participants will be using many of the skills learnt in the geological and geomorphological sessions. Finally, emphasize the fact that the most important factors in successful assessment and treatment of a site are:

- ✓ Careful site examination.
- ✓ Attention to detail.

If they do not have these properly, the whole process of the attempt to stabilize the slope is likely to be a big waste of time and money. Finally, distribute the handout H 15-1.

15.2 Training resources

Handout

- ✓ H15-1 Compatibility of structures 20

Facilitation aids

- ✓ PPS 15-2 Power Point slide Life span of small civil engineering structures 1 Set
- ✓ PPS 15-3 Power Point slide on Life span of vegetative engineering structures 1 Set
- ✓ PPS15-4 Power Point slide on Life span of combined structures 1 Set
- ✓ PPS 15-7Power Point slide on compatibility of engineering structures 1 Set
- ✓ PPS 15-9Power Point slide on physical relationship of structures 1 Set
- ✓ PPS 15-10 to 11 Power Point slides on selection of optimal techniques 1 Set

Equipment and materiels

Notes

Make sure that you have LCD projector and computer with continuous source of power.

■ ■ ■

Session Plan

Location: Field site **Duration**: 3 hours

Session aim: To teach the participants how to apply their work on vegetative engineering structures and their principles on identifying and evaluating existing systems in the field so that they can use this knowledge in the planning, design and implementation of bioengineering.

Session Objectives

The participants will be able to:

- ✓ Identify the functions and operation of vegetative engineering systems on sites.
- ✓ Explain the interaction between vegetative and small engineering system.
- ✓ Explain the principles that are involved.
- ✓ Evaluate existing systems and propose alternatives.

Content

Introduction	**Timing**
Purpose of session to apply theory in the field	5(5)
Procedure	
Travel to first site	10(15)
Development	
Introduction	
This session links theory of bioengineering structures to work on instability and applies this to sites.	5(5)
Travel to first site	30 (35)
Development	
1 Site assessment for the performance evaluation of grass/shrub plantation	30(65)
2. Site assessment for the performance evaluation of brush layering	30(95)
3. Site assessment for the performance evaluation of bamboo	30(125)
Conclusion	
✓ Summary of the field work	5(130)
✓ Travel between sites	20(150)
✓ Return to training center	30(180)
✓ Arrange the tea break in between travel.	

16.1 Facilitator's notes

16.1.1 Introduction

Introduce the session in the vehicle en route to the site by explaining that this is an opportunity for the participants to apply the work they have been doing in the classroom to field sites. They will be examining bioengineering applications on three sites. These are the same sites that they have used for examining civil engineering systems.

Explain that they will be working in four groups. At each site, they will work through the same procedure. Distribute handout H 16-1 and briefly work through this. Divide the participants into four groups. Get the participants into the vehicles and take them to the first two sites.

16.2.1 Development

At each site, make sure the participants know the limits of the site and the features that they should be examining. Arrange for one group to start at each end of the site and work to the opposite end. This limits the amount of time they are working near each other, without making the procedure too complicated.

Tell them that they have 20 minutes and ask them to start working. While they are investigating the site, you should walk between the groups, giving any guidance they require. Do not answer the questions on the handout. They have to collect this information by themselves through observation. If necessary, you can ask some questions to guide them in the right direction.

When the time is up, bring the groups together and ask them to share their conclusions. Use the series of points on the handout as a basis for managing the discussion. Try to get as much as possible out of the group without supplying the information yourself. Make them think why the different systems have been used and why particular planting patterns have been adopted. If they are mistaken or confused, lead them to the right answers.

You have ten minutes for this discussion, and just before the end, you should make sure that they have covered all the main points related to bioengineering on the site.

As soon as the discussion completes, move on to the next site and repeat the same procedure. Remember that you have 30 minutes per site.

16.2.1.1 Site assessment for the performance evaluation of grass shrub plantation

This site is composed of a landslide, which is treated with grass shrub plantation. Tell them to work on the site.

16.2.1.2 Site assessment for the performance evaluation of brush layering

This site is composed of debris. Most of the brush layers are damaged due to mishandling.

16.2.1.3 Site assessment for the performance evaluation of bamboo plantation

This site is a sediment accumulation area and flood plain.

16.3.1 Conclusion

In this conclusion, emphasize the point that they have looked at a variety of different systems and combinations of systems. These have been designed to meet the individual site requirements, because there is no single solution to instability problems. They must examine each site carefully and consider the range of techniques.

Tell them that both civil and vegetative structures require maintenance if they are to continue working effectively.

16.2 Training resources

Handout

- ✓ H 16-1 Bioengineering systems field exercise — 20

Facilitation aids

Equipment and materiels

- ✓ Chart paper — 24 Sheets
- ✓ Markers — 8

Notes

Arrange transport for this session to enable the participants to travel with trainers. You may have just one bus and one Jeep. At a suitable stage of the session, take a refreshment break. This is probably most easily managed when groups are passing through a city junction.

You need two trainers for this session, so that one trainer can work with each group. Make sure that both of you are fully familiar with these sites before the session. Make your own notes on them to help you as you lead the discussions.

Session Plan

Location: Training room **Duration**: 2 hours

Session aim: To teach the participants how to select suitable plant species to meet the requirements of specific sites, so that they can apply this knowledge in planning bioengineering implementation.

Session Objectives

The participants will be able to:

- ✓ Describe the process of selecting appropriate plant species for specific situations.
- ✓ Identify suitable species for a range of situations and justify their choices.

Content

Introduction	**Timing**
Previously considered general points in selection of species In this session, make specific selections.	5(5)
Development	
1. Procedure for identifying suitable species	40(45)
a. Site requirements	
b. Site environmental conditions	
c. Availability and other factors	
2. Reference material	15(60)
3. Plant species selection	55(115)
a. Calculation of highway slope site drought factor	
b. Exercise on plant species selection	
Conclusion	
✓ Choice of correct species extremely important	5(120)
✓ Knowledge of suitable species still being developed	

17.1 Facilitator's notes

17.1.1 Introduction

Commence this session by asking them what we plant to perform an armor function. They might say that we need to plant *'Dubo'.* Then again ask them why we cannot plant Napier instead of *'Dubo'*. Introduce the session by reminding the participants that they have just been thinking about considerations in the selection of plant species. Establish that, directly or indirectly, all the work on the course has been related to the selection of species. Ask the participants how many plant species are available in Nepal. They may not know the exact number. Remind them that there are more than ten thousand species. Among them, more than six thousand are easily available. Furthermore, more than 400 species have been proven in bioengineering application.

Explain that in the next part of this session, they will go through the main points that we need to consider in selecting species. They will then use their knowledge and reference materials in selecting plants species to meet the requirements of specific sites.

17.2.1 Development

17.2.1.1 Procedure for identifying suitable species

Ask the participants what the key points are that we have to consider in the plant type selection. They might be able to give some points. Now show the slide PPS (17-2) on major factors that affect the distribution of plants in Nepal. Develop the session gradually, showing the slides on the factors affecting the selection of plant types.

17.2.1.2 Physiographic zones:

Ask the participants how many zones are there in Nepal from the geomorphological point of view. Remind them of the block diagram and establish the 6 physiographic zones. It may serve as the ecological zones as well. Show the slides (PPS 17-3 to 5) to remind them of the physiographic zones.

17.2.1.3 Vegetation zones

Remind them that they have studied about the Plant Zones in Nepal. Tell them that this is important because it influences how well a species will grow in a particular area. Now show slides (PPS17-6 to 12), and discuss other plants available in those zones.

17.2.1.4 Availability of moisture

Ask the participants why, despite the same altitude and ecological zone, the pattern of plant growth is different on the two faces of the slope. They might answer that the southern part is drier and the plant cannot grow the same as in the moist sites. Show the slide (PPS 17-3) and ask them what other plants can grow in drier sites and add them to the list

17.2.1.5 Plant community management.

Ask the participants whether a group of people with the same height, caste, age and gender comprises a community. Tell them that it is not possible for such an independent, homogenous group to exist. Then ask them about the importance of the community. Tell them that the same story is true in the case of plants as well. Now show the slide PPS (17-14 to 15) and deal with the terminologies and the importance.

Show the slide (PPS 17-16) and discuss each factor. Tell a story to prove that the plant should be locally available as far as practicable. Emphasize the importance of each factor.

17.2.1.6 Site requirements

Ask the participants to recall the engineering functions which may be performed by vegetative structures. Remind them that the contribution of different types of plants to bioengineering depends upon the compatibility of site requirements and the plant morphology. They should be able to recall, for example, trees which are good for anchoring and supporting, and matting grasses as the best for armoring a slope. Use this to show the engineering function that is required and that will affect the general type of plant that we choose.

Then ask them to suggest two vegetative techniques that can be used to achieve each of the engineering functions. Discuss for a while and explain that the techniques we choose influences the structural characteristics we require in our plant. Now show the flow chart to consider all the factors. Show the slide (PPS 17-17) and discuss the importance of peoples' participation.

Explain that, so far, they have thought about selecting a plant which is capable of doing the required job.

17.2.1.7 Drought factor

You can state that the major consideration in selecting species is how well the plants grow on a site. They have already looked at a major factor which limits plant growth: the availability of moisture. The slope site drought factor is just one of the site characteristics that influences the success of our plants. Remind them that they have to consider the way plants interact and compete with each other. These points need to be considered when we select species.

17.3.1 Reference material

We do not expect them to remember all the possible bioengineering species. Explain that this is why they have been given copies of the plant species that have thus far been used in bioengineering practices. If they are to make good use of these sources of information, they have to become familiar with them. That is why the remainder of this session will be spent on an exercise to identify plant species for different sites.

17.4.1 Plant species selection

17.4.1.1 Calculation of slope site drought factor

Ask the participants how many plant species they know. It is difficult to identify the plants and use them. So it would be easier to select the plant type on the basis of certain technical guidelines. The Department of Roads has developed such a guideline based on their experience. Now we can use it for the purpose of plant type selection based on the slope site drought factor. Explain that it depends upon the five main factors: altitude, slope angle, aspect, stoniness and the rainfall data. The scoring system can be used as they have developed or we can devise one for our case. Show the slide (PPS 17-18 to 23) to give the idea of a scoring system. Since they will use this in their species selection, you should work through an example with them. Give the participants arbitrary data of a site and tell them to identify the site type. Now tell them how the appropriate plant type can be selected from the reference sheet on the basis of site class.

17.5.1 Conclusion

As a conclusion, remind them that the correct choice of species is extremely important . It may make the difference between the survival and death of their plants and the success or failure of their bioengineering works. Give out copies of handout H 17-1 as a summary of the process of selecting species for bioengineering use.

Finally, inform them about our knowledge of suitable species for bioengineering -- something which is still being developed. Their own experience may contribute to this knowledge in the future.

17.2 Training resources

Handouts

- ✓ H 17-1 Plant type selections 20
- ✓ H 17-2 Reference materials for plant type selection 20

Facilitation aids

- ✓ PPS 17-2 Power Point slide on factors affecting the plant distribution in Nepal 1 Set
- ✓ PPS 17-3 to 5 Power Point slides on physiographic zone of Nepal 1 Set
- ✓ PPS 17-6 to 12 Power Point slides on vegetation zones of Nepal 1 Set
- ✓ PPS 17-13Power Point slide on plant type based on moisture availability 1 Set
- ✓ PPS 17-14 to 15 Power Point sides on plant community 1 Set
- ✓ PPS 17-16 Power Point slide on other consideration 1 Set
- ✓ PPS 17-17 Power Point slide on total consideration 1 Set
- ✓ PPS 17-18 to 23 Power Point slides on other factor slope site drought factor 1 Set

Equipment and materiels

Notes

Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the participants the importance of bioengineering maintenance, the tasks which are required, and the frequency with which these tasks have to be carried out, so that they can use this information as a basis for programming bioengineering maintenance.

Session Objectives

The participants will be able to:

- ✓ Explain the importance of maintaining bioengineering works.
- ✓ Identify the main tasks performed in bioengineering maintenance.
- ✓ Explain the frequency with which maintenance tasks must be carried out.
- ✓ Outline the recommended procedures for thinning and pruning trees.

Content

Introduction	**Timing**
Following implementation of works, maintenance must commence. Deterioration may result in slope failure.	5(5)
Development	
1. Causes of damage to bioengineering works	10(15)
2. Categories of maintenance tasks	10(25)
3. Maintenance tasks	10(35)
4. Frequency of maintenance activities	5(40)
5. Care of young plants	15(55)
Conclusion	
Session has introduced bioengineering maintenance. Planning and programming maintenance are in coming sessions.	5(60)

18.1 Facilitator's notes

18.1.1 Introduction

Ask what needs to be done once the works have been completed. If needed, lead them to the fact that the work needs to be maintained. From a management point of view, this means that they need to be thinking about maintenance planning.

Remind the participants that bioengineering works deteriorate with time, even though they have been properly carried out in the first place. This deterioration commences as soon as each component of works is completed. But in bioengineering, deterioration is much more complex than in normal civil engineering. Get the participants to tell you why. The main reason is that many bioengineering measures strengthen over time, rather than immediately starting to decay, as with physical structures. However, all plants reach a stage of maturity and then begin to lose strength as well.

Point out that there is one important difference between normal engineering maintenance and bioengineering maintenance. Deterioration of bioengineering works may lead to slope failure and cause disaster. This may be brief or it may extend for a long time. It leads to costs. There are also social costs and repair costs. In order to reduce these direct and indirect costs, maintenance of the bioengineering works is essential.

Elucidate in this session that you are going to have a standard procedure for identifying maintenance needs. This is similar to many used for other road maintenance activities.

18.2.1 Development

18.2.1.1 Causes of damage to bio-engineering works

Show the slides (PPS 18-1to 3) to show the problems on the bioengineering sites. Ask them what the problems at the site are and lead them to the fact that damage to bioengineering works may result from a variety of causes. Ask the participants to identify possible causes of failure or damage in bioengineering works and note them down. Explain that they should think as widely as possible. During the course, they have seen a number of these factors, but they will have experience of a broader range. By the end of this part of the session, ask them to share the points they have collected. They will probably suggest several causes.

18.2.1.2 Categories of maintenance tasks

Explain that many of the causes of damage that they have identified can be prevented by maintenance. The effects of others can be reduced by maintenance. Point out that, at the moment, they have a list of causes of damage which is likely in random order. Since being systematic helps us plan, it would be useful to divide them into categories. Explain that you want to identify five categories of maintenance tasks, which will help us when we plan maintenance to reduce or overcome these problems.

Commence this by asking them to identify problems that are related to animals. They may quickly pick out grazing. You may have to point out that damage by people, such as firewood or timber collection, fits the same category. Discuss the fact that these are controlled by prevention or protection. Ask if there is anything else in the list of causes that might be controlled by prevention or protection measures. Establish that we can fit protection from fire into the same category. State that the first category of tasks is protection works. Now show the slide (PPS 18-4).

Show the slides (PPS 18-5to 9) to explain other categories of maintenance tasks. Now point out that there are some causes of failure related to vegetation. Ask what general difference there is between competition from weeds and the failure of a fascine. You may need to prompt them that the former is related to individual plants and the latter to the failure of a plant structure. Explain that we can describe these maintenance works as being concerned with plant treatment and repairs to vegetation structures.

Ask if bioengineering only involves the use of vegetation. This is something that was discussed at the beginning, but since then, they have had many reminders that bioengineering includes the use of small civil engineering structures. Explain that repairs to gabion bolsters, jute netting and small check dams can be called repairs to inert structures.

Finally, ask if they can see any causes of failure that are not covered by these categories of maintenance works. If needed, ask what action may be required first if there has been a slippage. Establish that it is slope trimming. Explain that we can label this as geophysics. Tell the participants that they will come across these categories again in Session 88 when they look at scheduling maintenance. Leave all this information on the board for the next part of the session.

18.2.1.3 Maintenance tasks

Make clear that, having identified some of the causes of damage and the categories of maintenance tasks, they now need to identify the actual tasks that need to be carried out. Divide the participants into four groups and ask them to list as many maintenance tasks related to bioengineering as they can. Ask them to write their list on A4 paper at this stage. Emphasize that they should make sure that each of the items they suggest relates to maintenance, but not the implementation, and that they should also check the items concerned with bioengineering. Remind them that the maintenance of small civil engineering structures features in the list. Notify them they have only 10 minutes for this. Point out that the list of causes of damage, which you have left on the board, may help them think.

While they are working, walk round encouraging them, but do not provide suggestions. When time is up, distribute the handout H 18-1.Explain that this shows lists of maintenance tasks in five categories. Go through these briefly and discuss whether these are appropriate and have been put into the correct categories.

18.2.1.4 Frequency of maintenance activities

Ask if all of the maintenance of civil engineering works is carried out at the same intervals. If needed, point out that permanent persons are employed to carry out continuous maintenance. Then ask how often house painting should be carried out. Use this to establish that civil engineering maintenance is carried out at varying intervals depending on the task. Ask if each of the bioengineering maintenance tasks needs to be carried out with the same frequency. They should realize that, once again, the frequency depends on the nature of the task.

Establish that you have already mentioned time length and persons, and that they should carry out routine maintenance. Show the slide (PPS 18-10) and discuss the frequencies to be followed for the maintenance activities. Remind the participants that much of the civil engineering maintenance program can be planned on a cyclic basis. For example, we may predict that bitumen will last for five years before it needs any maintenance, but it should then be treated. In bioengineering, we are mainly working with living material and so it is much harder to predict when maintenance will be required.

18.2.1.5 Plant management tasks

Ask the participants to think of the main tasks needed to be carried out between the times of seed sowing (or cutting) or planting in nurseries (or similar) and when these plants are almost ready to be taken out to the site. Show the slides PPS 18-11 to 17, which have this information reorganized according to the way you are going to teach it. Now go through each point in brief.

18.3.1 Conclusion

Put in plain words that this has been an introduction to maintenance related to bioengineering works. Briefly remind the participants that they have related maintenance to the types of damage suffered by these works. They have divided maintenance tasks into major categories and also considered the frequency in which this work is carried out.

Nevertheless, they have not considered how the actual maintenance works relate to the different seasons; neither have they thought about planning and programming of these works. Explain that this is the next stage of the process of considering maintenance and it will be covered in the next session.

Tell the participants the importance of care of young plants. Establish the theme "Care with Fare."

18.2 Training resources

Handout

- ✓ H 18-1 Bio-engineering maintenance and care of young plants — 20

Facilitation aids

- ✓ PPS 18-1 Power Point slide on the damaged sites — 1 Set
- ✓ PPS 18-2 Power Point slide on maintenance tasks — 1 Set
- ✓ PPS 18-3 Power Point slide on frequency of maintenance — 1 Set
- ✓ PPS 18-4 Power Point slide on infiltration of surface water — 1 Set
- ✓ PPS 18-5 Power Point slide on effect of subsurface water — 1 Set

Equipment and materiels

- ✓ Chart paper — 8 Sheet
- ✓ Chart pens — 4 Set
- ✓ Drawing pet — 1 Box

Notes

Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 3 hours

Session aim: To give participants the practical experience of examining established bioengineering sites and planning their maintenance, so that they are able to manage the maintenance of bioengineering sites.

Session Objectives

The participants will be able to:

- ✓ Assess the maintenance needs of an established bioengineering site.
- ✓ Plan a maintenance program for an established bioengineering site.
- ✓ Select the appropriate type of plant for bioengineering.

Content

Introduction	**Timing**
Introduction to exercise	5(5)
Travel to sites	30(35)
Development	
1. Site investigation	30(65)
2. Return to Training Center.	30(95)
3. Break	
4. Maintenance activities	40(135)
5. Selection of plant types	40(175)
Conclusion	
✓ Variation in site requirements	5(180)
✓ Importance of treating each site individually	

19.1 Facilitator's notes

19.1.1 Introduction

Introduce the session to the participants by explaining that the main aim is to give them practical experience of examining established bioengineering sites, planning their maintenance and selecting the bioengineering plant species. This will enable them to apply work from earlier sessions to the management of the maintenance of bioengineering sites.

Briefly explain the format of the session. This is that they will do:

- ✓ Work in four groups, each group examining a different site.
- ✓ Have half an hour on site carrying out site examination.
- ✓ Return to training center.
- ✓ Have a break.
- ✓ Spend an hour preparing their presentations.
- ✓ Have ten minutes for making each presentation and running a short discussion.

Distribute the handout H 19-1 and run through it quickly. Provide an opportunity for them to ask questions for clarification. Point out that, although half an hour sounds a long time for the site

investigation, they will have to organize themselves and work quickly to collect all the necessary information. Clarify that you will be supplying chart paper and pens when they return to the Training Center.

Once you have done this, get the participants into the transport and take them to the sites.

19.2.1 Development

19.2.1.1 Site investigation

When they start their work, make sure that they are clear on the boundaries of the site they are examining. Walk around the sites with the participants, but do not interfere if they are working well. You may need to encourage them to work faster if they are taking too long examining a part of the site. Check the accuracy and completeness of the information they are collecting while they are working. Towards the end of the time, you can ask questions to prompt them to check details or collect additional information, but do not supply the facts yourself. At the end of the time, take them back to the training center.

19.2.1.2 Maintenance programs

Now ask the participants to design the maintenance activities for the site. The project should include the characteristics of the site and its proper treatment.

19.2.1.3 Selection of plant species

Now tell the participants to recall the factors affecting the plant type selection. Tell them that, upon considering all the relevant factors, they should select the plant types. In this process, ask them to calculate the drought factor and select the plant type(s), based on the drought factor.

19.2.1.4 Presentations of programs

Ask each group, in turn, to make a five-minute presentation of their site, their maintenance program and plant type selection. Control this time and, when it is up, ask the other participants to raise questions and discuss the proposals. If they are slow to put questions, you can ask some based on your own observations.

19.3.1 Conclusion

In your conclusion, thank the participants for their work and the presentations that they have made. Refer to the differences between the four sites. Point out the variety that they have seen and how the differences between the sites are reflected in the different maintenance requirements.

19.2 Training resources

Handout

- ✓ H 19-1 Assessing bioengineering site maintenance requirements 20

Facilitation aids

Equipment and materiels

- ✓ Chart paper 24 Sheets
- ✓ Chart pen 4 Sets
- ✓ Drawing pins 1 Box

Notes

This session requires four sites, all with established bioengineering works and with variations between them. They must be quite close to the training center to keep traveling time to a minimum. If possible, one trainer should accompany each group. Arrange transport for this session.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the participant show to carry out the estimation of bioengineering requirements on site and build up to costs for the work, so that they are able to carry out this essential work on bioengineering sites.

Session Objectives

The participants will be able to:

- ✓ Estimate the quantities required by a simple bioengineering problem.
- ✓ Establish the approximate costs for the work.

Content

Introduction	**Timing**
Link to previous session Introduction to exercise	5(10)
Development	
1 Site examination and measurement	10(20)
2. Return to training center	5(25)
3. Calculation of requirements and estimation of costs	20(45)
4. Applying the process of estimating and costing	10(55)
Conclusion	
✓ Worked example ✓ Link to standard specifications	5(60)

20.1 Facilitator's notes

20.1.1 Introduction

Commence the introduction by linking this session with the previous one. Ask the participants how many bricks are necessary for a cubic meter of brick masonry. Some of them should be able to answer it. Now establish the provision of the standard norms. Show the slides PPS 20-1 to 7 on the norms of bioengineering works. Now, the objective of this exercise is to enable them to carry out a practical estimation of the bioengineering requirements of a site. From this, they will build up a costing for the work.

Explain that the participants will work in four groups. Each group will be given site with a bioengineering problem. They will have to measure the site and estimate the quantities required. Using bioengineering norms, they will establish the approximate costs for the work using standard rate analysis forms. Explain that time is limited and so they should concentrate on just the bioengineering works.

Show the slide (PPS 20-8) and take the participants to the site, asking them to measure the site for the bioengineering application. Distribute the handout H 20-1 and briefly work though the instructions. Tell them that they have ten minutes for the measurement of the site.

20.2.1 Development

20.2.1.1 Site examination and measurement

As experienced technicians, the participants should have few problems in carrying this out. You may need to challenge them to think about the appropriate course of action for protecting the sites.

20.2.1.2 Calculation of requirements and estimation of costs

Ask the groups to start work on the calculations and warn them that they have only 20 minutes. As the groups carry out this part of the exercise, move around and spend a few minutes with each one .Check they are on the right track and answer any queries. Encourage them to use bioengineering information as well as the summary information provided on the handout. There is no general feedback on the results of their calculations. So you should walk around towards the end of this part of the session, checking that their proposals are reasonable.

20.2.1.3 Applying the process of estimating and costing

Once the groups have reached a satisfactory stage of completion, call them all together. Ask them if they found it easy to carry out the exercise with the information they had. This should have been very easy for technicians, since it follows their standard procedures. Check if they used the rate analysis norms for bioengineering works. Ask if they had any difficulties with the document and discuss solutions to these problems. They should have had no problems with the exercise, since it is straightforward work.

20.3.1 Conclusion

Finally, describe that in the following sessions they will continue the management work they commenced with an examination of the rate analysis norms.

20.2 Training resources

Handout

- ✓ H 20-1 Estimating and costing 20

Facilitation aids

- ✓ (PPS 20-1 to 7) Power Point presentation on norms for bioengineering works 1 Set
- ✓ (PPS 20-8 to 10) Power Point presentation on exercise. 1 Set

Equipment and materiels

- ✓ Chart paper 20 Sheets
- ✓ Permanent markers 8
- ✓ Drawing pins 40

Notes

The participants have to be well informed to bring the materials of the previous sessions, so that it could be used in the relative sessions. Therefore, it is essential to bring the materials of the session on the instability mapping.

■ ■ ■

Session Plan

Location: Training suite **Duration**: 1 hour

Session aim: To teach the participants to program bioengineering works in relation to the biological calendar, and how this program can be accomplished within the framework of the financial systems of the government of Nepal (GoN) so that they are able to manage the programming of bioengineering work.

Session Objectives

The participants will be able to:

- ✓ Explain the importance of careful programming from the biological point of view.
- ✓ Prepare a bioengineering calendar.
- ✓ Explain how bioengineering programs may be achieved within the framework of the Fiscal Year of GoN.

Session content

Introduction	**Timing**
Relate topic to current experience of programming work The importance of careful programming for bioengineering works	5(5)
Development	
1. Bioengineering operations a. Timing of each operation b. Calendars of operations	35(40)
2. Fitting operations into the GoN's financial calendar a. Restrictions imposed by the GoN's Fiscal Year b. Working with the GoN's system to reduce financial problems	15(55)
Conclusion	
✓ Importance of programming related to biological and financial calendars ✓ Link to practical exercise	5(60)

21.1 Facilitator's notes

21.1.1 Introduction

Start the introduction by explaining that they have looked at methods of bioengineering work and have considered many technical details of their implementation. At times, they have noted points about the timing of these operations and now they are going to start looking at bioengineering programming.

Any organization requires a lot of programming so the project technicians are already very familiar with this. It means that they have already a good starting point. Ask the participants what types of planning and programming they already do in their work. Briefly discuss this point.

Now ask them to think about the importance of careful programming for bioengineering works. Ask why, in general, bioengineering works have to be programmed more carefully than civil engineering works. The main answer is that some biological features, such as seed collection, are highly seasonal in nature. If they miss the critical period, the whole program is completely messed up. Show the slide

(PPS 21-1) and give the participants a piece of thread. Now ask them to move it forward. Many of them start to push it as shown. Now demonstrate it by pulling from the front and disseminate the idea of pulling the project, not pushing.

21.2.1 Development

21.2.1.2 Scheduling

As in any engineering project, it is essential to schedule well in advance. Tell them the importance of total programming. Ask them the concept of total programming. Show the slide PPS 21 2 to 15 and explain the programming work turn by turn.

21.2.2 Bioengineering operations

21.2.2.1 Timing of each operation

Ask the participants to help devise chains of activities to fulfil a number of bioengineering objectives. Through questions and prompts, obtain the following sequences:

Planting a grass seedling on site

Identify suitable species --> find seed source --> wait till seeds are ripe --> collect seeds--> treat seeds--> store seeds--> prepare seed bed--> sow seeds shade--> water, weed etc.--> space out--> prepare site --> lift seedlings--> transport to site--> plant seedlings--> look after

Now show the slide **(PPS 21 -16)** and compare it with their findings. Likewise, it can be done for other activities as well.

21.2.2.2 Grass slip planting

Identify suitable species --> find plant source --> prepare nursery bed --> collect slips--> plant in nursery bed--> shade, water, weed, etc. --> space out--> lift slips--> transport to site--> plant slips --> look after them.

Emphasize the number of steps.

Now ask them to identify the steps which are fixed by seasons. Underline them on the screen. They are shown below in CAPITALS.

21.2.2.3 Planting a grass seedling on site

Identify suitable species--> find seed source--> wait till seeds are ripe--> COLLECT SEEDS--> treat seeds--> store seeds-->prepare seed bed--> SOW SEEDS shade, water, weed etc.--> space out--> prepare site--> lift seedlings--> transport to site--> PLANT SEEDLINGS--> look after them.

21.2.2.4 Grass slip planting

Identify suitable species--> find plant source-->prepare nursery bed--> COLLECT SLIPS--> PLANT IN NURSERY BE--> shade, water, weed, etc.--> SPACE OUT--> lift slips--> transport to site--> PLANT SLIPS -->look after them.

Use this to establish the fact that within each operation there are several critical steps which are determined by the biological calendar. If any of these points are missed, the whole operation will be delayed. Work through one of these sequences and identify the times when the different steps must be carried out. Ask them if the government financial calendar affects civil engineering work programming. Clearly it does. But they have now seen that in bioengineering work's programming, they have to fit within the biological calendar as well as the GoN's financial calendar. Distribute the handout H 21-1. It gives the summary annual calendar of bioengineering works. This is based on the GoN's fiscal year. Go through it with the participants, pointing out the main seasonal activities. Discuss them and talk about how they relate to each other.

21.2.2.5 Calendars of operations

Now give out handout H 21-2, which gives some examples of programs. Show the slide (PPS 21- 20 to 23) and describe in brief. Emphasize that these are very simple illustrations. The participants will have a chance to devise more comprehensive programs during the next session. Work through the programs and highlight the way in which operations are seasonally fixed for biological reasons. Show how they go in sequence and how they fit into the calendar in an inter-dependent way.

21.2.3 Fitting operations into the GoN's financial calendar

21.2.3.1 Restrictions imposed by the GoN's fiscal year

Ask the participants to tell the main restrictions created by the GoN's fiscal year system. They may mention many items. But the main ones you should highlight are those which affect the annual programming of bioengineering works. Show the slide (PPS 21- 17 to 19), and briefly discuss on the points.

Discuss these solutions. The general message to get across is that the system is not bad. It may mean some extra work, but you can get around any difficulties if you choose to do so.

21.3.1 Conclusion

Sum up the discussion and the main points covered in this session. Emphasize that the most important points are that:

- ✓ Many bioengineering activities are dependent on critical timing.
- ✓ Careful programming is very important in bioengineering works.
- ✓ The fiscal year ends at a very bad time for managing bioengineering work, but there are ways of getting around this.

You need to link this session to the practical exercise in the following session. In that session, they will be planning bioengineering programs for the whole year.

21.2 Training resources

Handout

- ✓ H 021-1 Bioengineering programming 20

Facilitation aids

Equipment and materiels

Notes

■ ■ ■

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To teach the main aspects of monitoring in bioengineering works for ensuring quality control. It is for the purpose that the participants are able to ensure the responsible bioengineering works and it can be carried out effectively.

Session Objectives

The participants will be able to:

- ✓ Describe the main criteria for assessing quality of bioengineering works.
- ✓ Explain what needs to be monitored over different time frames.
- ✓ Assess the quality of implemented bioengineering works against the stated criteria.

Session content

Introduction	**Timing**
Introduction to standard specifications Importance of ensuring that these are applied	5(5)
Development	
1. Monitoring and quality control	5(10)
2. Criteria for assessing the quality of bioengineering works	30(40)
3. Monitoring over different time frames	15(55)
Conclusion	
✓ Checking for quality is the responsibility of everyone involved in operations.	5(60)
✓ Permanent project staffs have legal responsibility.	

22.1 Facilitator's notes

22.1.1 Introduction

Link this back to the previous session where the participants had considered the cost estimation for bioengineering works. Nevertheless, it did not mention the quality of the work. Ask the participants whether shirt put on by someone has a quality. From the discussion, establish the definition of the quality and it is evaluated on the basis of certain document which has a standard specification. Just show the slide PPS 22-1 to 5 and inform the contents and details of bioengineering standard specification. Tell them that it is a basis for determining what should be required in contracts and what should be achieved when work is carried out.

Emphasize that the standard specifications have no value unless we ensure that they are applied. However, this is not simply a process of the check when the work has been completed; the work must be monitored throughout its implementation and subsequently. This is the topic for this session. Do not discuss the time of monitoring at this stage.

22.2.1 Development

22.2.1.1 Monitoring and quality control

Now, introduce the concepts of monitoring and quality control. Ask the participants what they understand as the meaning of monitoring. Show the slide (PPS 22-6 to 7) and establish the meaning of monitoring and quality control. Continue by discussing about the quality. There are many definitions of

quality, but for the purposes of this session, explain that it means meeting the required standards. Then, ask the participants why we need monitoring and quality control. In the discussion, establish that we need them because we must produce good work and to ensure the work is of the highest quality achievable because we must not let junior staffs or contractors produce sub-standard work.
Finally in this part of the session, ask whose responsibility they are and then explain that they are the responsibility of the project. The project is represented by its permanent staffs i.e. All of them are responsible. Clarify that often some responsibility for quality is delegated to temporary staffs i.e. the supervisor, the 'Naike' and even the labourer. Although responsibility may be delegated to junior employees, the ultimate responsibility always lies with the senior officer.

22.2.1.2 Criteria for assessing the quality of bioengineering works

Divide the participants into four groups and ask them to discuss the main criteria for assessing the quality of bioengineering works. Show the slide (PPS 22-8) to give them some things to think about. Tell them that they have only ten minutes to identify criteria for assessing quality in bioengineering works. Distribute the chart paper and chart pens and ask them to write their ideas down. Ask one group to bring up their chart and present their findings. Then ask if the other groups can add to this without repeating ideas. Discuss the findings briefly as any questions emerge. Discuss any major differences or omissions from their lists.

Explain that these are visible aspects that can be checked in the field. There are several tests that we can perform scientifically. We can count and check survival rates and these can even be analyzed statistically. However, this analysis is unlikely to contribute much to maintaining or improving quality. It is important that the criteria are used and the participants will have an opportunity of doing this on later site visits.

22.2.1.3 Monitoring over different time frames

Remind the participants as you have said that ensuring the standard specifications were being applied was not simply a matter of checking when the work had been completed. It had to be monitored throughout its implementation and subsequently. Show the slide (PPS 22-9) which gives a short exercise on monitoring over different time frames. Ask the participants to discuss this in pairs. Allow them 10 minutes for this.

While they are working, check if they have completed the task satisfactorily, but do not provide the answers.

When the 10 minutes allowed for the exercise have elapsed, show the slide PPS 22-10 and tell them to compare. This gives a worked example of the exercise. Let the participants read through it and then ask for comments. There is likely to be a fair amount of discussion.

Remind the participants that there are no set rules to the number and frequency of monitoring inputs. Generally, more frequent monitoring is better. Engineers need to think about delegation as much as possible if this is to be achieved. It is a matter for each individual to decide what is best in their own particular area. This comes under the general management of the project's works.

22.3.1 Conclusion

Sum up the findings of the session and emphasize that checking for good quality is the responsibility of everyone involved in the operations.

22.2 Training resources

Handout

- ✓ H 022-1 Monitoring and quality control works 20

Facilitation aids

- ✓ PPS 22-1 to 5 Power Point slide on standard specification 1 Set
- ✓ PPS 22-6 Power Point slide on assessing criteria 1 Set

- ✓ PPS 22-7 Power Point slide on monitoring 1 Set
- ✓ PPS 22-8 Power Point slide on quality control 1 Set
- ✓ PPS 22-9-10 Power Point slide on monitoring frequency 1 Set

Equipment and materiels

- ✓ Chart paper 12 Sheets
- ✓ Chart pens 4 Sets
- ✓ Drawing pins 1 Box

Notes

Make sure that you have LCD projector and computer with continuous source of power.

■ ■ ■

Session Plan

Location: Training room **Duration**: 3 hours

Session aim: To provide an opportunity for the participants to integrate the work completed on the previous sessions on site appraisal, and the design of bioengineering works with the quantity estimation and programming so that they are able to perform this work in their own areas.

Session Objectives

The participants will be able to:

- ✓ Prepare abstract of cost for the work.
- ✓ Prepare work schedules for implementing bioengineering design.

Content

Introduction	**Timing**
General need for standard norm, abstract of cost and programming	5(5)
Development	
1. Bioengineering standard norms	10(15)
1. Layout and content	
2. Relationship to main standard norms	
2. Application of the norms to bioengineering activities	45(60)
1. List of Activities	
2. Rate analysis	
3. Quantity and cost estimation	
3. Programming works	100 (160)
1. Yearly program	
2. Human resource schedule	
3. Financial schedule	
4. Tools and equipment schedule	
5. Materials schedule	
4. Preparation for presentation	
Conclusion	
✓ Bioengineering specifications must be used with departmental specifications.	5(180)
✓ Need for constructive feedback on bioengineering specifications.	

23.1 Facilitator's notes

23.1.1 Introduction

Commence the introduction by linking this session to the previous one. They have looked at rate analysis norms on a theoretical basis and now the objective of this exercise is to enable them to carry out a practical estimation of the bioengineering requirements of a site. From this, they will build up a costing for the work.

Explain that the participants will work in four groups. Each group had assessed the site in the instability mapping session. They have measured the site and now they have to identify the proper solution for the site and calculate the quantities of the work required. Using bioengineering norms, they will now establish the approximate costs for the work using standard rate analysis forms. Explain that the time is limited, so they should concentrate on the works. Similarly, they will practice preparing the programming for the work.

Show the slide PPS 23-1 and distribute the handout H 23-1 and briefly work though the instructions.

23.2.1 Development

23.2.1.1 Site examination and measurement

As experienced technicians, the participants should rarely have problems in analyzing the site. Now they have knowledge on different aspects. Therefore, they are now asked to propose the appropriate solution to the problem assessed at the site. Now tell them to review the measurement and the data of the field work.

23.2.1.2 Calculation of requirements and estimation of costs

Ask the groups to start work on these assessments and inform them that they have only 20 minutes. As the groups carry out this part of the exercise, move around and spend a few minutes with each one. Check they are on the right track and answer any queries. Encourage them to use bioengineering information as well as the summary information provided on the handout.

There is no general feedback on the results of their calculations, so you should walk around towards the end of this part of the session, checking if their proposals are reasonable.

23.2.1.3 Applying the process of estimating and costing

Once the groups have reached a satisfactory stage of completion, call them all together. Ask them if they have found it easy to carry out the exercise with the information they had. This should have been very easy for technicians, since it follows their standard procedures. Check if they used the rate analysis norms for bioengineering works. Ask if they had any difficulties with the document and discuss solutions to these problems.

They should have had no problems with the exercise, since it is straightforward work.

23.2.1.4 Programming of the works

The work activities mentioned above are to be carried out through out the whole year. Therefore, tell them to prepare the annual program and other schedules, like materials, human resources, money, tools and equipment schedules. Remind them that the money to be spent for the project has to be allocated across the whole year.

23.3.1 Conclusion

The groups may not have finished all of their preparations, so you should emphasize that they must be ready by the start of the morning session. Give the participants some guidance on making their presentations in the morning. Tell them not to read everything from their charts, rather hey should emphasize the main points. When they are using the overhead projector, they should point at the transparency with a pen or pencil rather than pointing at the screen. Above all, they should speak clearly and not too rapidly.

24.2 Training resources

Handouts

- ✓ H 023-1 Application of the standard norms, Standard specifications for bioengineering works and calculation of cost estimation 20

Facilitation aids

✓ PPS 23-1 Tasks to be performed	1 Set

Equipment and materiels

✓ Chart paper	24 Sheets
✓ Markers	24 Sets
✓ Pins	1 Box

Notes

Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 2 hours

Session aim: To teach the participants how to select suitable nursery sites through assessment of the characteristics of land position, natural qualities and location, and estimate the design requirements and the management of the nursery, so that they can efficiently produce plants for bioengineering work.

Session Objectives

The participants will be able to:

- ✓ State the components of a nursery.
- ✓ State the resources required for nursery management.
- ✓ Site characteristics and resources which are needed for a good nursery .
- ✓ Identify suitable sites and evaluate proposed site.
- ✓ Design of nursery beds.
- ✓ Design requirements of nursery beds and components.
- ✓ Estimate required space.
- ✓ Collect seeds.

Content

Introduction	**Timing**
Reasons for having nurseries	5(5)
Development	
1. Nursery components and required resources	10(15)
2. Site characteristics and resources	20(35)
3. Nursery site selection	15(50)
4. Design of nursery beds	30(80)
5. Space required for a nursery	10(90)
1. Grass slip multiplication requirements	
2. Area calculations	
6. Nursery requirements	15(105)
7. Seed collection	10(115)
Conclusion	
Recap the importance of bioengineering nursery.	5(20)

24.1 Facilitator's notes

24.1.1 Introduction

Remind the participants that they have mainly looked at theoretical aspects behind bioengineering during the previous sessions. Now they will start with nurseries. Ask the participants why we have nurseries. Through discussion, establish that nurseries are required for producing enough plants at the required quality, at the required time, at an affordable cost for the bioengineering work that is going to be carried out. Then ask questions to stress that they must be available at the right time and at a reasonable cost. Show the slides(PPS 24-1to 2) to summarize this information. Explain that site

planting is restricted to a short period, because of the climatic conditions. Without nurseries, we would not have enough planting stock of the right type(s) ready for the site at the right time. We can think of a nursery as a factory for producing plants.

Tell the participants that the site of the nursery contains two elements. The first relates to the natural characteristics of the place, in which it is set, and another one is to the ability of the nursery to meet the demand for planting material.

24.2.1 Development

24.2.1.1 Nursery components and resources required

Ask the participants what the component parts of a nursery are. They may answer some of them. Now show the slide (PPS 24-3) briefly and introduce all the components. Now ask them what the materials and tools are, as well as the equipment they need to run a nursery. Again, show the slide (PPS 24-4) and discuss what other things can be added to this list. Add the reasonable points that the participants raise.

24.2.1.2 Nursery site selection

Ask them what the most important factor for the site selection is. They may give many answers. Tell them that every factor is important. Nevertheless, there are some points that must be considered while selecting the nursery sites. Show the slides(PPS 24-6to 12) and go through every factor.

24.2.1.3 Types of beds

Tell the participants that growing of plants in a haphazard way cannot be considered a nursery. That is why it is necessary to establish the beds with standard specifications. Show the slides(PPS 24-12to18) and explain the importance of each component of the beds turn-by-turn.

24.2.1.4 Space requirement There should be enough space for the nursery operation. So, there must be a proper way of estimation for the nursery components. Show the slides (PPS 24-19to 25) and explain the method of space calculation. Try a small exercise in this process, as well.

24.2.1.5 Design requirements

Show the slides (PPS 24-26to 36) and briefly discuss on the design requirements.

24.2.1.6 Seed collection

Seed is the key factor for the nursery. To stress this point, show the slides(PPS 24-37to 49) and explain briefly about the quality of seed, as well as collection and storage processes.

24.3.1 Conclusion

Sum up the session with the importance of the nursery, and tell them that there are many aspects of nursery operation and management. Therefore, request them to study the reference material and try to implement accordingly to best practices.

24.2 Training resources

Handouts

- ✓ H 024-1 Introduction to nursery 20

Facilitation aids

- ✓ PPS 24-1 to 2 Power Point presentation on definition of nurseries 1 Set
- ✓ PPS 24-3 Power Point presentation on nursery components 1 Set
- ✓ PPS 24-4 Power Point presentation on material list 1 Set
- ✓ PPS 24-5 Power Point presentation on tools and equipment list 1 Set
- ✓ PPS 24-6 to 11 Power Point presentation on nursery site selection 1 Set

- ✓ PPS 24-12 to 18 Power Point presentation on nursery beds 1 Set
- ✓ PPS 24-19 to 25 Power Point presentation on space requirements 1 Set
- ✓ PPS 24-26 to 36 Power Point presentation on design requirement 1 Set
- ✓ PPS 24-36 to 49 Power Point presentation on seed collection 1 Set

Equipment and materiels

Notes

Make sure that you have LCD projector and computer with continuous source of power.

Session Plan

Location: Training room **Duration**: 1 hour

Session aim: To enable the participants to prepare presentations on their site appraisals and designs of bioengineering works, so that they are able to make their presentations and present this type of information in the future.

Session Objectives

The participants will be able to:

- ✓ Select material for presentation.
- ✓ Prepare presentations including site description and appraisal.
- ✓ Prepare presentations on the design of appropriate small civil engineering and bioengineering structures for a site.

Content

Introduction	**Timing**
Link to project work in the site	5(5)
Development	
1. Organization of presentations	5(10)
1. Each site to be presented by each group in turn	
2. Time allowed	
3. Brief discussion of the proposals	
4. All members of group should be involved	
5. Order of sites to be announced later	
2. Approach to presentation	5(15)
1. Need to be clear and concise	
2. Content to be covered	
3. Visual display	
4. Preparation	40(55)
Conclusion	
Give full attention to all presentations	5(60)
Sequence of sites	

25.1 Facilitator's notes

25.1.1 Introduction

Thank the participants for the hard work they did over the course of the whole training period and explain that you are looking forward to observing them presenting the results of this work.

Remind them that this work involves looking back over the topics they have considered in all of the previous sessions, and seeing how they can be applied.

25.2.1 Organization of presentations

25.2.1.1 Each site to be presented by each group in turn

Remind them that three sites have been examined and each site was seen by all groups. In the presentation session, the emphasis can be placed on the sites rather than the groups. This means that each site will be considered in turn. Explain that this will enable all the participants to consider and compare the conclusions which the groups have reached on each site. Remind them that differences do not mean much about the appropriateness of one group over another. They have already seen that there may be more than one solution to the problems on a particular site.

25.2.1.2 Time allowed

Tell the participants that they will be allowed ten minutes to present each site and they must include some time for other participants to ask questions for clarification. Explain that you will be carefully controlling the time so that each group has an equal opportunity.

25.2.1.3 Brief discussion of the two proposals

After the presentations of the site, there will be a further five minutes for discussion. Explain that the other participants should be ready to ask constructive questions. The presenting groups should be ready to answer.

25.2.1.4 All members of group should be involved

Emphasize that these are group presentations. Everybody in each group was involved in the site examination. They should all be involved in the preparations and in the presentations.

25.2.1.5 Order of sites to be announced later

Explain that you will be announcing the order of presentations later. This means that they all have to complete their preparations by the end of this session. They cannot rely on being able to complete their work over one of the breaks.

25.3.1 Approach to presentation

25.3.1.1 Need to be clear and concise

Tell the participants that they should imagine that they are presenting the information in front of the chief guest when he makes visit to their project. He will have limited time and so their presentations need to be clear and concise.

25.3.1.2 Content to be covered

Show the slide PPS 25-1 to indicate the points that they should cover in their presentations. Remind them again that they need to be concise. As an example, point out that they should simply state the background information on a site, or they can show it on a visual aid. They should not discuss it.

25.3.1.3 Visual display

Remind the participants that a lot of the material during this first block has been presented visually. It is often clearer that way and it can also save a lot of time. Explain that you expect them to use charts and overhead transparencies in each presentation. Tell them not to write too much on either of these aids. A few points concisely made with clear writing and drawings are what one requires. They should not simply read all the information off these aids in their presentations.

25.4.1 Preparation

This is the main part of the session. You and your colleagues should act as facilitators. You are not there to interfere in their work or tell them what to do. If they are proceeding well, allow them to work uninterrupted.

25.5.1 Conclusion

Explain that the next session is not simply designed as an opportunity for them to make presentations. It will also enable them to learn from the experience and presentations of the other groups. Therefore they should give full attention to all of the presentations.

25.2 Training resources

Handout

- ✓ H 025-1 Content of presentations — 20

Facilitation aids

- ✓ PPS 25-1 Power Point slide on sequence of presentations — 1 Set

Equipment and materiels

- ✓ Chart paper — 24 Sheets
- ✓ Chart pens — 4 Sets
- ✓ OHP pens — 4 Sets

Notes

Make sure that you have LCD projector and computer with continuous source of power.

At the end of this session, you need to arrange the room so that the screen, whiteboard and two chart stands can all be used easily.

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Session Plan

Location: Training room **Duration**:2 hours

Session aim: To enable the participants to present and examine site appraisals and designs of bioengineering works, so that they are able to combine and apply the work in making and evaluating presentations related to bioengineering in the future.

Session Objectives

The participants will be able to:

- ✓ Present site appraisals and proposals for bioengineering works.
- ✓ Evaluate presentations.

Session content

Introduction	**Timing**
Completion of course work Procedure and control	5(5)
Development	
1. presentation by each group in turn	20(25)
1. Presentations and discussion on site by one group	
2. Presentations and discussion on site by the second group	20(45)
3. Presentations and discussion on site by the third group	20(65)
4. Presentations and discussion on site by the fourth group	
Evaluation of the course	20(105)
Comments	10(115)
Conclusion ✓ Thank participants. ✓ Bring material for binding after lunch.	5(120)

26.1 Facilitator's notes

26.1.1 Introduction

Remind the participants that this session marks the end of the technical work in the training course. Briefly reinforce the procedure for the presentations and explain that they can seek clarification of points after each presentation, but should not discuss the information until after each presentation has been completed. Ask the groups to be ready to start their presentations as soon as they are asked to do so. Keep your introduction extremely brief.

26.2.1 Development

26.2.1.1 Presentation by the first group

26.2.1.1.1 Presentation by each group in turn

Ask group C to commence their presentation of the sites. Keep careful control over the time and make sure that they provide an opportunity for the other gro ups to ask questions for clarification within their ten minutes. Do not allow any general discussion at this stage. After the completion of the presentation of the first group, ask group A to present. Likewise, let group D present, followed by group B.

26.2.1.1.2 Discussion of presentations on site

When a group has clarified any points raised by the other participants, allow the participants to discuss the material that has been presented. You should keep the discussion under control, but remember that this is an opportunity for the participants to share their ideas as well. Keep the discussion positive. If anybody criticizes a point, they should be able to present alternatives

26.2.1.1.3 Evaluation of the training

Distribute H 26-1 and ask them to fill it out. Tell them that the comments they make will help us to improve the course in the future. Give them 10 minutes for this task, then collect the forms and make the final comment from the side of trainers.

26.3.1 Conclusion

Thank the participants for the hard work they have done. Express your hope that they have found it a worthwhile exercise.

Explain that they have seen, in many situations, alternative ways of solving problems. Finally, remind them that they should bring all the material they want in the afternoon session. The materials should be in the order that they want them bound. Ask them to remove all staples for the binding machine.

26.2 Training resources

Handout

✓ H 26-1	20

Facilitation aids

Equipment and materiels

✓ Chart paper	24 Sheets
✓ Markers	20
✓ Drawing pins	
✓ Masking tape	1 Roll

Notes

Make sure that you have LCD projector and computer with continuous source of power.
Prepare to bind the participant's handouts after lunch.

Session Plan

Location: Training room **Duration**:1 hour

Session aim: To close the course and ensure that the participants have a sense of achievement from it and are motivated to continue investigating bioengineering and plan to use their experience in their work moving forward.

Session Objectives

The participants will be able to:

- ✓ Express their appreciation of the work they have accomplished.
- ✓ Return to their project area with a desire to carry out bioengineering work more effectively.

Content

Introduction	**Timing**
Introductory remarks	5(5)
Development	
1. Closing comments by course co-ordinator	10(15)
2. Comments by representative participant	5(20)
3. Comments by organizer	5(25)
4. Comments by a trainer	5(30)
5. Closing remarks by chief guest and certificate distribution	25(55)
Conclusion	
✓ Vote of thanks	5(30)
✓ Refreshments	

27.1 Facilitator's notes

27.1.1 Introduction

This is the formal closing ceremony for the whole course. It is a significant event and designed to send the participants on their way, feeling very positive about their experience over the course of the training. However, you should keep a fairly light approach to the session.

You should invite a chief guest who has a strong personal and professional interest in bioengineering. You should have retained the display material that was prepared in Session 26 and you need to put this on view before the session. You should ask the participants to be ready to explain the work they have done during the course to the visitors.

Before the session, you should invite the participants to select a representative to make a few remarks on their behalf.

You will need to select one of the trainers to chair the session.

The program given on the next page is an example of a closing ceremony. You can use it as a guide to how the ceremony could be organized, but you do not have to follow this pattern strictly.The actual program depends on the guests who are available. The closing ceremony may not take the full time, in which case, there will be more time for the participants to talk to the guests.

27.2.1 Development

This is the first step toward the professional practice after the training program. Therefore, it is an important session, because it needs to set a good atmosphere for the working aptitude. There are project manager/s of the project/s, technicians working in the project area, concerned authorities and stakeholders. So, it is necessary to motivate the participants to use the knowledge, skills and the attitude from all these sides. For this purpose, guests are invited to deliver very short speeches to demonstrate the importance of application of the outputs from this training in their own work moving forward.

The participants are suggested to select a representative to express their comments on the training course on behalf of the entire trainees. The training coordinator invites all the participants and the guests to the training room and requests them to take their seats. S/he starts the session with a warm welcome and distributes the program sheet (H 27-1). S/he invites the prescribed person to give a short welcome speech on behalf of the organizer. The speakers should be kept on track with the rather tight time schedule.

Tell them that you have worked very closely with them over the whole week. It is now the time for a formal closing. Invite one of the trainers to sum up the training program. Then the representative of the participants is brought forward to express their view on the course. Then it is the turn of the training coordinator to comment on the performance of the participants. Lastly, the chief guest is requested to distribute the certificates and deliver the closing remarks. This is the end of the session and the training course as a whole. Now thank all and invite them to the refreshments.

27.2 Training resources

Handout

- ✓ H 26-1 Closing ceremony program sheet 20

Facilitation aids

Equipment and materiels

Notes

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Mercy Corps is an international, non-governmental humanitarian relief and development agency that exist to alleviate suffering, poverty and oppression by helping people to build secure, productive and just communities. Mercy Corps was established in 1979, and has headquarters in the USA and UK. Since 1979, Mercy Corps has worked in over 100 countries. Mercy Corps currently works in 40 countries around the world focusing on countries in transition, where countries are in the midst of or recovering from conflict, economic collapse, or disaster; Mercy Corps sees these crisis situations as moments of opportunity to go beyond traditional boundaries of relief and catalyze lasting change. Globally, Mercy Corps implements programs in a range of sectors, including agriculture and food security; market development; emergency response; disaster risk reduction; climate change; health; conflict management; youth engagement; and community mobilization/ governance. In Nepal, Mercy Corps began its operation in 2005 and focuses on the sectors of Agriculture and Food Security, Financial Services, and Disaster Risk Reduction with early warning and Youth Engagement, with the inclusion of women and disadvantaged groups as a cross cutting issue.

The Hariyo Ban Program, funded by USAID and implemented by a consortium of WWF, CARE NTN and FECOFUN with WWF as the lead, aims to reduce adverse impacts of climate change and threats to bio-diversity in Nepal. It works on 3 core interwoven components – bio-diversity conservation, sustainability landscape and climate change adaptation – with livelihoods, gender and social inclusion being important cross-cutting themes.

Mercy Corps is one of the resource partners for Hariyo Ban and is implementing a number of initiatives aimed at improving resilience to climate-induced disasters, with a particular emphasis on flooding, while at the same time decreasing the negative impacts on livelihoods, for flood-prone communities in the Terai region of Far Western Nepal. This document is part of Mercy Corps partnership with the Hariyo Ban consortium documenting successful approaches, identifying and recommending corrections for less successful approaches and helping chart forward an evidence-based course for scaling up climate change resilience of communities and ecosystems in Hariyo Ban areas through analyzing successful approaches in climate-induced disaster risk reduction and livelihood enhancement.

The Hariyo Ban Program is named after the famous Nepali saying 'Hariyo Ban Nepal koDhan' (Healthy green forests are the wealth of Nepal). It is a USAID funded initiative that aims to reduce the adverse impacts of climate change and threats to biodiversity in Nepal. This will be accomplished by working with the government, communities, civil society and private sector. In particular, the Hariyo Ban Program works to empower Nepal's local communities in safeguarding the country's living heritage and adapting to climate change through sound conservation and livelihood approaches. Thus the Program emphasizes the links between people and forests and is designed to benefit nature and people in Nepal. At the heart of Hariyo Ban lie three interwoven components – biodiversity conservation, payments for ecosystem services including REDD+ and climate change adaptation. These are supported by livelihoods, governance, and gender and social inclusion as cross-cutting themes. A consortium of four non-governmental organizations is implementing the Hariyo Ban Program with WWF Nepal leading the consortium alongside CARE Nepal, FECOFUN and NTNC.

Disclaimer: This guidebookis made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of Mercy Corps and do not necessarily reflect the views of USAID or the United States Government.