RQF LEVEL 5

TRADE: FORESTRY

MODULE CODE: FORFP501

TEACHER'S GUIDE

Module name: FOREST PATHWAYS

Table of content

Contents

Acronyms

M^2: meter square

m: meter

%: percentage

LP: Level Peg

SP: Slope Peg

GPS: Global Position System

0^0: Degree

Hrs: Hours

Introduction

This module describes briefly different possibilities and realization applied in forest pathways construction. The objective of this module is to allow the trainees of level5 in forestry to design and construct a forest pathway allowing a truck (without trailer) to circulate securely at a reduced speed and to ensure the longevity of the constructed forest pathway by the choice of suitable technical norms.

In Rwanda, the construction of forest pathways is done entirely in soil excavation (cutting), this for two main reasons: The mean slopes of land in our country is often superior to 60% and the construction by soil excavation and soil filling would only possible with the construction of retaining walls, what is difficult to construct and expensive. Finally, all terracing works are done using hand tools without the use of sophisticated machine for fill compaction.

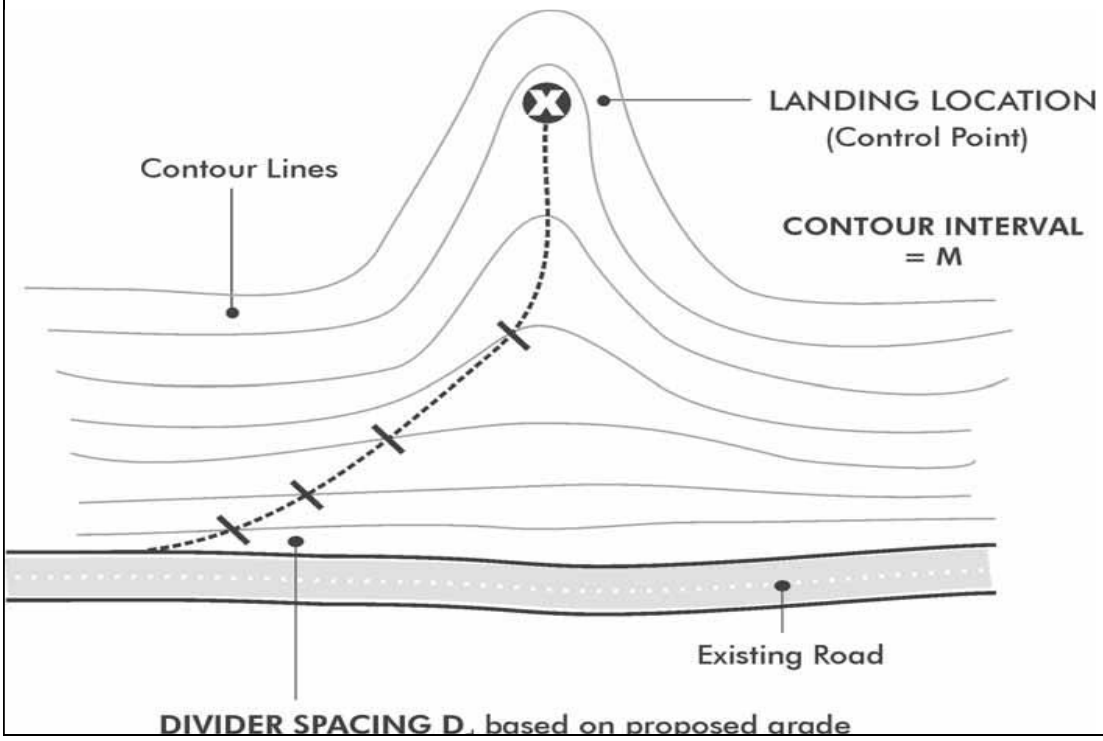
FORFP501. FOREST PATHWAYS

Learning Units:

1. Design pathway network
2. Apply forest pathways construction
3. Maintain forest pathways

Learning Unit 1: Design pathway network

Picture/s reflecting the Learning unit 1



STRUCTURE OF LEARNING UNIT

Learning outcomes:

1.1. Prepare tools, equipment and materials
1.2. Delimitate the site

1.3. Examine the site
1.4. Design forest pathway network

Learning outcome 1.1. Prepare tools, equipment and materials

Duration: 2hrs

Learning outcome 1 objectives

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly forest pathway tools, equipment and materials used in forest pathway designing.

2. Select correctly the criteria for tools, equipment and materials used in forest pathway designing.

3. Handle appropriately tools and equipment used in forest pathway designing.

Resources

Equipment	Tools	Materials
Theodolite, Dumping Level, GPS,	Ranging Poles, Pegs, Carpenter Level, Machete, Hand Hoes, Tape Measures, Ropes,	Pencils, Papers, Existing Map, Markers, Field book, Graph paper, Paints, Rubber, Warning tapes.

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway designing.

- ✓ Trainer should have good collaboration with local authorities.

Indicative content 1.1.1: Identification of tools, equipment and materials

The general network of forest pathways is the set of pathways and unloading pathways foreseen within a considered area (zone). The required tools, equipment and materials for performing the forest pathways designing are:

- ✓ Tools: **Ranging Poles, Pegs, Carpenter Level, Machete, Hand Hoes, Tape Measures, Ropes.**
- ✓ Equipment: Clinometers, Dumping Level, GPS, Theodolite, s,
- ✓ Materials: Paints, markers **Pencils, Papers, Existing Map, Markers, Field book, Graph paper, Paints, Rubber, Warning tapes.**

Theoretical learning Activity

- ✓ Presentation on tools, equipment and materials used in forest pathway design.
- ✓ Brainstorming on selection criteria for tools, materials and equipment used in forest pathways designing.
- ✓ Group discussion on handling of tools and equipment used in forest pathway designing.

Practical learning Activity

- ✓ Each trainee performs the identification of tools, Equipment and materials required for forest pathway designing.

Points to Remember (Take home message)

A tools and equipment used in forest pathway designing vary according to the task to perform. Tools and equipment used for:

- ✓ Land clearing
- ✓ Distance measurement and
- ✓ Designing

Indicative content 1.1.2. Selection criteria of tools, equipment and materials

- ✓ **Task to perform:** Tools and equipment are chosen in accordance with the specific task to perform.
- ✓ **Topography**: The land is the fixed basis data that influences a general network of forest pathways. The topography of land determines the unloading techniques to use.
- ✓ **Climate/season**: To avoid tools/equipment depreciation, some tools and/or equipment are adopted.
- ✓ **Precision of the tool/equipment**: In order to minimize errors, more precise tools/equipment are adopted.
- ✓ **Skills of the operator:** The operator has tendency to choose the tool/equipment that is easy for him/her to manipulate.
- ✓ **Availability of tools and equipment or materials:** some tools and equipment are not available on the local markets regardless their cost.
- ✓ **Financial means:** The available financial means are often limited. It is useful to be able to compare the cost of obtained different variants (based on the survey done) and make the different between their cost and profit.

Theoretical learning Activity

- ✓ Presentation on tools, equipment and materials used in forest pathway designing.
- ✓ Brainstorming on selection criteria for tools, materials and equipment used in forest pathways designing.
- ✓ Discussion on handling of tools and equipment used in forest pathway designing.

Practical learning Activity

- ✓ Each trainee performs the identification of tools, Equipment and materials required for forest pathway designing.

Points to Remember (Take home message)

Selection criteria of tools and equipment used in forest pathway designing vary according to: ✓ Task to perform ✓ Topography ✓ Climate ✓ Precision of the tool/equipment

Indicative content 1.1.3. Proper handling of tools and equipment used in forest pathway designing

All tools and equipment should be handled correctly which enhance the efficiencies of tools/equipment.

Incorrect use is detrimental to the tools/equipment and may be dangerous to the user and other peoples.

- ✓ **Adjustment of tools/equipment consists of**:
  - Adjustment of tools and equipment,
- ✓ **Maintenance of tools/equipment refers to:**
  - Cleaning,
  - Sharpening,
  - Oiling,
  - Safe keeping and proper storage,
  - Welding.


Theoretical learning Activity

- ✓ Presentation on tools, equipment and materials used in forest pathway designing.
- ✓ Brainstorming on selection criteria for tools, materials and equipment used in forest pathways designing.
- ✓ Discussion on handling of tools and equipment used in forest pathway designing.


Practical learning Activity

- ✓ Each trainee performs the identification of tools, Equipment and materials required for forest pathway designing.
- ✓ Trainees in pair of four (4) perform handling of tools and equipment used in forest pathway designing.


Points to Remember (Take home message)

In handling of tools and equipment, the following points are considered:
- ✓ Adjustment of tools and equipment,
- ✓ Maintenance of tools and equipment.
- ✓ Storage condition of tools and equipment.

Learning outcome 1.2. Delimitate the site

Duration: 2hrs

Learning outcome 2 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Define correctly the terms latitude, longitude and altitude as used to delimitate the site in forest pathway.

2.Perform appropriately the procedures of marking as used in forest pathway designing.

Resources

Equipment	Tools	Materials
Clinometers, Dumping Level, GPS, Theodolite	Ranging Poles, Pegs, Carpenter Level, Machete, Hand Hoes, Tape Measures, Ropes, Ropes, Sledge Hammer Spade Poles	Pencils, Papers, Existing Map, Markers, Field book, Graph paper, Paints, Warning tapes.

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway delimitation.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 1.2.1. Determination of geographical location

- ✓ **Determination of geographical location**

  The site delimitation consists to set out or establish the limits or boundaries of site where the forest pathway will be constructed.
  Geographic coordinates system is coordinate system that enables every location on the earth to be specified by a set of number or letter.
  A common choice of coordinates is latitude, altitude and longitude.
- ✓ **Altitude:** Altitude or elevation is defined as the vertical distance from a datum plane, usually mean sea level, to a point above the earth surface, expressed in meters above sea level.
- ✓ **Latitudes**: Latitudes are imaginary lines drawn across maps running from east to west. The main latitude is the equator at **0**◦. It divides the earth into equal parts. The part north of the equator is called the northern hemisphere. The part south of the equator is called the southern hemisphere.
- ✓ **Longitudes:** These are imaginary lines drawn on maps running from North to South. The main longitude at **0**◦ is called Prime Meridian or Greenwich Meridian.


Theoretical learning Activity

- ✓ Presentation on tools and equipment used in geographical location determination.
- ✓ Brainstorming on common geographical coordinates.


Practical learning Activity

- ✓ trainees in group of four (4) members perform site delimitation.


Points to Remember (Take home message)

In site delimitation, we have to consider the following coordinates:
- ✓ Latitude,
- ✓ Altitude and

✓ Longitude.

Indicative content 1.2.2. Marking procedures

✓ Marking procedures

Clearing of site: it consists of removing all obstacles present on the site so that to make the next activities easy.

Marking of boundaries: It consists of identifying the limits and borders of the road zone. In so doing the following measurements (horizontal angles, vertical angles, horizontal distance.) need to be taken and filled in the forms.


Theoretical learning Activity

✓ **Discussion on marking procedures** used in forest pathways designing within groups.


Practical learning Activity

✓ Trainees in pair perform marking of forest pathway at the distance of 10 meters.


Points to Remember (Take home message)

In marking procedures, we have to consider the following:

- ✓ Clearing of site
- ✓ Marking of boundaries

Learning outcome 1.3. Examine the site

Duration: 2hrs

Learning outcome 1.3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly physical features of the site on which forest pathway will designed.
2. Identify correctly positive and negative fixed points used in forest pathway designing.

Resources

Equipment	Tools	Materials
GPS Wheel Barrow, Electronic Balance.	Hand Hoes, Tape Measures, Spade, Poles, Soil auger, Sieves	Papers, Existing Map, Markers, Field book,

Advance preparation

- ✓ Trainer have to avail tools, materials and equipment used in site examination.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 1.3.1. Physical properties of the site

- ✓ **Soil fertility and vegetation**

The type of vegetation and soil fertility of different zones are the good indications (signs) that can help us to make a good choice. On will elaborate the variant permitting to go against to the most fertile parts of the perimeter (unit).

- ✓ **Hydrology and exposition**

For the purpose of environment protection road should not cross over the wetlands (marshes and swamps) nor seeping soils wherever possible. Slope orientation is defined as the bearing /azimuth, usually expressed in degrees (o) or according to 4 or 8 cardinal directions, of the downhill direction of the imaginary line following the steepest slope gradient (where water could run off) used to determine the slope, measured with a Compass.

- ✓ **Location of negative and positive fixed points**

One calls a fixed positive point a place to reach while a negative fixed point a place to avoid. These fixed points (positive and negative) are localized in the network unit during the land visits.

Examples of positive fixed points: land gradient with 2-7%, hard soil

Examples of negative fixed points: wetlands, terrain with low bearing capacity, steep land and/or unstable slopes, landslide/prone areas, flood plains, infrastructures, terrain with >10%.


Theoretical learning Activity

- ✓ Brainstorming on physical examination of the site used in forest pathways within groups.


Practical learning Activity

- ✓ Trainees in pair assess the physical examination of the site used in forest pathways.

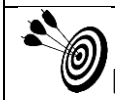

Points to Remember (Take home message)

Physical examination of the site used in forest pathways design are:

- ✓ Soil fertility and vegetation
- ✓ Hydrology
- ✓ Exposition
- ✓ Location of negative fixed points
- ✓ Location positive fixed points

Learning outcome 1.4. Design forest pathway network

Duration: 2hrs



Learning outcome 3 objectives :

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly criteria of selection of favourable place for forest pathway network
2. Identify correctly the admissible technical norms of forest pathway
3. Mark correctly slope line used in forest pathway.
4. Identify correctly levels on which the slope line of forest pathway is designed.

Resources

Equipment	Tools	Materials
Theodolite, Dumping Level, GPS, N-frame level	Ranging Poles, Pegs, Compass, Clinometers, Carpenter /water Level, , Machete, Hand Hoes,	Pencils, Papers, Map, Field book, Paints,

	Tape Measures, Ropes,	

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway design
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 1.4.1. Selection criteria of favorable place for forest pathway network

Important factors to consider during the survey of general network of forest pathways are:

✓ Land

The land is the fixed basis data that influences a general network of forest pathways. The topography of land determines the unloading techniques to use. Then, the soil nature influences on the construction techniques and on the realization cost. Thus, it is very important to know the land so that to make an optimal choice.

✓ Existing road network

The network of roads/pathways should allow the easy access to the perimeter (unit) and easy transport of the forest products towards the (purchase) industrial centers. It must be joined to the existing road/pathways

✓ Soil fertility and vegetation

The type of vegetation and soil fertility of different zones are the good indications (signs) that can help us to make a good choice. On will elaborate the variant permitting to go against to the most fertile parts of the perimeter (unit).

✓ Unloading mode

The unloading mode acts directly on the global concept of the forest road/pathways network. In the countries where the mechanized unloading exists, one uses the aerial cables installed on the mountain on which the logs roll through the pulleys attached on those cables. A road is installed (constructed) on the lower part of the wooded sides so that to facilitate the transport of logs after their unloading (detachment on the cables).

✓ Admissible technical norms

In forest pathways construction, some technical norms are restrictive (limitative), in particular the maximum longitudinal slope (<10%). This factor is very important, considering the high difference in level within the forest pathway unit.

✓ Budget

The available financial means are often limited. It is useful to be able to compare the cost of obtained different variants (based on the survey done) and make the different between their cost and profit

✓ Technical skills

The skills of technicians have crucial impact in selecting favorable places for forest pathway network because if not done properly it leads to economic losses.

Theoretical learning Activity

Brainstorming on criteria to consider while selecting favourable place for forest pathway network.

Practical learning Activity

✓ Not applicable.

Points to Remember (Take home message)

Important factors to consider during the survey of general network of forest pathways are:

✓ Land
✓ Existing road network
✓ Soil fertility and vegetation
✓ Unloading mode
✓ Admissible technical norms
✓ Budget
✓ Technical skills

Indicative content 1.4.2. Admissible technical norms of forest pathway

Admissible technical norms of forest pathway

- ✓ In forest pathways construction, some technical norms are restrictive (limitative), in particular the maximum longitudinal slope (<10%). This factor is very important, considering the high difference in level within the forest pathway unit.
- ✓ The standards norms for forest pathway are:
  - width varying from 3.5 to 5m;
  - longitudinal slope varies from 2 to 7% and
  - in rocky soil, side slope/embankment is 10/1 or 5/1 and
  - in normal soils side slope/embankment is 1/1 or 2/1.

Theoretical learning Activity

- ✓ Brainstorming about technical norms to respect in forest pathway design within groups.

Practical learning Activity

- ✓ Not applicable

Points to Remember (Take home message)

The standards norms for forest pathway are:

- ✓ Width varying from 3.5 to 5m;
- ✓ Longitudinal slope varies from 2 to 7% and
- ✓ In rocky soil, side slope/embankment is 10/1 or 5/1 and
- ✓ In normal soils side slope/embankment is 1/1 or 2/1.

Indicative content 1.4.3. Slope line marking

Marking of slope line

- ✓ A slope line is a line that follows the ground level (on the soil surface) with a certain percentage of slopes.
- ✓ When the ground is regular with few vegetation, the staking out of the slope line could be done at every **50m**.
- ✓ If the ground is irregular with more vegetation (obstacles), the pegs should be driven at every **10** or **20meters**.It is important to clear the slope line using paint on some trees or other mark (sign) on the trees.
- ✓ The slope variation must be shown on the pegs and then, a path can be made between every two pegs in order to make the slope line more visible.
- ✓ The survey of slope line is made on two levels:
  - On the ground and
  - In the office

Theoretical learning Activity

- ✓ Brainstorming about the procedure to follow when marking slope line.

Practical learning Activity

- ✓ Trainees form groups of four (4) members and mark the slope line.
- ✓ From the recorded data, each trainee designs the slope line according to the given scale.

Points to Remember (Take home message)

The marking procedures of slope line are:

- ✓ Pegs are fixed/driven at every 50meters if the land is regular without more vegetation

- ✓ Pegs are fixed/driven at every 10 or 20 meters if the land is irregular with more vegetation.
- ✓ The slope variation must be shown on the pegs by using paint/markers.

Learning unit 1. formative assessment

Written assessment

Question 1. Define the term slope line. /1mark

answer

A slope line is a line that follows the ground level (on the soil surface) with a certain percentage of slopes. /1mark

Question2. What are important factors to consider during the survey of general network of forest pathways are:/5marks

Answer

Important factors to consider during the survey of general network of forest pathways are:

- ✓ Land
- ✓ Existing road network
- ✓ Soil fertility and vegetation
- ✓ Unloading mode
- ✓ Admissible technical norms
- ✓ Budget
- ✓ Technical skills

Consider 5 correct answers

Question3. Choose the correct answer

A. One of the following types of terrains is a good example of negative fixed point (during the forest pathways construction). /**1mark**

a) Swamp /wetland
b) Terrain with gentle slope
c) Terrain with clay soil
d) Terrain with more vegetation
e) All answers are correct

B. The followings are the examples of positive fixed points EXCEPT: /**1mark**

a) Terrain with gentle slope
b) Hard and compact soil
c) Non habited area

d) Terrain with rocky soil
e) Unfertile/poor zone /area

Answers

A. The following is a good example of Negative fixed point:
a) Swamp /wetland/**1mark**

B. The characteristics of a good example of positive fixed points are the following EXCEPT:
d) Terrain with rocky soil/**1mark**

Practical assessment

✓ Not applicable

Learning Unit 2: Apply forest pathways construction

STRUCTURE OF LEARNING UNIT

Learning outcomes:

2.1. Stake out forest pathways
2.2. Estimate financial means and human resource

2.3. Terrace forest pathways 2.4. Construct water evacuation system

Learning outcome 2.1. Stake out forest pathways

Duration: 8hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly tools, equipment and materials used for forest pathway staking out.
2. Select correctly tools, equipment and materials used for forest pathway staking out
3. Handle appropriately tools, equipment and materials used for forest pathway staking out.

Resources

Equipment	Tools	Materials
Theodolite, Dumping Level, GPS, N-frame level	Ranging Poles, Pegs, Compass, Clinometers, Carpenter /water Level, Machete, Hand Hoes, Tape Measures, Ropes,	Pencils, Papers, Map, Field book, Paints,

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway staking out.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 2.1.1. Staking out procedures of forest pathway

The method of determination of the slope (based on the topographic, geological and climatic conditions) permits to carry out the definitive picketing of the slope line. The slope measurement is often done using back reading method.

This technique presents several advantages such as:

- ✓ One measures on a fixed point (already definitive);

There are no verbal instructions given by the operator to his/her assistant. So the operator displaces himself;

- ✓ In the case of an irregular land, the operator finds the wanted slope more quickly;
- ✓ One can control the level at the same time of staking in (driving) of pegs.

The definitive staking out of a forest pathway delimits every point of the pathway by the level pegs (LP) having the notch, placed on the outside of pathway and the slope pegs (SP) placed to the summit (top side) of the cut slope. There are three main factors that determine the distance between level pegs and slope pegs such as:

- ✓ Width of the pathway to construct;
- ✓ Slope of cut slope (side slope) and
- ✓ Slope of land.

To mark the slope line, the operator proceeds as follows:

- ✓ To measure 10m (in general) from the last determined point;
- ✓ To measure approximately the wanted slope (2to7%);
- ✓ To clear the place where is going to be the peg; The aim of clearing of that place is to eliminate /reduce the irregularities of land and to remove away the soft soil layer;
- ✓ To look for the precise place to have the wanted slope. Thus, the operator moves on the free place while controlling the distance between the points;
- ✓ To drive /fix the numbered peg having the notch that shows the level of future forest pathway;
- ✓ From the level peg (LP), to measure the slope of land perpendicularly to the axis of the pathway to construct.
- ✓ To read in the table of measures for forest pathway construction the distance corresponding to the measured land slope;
- ✓ From level pegs (LP), measure the read distance and drive (fix) the slope peg (SP) on this place;
- ✓ To restart the operation for the neighboring point.

Theoretical learning Activity

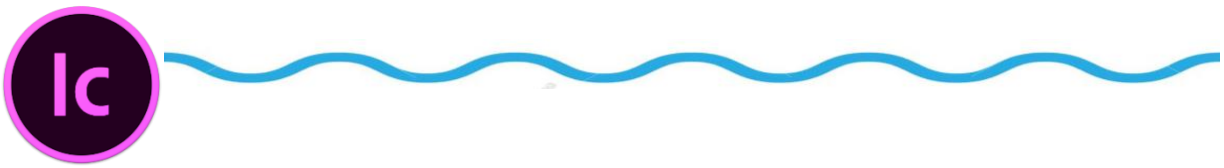
- ✓ Brainstorming about types of tools, materials and equipment used in forest pathways staking out within groups.

Practical learning Activity

- ✓ Trainees in pair select forest pathway tools, Equipment and materials used in forest pathway staking out.
- ✓ Trainees in pair handle forest pathway tools, Equipment and materials used in forest pathway staking out.

Points to Remember (Take home message)

- ✓ The slope measurement in staking out of forest pathway is often done using back reading method.
- ✓ The main factors that determine the distance between level pegs and slope pegs such as:
  - Width of the pathway to construct;
  - Slope of cut slope (side slope) and
  - Slope of land.



Indicative content 2.1.2. Peg standards used in staking out forest pathway

- ✓ The standard dimensions of level pegs used in forest pathway staking out are:
  - Length of 70 cm,
  - Diameter of 3-5 cm.
  - Numbered
  - Have notch

- ✓ The standard dimensions of slope pegs used in forest pathway staking out are:
  - Length of 70cm
  - Diameter of 3-5cm
  - Numbered


Theoretical learning Activity

- ✓ Brainstorming on the standard dimensions of pegs used in forest pathways staking out within groups.

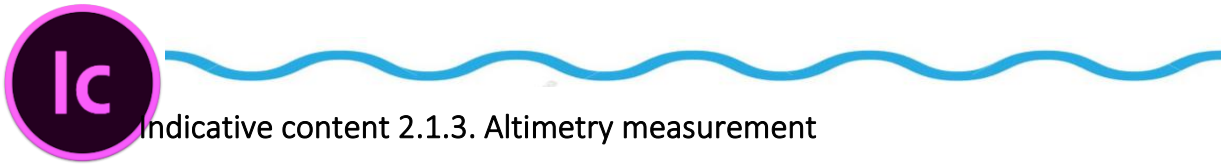

Practical learning Activity

- ✓ Trainees in pair prepare four (4) standardized pegs used in forest pathway staking out.


Points to Remember (Take home message)

There are two types of Pegs used in staking out forest pathway:

- Slope pegs
- Level pegs


Indicative content 2.1.3. Altimetry measurement

- ✓ Altimetry is the measurement of height or altitude.
- ✓ Altimeter: is a device that measures altitude, the distance of a point above sea level.

Altitude

- Altitude or elevation is defined as the vertical distance from a datum plane, usually mean sea level, to a point above the earth surface, expressed in meters above sea level.

- Equipment used to determine altitude are : GPS and altimeter

 Theoretical learning Activity

✓ Brainstorming on altimetry measurement in forest pathways staking out within groups.

 Practical learning Activity

✓ Not applicable

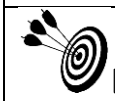
 Points to Remember (Take home message)

In altrimetry measurement we consider the folowing points:

- Altitude
- Elevation /height

Learning outcome 2.2. Estimate financial means and human resource

 **Duration: 8hrs**

 Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Estimate correctly the quantity of soil to cut in forest pathway construction.
2. Estimate correctly required time for constructing the forest pathway
3. Estimate correctly the number of workers required for constructing the forest pathway
4. Estimate accurately tools, equipment and materials required for constructing the forest pathway

 **Resources**

Equipment	Tools	Materials
	Calculator, labour code, table of measures.	Sheet of papers

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway construction.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 2.2.1. Estimation principles of tools/equipment and human resource

- ✓ **A man-hour** is the amount of work performed by the average worker in one hour. It is used in written "**estimates**" for estimation of the total amount of uninterrupted labor required to perform a task.
  - Man-hours do not take account of the breaks that people generally require from work, e.g. for rest, eating, and other bodily functions. They only count pure labor. Managers count the man-hours and add break time to estimate the amount of time a task will actually take to complete.
- ✓ **Working days**: days per week a worker/ person works. In Rwanda, the working days per week are 5days while the working hours per day vary from 8 to 9 hours. Thus, the working days per month are estimated at 25 days.
- ✓ ***A simple formula: No. of forestry workers= Total man-hours ÷ actual work days ÷ working hours/day.***

Theoretical learning Activity

- ✓ Brainstorming on estimation principles of tools equipment and human resource within groups.

Practical learning Activity

Considering that, it requires 30000 man-hours to construct a forest pathway for six months. Trainees in pair estimate the number of workers you will need to perform that task if every worker works 8hours per day. Remember that the working days for each month are 25days.

Answer:

Total number of working days= 25days ×6= **150days**

No. of forestry workers= Total man-hours ÷ actual work days ÷ working hours/day.

No. of forestry workers= 30000 man-hours ÷ 150 work days ÷ 8 hours/day= **25 forest workers**

Points to Remember (Take home message)

- ✓ Estimation principles of tools/equipment and human resource in forest pathway construction are:
  - Local cost for man day
  - Man-hour
  - Local cost for Tools and equipment
  - Cost of tools and equipment
  - Labour code (working hours per day, working days per week, per month)
  - Payment system (daily, monthly, by task)

Indicative content 2.2.2. Estimation of soil cut and fill

- ✓ **Calculation of soil volume to cut**

On the drawing of profile across, one calculates the surface representing the soil cut (m3 /m). One takes the sum of height multiplied by 1meter section what gives the profile surface. The volume of soil cut between two profiles across is calculated using the following formula:

- Soil volume= $\frac{profile\ surface\ 1 + profile\ surface 2}{2}$ × Distance between two profiles.

Theoretical learning Activity

- ✓ Brainstorming about estimation of soil cut and fill during forest pathway construction.

Practical learning Activity

Considering that the surface area of one profile is 92 cm^2 while the second profile is 120cm^2. Determine the soil volume to cut if the distance between those profiles is 1 meter.

- Answer:

Formula of soil volume to cut

Soil volume= $\frac{profile\ surface\ 1+profile\ surface2}{2}$ × Distance between two profiles.

$\frac{92cm2+120cm2}{2}$ × 1m= $\frac{212cm2}{2}$ ×1m =$\frac{2.12m2}{2}$ ×1m = 1.06 m^3

Points to Remember (Take home message)

- ✓ Calculation of soil volume to cut.
  - Surface area of each profile.
  - Distance between profiles.
  - Estimation of soil cut and fill by using formula.

Learning outcome 2.3. Terrace forest pathways

Duration: 12hrs

Learning outcome 2.3. objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly the terracing procedures followed in forest pathway terracing.
2. Select appropriately the profile types to be used in forest pathway terracing.
3. Identify correctly the standard dimensions of a well-constructed forest pathway

Resources

Equipment	Tools	Materials
Wheelbarrow, Trucks, Bulldozers, Rock drill, Excavator, Compactors.	Machetes, hoes ,tape measure, rope, spades, surfacing material, axes, pickaxes, metal/mine bars, hammer, carpenter level.	warning tape, paint.

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway construction.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 2.3.1. Terracing procedures

During the forest pathway construction, the following steps must be performed:

✓ To reclaim and clear the distance between level pegs (LP) and slope pegs (SP) and cut the vegetation above the slope pegs until 1meter;

✓ To put the cut vegetation (including trees) below the pathway so that to keep the soil during terracing;

✓ To dig a street of 1m large between the level pegs while respecting the longitudinal slope;

- ✓ To begin the digging (terracing) starting from the slope pegs level;
- ✓ To descend progressively while pushing the soil behind the level pegs while respecting the slope of cut slope;
- ✓ To continue to dig soil until the required width is reached.
- ✓ To assure the rain water evacuation system by creating the trenches (openings / outlets) in the bench;
- ✓ To regularize the slope of cut slope (Embankment) from the bottom to the summit;
- ✓ To respect the pathway level identified by the notch of level pegs and make level (levelling) the travel- way while respecting the wanted profile (in general 5%);
- ✓ To prepare the benches while respecting a height of 50cm, internal slope:2/1 and make level on its top side;
- ✓ To finish the openings in the benches (outlets), width on the bottom:50cm, lateral side slope:2/1, water evacuation slope:10%;
- ✓ To proceed to the finishing works: gravels spreading on the travel-way, pavement of openings in the benches using the flat stones.

Theoretical learning Activity

- ✓ Brainstorming on terracing procedure in forest pathway construction within groups.

Practical learning Activity

- ✓ Trainees in group of five (5) perform terracing of a street of 1m wide and 5m long

Points to Remember (Take home message)

- ✓ Stages of forest pathway construction
- ✓ Slant of forest pathway.
- ✓ Width of forest pathway.

Indicative content 2.3.2. Types of pathway profile

✓ **Travel-way having flat profile**

This type of forest pathway having the flat profile is little frequent used as it very difficult to evacuate water on the travel-way level.

- ***Advantages*** of a forest pathway having a flat profile (Balanced earth work section):
  - There is a minimal clearing width on the site;
  - There is a little skidding risk of vehicles/trucks

✓ **Travel-way having an out sloped profile**

- ***Characteristics:***
  - Width: 3m or 4m large;
  - Slant downstream inclined to 5%;
  - Regular without depressions or bumps;
  - Constructed on the stable land (hard soil).

✓ **Travel-way having an in-sloped profile.**

In general, one changes the slant of the forest pathway on the places where there are the tightened corners having the centre on the uphill side so that to avoid the skidding of vehicles/trucks. Therefore, it is important that the profile of forest pathway remains the same (identical) on the whole length of corner.

It is necessary to plan the widening of forest pathway for ditch construction or the widening due to the tight corner. The travel-way having an in sloped section is used in the case we want to avoid that the rain water does not run (flow) in the downstream direction just above the habitations or the parts rightly over the corner.
Normally, after every change of slant, it is necessary to install a gutter that will evacuate the rain water coming from uphill ditch.

✓ **Travel-way having a crowned / rounded profile.**

In general, the travel-way with a crowned section is little frequent used in forest pathway construction. This type of profile is used for the forest pathways passing on the top line (ridge) where the rain water could be poured directly on two sides of pathway (left and right sides).

Theoretical learning Activity

✓ Discussion on different forest pathway profile within groups.

Practical learning Activity

✓ Not applicable

Points to Remember (Take home message)

✓ Types of pathway profile in forest pathway construction are:

- Flat (balanced)
- In-slopped
- Out-slopped
- Crowned

Indicative content 2.3.3. Selection of surfacing materials

The objective of surfacing pathway /road is to give it a surface which is more stable, harder wearing and less slippery than the material of which the main formation is made.

There are two principal types of material which a road can be surfaced, those with binders and those without. Crushed stones and gravels have no inherent binding quality. Quarry gravels and rotten rock will usually contain some proportion of binder in them, and clay is used purely as a binder. Each material has its particular properties in use.
The common surfacing materials used in forest pathway construction are the following:

✓ **Broken/crushed stones**

The broken stones are obtained by crushing the stones by using hammer. This is the cheapest way for finding out the surfacing material.
This is hard, will provide a non-slip surface but lacks any binder. If applied directly to a clay formation, this is best done when the clay is still wet after rain. It can then be spread and rolled in immediately and this will ensure that it is well bound by the clay. Well done, this type of surface can be almost as good as a tarmacadam road and will last well for as long as the moisture content of the formation is correct.

✓ **Gravel**

Like broken stone, gravel will be lacking in any binder. It will have the advantage of being rounded which make it much kinder on the tyres of the trucks /vehicles using the pathway /road but will also provide a marginally poorer grip in wet weather. Spread as broken stone. Volcanic soils or gravel taken from river bank are the cheapest surfacing material for the forest pathways and feeder roads.

✓ **Laterite soil**

On rural projects the native soil itself will form the primary building material for the forest pathways / feeder roads. It is important therefore to be able to recognize which soils are suitable and which soils are likely to give trouble. Fortunately, most soils are good for agriculture for the very same reason that they can be good for road making namely their structure.
Well-structured soils have excellent bearing quantity when normally moist, though they will break down under heavy loads if either too wet or too dry.


Theoretical learning Activity

- ✓ Discussion on different surfacing materials used in forest pathway construction within groups.


Practical learning Activity

✓ Not applicable


Points to Remember (Take home message)

- ✓ Types of surfacing materials used in forest pathway construction are
  - Gravel
  - Laterite
  - Broken stones

Indicative content 2.3.4. Soil erosion control around the forest pathway.

- ✓ **Side slope (embankment) stabilization methods**
  - To install /plant the fixing plants on soft or unsteady parts (for example after big slips).
  - To create terraces in the form of stairs to avoid sliding of embankment
  - To construct a stone beach that works as barrier

- ✓ **Ways used to stabilize fill slope of the forest pathway**
  - To sow directly on the fill slope,
  - To establish cuttings on lines (using depth: 20cm, spacing: 40cm x 50cm): or planting of adequate plant species.
  - To plant to roots or clods:
  - These activities are carried out on the upper part of fill slope at least from 3 to 5m, (according to the length of fill slope).

- ✓ **Instructions to follow when stabilizing fill slope of the forest pathway**
  - To plant tightly (using short spacing);
  - The tree species having many roots will be planted below the travel-way level;
  - To plant in the rain season.
  - To construct a stone beach that works as barrier


Theoretical learning Activity

- ✓ Discussion on fill slope stabilization within groups.


Practical learning Activity

- ✓ Trainees in group of four (4) members, perform stabilization of fill slope at a distance of five (5) meters.

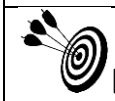
Points to Remember (Take home message)

✓ Soil erosion control around the forest pathway we consider the following:

- Methods Side slope (embankment) stabilization
- Ways used to stabilize fill slope of the forest pathway
- Instructions to follow when stabilizing fill slope of the forest pathway.

Learning outcome 2.4. Construct water evacuation system

Duration: 8hrs



Learning outcome 2.4. objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly water evacuation structures used in forest pathway.
2. Mark correctly any water evacuation structure used in forest pathway
3. Install correctly water evacuation structures used in forest pathway.

Resources

Equipment	Tools	Materials
Theodolite Dumping Level Bulldozer, Trucks, Wheelbarrow, Rock drill Excavator	Ranging Poles, Pegs, Clinometers, Water Level, Machete, Hand Hoes, Tape Measures,	Logs; Nails; Galvanized fil; Cement; Gravel; Sand; Water.

	Ropes, Spade Sledge Hammer Pickaxe, Metal/Mine Bar, Gabbaret/ Channel, Poles.	

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway construction.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 2.4.1. Water evacuation structures designs

- ✓ **Uphill ditch**

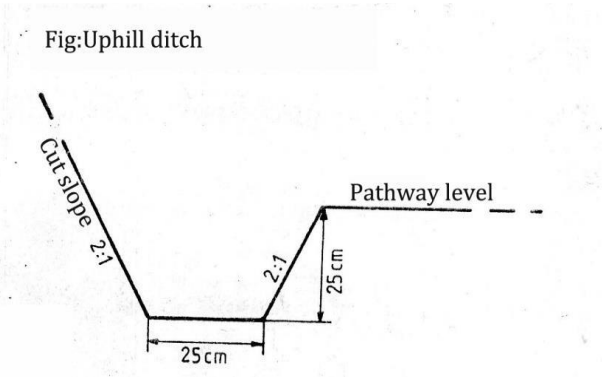


Fig:Uphill ditch

- ***Objectives***
  - To conduct rain water towards gutter;
  - To allow the maintenance of ditch using a shovel or spade.

- ✓ **Gutter**

During forest pathway construction, a gutter is the edge of pathway/ road where rain water flows away.

Objectives of a gutter is to conduct the rain water coming from uphill ditch

- ***Characteristics:***
  - Gutter may be covered or not, respecting the travel-way level;
  - Constructed using hard and healthy wood: minimum length: 2m, minimum diameter: 25cm;
  - All logs used to construct gutter are supported by two load bearing logs;
  - If covered: soils layer having at least 25cm thickness, with stones between the logs. Then, the lateral logs reduce the risk of soil erosion;
  - The four signaling posts (15cm diameter) established in four corners. Other function of four signaling posts is to keep firmly the load bearing logs.
  - Depth: 50cm under the logs;
  - Width to the bottom: 50cm;
  - Water evacuation slope: 5 to 10%.

Fig:Good cutting of gutter

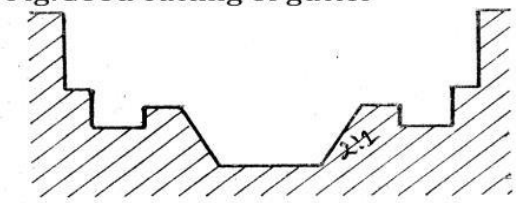
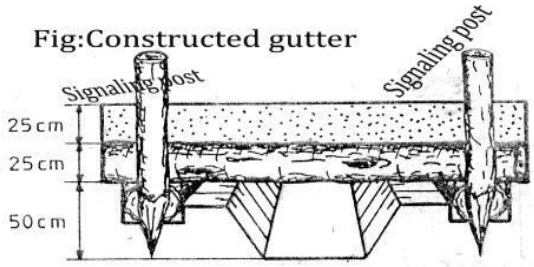
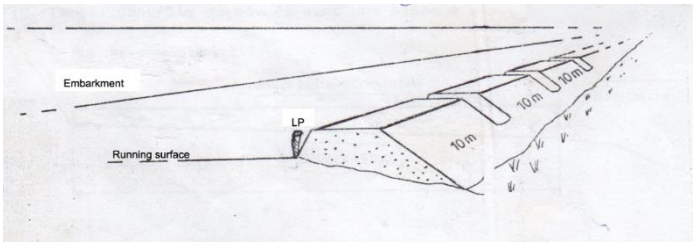


Fig:Constructed gutter



✓ **Opening in the benches (outlet)**

Outlets are the cuts done into the bench so that to facilitate the water evacuation from the travel way (running surface).



They are created at every 10 meters and have the following characteristics:

- Width on the bottom: 50m;
- Internal side slope: 2/1;
- Water evacuation slope 5 to 10 %.

✓ **Bridge**

Bridge is a structure that is built over a stream or river so that people or vehicles can cross from one side to another.

The bridge sites can be classified by whether they are on the river's torrent course or flood plain course, whether the banks are of rock or of soil, whether one span or several spans are required and, if several spans, whether the river bed is soft, stony or of rock.

Site type will largely determine the foundations to be used. If the site is rocky, piling is impossible. If the bridge is to cross a deep narrow valley it is likely that the bridge foundations can be placed well above any conceivable water level and piling will be unnecessary. If the foundations are liable to be washed over by the river when it is in flood, something more substantial like gabions or reinforced concrete footing will be required.

Bridge widths should ideally comfort to road widths since road widths are going to be related to traffic density. A single lane width bridge is logical on forest pathways / feeder roads, provided that it is wide enough for all the trucks that are going to use and maintain the pathways to pass over it with reasonable clearance. For main roads, width enough for vehicles to pass one another is desirable.

✓ Before the construction of a bridge, the following criteria should be considered: Watershed dimensions,

- **Precipitation:** highest water level in the river (per year) and the discharge of the river. This information allows the forest technician to data about the surface water width, water depth and river bed width.
- **Sub-soil quality** (rock, gravel, firm soil, sandy or clay soil)
- **Topographical condition**,

- **Traffic intensity**: on the forest pathways, the traffic intensity is not high, few vehicles run on the pathway per week, but during the forest harvesting activities, the circulation and weight of trucks will be increased.
- **Available economic means**.

Theoretical learning Activity

- ✓ Brainstorming on standard dimension of water evacuation structures of forest pathway within groups.
- ✓ Brainstorming on factors to consider when constructing a bridge of forest pathway within groups.

Practical learning Activity

- ✓ Trainees in group of four (4) members perform construction of gutter.
- ✓ Trainees in group of four (4) members perform construction of uphill ditch of 10 meters long.

Points to Remember (Take home message)

- ✓ Water evacuation structures of forest pathway are:
  - Uphill ditches
  - Gutter
  - Opening in the benches (outlet)
  - Bridges

Indicative content 2.4.2. Construction procedure of water evacuation structures

✓ **Uphill ditch**

- ***Objectives***
  - To conduct rain water towards gutter;
  - To allow the maintenance of ditch using a shovel or spade.

✓ **Gutter**

During forest pathway construction, a gutter is the edge of pathway/ road where rain water flows away.
Objectives of a gutter is to conduct the rain water coming from uphill ditch

- ***Characteristics:***
  - Gutter may be covered or not, respecting the travel-way level;
  - Constructed using hard and healthy wood: minimum length: 2m, minimum diameter: 25cm;
  - All logs used to construct gutter are supported by two load bearing logs;
  - If covered: soils layer having at least 25cm thickness, with stones between the logs. Then, the lateral logs reduce the risk of soil erosion;
  - The four signaling posts (15cm diameter) established in four corners. Other function of four signaling posts is to keep firmly the load bearing logs.
  - Depth: 50cm under the logs;
  - Width to the bottom: 50cm;
  - Water evacuation slope: 5 to 10%.

Fig:Good cutting of gutter

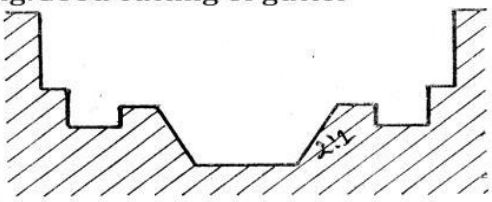
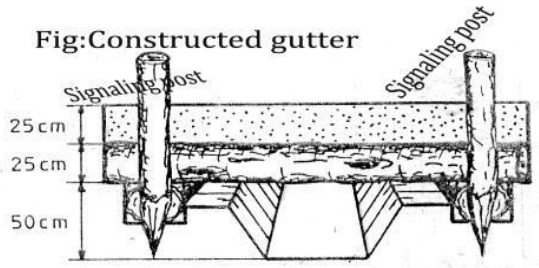


Fig:Constructed gutter



✓ **Opening in the benches (outlet)**

Outlets are the cuts done into the bench so that to facilitate the water evacuation from the travel way (running surface).

✓ They are created at every 10 meters and have the following characteristics:
- Width on the bottom: 50m;
- Internal side slope: 2/1;
- Water evacuation slope 5 to 10 %.

✓ **Bridge**

- Bridge is a structure that is built over a stream or river so that people or vehicles can cross from one side to another.

- The bridge sites can be classified by whether they are on the river's torrent course or flood plain course, whether the banks are of rock or of soil, whether one span or several spans are required and, if several spans, whether the river bed is soft, stony or of rock.

- Site type will largely determine the foundations to be used. If the site is rocky, piling is impossible. If the bridge is to cross a deep narrow valley it is likely that the bridge foundations can be placed well above any conceivable water level and piling will be unnecessary. If the foundations are liable to be washed over by the river when it is in flood, something more substantial like gabions or reinforced concrete footing will be required.

- Bridge widths should ideally comfort to road widths since road widths are going to be related to traffic density. A single lane width bridge is logical on forest pathways / feeder roads, provided that it is wide enough for all the trucks that are going to use and maintain the pathways to pass over it with reasonable clearance. For main roads, width enough for vehicles to pass one another is desirable.

✓ Before the construction of a bridge, the following criteria should be considered: Watershed dimensions,

- **Precipitation:** highest water level in the river (per year) and the discharge of the river. This information allows the forest technician to data about the surface water width, water depth and river bed width.
- **Sub-soil quality** (rock, gravel, firm soil, sandy or clay soil)
- **Topographical condition**,
- **Traffic intensity**: on the forest pathways, the traffic intensity is not high, few vehicles run on the pathway per week, but during the forest harvesting activities, the circulation and weight of trucks will be increased.
- **Available economic means**.

Theoretical learning Activity

- ✓ Brainstorming on standard dimension of water evacuation structures of forest pathway within groups.
- ✓ Brainstorming on factors to consider when constructing a bridge of forest pathway within groups.

Practical learning Activity

- ✓ Trainees in group of four (4) members perform construction of gutter.
- ✓ Trainees in group of four (4) members perform construction of uphill ditch of 10 meters long.

Points to Remember (Take home message)

- ✓ Water evacuation structures of forest pathway are:
  - Uphill ditches
  - Gutter
  - Opening in the benches (outlet)
  - Bridges

Learning unit 2. Formative assessment

Written assessment

Question1. Identify at least four (4) standard measurements to respect /apply during the forest pathways construction. **/4marks**

Answer:

- ✓ Travel way width varying from 3.5 to 5m;
- ✓ Longitudinal slope varies from 2 to 7%;
- ✓ In rocky soil, side slope/embankment is 10/1 or 5/1 and
- ✓ In normal soils side slope/embankment is 1/1 or 2/1;
- ✓ Fill slope: 1/1;
- ✓ Bench: height 50cm; flat on the top; top side minimum 1m width.

Question2. Choose the correct answer

A. Which of the following is NOT a component of the water evacuation system?

a) Uphill ditches,
b) Outlets (openings in the benches)
c) Gutters.
d) Travel-way (running way).

B. The objectives of stabilizing the fill slope (downstream slope) are:

a) To avoid land sliding / disconnecting;
b) To reduce the risk of soil erosion;
c) To have the logs for gutters repairing in the future.
d) All answers are correct
e) Non correct answer

C. An advantage of the travel-way having an in-sloped cross-section is:

a) There is a minimal clearing width on the land;
b) There is no maintenance of ditch and gutter.
c) The water coming from uphill side (cut slope) does not crosses the travel-way;
d) All answers are correct.
e) There is no correct answer.

Answers:

A. Which of the following is NOT a component of the water evacuation system:

d) Travel-way (running way).

B. The objectives of stabilizing the fill slope (downstream slope) are:

d). All answers are correct

C. Advantage of a travel-way having an in-sloped cross-section is:

c) The water coming from uphill side (cut slope) does not crosses the travel-way.

Practical assessment

Your school wants to construct a forest pathway connecting the nursery site and the nearest road. In group of four members, you are asked to perform terracing of a street of 1m wide and 5m long

Instructions:

All tools and equipment are available in the school store.

Use the outsloped profile

The task will be performed in 4 hours.

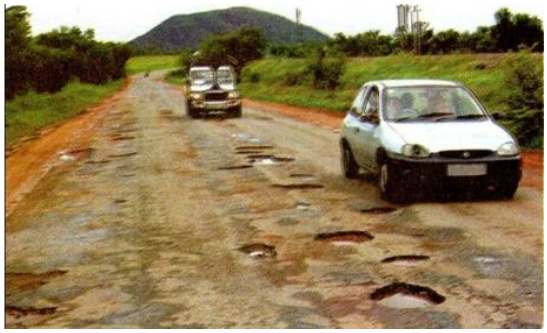
Checklist

Criteria	Indicators and Elements of verification	Score	
Quality of process	**Indicator 1:** tools and equipment are adequately prepared	Yes(Y)	No (N)
	1. tools and equipment for land clearing are prepared		
	2. tools and equipment for land measuring are prepared.		
	3. tools and equipment for land soil digging are prepared		
	Indicator2. stages of forest pathways terracing are well respected		
	1.distance between LP and SP is cleared		
	2.vegetation above SP is cut		
	3. soil excavation is done		
Quality of product	**Indicatot1:** Dimensions are well respected		
	1.width of 1meter is measured		
	2.slope of embankment is respected		
	3.level of street is identified by the notch of LP		
	4.Slope of embankment is respected		
	Indicator 2: street profiles is well respected		
	1.slant is inclined toward the bench at 5%		
	2.width of 1m is respected		
	3.uphill ditch is absent		
	4. profile levelling is done		
Relevance	**Indicator 1.** The selected tools, materials ,equipment are used properly		
	1.No damaged tools		
	2.No lost tool or equipment		
	3.Selected tools, materials and equipment are used intended task.		
	Indicator 2. Time is well respected.		
	1.four (4) hours are respected		
	Indicator 3: water evacuation systems are well established		

	1.bench is established		
	2.outlets are created in the bench		
	3.water evacuation slope (5-10%)is respected		
	4.Internal slope (2/1) is respected		
Safety	**Indicator 1**. Hazards are well controlled		
	1.Risk and hazard are identified		
	2.Risk and hazard are removed		
	Indicator 2. PPE is worn properly		
	1.Helmet is worn		
	2.Overall is worn		
	3.Boots is worn		
	4.Gloves is worn		
	Indicator 3. Handling tools and equipment are well done		
	1.Manipulation is applied		
	2.Adjustment of tools is done		
	3. Cleaning is respected		
Hygiene	**Indicator 1.** Tools, material and equipment are well maintained		
	1.Cleaning is respected		
	2.Oiling is respected		
	3.Washing is done		
	4.Drying is respected		
	Indicator 2. Tools, material and equipment are well stored		
	1.Tools and equipment are stored in suitable place		
	2.no tools and equipment are lost		
	Indicator 3. Workplace hygiene is well respected		
	1.All used tools materials and equipment are collected		
	2. All stones are deposed in appropriate place		

Learning Unit 3: Maintain forest pathways

Picture/s reflecting the Learning unit 3



STRUCTURE OF LEARNING UNIT 3. Maintain forest pathways

Learning outcomes:

3.1. Assess the status of forest pathways
3.2. Clean up the forest pathway
3.3. Rehabilitate the damaged forest pathways

Learning outcome 3.1. Assess the status of forest pathways

Duration: 3hrs

Learning outcome 3.1. objectives:

By the end of the learning outcome, the trainees will be able to:

1. Assess correctly forest pathway status.
2. identify correctly damaged forest pathway parts.
3. Set appropriately frequencies maintenance of forest pathway.

Resources		
Equipment	**Tools**	**Materials**
	Ranging Poles, Carpenter Level, Tape Measures, Spade, Gabbaret/ Channel, Poles.	

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway status assessment.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 3.1.1. Inspection frequency

- Normally, the damages must be repaired as early as possible, as soon as they are observed. It is necessary to inspect the forest pathway status during and after the rainfall. Firstly, one controls the water evacuation system to ensure that ditches, gutters and openings in the benches accomplish their function.
- When it rains or when the forest pathway is wet, it is not better to execute the maintenance works on the travel-way, cut slope and fill slope. Some particular works such as the replacement of rotted logs on the gutter can be done during the period at which they are less works.
- The inspection of forest pathway can be done on daily, weekly, monthly, quarterly and annually basis. It consists of checking of the pathway profile (flat, in-slopped, out-slopped, and crowned), the recommended size of pathway parts (embankment, fill slope, width) and status of pathway structures such as uphill ditch, gutter, outlet, and bridge.

Theoretical learning Activity

- ✓ Brainstorming on inspection frequency in forest pathways maintenance within groups.

Practical learning Activity

✓ Not applicable

Points to Remember (Take home message)

- ✓ The forest pathway maintenance frequencies are:
  - Daily
  - Weekly
  - Monthly
  - Quarterly and
  - Annually basis
- ✓ Forest pathway parts to assess are:
  - Travel way;
  - embankment/ cut slope;
  - water evacuation systems and
  - fill slope.

Indicative content 3.1.2. Standard dimensions of forest pathway parts

- ✓ Embankment/ Side slopes: 2/1; 5/1;10/1
- ✓ fill slope: 1/1
- ✓ running surface (travel way): 3-5m width; water evacuation slope: 5%;
- ✓ Uphill ditch: Width to the bottom: 25cm; Depth: 25cm; Regular longitudinal slope.
  Gutter: Depth: 50cm under the logs; Width to the bottom: 50cm; Water evacuation slope: 5 to 10%.

- ✓ outlet: height 50cm; Width to the bottom: 50cm; Water evacuation slope: 5 to 10%; side slope 2/1.

- ✓ Bridge: The standard dimensions of bridge vary depending on:
  - Watershed dimensions
  - Precipitation:
  - Sub-soil quality
  - Topographical condition,
  - Traffic intensity:
  - Available economic means


Theoretical learning Activity

- ✓ Brainstorming on standard dimensions of forest pathway parts to be assessed within groups.


Practical learning Activity

- ✓ Trainees in pair determine the standard dimensions of forest pathway parts.


Points to Remember (Take home message)

- ✓ Standard dimensions of forest pathway parts are:
  - Embankment: 2/1; 5/1;10/1
  - Fill slope: 1/1
  - Uphill ditch: Width: 25cm; Depth: 25cm; Regular longitudinal slope.

  Gutter: Depth: 50cm under the logs; Width to the bottom: 50cm; Water evacuation slope: 5 to 10%.
- ✓ Outlet: height 50cm; Width to the bottom: 50cm; Water evacuation slope: 5 to 10%; side slope 2/1.

Learning outcome 3.2. Clean up the forest pathway

Duration: 5hrs

Learning outcome 1 objectives:

By the end of the learning outcome, the trainees will be able to:

1. Perform correctly desilting of water evacuation structures of forest pathway.
2. Apply correctly weeding of water evacuation structures of forest pathway.
3. Apply correctly clearing of forest pathway embankment.

Resources

Equipment	Tools	Materials
Trucks, Wheelbarrow.	Sickle, Tape Measures, Spade, Gabbaret/ Channel, Poles, Machete .	Warning tape

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway cleaning.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 3.2.1. Desilting of water evacuation structures

- ✓ The main objective of forest pathways maintenance is to keep them in good status for all time and in the economic way. A good maintenance of a forest pathway that is done

at a favourable moment guarantee a practicable pathway manages vehicles and permits a rational use of economic means.

✓ Desilting procedures

- To empty the ditches so that they recover their ideal profile;
- The removed material on the bottom of ditches must not be spread on the travel-way surface, but thrown behind the benches;
- To replace the rotted logs by the hard and healthy logs;
- The removed material on the bottom of ditches must not be spread on the travel-way surface, but thrown behind the benches;
- If necessary, to give back the ideal profile.

Theoretical learning Activity

✓ Brainstorming on desilting of water evacuation structures within groups.

Practical learning Activity

✓ Trainees in pair perform desilting of water evacuation structures.

Points to Remember (Take home message)

✓ Desilting procedures of water evacuation structures

Indicative content 3.2.2. Weeding and pavement of water evacuation structures

✓ Weeding procedures

- To uproot the vegetation growing in the openings (weeding);
- The removed material on the bottom of ditches must not be spread on the travel-way surface, but thrown behind the benches.
- To replace the rotted logs by the hard and healthy logs.
- If necessary, to give back the ideal profile

Theoretical learning Activity

Brainstorming on weeding and pavement of water evacuation structures in forest pathways within groups.

Practical learning Activity

Trainees in pair perform weeding and pavement of water evacuation structures.

Points to Remember (Take home message)

- ✓ Weeding procedures

Indicative content 3.2.3. Clearing of embankment

- ✓ Procedures of embankment clearing
  - To cut the vegetation without pulling them;
  - To remove away the descended material that is accumulated on the travel-way side;
  - To control the slope of embankment eventually to repair the places of slips;
  - To install /plant the fixing plants on soft or unsteady parts (for example after big slips).

Theoretical learning Activity

- ✓ Brainstorming on procedures of embankment clearing within groups.
- ✓ Brainstorming on procedures of embankment stabilization within groups.

Practical learning Activity

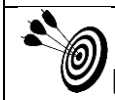
- ✓ Trainees in pair perform embankment clearing.
- ✓ Trainees in pair perform embankment stabilization.

Points to Remember (Take home message)

✓ Procedures of embankment clearing. ✓ Procedures of embankment stabilization.

Learning outcome 3.3. Rehabilitate the damaged forest pathways

Duration: 2hrs



Learning outcome 3.3. objectives:

By the end of the learning outcome, the trainees will be able to:

1. Identify correctly rehabilitation procedure of forest pathway.
2. Determine correctly maintenance frequency of forest pathway.

Resources

Equipment	Tools	Materials
Compactors, Trucks,	Ranging Poles,	Laterite, Gravel,

Wheelbarrow,	Pegs, Carpenter Level, Machete, Hand Hoes, Tape Measures, Ropes, Sledge Hammer Spade Pickaxe, Gabbaret/ Channel, Poles	Sand, Broken stones, Logs, Galvanized wires, Nails.

Advance preparation:

- ✓ Trainer have to avail tools, materials and equipment used in forest pathway rehabilitation.
- ✓ Trainer should have good collaboration with local authorities.

Indicative content 3.3.1. Rehabilitation procedure of damaged forest pathways

- ✓ Travel way rehabilitation procedures
  - To redo the travel-way so that to give back the wanted profile;
  - To uproot the vegetation growing on the travel-way and throw them behind the benches.
  - To fill in them using a good material (firm and hard soil). Not use fine or sandy soils but use gravel or broken stones!
  - To break down too big stones on the travel-way.
  - A preventive measure for their maintenance is to educate the drivers to pass on the whole width of travel-way rather than to use the same traces always.
- ✓ Gutter rehabilitation procedures
  - To replace the rotted logs by the hard and healthy logs.
  - If necessary, to give back the ideal profile;
  - To apply pavement by using flat stones.
- ✓ Ditches rehabilitation procedures
  - To uproot the vegetation growing in the openings;

- To remove away the accumulated material on the bottom side of openings;
- If necessary, to give back the ideal profile.

✓ Embankment rehabilitation procedures

- To control the slope of cut slope eventually to repair the places of slips;
- To install /plant the fixing plants on soft or unsteady parts (for example after big slips).
- To reshape the embankment so that it regains its ideal profile;

Theoretical learning Activity

Brainstorming on rehabilitation procedures of damaged forest pathways within groups.

Practical learning Activity

✓ Trainees in pair rehabilitate damaged forest pathway on the distance of 10 meters .

Points to Remember (Take home message)

✓ Embankment rehabilitation procedures.
✓ Ditches rehabilitation procedures.
✓ Gutter rehabilitation procedures.
✓ Travel way rehabilitation procedures.

Indicative content 3.3.2. Maintainance frequency

- Normally, the damages must be repaired as early as possible, as soon as they are observed. It is necessary to remove the damages on the forest pathway as soon as observed.

- When it rains or when the forest pathway is wet, it is not better to execute the maintenance works on the travel-way, cut slope and fill slope.
- The maintenance of forest pathway frequency can be done on daily, weekly, monthly basis. It consists of maintenance of the pathway parts according the level of damage.

Theoretical learning Activity

✓ Brainstorming on maintenance frequency of forest pathway within groups.

Practical learning Activity

✓ Not applicable

Points to Remember (Take home message)

✓ The forest pathway maintenance frequencies are:
- Daily
- Weekly
- Monthly

Learning unit 3. Formative assessment

Question1.Choose the correct answer

The maintenance of the travel way consists to perform the following activities except:

a) The uprooting of vegetation
b) The filling in the holes and wheel ruts using a good material (firm and hard soil).
c) Grading (redoing) the travel-way so that to give back the wanted profile;
d) Cutting the vegetation growing on the travel way
e) Break down too big stones on the travel-way.

Answer

The maintenance of the travel way consists to perform the following activities Except:

e) Cutting the vegetation growing on the travel way

Question2. What is the main objective of forest roads maintenance? /3marks

Answer:

The main objective of forest pathways maintenance is to keep them in good status for all time and in the economic way. /3marks

Question3. Briefly, explain how the maintenance of the forest road is done especially for:

a. The travel-way /running surface. /4marks

Answer

- ✓ To redo the travel-way so that to give back the wanted profile;
- ✓ To uproot the vegetation growing on the travel-way and throw them behind the benches.
- ✓ To fill in them using a good material (firm and hard soil). Not use fine or sandy soils but use gravel or broken stones!
- ✓ To break down too big stones on the travel-way.

b. The embankment. /3marks

Answer

- ✓ To cut the vegetation without pulling them;
- ✓ To remove away the descended material that is accumulated on the travel-way side;
- ✓ To control the slope of embankment eventually to repair the places of slips;
- ✓ To install /plant the fixing plants on soft or unsteady parts (for example after big slips).

Question4. Normally, the damages on the forest road must repaired as early as possible they are observed. For that reason, some people said that "*It is better to repair /maintain the forest road when it is yet too wet"* while others said that *"It is NOT better to repair /maintain the forest road when it is yet too wet".* According to you as forest technician, what is your opinion about to both sentences above? Explain your answer. /3marks

Answer

- ✓ When it raining or when the forest pathway is too wet, it is not better to execute the maintenance works on the travel-way, cut slope and fill slope because it may accelerate forest pathway damage level. /3marks

Practical assessment

All parts of forest pathway located near you school are damaged by rain water and high traffic intensity. In group of five (5), you are asked to maintain that damaged forest pathway at 10 meters long.

Instructions:

Tools, materials and equipment are available in the school store.

The task will be performed in 5 hours.

Checklist

Criteria	Indicators and Elements of verification	Score	
Quality of process	**Indicator 1:** tools, materials and equipment are adequately prepared	Yes(Y)	No (N)
	1. tools, materials and equipment for soil cutting are prepared		
	2. tools and equipment for soil transportation are prepared.		
	3. tools and equipment for desilting are prepared		
	4.tools, materials and equipment for reconstruction are prepared		
	Indicator2. Surfacing materials for forest pathway maintenance are well selected		
	1.gravel is selected		
	2.laterite soil is selected		
	3. broken tones are selected		
Quality of product	**Indicatot1:** Dimensions are well respected		
	1.width of forest pathway is restored		
	2.slope of embankment is reshaped		
	3.running surface/travel way is levelled		
	4.fill slope is repaired		
	Indicator 2: water evacuation system is well maintained		
	1.gutter is repaired		
	2.uphill ditch is reshaped		
	3.opening in the benches are reshaped		
Relevance	**Indicator 1.** The selected tools, materials ,equipment are used properly		
	1.No damaged tools		

	2.No lost tool or equipment		
	3.Selected tools, materials and equipment are used intended use.		
	Indicator 2. Time is well respected.		
	1.four (5) hours are respected		
	Indicator 3: water evacuation systems are well established		
	1.standard dimensions of gutter are respected		
	2. standard dimensions of uphill ditch are respected		
	3. standard dimensions of opening in the benches are respected		
Safety	**Indicator 1**. Hazards are well controlled		
	1.Risk and hazard are identified		
	2.Risk and hazard are removed		
	Indicator 2. PPE is worn properly		
	1.Helmet is worn		
	2.Overall is worn		
	3.Boots is worn		
	4.Gloves is worn		
	Indicator 3. Handling tools and equipment are well done		
	1.Manipulation is applied		
	2.Adjustment of tools is done		
	3. Cleaning is respected		
Hygiene	**Indicator 1.** Tools, material and equipment are well maintained		
	1.Cleaning is respected		
	2.Oiling is respected		
	3.sharpening is done		
	4.Drying is respected		
	Indicator 2. Tools, material and equipment are well stored		
	1.Tools, materials and equipment are stored in suitable place		
	2.no tools, materials and equipment are lost		
	Indicator 3. Workplace hygiene is well respected		

	1.All used tools materials and equipment are collected		
	2. All wastes are managed		

References:

Ennio Grisa, 1990: *Les routes forestières en Prefecture Kibuye*.53p.

John M. Morris, MBE, 1990: *Earth roads*: *a practical manual for the provision of access for agricultural and forestry projects in developing countries*. 209p.

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