

Training Curriculum

For the purpose of the Project

"Natural Resource Management and Promotion of Sustainable Farmers' Livelihoods in Four Districts of Samangan"

Land Preparation in Rain-fed Areas

Topics Covered:

Terracing
Trenches

Training Duration: 1 day

Prepared by: Matouš Bořkovec and Mohammad Yousuf "Fakoor" People in Need, 2016

GENERAL LEARNING OBJECTIVE

By the end of the training the participants will be familiar with the topic of construction of terraces and trenches on rain-fed land in order for them to use these techniques on the land they cultivate to increase water retention and decrease erosion.

SPECIFIC LEARNING OBJECTIVES – KNOWLEDGE

By the end of the training, participants will know:

- The water retention function of terraces and trenches.
- The difference between flat bench terraces and inward-sloping terraces with drainage.
- How to design terraces to prevent damage by water erosion.
- The maximum incline of slope for terraces and trenches.
- Measures to protect terraces from damage.

SPECIFIC LEARNING OBJECTIVES - SKILLS

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

- Identify the contour line using an A-frame.
- Measure the incline of a slope.
- Mark out the terrace to be constructed with wooden sticks and rope.
- Dig a trench with suitable depth and size.
- Construct a flat bench terrace.
- Construct an inward-sloping terrace with drainage and safe outlet for water.
- Construct shoulder bunds on terraces.
- Reinforce terraces with grass, hedges, trees and stones.
- Repair damaged terraces and trenches.

TRAINING DURATION

The training is designed for 1 day.

TRAINING LOCATION

Suggested location for the training: Demo-plot with sloping rain-fed land (approx. 10 – 50% slope)

NECESSARY TOOLS AND MATERIAL

- Spades, shovels, rope, wooden sticks (20+)
- A-frame(s), measuring tape
- Seeds of grasses, seedlings of bushes, trees (in case it is season for plantation)
- Stones for reinforcement of terrace

TRAINING SCHEDULE

Activity	Name	Duration
Introductory Activity	Discussion: Water erosion in rain-fed fields	15 minutes
Training Activity 1	Measuring contour with an A-frame	30 minutes
Training Activity 2	Measuring incline of a slope	15 minutes
Training Activity 3	Discussion: Appropriate slope for trenches and terraces	15 minutes
Training Activity 4	Designing terraces and trenches	30 minutes
Training Activity 5	Constructing a trench, a flat bench terrace, an inward-sloping terrace	3 hours
Training Activity 6	Discussion: Expected movement of rain-water on terraces	15 minutes
Training Activity 7	Constructing a drainage channel, safe outlet for water and shoulder bund	30 minutes
Training Activity 8	Reinforcing terraces with stones, planting grass, hedges, trees	1 hour
Final Activity	Questions checking learning progress	30 minutes
Total time		7 hours

INTRODUCTORY ACTIVITY - DISCUSSION: water erosion in rain-fed fields

Ask participants whether they have experienced water erosion on their rain-fed fields. How does the water erosion work? Why is it problematic? Farmers should describe impacts similar to the picture below:



- Water takes the top-soil (the most fertile part of the soil) from the field and washes it away.
- Cracks or gullies form in the field, making cultivation difficult.
 - Sometimes growing crops are washed away as well.

Explain to them:

- Water needs to be stopped on the slope in order for it to infiltrate into the soil.
- Two good ways to do it are: TERRACES AND TRENCHES.
 - TERRACES can be used for the cultivation of crops.
 - TRENCHES can be used for the cultivation of trees.
- These measures are to be used in sloping land only – first we need to know the incline, or the steepness of the slope and where the contour line is.

TRAINING ACTIVITY 1: measuring contour with an A-frame

Have the A-frames ready. Do not waste time by making the A-frames with participants. Explain to the participants that FINDING THE EXACT COUNTOUR IS VERY IMPORTANT because water always flows exactly down the slope and if trenches or terraces are not constructed exactly along contour, they can be EASILY DAMAGED BY WATER.

You can use this video or similar videos to get familiar with usage of A-frame yourself <https://www.youtube.com/watch?v=ku2rvof60j0>. Show the correct procedure PRACTICALLY to the participants and mark the contour line with wooden sticks. Let the participants continue and use the A-frame themselves!

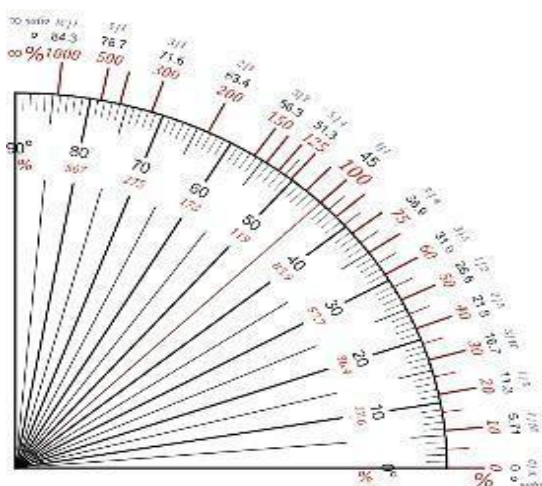


TRAINING ACTIVITY 2: Measuring the incline of a slope

Now when the contour line is marked with wooden sticks, you can easily measure the incline, or steepness of the slope.

Explain to participants that we can measure slope in percent (%). 100 % slope is equal to 45°, meaning that when you go down the slope, you go the same distance horizontally and vertically.

This is how the incline in percent (%) looks like:



Measuring the incline of the slope

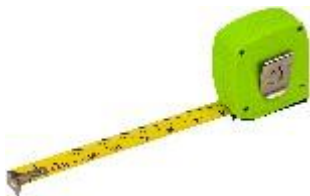
1. Wrap a rope, or string around the bottom of one of the wooden sticks in the contour line. Make sure the rope is wrapped at ground level.
2. Hammer another wooden stick exactly 1 meter away from the first stick, perpendicular down the slope.
3. Wrap the rope around the second stick and pull it firm at a height that looks level.
4. Use the A-frame or water level to adjust the rope

height on the second stick until it is in the exactly level position.

5. On the second stick, measure the vertical height from the ground to where the rope is wrapped around the second stick.
6. The result in centimeters (cm) is equal to the percent (%) of incline of this slope.
eg 10 cm = 10% incline. 30 cm = 30% incline



Use a measuring tape for your measurements (in cm):



Learn how to do it using this or similar video:

<https://www.youtube.com/watch?v=h0F3pnyDwi0>

Make sure that you, and each participant understands how the measurement is done.

TRAINING ACTIVITY 3: DISCUSSION: appropriate slope for trenches and terraces

Now that you know the incline of the slope, discuss if terrace or trenches are suitable for this incline.

Explain to the participants, that **the maximum incline suitable for terraces in Afghanistan is about 40%**. The more inclined the land is, the more susceptible to damage by water the terraces will be! Do not attempt to construct terraces on land with higher incline. In general, trenches in Afghan conditions can be dug on land with maximum incline of about 70%. But be careful not to cause a landslide and act based on experience, soil type and testing.

In the pictures above, trenches support water retention in an enclosed area of WFP project in Khwaja Sangbur, Samangan. Note the difference in vegetation above and below the ditch protecting the area from animals. Pistachios and hing are planted in and around the trenches and watered by farmers in exchange for food. The trench in the picture on the right is old and not maintained, but it supported the growth of pistachio trees.

Trenches can also have additional round holes for tree plantation. This helps to bring all the moisture to the trees.



Terraces constructed by PIN in Khwaja Sangbur and Shurqul.

TRAINING ACTIVITY 4: Designing terraces and trenches

Designing trenches

The size of the trench, should be calculated according to the size of the catchment above, and the largest amount of precipitation likely to fall in the area at one time.

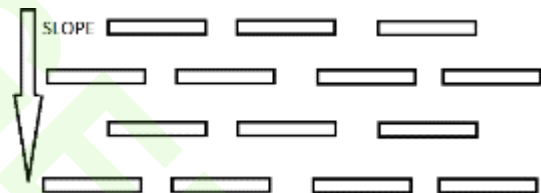
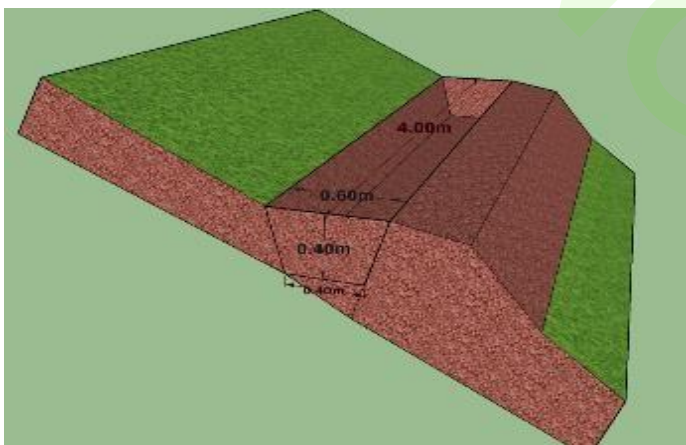
The distance between trenches should be according to the table below, OR dug one adult human's height apart in elevation.

Table 1. Trench spacing interval by hillslope (MANAGE 2007).

Hillslope (%)	Distance between trenches
0 to 4	10 to 12 m
4 to 8	8 m
8 to 15	6 m
15 to 33	4 m



For Afghanistan the trench size can usually be 30 cm to 40 cm deep, 40 cm wide at the bottom, and 60 cm wide at the top, approximately as shown below, depending on conditions. Trenches that are too big can lead to more erosion! Trenches should not be too long (2 to 4 m) as this could cause accumulation of too much water and lead to damage. They should be organized in a staggered manner, so that water is stopped when going down the slope. They can be also organized in an in-line manner, however flow of water sideways must be prevented by soil bunds (see below).



Trenches can be located in one line, however flow of water sideways or its accumulation in one place must be prevented by soil bunds.

The soil that is dug from the trench should be always used to form a soil bund on its lower side in order to decrease potential overflow and damage by water.

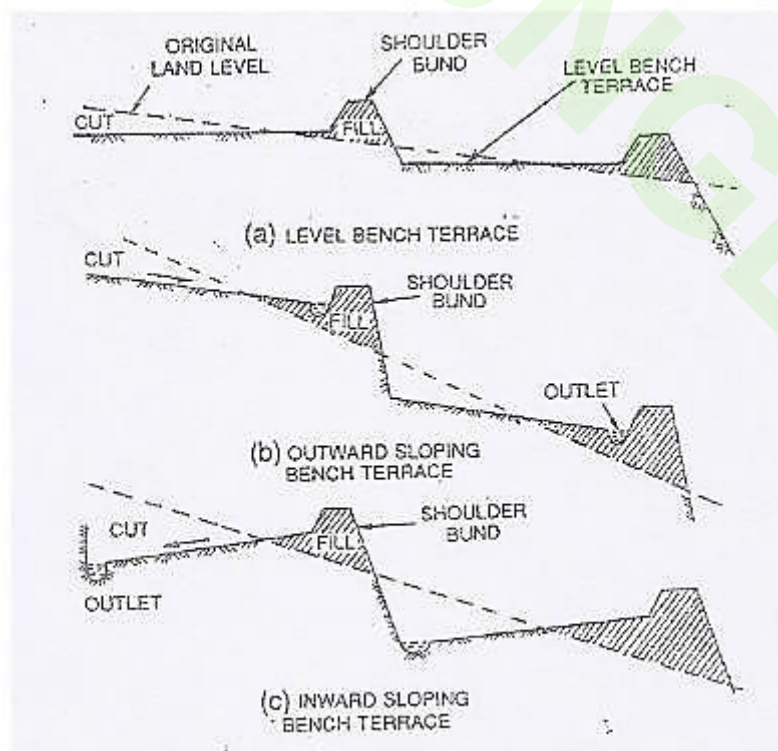
Trees can be planted:

- inside the trench,
- in round holes specially made for them on the lower side of the trench, or
- on the earth bound next to the trench.

The best location must be determined by experience, as it depends on soil structure, fertility and available moisture.

Designing terraces

Terraces need to be designed properly before construction starts in order to have a correct width of the terrace, height of the rise and incline of the terrace. First you need to decide whether you construct a **level (flat bench) terrace** or a **terrace with inward incline**. Outward sloping terraces are not recommended for Afghanistan (they would be damaged by flowing water too quickly).



The inward-sloping terrace has a sideways incline so that water can flow to the left or right side along the heel of the rise. This is the drainage channel. It must lead to a safe outlet for water (reinforced with stones or grass) so that water erosion is prevented.

In conditions when the level (flat bench) terrace is prone to water erosion, the in-ward sloping

terrace should be built. Otherwise the level terrace is better as its construction and maintenance is easier.

The size of the terrace will depend on the incline of the slope and the maximum depth of cut (the maximum depth to which it is possible to dig and still the soil is suitable for cultivation – there is no rock or big stones). The higher the terrace (and greater the width of it), the costlier its construction and more demanding is its maintenance (as the rise is higher). The higher the rise is, the more susceptible the terrace is to erosion. At the same time, the minimum width of a terrace should be 2 meters, so that it is wide enough to be ploughed by oxen or donkeys.

The approximate width of the terrace can be found in the table below. On the left side, select the incline of the slope (in percent). On the top, select the maximum depth to which you want to dig (because of the soil conditions). The number in the table is the width of the terrace.

Remember that if you have more terraces above each other, the height of the rise will be twice the depth of cut. Avoid constructing too high terraces as they can be too prone to collapse under heavy rainfall. In Samangan conditions, the rise should not be higher than 2 meters.

		Maximum depth of cut (m)				
		0.5	0.75	1	1.25	1.5
Incline of land (%)	5 %	20m	30m	40m	50m	60m
	10 %	10m	15m	20m	25m	30m
	15 %	6.7m	10m	13.3m	16.7m	20m
	20 %	5m	7.5m	10m	12.5m	15m
	25 %	4m	6m	8m	10m	12m
	30 %	3.3m	5m	6.7m	8.3m	10m
	35 %	2.9m	4.3m	5.7m	7.1m	8.6m
	40 %	2.5m	3.8m	5m	6.3m	7.5m
	45 %	2.2m	3.3m	4.4m	5.6m	6.7m

The rise can be more or less vertical or it can have incline, no less than 100%. A rise with an incline will be more stable but will decrease the amount of arable land available.

The length of the terraces should also not be too high. When the terrace has a side incline (to the left or right when you look perpendicular to the slope) it can cause water to reach dangerous velocity and damage the terrace. The inward-sloping terraces should not be longer than 20 m. Long flat bench terraces should be broken into smaller plots in order to avoid water flowing to the side (see picture – source Helvetas Swiss Intercooperation 2015).

TRAINING ACTIVITY 5: Constructing a trench, a flat bench terrace and an inward-sloping terrace

Construct the model terrace(s) and trench(es) with the participants. The number of terraces and trenches constructed during the training will depend on the number of participants and tools. It is fine if only one terrace and one trench is constructed so that there is not too much hard labour involved during the training.

TRAINING ACTIVITY 6 - Discussion: Expected movement of rain-water on terraces

Now that the terrace and trench are constructed, discuss with the participants what happens when heavy rain occurs. Will the water infiltrate or will it overflow the terrace/trench? If it flows over, will it have a dangerous velocity and will it damage the terrace? What do the participants think based on their experience? Adjust the design if necessary and construct shoulder bunds to prevent water from overflowing the terrace too easily. If there are multiple flat bench terraces above each other, it is advisable to also construct a **drainage channel** at least under each three terraces, taking the water sideways into a safe outlet. Otherwise water will accumulate on the lower terraces and cause extensive damage!

TRAINING ACTIVITY 7: Constructing a drainage channel, safe outlet for water and shoulder bunds

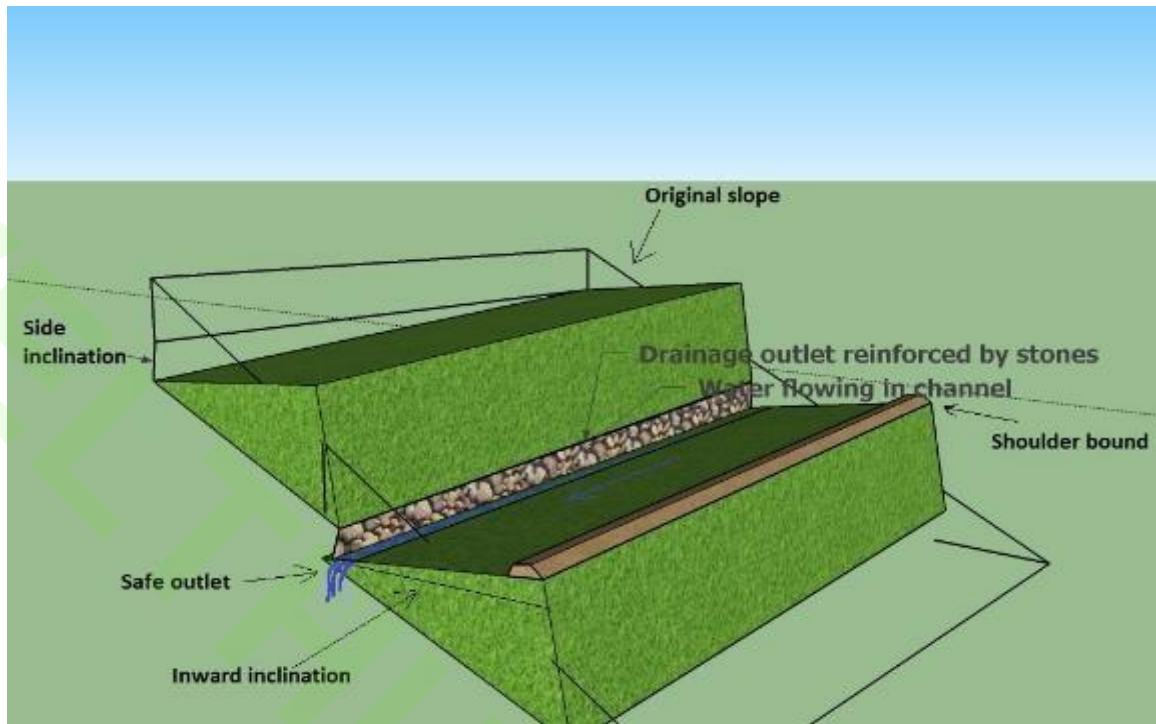
With inward-sloping terraces, the drainage channel takes water sideways into a safe outlet in case of heavy rainfall. It helps to prevent water damage to the terrace. Thanks to the drainage channel water doesn't flow over the edge of the terrace. The drainage channel should be reinforced by stones because otherwise running water can cause damage to the heel of the terrace, causing it to collapse!

Shoulder bunds

Shoulder bunds are bunds made of soil, ideally reinforced by grass, hedges or trees (not to be planted too close to the edge of the terrace). Bunds prevent rain-water from flowing over the edge of the terrace. They help to protect the terrace from damage.

Safe outlet

A safe outlet is an ending of the drainage channel. It must be reinforced by grass or stones in order to take the water safely down the slope without damaging the terrace. Look at the picture below to see approximate shape and function of the shoulder bund, drainage channel and safe outlet in the inward-sloping terrace.



TRAINING ACTIVITY 8: Reinforcing terraces with stones, planting grass, hedges or trees

Once the terrace is constructed, it should be reinforced with stones, grasses, hedges and/or trees in order to improve its stability. Stones should be used specially to reinforce the heel of the rise. This part must not be eroded by water as the terrace could collapse!

Grass should be planted on the rise and shoulder bund. Local grasses are good for this purpose. If seeds are not available in the market, they can be collected from the wild. Or turfs of grass taken elsewhere can be placed on the rise and shoulder bund. **Grazing must not be allowed at the terraces so that grass can fully establish!**

Bushes (atriplex, sea buckthorn and others) should be planted on the shoulder bunds. Trees (pistachio, almond or suitable non-fruit trees) should be planted on the terrace but not too close to the edge of the terrace! Remember that their roots should not grow out of the rise or the weight of the tree could de-stabilize the terrace instead of supporting it.

FINAL ACTIVITY: Questions checking learning progress

Ask each participant at least one question and let them answer, explain to others and show it practically, without any interference from the trainers' side. After the participant answers, let others add their ideas or opinions or correct the answer if necessary. Give an appropriate mark to the group response as indicated below. Calculate the total score after the training is finished and report it to your line-manager.

Q1: What are the main reasons why terraces are built in semi-arid areas? Name three reasons.

Right answer: 1) To retain water (increase water infiltration), 2) To decrease water erosion on the field, 3) To provide flat land for cultivation.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
No answer, incorrect answers or don't know.	One correct reason.	Two correct reasons.	Three correct reasons.

Q2: Describe why it is important to find the exact contour line before constructing terraces or trenches. Show practically how to do it with an A-frame.

Right answer: Trenches and terraces must be built exactly along the contour in order to decrease the risk of damage by water erosion (when they are not exactly following the contour line, water accumulates in one place and destroys the terrace or trench).

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Can't explain and can't demonstrate practically.	Can explain but cannot show practically.	Can both explain and show practically but with some mistakes.	Can both explain and show practically in a correct way.

Q3: Explain how the incline of a slope is measured, show how the slope of 0 %, 50% and 100% looks like. Show practically how slope is measured with wooden sticks, a rope and a measuring tape.

Right answer: Incline is measured in percent. It is the vertical height divided by horizontal length. A slope of 0% is water level. A slope of 100% equals 45° (same distance horizontally and vertically). A slope of 50% is in between the two (equals 22.5°).

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Can't explain and can't demonstrate practically.	Can explain but cannot show practically.	Can both explain and show practically but with some mistakes.	Can both explain and show practically in a correct way.

Q4: What is the maximum slope for the terrace and for trench to be safe to build?

Right answer: Terraces can be built on land with up to 45% slope. Trenches can be constructed on land of up to 100% slope. However, it depends on soil properties, precipitation and must be based on experience.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
No answer, incorrect answer or don't know.	One correct answer.	Two correct answers but not exact.	Two exactly correct answers.

Q5: Explain the difference between flat bench terrace and inward-sloping terrace. Describe all differences. Show them on existing terraces if available.

Right answer: A flat bench terrace is level. Water flows from it to all sides equally. It doesn't have a

drainage channel. It usually doesn't have a shoulder bund. Inward-sloping terraces have a slight incline inward (in the direction into the hill) and they also have a slight incline sideways (left or right) in order for the water to flow away from the terrace to the side. They have a drainage channel (should be reinforced by stones, leading to a safe outlet). They have a shoulder bund as water is not supposed to flow over the edge of the terrace at any time.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Can't explain.	Can explain only one difference.	Can explain the differences but with some mistakes.	Can explain all the differences in a correct way.

Q6: Describe the appropriate size, location and spacing of trenches. Show where the trees can be planted. Show how damage of trenches by water can be prevented.

Right answer: Trenches should be around 40 cm deep, 40-60 cm wide and around 2-4 meters long. If trenches are too long, too much water can accumulate in one place in the trench, causing damage. Trees can be planted inside the trench, in round holes specially made for them on the lower side of the trench or on the earth bound next to the trench. Trenches should be placed in staggered order or linear order. Flow of water to one side or its accumulation in one place must be prevented by careful design and well-built soil bunds.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Can't describe.	Can describe only one characteristic of a trench.	Can describe trench, location of trees and prevention of water damage but with mistakes.	Can describe trench, location of trees and prevention of water damage correctly.

Q7: Explain how you decide on width and length of a terrace.

Right answer: Width of terrace depends on the slope incline and on maximum depth of cut (or maximum height of the rise that we want – height of the rise is twice the depth of cut). We need to have at least somewhat fertile soil on the terrace so we can dig only as deep as the soil allows for the crops to grow. The higher the rise, the more susceptible to erosion and collapse it is. The rise should not be higher than 2 meters. The length of terraces depends on the shape of terrain. Length of inward-sloping terraces should not be more than 20 meters, otherwise too much water could accumulate and cause damage. Long flat bench terraces should be divided into smaller ones by soil bunds in order to prevent water from flowing sideways and causing damage.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Can't explain.	Can explain only one factor of width or length of terraces.	Can explain the factors determining width and length of terraces but with some mistakes	Can explain factors determining width and length of terraces correctly.

Q8: Describe and show practically where the terraces should be reinforced by stones, grass and

hedges and explain why.

Right answer: Stones should reinforce especially the heel of the rise of a terrace. Grass and hedges should reinforce the rise and shoulder bund of a terrace. Reinforcement prevents damage of terraces by water. Grazing must be prevented and some irrigation provided in order for grass and hedges to develop.

Answer for 0 points	Answer for 1 point	Answer for 2 points	Answer for 3 points
Can't describe.	Can describe only one method of reinforcement of a terrace.	Can describe the reinforcement by stones, grass and bushes with mistakes.	Can describe reinforcement by stones, grass and bushes correctly.

Total Points Received:

_____ OF 21 POINTS or _____ %