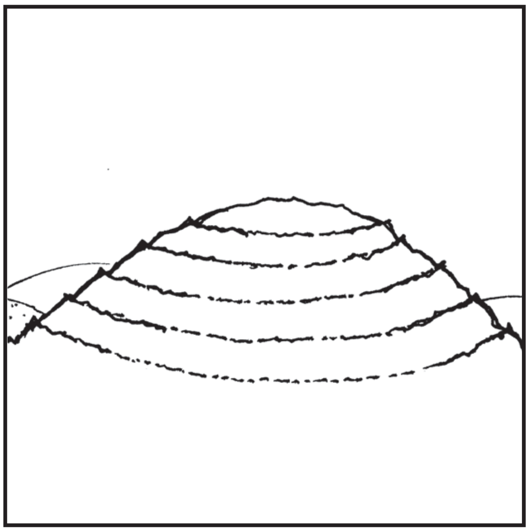
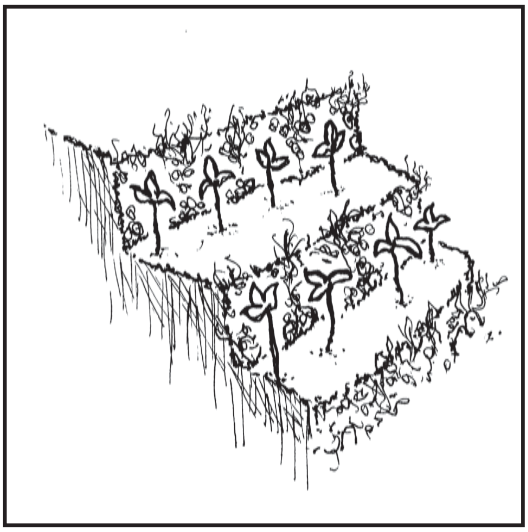
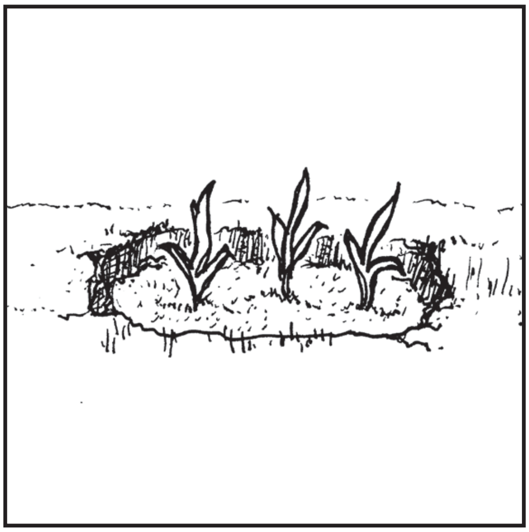
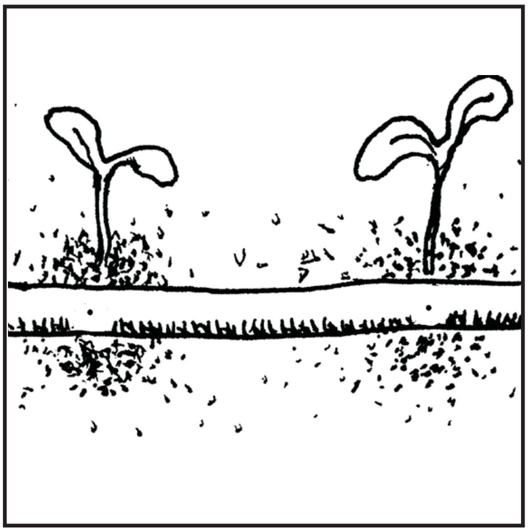
WATER HARVESTING AND CONSERVATION

HDRA

Water harvesting and conservation

In many farming areas, readily available water is in short supply. Although the total annual rainfall in an area may be enough to sustain farm needs, it is often distributed very unevenly so that long dry periods are interspersed with periods of intense rainfall. In many cases, a crop is unable to use a high proportion of this water, as much of it is lost through run off or leaching. This may also cause soil erosion and loss of soil nutrients.

The techniques described in this booklet aim to maximise the available water through water harvesting and conservation. Water harvesting techniques gather water from an area termed the 'catchment area' and channel it to the cropping area or wherever it is required. Conservation techniques conserve water within the biomass and the soil by reducing run-off and keeping the water where it falls, as much as possible.

Principles of Water Harvesting and Conservation

In deciding which techniques to use to make more efficient use of the available water, it is important to consider how crops receive or lose water. Crops receive water through rainfall, irrigation and stored soil water. They lose it through run off, evaporation and drainage. Some key principles on effective water management are:

- **Use rainwater effectively.**

In many climates, rainfall is distributed unevenly in intense downpours that cannot be readily used by a crop. Storage techniques (such as external catchments or roof top collection) increase the availability of water in the drier seasons. They also harvest water from a wider area making more water available to the crop. Measures can also be taken to avoid the rainwater running off the surface during intense rainfall (explained below).

- **Make effective use of soil water reserves.**

The soil stores water from rainfall providing a reserve that is available to the crop. How much water is available depends on the soil type and the rooting system of the crop. Sandy soils hold much less water than clay or silt soils, so crops will require watering more often. Deeper rooting crops, such as grasses or cereals will exploit soil water reserves more effectively than shallower rooting crops such as vegetable crops and therefore can be grown in drier periods. Good cultivation practices (e.g. not ploughing too deep or when the soil is wet) that result in a soft, friable soil will also promote deep rooting and efficient use of soil water reserves.

- **Take measures to avoid run off**

Run off is where water is not absorbed by the soil but runs across the surface away from where the crop can use it. Structures such as contour schemes, terracing, pits and bunds can reduce run-off. Run off is more likely to occur on silty or clay soils where the surface has been subjected to intense rainfall then baked in the sun to form a crust or cap. Adding mulch to break up the intensity of rainfall, or adding manure, compost or incorporating green manure residues will reduce the tendency of the soil to form a crust.

- **Avoid wasting water through evaporation**

Water that evaporates directly from bare soil is wasteful as it is not being used for productive plant growth. It is desirable to maintain full ground cover for as much of the time as practically possible. Applying mulch to the soil will also reduce evaporation considerably. Use of drip irrigation and irrigating in the evening will also reduce the amount of water lost through evaporation.

- **Reduce water losses through drainage**

When water drains out of the soil, not only is it wasted but essential mobile nutrients such as nitrogen are also washed out. This is more of a problem on light sandy soils. Adding organic matter in the form of compost, manures or plant residues will eventually increase the amount of water a soil can retain, but this will only have an effect if it is added over a longer period of years. Most drainage occurs during the heavy rains, especially if the soil is left bare. Growing a cash or cover crop during this period reduces these losses, as the roots lift water and nutrients back from deeper to shallower soil profiles.

- **Plan your irrigation**

Irrigation is one way of supplementing water from rainfall and soil reserves, but can waste large amounts of water if not used carefully. A key way of making the most of the water supply is to only irrigate when necessary. Many people irrigate on a regular basis whether the crop needs it or not. If water is scarce, irrigation should be restricted to the most critical periods such as germination and fruit set. Drip irrigation makes much better use of water than overhead systems as it is targeted to the roots rather than sprayed up into the air.

This booklet describes practical water harvesting and conservation techniques. Different techniques will be suitable in different contexts - a technique that is successful in one area may not be in another. It is important that these techniques are locally adapted and developed to suit specific conditions[1].

[1] This booklet draws from Duveskog, D., 2003. "Soil and Water Conservation with a focus on Water Harvesting "

1. CONTOUR FARMING

Contour farming refers to field activities such as ploughing and furrowing that are carried out along contours rather than up and down the slope. They conserve water by reducing surface run off and encouraging infiltration of water into the crop area.

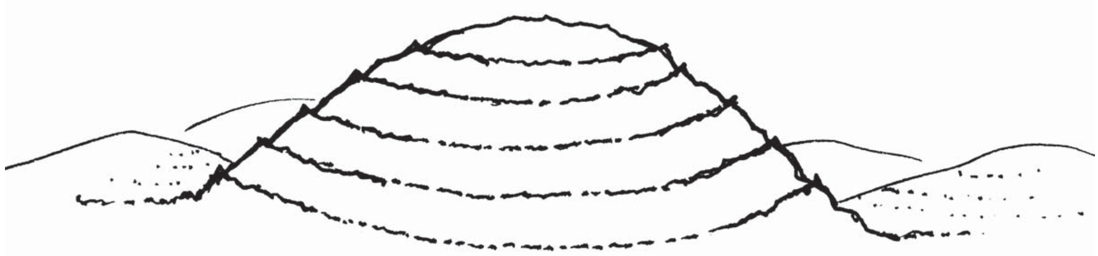
For all contour systems the first step is to determine a contour guideline. This can be done using the "A frame method" (see appendix). From this, parallel contour guidelines can be drawn up.

A number of water harvesting techniques are based along contours including: contour ploughing; contour ridges; stone lines; grass strips and terraces. The technique used depends on the steepness of the slope, soil type, conditions, crops grown and other factors such as the availability of labour.

1.1 Contour Ploughing

Ideally, any ploughing on a slope should be carried out along the contours rather than up and down as this reduces run off and soil erosion and increases moisture retention. Contour ploughing can be practised on any slope with a gradient less than 10%. On steeper slopes it should be combined with other measures such as terracing, bunds or strip cropping. It is not always carried out in practise because the shape and topography of the field may be considered a more important factor in determining the direction of ploughing. It is important to lay out contours properly or they may channel the water and increase run off.

Figure 1 Contour Ploughing



Summary: Contour Ploughing

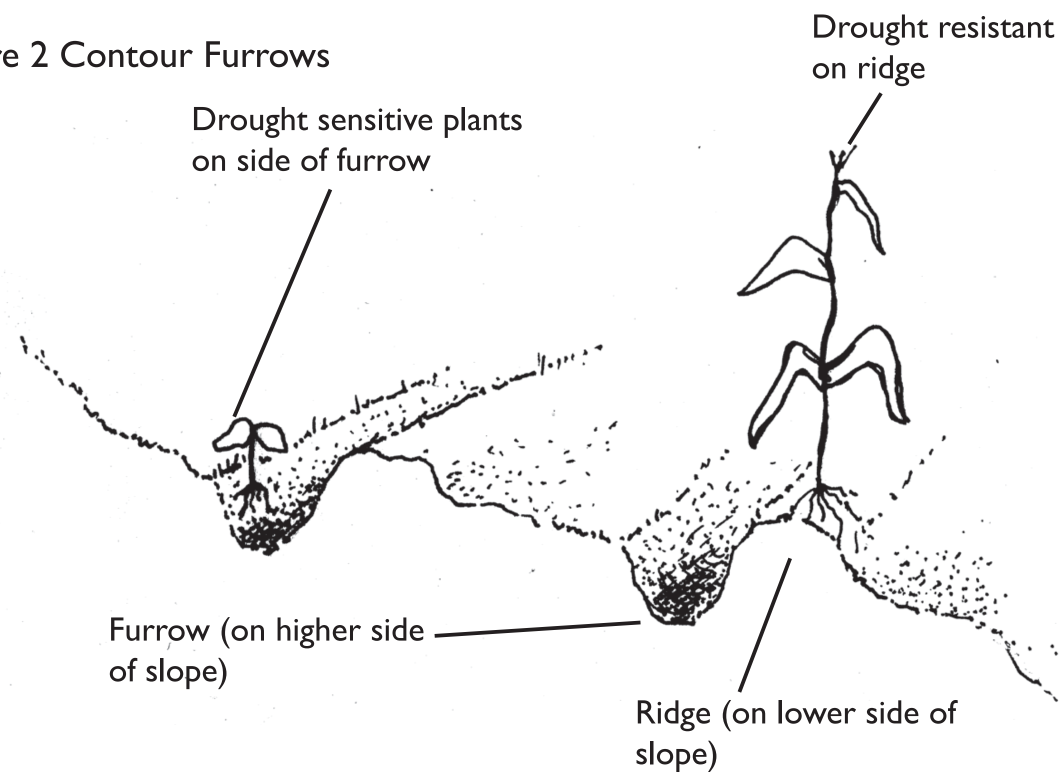
Slope	Medium (up to 10%)
Soil	Not suitable for heavier soil types with low infiltration
Rainfall	Medium - not suitable for very low rainfall areas as the catchment area is limited. Structures may be breached by intense rainfall
Labour	Medium and may require some labour to maintain
Crops	Many

1.2 Contour Furrows

Contour furrows are small earthen banks that run along a contour. A furrow is dug next to each bank on the upper side of the slope. The distance between the ridges varies between 1 - 2 m depending on the rainfall and the slope. The aim of contour furrows is to concentrate moisture into the ridge and furrow area where the crops are planted by trapping run off water from the catchment area between them. This also decreases the risk of erosion. Plants with higher water requirements, such as peas or beans, can be planted on the higher side of the furrow whereas cereal crops requiring less water, such as sorghum or millet, can be planted on the ridges.

The catchment area between the ridges should be left uncultivated and clear of vegetation so that run off into the ridges is maximised. Under drier conditions, the furrows are spaced further apart to harvest water from a larger catchment area. Contour furrows are suitable for areas with lower rainfall (350 – 700 mm). However, the amount of water harvested is limited, so they are not suitable for very dry areas. Extreme rainfall may cause the ditches to overflow and break. This is more likely to occur on heavier soils with a lower infiltration rate, or on steeper slopes. The risk can be reduced by building higher ridges, although this increases the labour requirement.

Figure 2 Contour Furrows



Summary: Contour Furrows

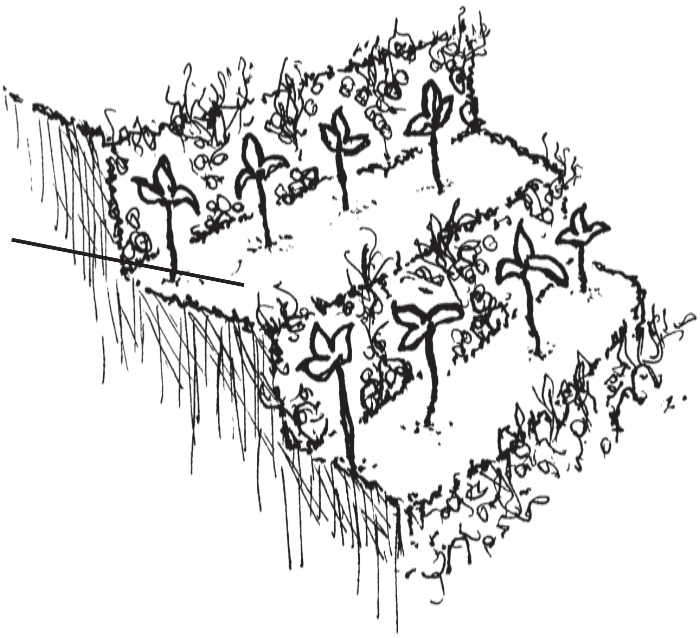
Slope	Gentle (0.5 –3%)
Soil	Not suitable for heavier soil types with low infiltration rates
Rainfall	Low rainfall (350 – 700 mm). Intense rainfall can cause the ditches to overflow and break
Labour	Not too much labour to set up, but furrows need to be maintained and repaired regularly
Crops	Cereals, peas and beans

1.3 Bench Terraces

Terraces are made by creating ridges and furrows along contours on a slope. The ridges hold back water and soil runoff and eventually turn the hillside into a number of terraces. These can be stabilised by planting grasses or shrubs on them. Terraces can be used on steeper slopes than other contour methods, but building them requires very high labour input. Terraces are formed by digging a ditch along a contour and throwing the earth either uphill or downhill to form a ridge. Water is stored behind the ridge. If the earth is thrown uphill the terraces are suitable for steep slopes with gradients of 30-55%. If the earth is thrown downhill there is a higher risk of the ridges breaking due to water pressure so this method is not suitable for steep slopes (up to 35% gradient) or areas with intense rainfall.

Stone terraces are constructed by digging a shallow ditch along a contour. Large stones are placed at the bottom of the ditch then smaller stones are added until the structure is 20–30 cm high. They are very stable and can be used in areas with high rainfall. They are also a useful way of removing stones from stony arable land. In general, the steeper the slope, the narrower the width of the terrace should be. For example, wider terraces of 20–60 cm are suitable for shallow slopes (gradient 1%) whereas very narrow terraces of 5–10 cm are required for steep slopes (gradient 40%). These narrow terraces are very labour intensive and the land is less useful for cropping.

Figure 3 Terraces



Summary: Bench Terraces

Slope	Steep (up to 40%) depending on the method
Soil	Needs to be stable
Rainfall	Stone terraces can tolerate high rainfall. Terraces formed by throwing the earth downhill should not be used in areas with intense rainfall
Labour	Extremely high
Crops	Large range

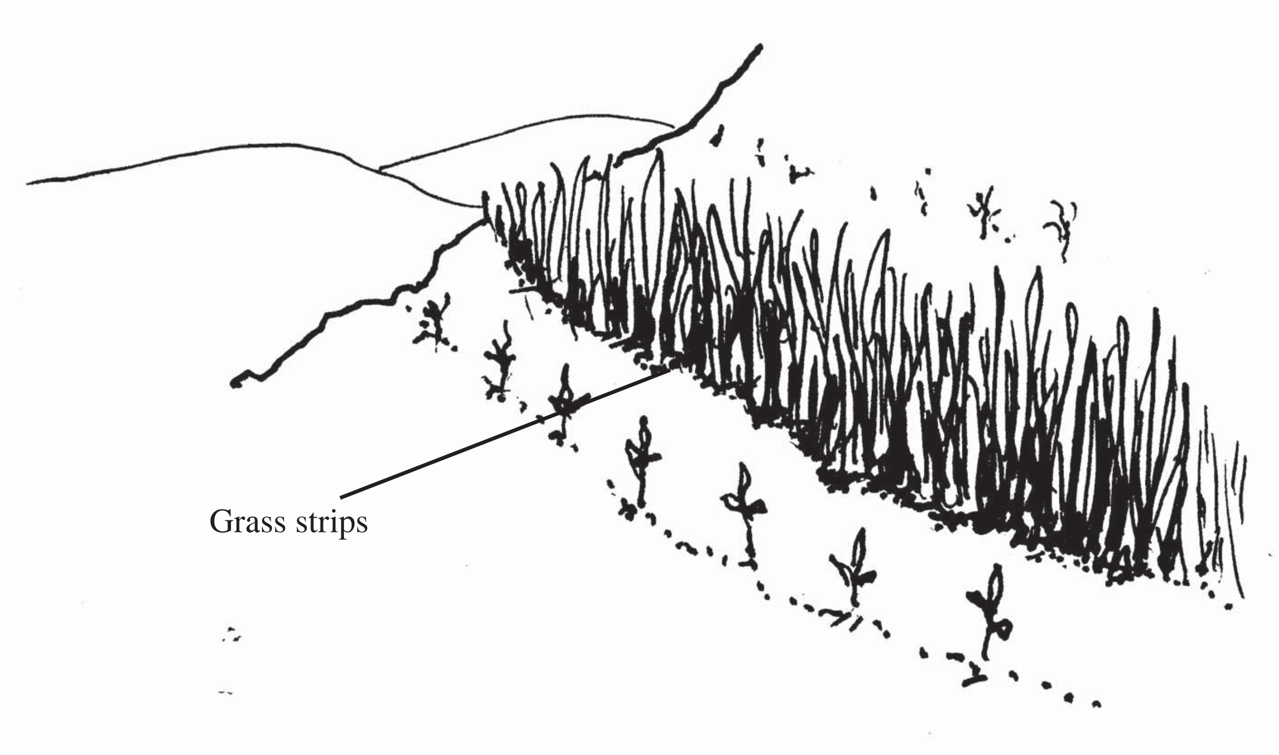
1.4 Grass Strips

Strips of grass (up to 1m wide) planted along a contour can reduce soil erosion and runoff. Silt builds up in front of the strip and over time benches are formed. On gentle slopes the strips should be widely spaced (20-30m apart), and on steeper slopes narrowly spaced (10-15m apart).

The grass needs to be trimmed regularly, to prevent it competing with crops. Many grass varieties can be used, depending on what is locally available. For example, Vetiver, Napier, Guinea and Guatemale grass. Alternatively a local Veld grass can be used. The strips need to be maintained to prevent the grass from spreading and becoming a weed problem or becoming a refuge for rodents and other pests.

Grass strips are most likely to be used in areas where fodder or mulch is also needed. They are not suitable for steep slopes or in very dry areas since grasses will compete with the crop. They can also be used in conjunction with other water harvesting techniques: grass strips can be planted along ditches to stabilize them, or on the rises of bench terraces to prevent erosion.

Figure 4 Grass Strips



Summary: Grass Strips

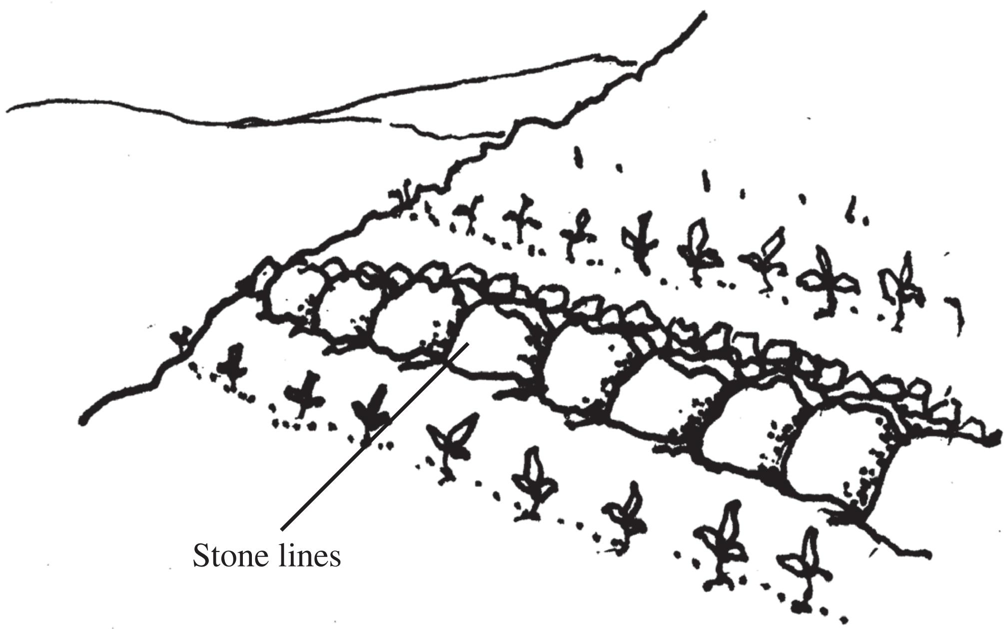
Slope	Shallow (1-2%)
Soil	Range of soils – may be problems with competition for water on very light sandy soils
Rainfall	Not suitable for very dry conditions (<500mm)
Labour	Easy to set up. High labour required for cutting and maintenance
Crops	Range of crops

1.5 Stone Lines

Stone lines running along the contour are one of the simplest contour techniques to design and construct. The lines of stones form a semi-permeable barrier that slows the speed of run off so that spread of water over the field and infiltration is increased, and soil erosion reduced. The lines are constructed by making a shallow foundation trench along the contour. Larger stones are then put on the down slope side of the trench. Smaller stones are used to build the rest of the bund. The stone lines can be reinforced with earth, or crop residues to make them more stable. When it rains, soil builds up on the upslope side of the line, and over time a natural terrace is formed. The stone lines are spaced 15-30m apart or a shorter distance on steeper slopes.

Stone lines are suitable on gentle slopes (0.5–3%) in areas with annual rainfall of 350-700mm. They are often used to rehabilitate eroded and abandoned land by trapping silt and are popular in dry stony areas. However, they may provide a refuge for rodents and other pests.

Figure 5 Stone Lines



Summary: Stone Lines

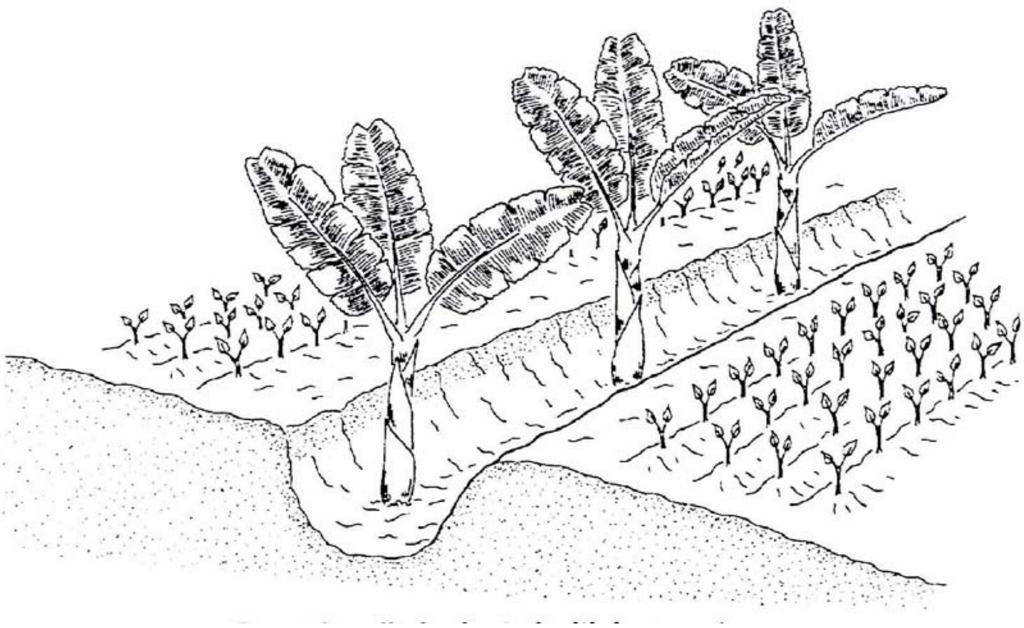
Slope	Gentle (0.5 – 3%)
Soil	Suitable for wide range of soils
Rainfall	Low 350 – 700 mm
Labour	Labour intensive to build
Crops	Wide range

1.6 Retention Ditches

Retention ditches work on a similar principle to contour furrows but on a larger scale. They are large ditches, designed to catch and retain all incoming run-off and hold it until it infiltrates into the ground, increasing the supply of water to crops planted in the ditch and reducing soil erosion. They vary from 0.3-0.6 m deep and 0.5-1 m wide. They are usually used on flat land where they may be spaced at 20 m or on gentle slopes where the spacing can be decreased to 10-15m. When constructing the ditches, the soil is thrown to the lower side to form an embankment that prevents soil from falling back in. This structure can be stabilised further by planting grass on it. On soils with lower infiltration rate, or on slopes, the ends can be left open to allow excess water to drain out.

Retention ditches are commonly used in semi-arid areas for growing crops that have high water requirements, such as bananas. They should be used on lighter, free draining soils that are deep, stable and not prone to landslides.

Figure 6 Retention Ditches [2]



Summary: Retention Ditches

Slope	Shallow (<2%)
Soil	Needs to be relatively free draining and stable.
Rainfall	Arid – semi arid (500 mm). When heavy rainfall occurs the ditches might overflow and break
Labour	High labour input to construct and need to be maintained and de-silted regularly
Crops	Can be used for larger more water demanding crops such as bananas

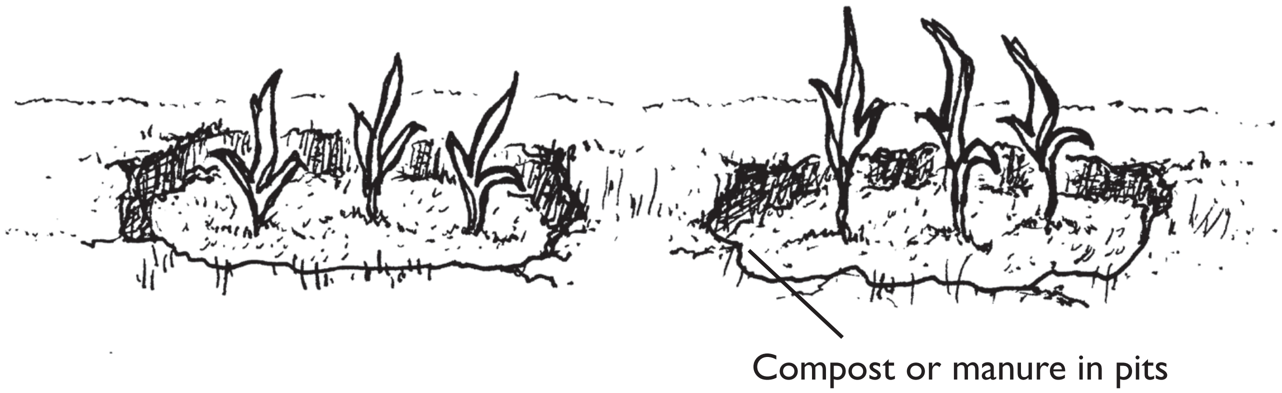
[2] Figure reproduced from Duveskog, D., 2003. "Soil and Water Conservation with a focus on Water Harvesting"

2. PLANTING PITS

Planting pits are a very simple form of freestanding water harvesting structure that are easy to construct. They consist of small pits in which individual or small groups of plants are sown. The pits catch run off and concentrate soil moisture around the roots. Normally the pits are 10-30 cm in diameter and 5 –15 cm deep and are spaced about 1 m apart. The earth removed from the holes is piled in a half moon shape along the lowest edge of the pit. Before planting, compost or manure is added to the pit to improve soil fertility and structure.

Planting pits are particularly successful in areas of low rainfall (350–750 mm) and are suitable for crops with low water demand such as sorghum or millet. They are more suitable for heavier clay soils, which tend to form a cap and have poor infiltration. As digging the pit reduces the depth of soil, they are not suitable for shallower soils. They are only suitable for gentle slopes (less than 2% gradient).

Figure 7 Planting Pits



Summary: Planting Pits

Slope	Shallow (<2%)
Soil	Clay / silt
Rainfall	Low (350 – 700 mm)
Labour	High, although the pits can be reused a second year
Crops	Sorghum, millet

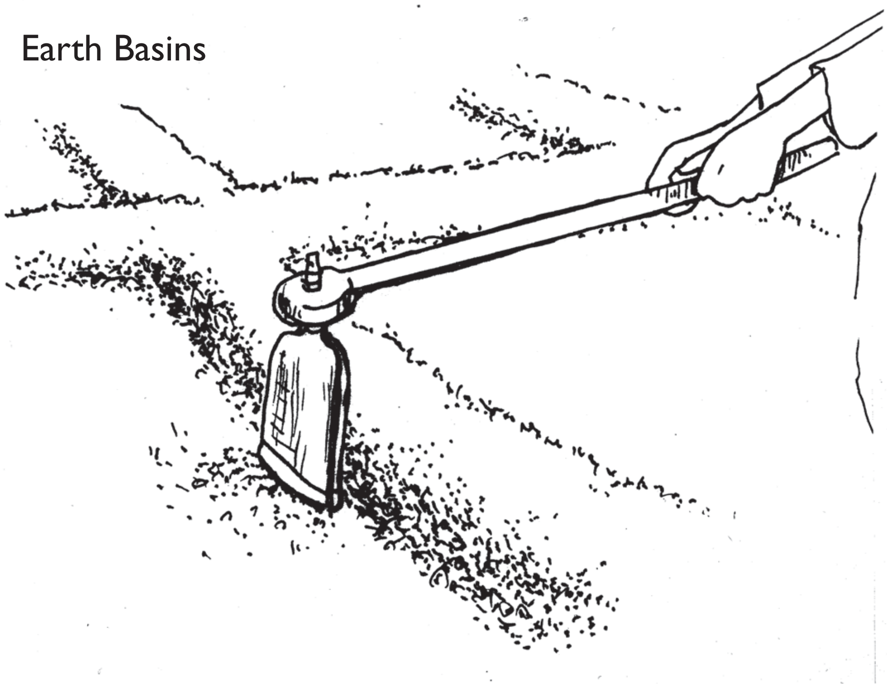
3. EARTH BASINS

Earth basins are designed to collect and hold rainfall and are easy to construct by hand. They are square or diamond shaped basins with earth ridges on all sides. Runoff water is channelled to the lowest point and stored in an infiltration pit. The lowest point of the basin might be located in one of the corners (on sloping land) or in the middle (on flat land). Earth basins are usually used for fruit crops and the seedling is planted in or on the side of the infiltration pit.

The size of the basin depends on local rainfall and the water requirements of the trees. They are larger on flat land and smaller on sloping land. They are usually 1-2 m long, though sometimes basins of up to 30m are constructed. Grass can be planted on the bunds for reinforcement. Manure and compost can be added to the basin to improve fertility and water-holding capacity.

Earth basins are suitable in arid and semi-arid areas, with annual rainfall amounts of 150mm and above. Soils should be deep, preferably at least 1.5 - 2m to ensure enough water holding capacity. The slope can be from flat up to about 5%. If earth basins are constructed on steep slopes they should be small.

Figure 8 Earth Basins



Summary: Earth Basins

Slope	Moderate (up to 5%)
Soil	Not suitable for very light soils
Rainfall	Arid – semi arid: >150mm. Heavy rainfall may cause overflow, as there is no outlet for excess water
Labour	High labour required. Damage should be repaired immediately and the basin must be kept clear of vegetation
Crops	Often used for fruit crops

4. SEMI-CIRCULAR BUNDS

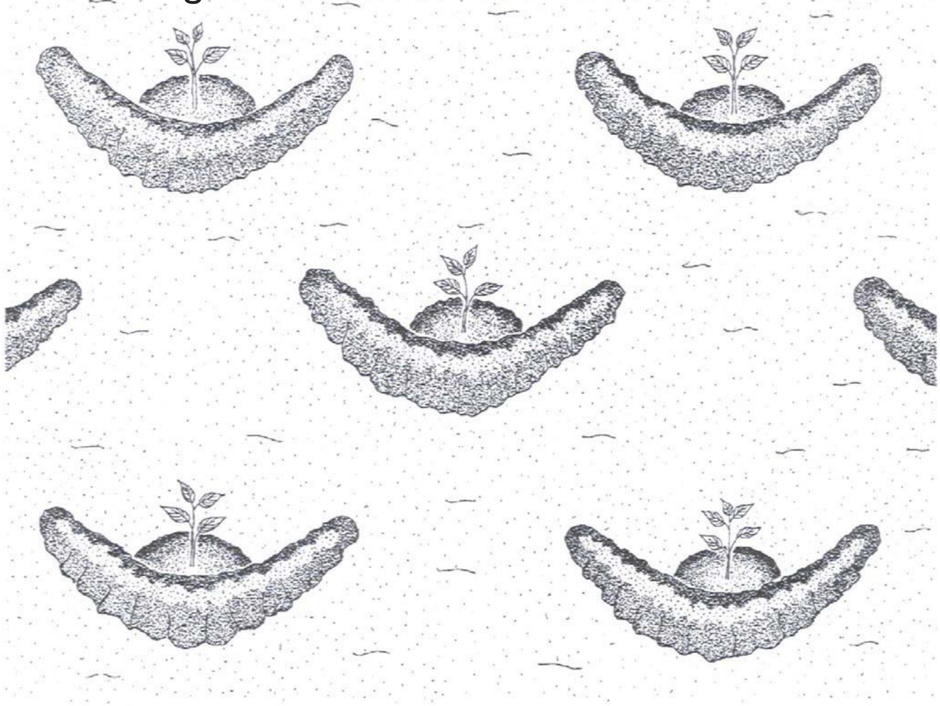
Semi-circular bunds are earth bunds formed in U-shapes on a slope. The uppermost tips of the U lie on a contour so that run off is collected in the lowest section of the U. A shallow pit is sometimes also dug in this section to help concentrate moisture. Their size varies from small structures (radius 2m) used for fruit trees or seedlings to very large structures (radius 30m) used for rangeland rehabilitation or fodder production.

Bunds are constructed by digging out earth from within the area to be enclosed and piling it up to form the bund. They should be constructed in layers of 10-15 cm, with each layer compacted before the next is added to ensure that they remain stable. They are easy to construct and reduce soil erosion.

The bunds are arranged along a contour line in a staggered arrangement so that water, which spills round the ends of the upper hill, will be caught by those lower down.

Semi-circular bunds are suitable on gentle slopes (normally below 2%) and uneven terrain in areas with annual rainfall of 350-700 mm. The soils should not be too shallow or saline.

Figure 9 Semi -Circular Bunds [3]



Summary: Semi Circular Bunds

Slope	Shallow (< 2%)
Soil	Not suitable for shallow soils
Rainfall	Low 350 – 700 mm
Labour	Considerable labour required for maintenance. Breakages during the first rainstorms after construction must be repaired immediately. The structures have to be dug out again after five years. Deposited silt and earth have to be regularly removed from around trees. The catchment area should be kept clear of vegetation
Crops	Most commonly used for trees

[3] Figure reproduced from Duveskog, D., 2003. "Soil and Water Conservation with a focus on Water Harvesting "

5. COVER CROPS/GREEN MANURES [4]

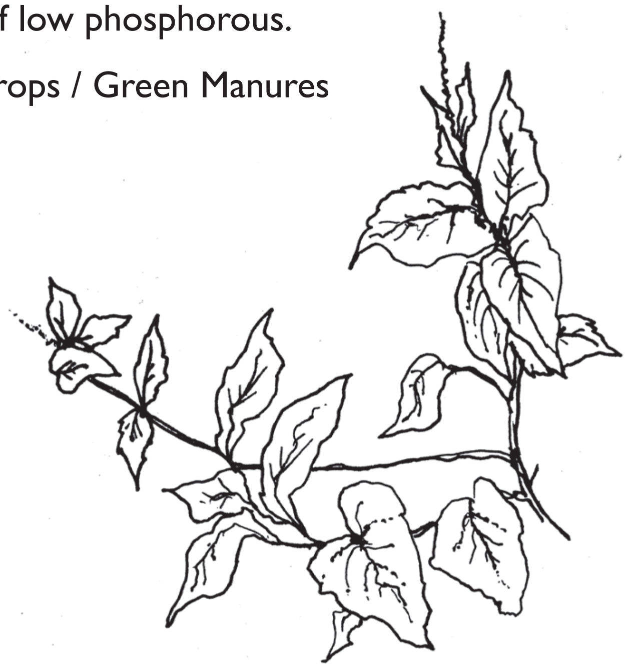
Cover crops are grown to protect the soil from leaching, erosion and to improve soil fertility. They build up organic matter in the soil, improve soil structure, suppress weed growth and increase soil fertility through nitrogen fixation. They also, reduce fluctuations in temperature and improve soil moisture. Legumes, such as beans and peas, or grasses are often used. They cover the ground surface between a widely spaced perennial crop, such as young fruit trees, coffee, cacao and oil palms or between rows of grain crops such as maize. Cover crops are often combined with mulching.

Cover crops can be a source of food, fodder and mulch and may provide some cash-income. However, they may also provide a refuge for rodents and pests.

The cover crop should be of a slow growing variety to minimize competition for water and nutrients with the main crop. It should be planted as soon as possible after tillage to be fully beneficial. This can be done at the same time as sowing the main crop, or after the main crop has established to avoid competition.

Cover crops are not suitable for dry areas with annual rainfall of less than 500mm, as they might compete for water with the main crop. Under such conditions it might be better to keep the weeds and natural vegetation as cover. They may not do well under conditions of low phosphorous.

Figure 10 Cover Crops / Green Manures



Summary: Cover Crops

Slope	
Soil	
Rainfall	Not suitable for dry areas
Labour	Labour required for cutting
Crops	

4 For more detailed information see the HDRA booklet "Green Manures/Cover Crops" http://www.gardenorganic.org.uk/pdfs/international_programme/GreenMan.pdf

6. MULCHING

Mulching means covering the soil between crop rows or around trees with a layer of loose material such as dry grass, straw, crop residues, leaves, manure or compost. This helps to retain soil moisture by limiting evaporation, suppressing weed growth and enhancing soil structure, reducing runoff, protecting the soil from splash erosion and limiting the formation of crust. In addition, mulching reduces fluctuations in soil temperature which improves conditions for micro-organisms. It is commonly used in areas affected by drought and weed infestation.

Mulch can be spread on a seedbed or around planting holes and it can also be applied in strips. Alternative row mulching is sometimes preferred to full mulching, because it reduces the fire risk. It is most effective if applied at the start of the rains, as it intercepts and increases water take-up, but it is frequently more practical to mulch towards the end of the rains when grass is available. When crop remains are used for mulching nutrients are released more slowly, so that more manure or fertilizer has to be applied.

Weeds can be a problem if some grass species are used and mulches can provide a possible habitat for pests and diseases

Use a mixture of fast and slow decomposing material and break large pieces of crop residue before application. Grass should be dried before applying as this reduces the chance of it rooting. The mulch layer should not be too thick; otherwise the soil underneath heats up. If lots of straw is used this can lock-up nutrients in the soil. The mulch can be covered with a layer of soil to protect it against wind.

Figure 11 Mulches

Summary: Mulching

Slope	Difficult to apply on steep land
Soil	Well-drained
Rainfall	Low. Not suitable for wet conditions
Labour	Medium
Crops	Any

7. DRIP IRRIGATION

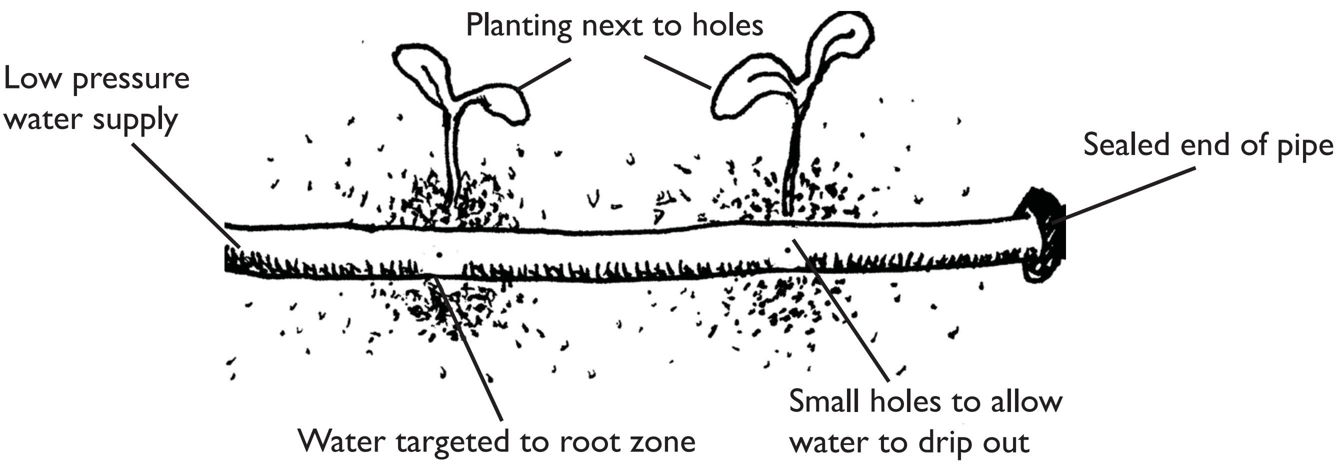
Drip irrigation can conserve water especially when used in conjunction with roof top harvesting. The principle is very simple: water seeps slowly out of small holes in a pipe on the soil surface. Holes are normally located close to plants so that the water is targeted directly to the root zone. Drip irrigation comes in many forms, but at its simplest, can be constructed by puncturing a piece of garden hose at intervals and connecting this to a water supply. The end furthest from the header tank should be closed off. For smaller areas the pressure from a header tank should be more than adequate to operate the system. Larger areas that require a longer length of tubing may need to be divided into sections and irrigated at different times. Separate sets of tubes with different hole spacing may be needed to match different crop spacing.

The system should include a simple wire mesh filter between the storage tank and the drip irrigation pipes. This mesh requires regular cleaning as it may get clogged up with algae. A small petrol pump can be used for larger areas, but this will add a fuel cost, will need servicing and is easily stolen.

The key advantage of a drip irrigation system is that water is targeted directly to the root zone so applications can be closely controlled. This considerably reduces the amount of water lost through evaporation compared to sprinkler systems. It also avoids problems of disease encountered from wetting the surface of the leaves and, because only a small area of the soil is watered, the area for weed control is far less than with sprinkler systems

The system requires considerable work to set up, but once this is done, irrigation is relatively easy. Therefore it is more likely to be used on smaller areas of high value crops that require regular watering.

Figure 12 Drip Irrigation



Summary: Drip Irrigation

Slope	Needs fairly level ground
Soil	Not so important
Rainfall	Depends on storage capacity
Labour	High to set up, thereafter low
Crops	Likely to be restricted to higher value horticultural crops

8. CONSERVATION TILLAGE

Conservation tillage refers to a type of agriculture where soil cultivation is kept to a minimum. It aims to reduce the negative effects of conventional tillage such as soil compaction, formation of pans, disturbance of soil fauna and moisture loss. The two main features that distinguish conservation tillage systems from conventional tillage systems are minimum cultivations and permanent soil cover.

Minimal cultivations vary in type. In a 'no till system' the land is prepared without the use of a conventional plough. In a 'minimum tillage' system, prong-based implements or hand hoes are used to open the soil just enough to allow a seed to be planted. Minimal cultivations reduce water losses because of a reduction in soil disturbance from tillage. In the long term the soil structure is improved. Less surface compaction and smearing at depth from the shares of the plough should increase rooting depth and therefore the drought tolerance of crops.

Permanent soil cover is commonly achieved by leaving crop residues on the ground as mulch after harvest (rather than incorporating them as in conventional tillage) or using cover crops or green manures between cash crops. This can reduce water loss and soil erosion from run off and prevent capping from heavy rainfall. Seeds or plants have to be sown or planted directly into mulch using a prong based implement or hoe.

Leaving crop residues on the soil can, however, increase the build up of pests and diseases. Leaving large amounts of straw type trash on the soil can also result in nitrogen being 'locked up' in a form that is not easily available for subsequent crops. Certain residues can have allelopathic effects (especially rye or vetch), which reduce germination of weeds but also subsequent directly sown crops for a period of up to six weeks.

There are many advantages and disadvantages to be considered in conservation tillage systems. In practice, many farmers have found that it takes several years before the advantages are realised so it should be considered a long-term project.

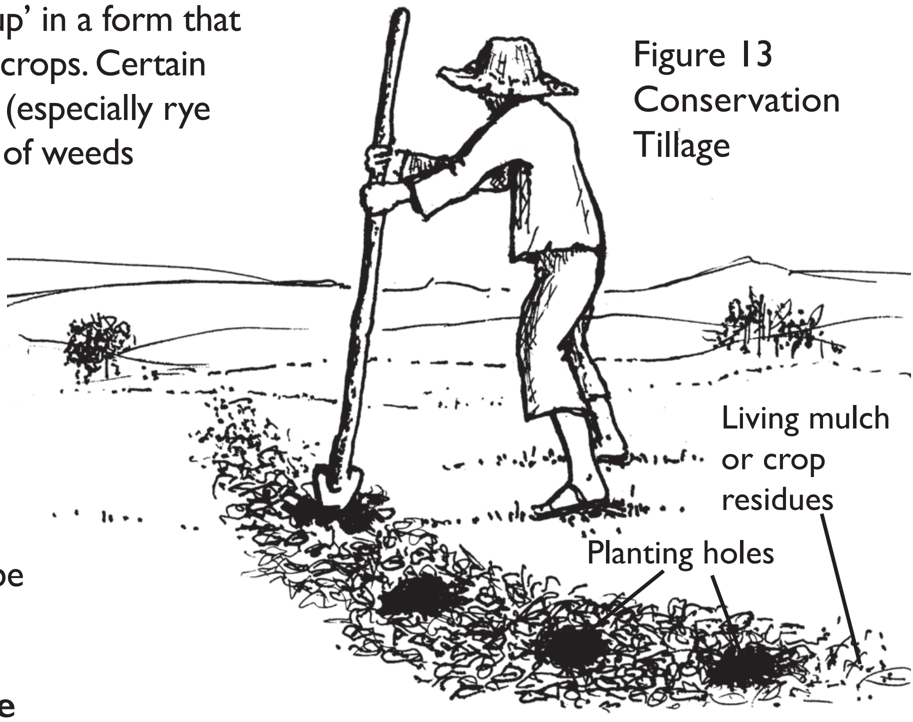


Figure 13 Conservation Tillage

Summary: Conservation Tillage

Slope	Many types
Soil	Weed control generally easier on lighter soil types
Rainfall	Depends on crop
Labour	Low for cultivation, high for weed control. Weeds can be a major problem especially in the first few years before the system stabilises
Crops	Many. Cost savings in reduced tillage are less important for high value/high input crops

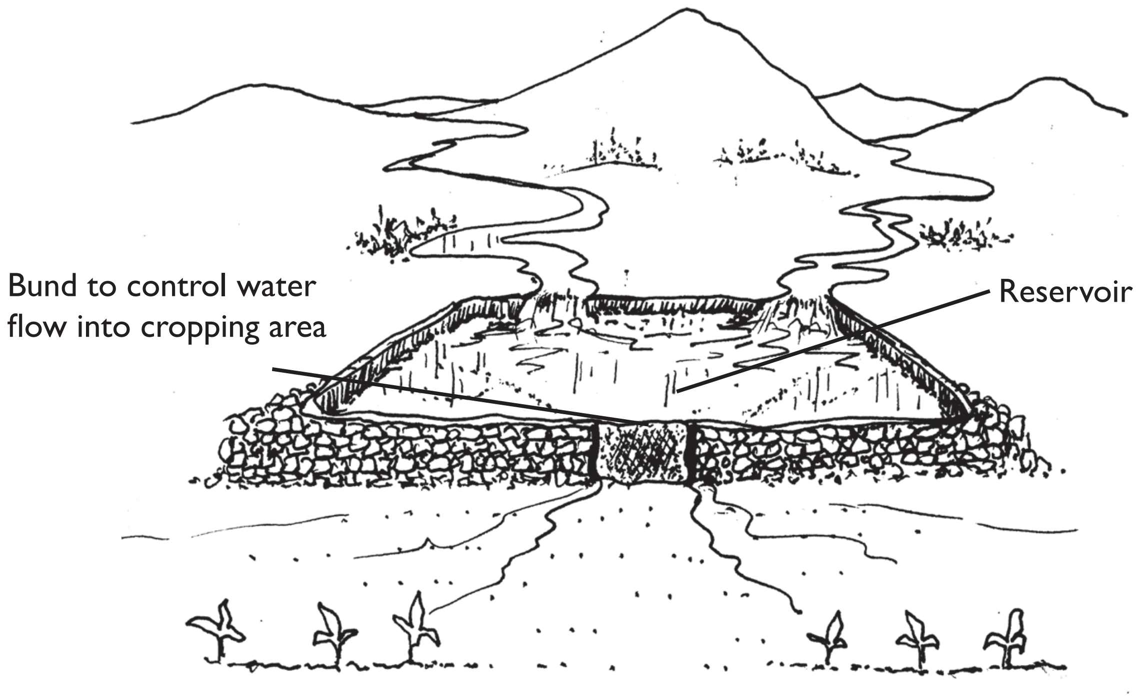
9. WATER HARVESTING FROM EXTERNAL CATCHMENT

Water harvesting from external catchments involves diverting runoff water from an area that is not cropped to the area where crops are grown. Water is stored in a simple reservoir structure and can be applied to the crops when it is needed. The flow of water from the reservoir into the cropped area can be controlled using tied bunds that can be built up or dismantled as required.

The external catchment area should not be cultivated and may include rough grazing areas, roads or homesteads. Ideally the soil should have a low infiltration rate in order to maximise runoff and therefore vegetation should be restricted to a minimum. The stored water will be lost gradually through evaporation and seepage, this can be reduced on silt or clay soils by capping the soil using puddling boards (used to encourage flooding in rice cultivation).

This technique is a much larger scale operation than the others and requires considerable labour to implement. It also requires a large area of uncultivated land, so is not suitable for densely populated areas. Construction may be on a community scale, and agreements need to be put in place to ensure that the management of the scheme and rights to access water are clearly defined.

Figure 14 Water Harvesting from External Catchment



Summary: External Catchment

Slope	Steep slopes in external catchment area
Soil	Heavy clay or silt best for external catchment and reservoir, lighter soil better for cropping area
Rainfall	Can be used in areas of low rainfall. The reservoir may overflow in periods of high rainfall
Labour	Very high
Crops	Wide range

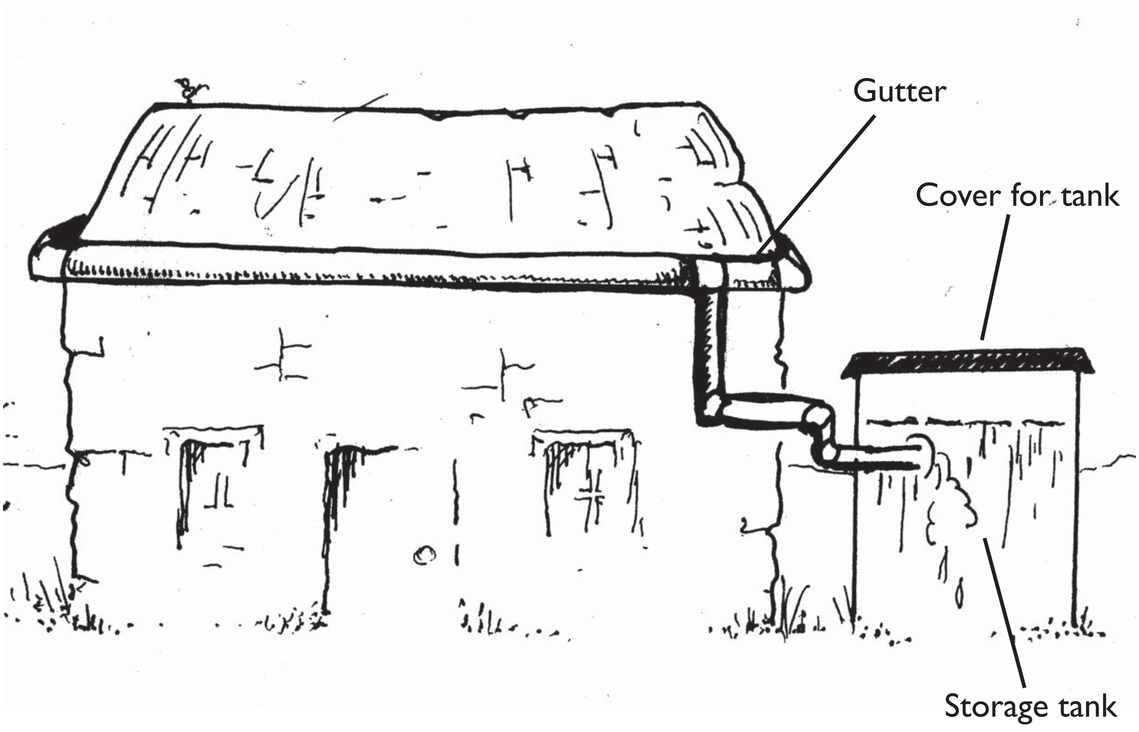
10. ROOF TOP HARVESTING

Roof top harvesting is a simple technique that can store large amounts of water from the rainy season for later use in the dry season. Although frequently used for domestic use, the stored water can also be used for small scale growing of high value horticultural crops which can be particularly drought sensitive. It works well in conjunction with drip irrigation described above.

The technique is simple - run off from sloping roofs is collected in plastic gutters then diverted through a down pipe into a storage tank. Covering the tank with some sort of temporary opaque cover (e.g. tarpaulin or black plastic) is essential to prevent the growth of algae that may clog up the system, and also the build up of mosquito larvae.

The height of the tank will also influence the operation and building. A tank at ground level is easier to build and may have a larger storage capacity, but when water levels in the tank are low, the low output pressure may restrict operations. A pump may be necessary to allow irrigation systems to work, which is an added expense in fuel and maintenance. Raised tanks, just below roof level, have the advantage of a greater head of pressure but require more structural work to build and this may also restrict the size of the tank.

Figure 15 Rooftop Harvesting



Summary: Rooftop Harvesting

Slope	Not applicable
Soil	Not important
Rainfall	Depends on storage capacity
Labour	Quite low – set up and maintenance is reasonably easy
Crops	Likely to be restricted to higher value horticultural crops

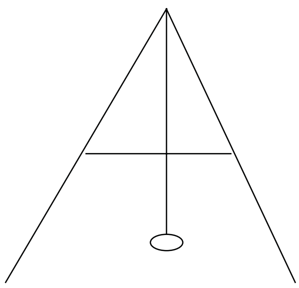
Appendix – Simple Survey Techniques

A Frame Construction

An A frame is one of the simplest tools that can be used for marking out contours on hillsides and measuring gradients. It is constructed using three pieces of wood nailed or fastened together in the shape of an A. A string with a weight hangs from the top of the A:

Figure1

A frame



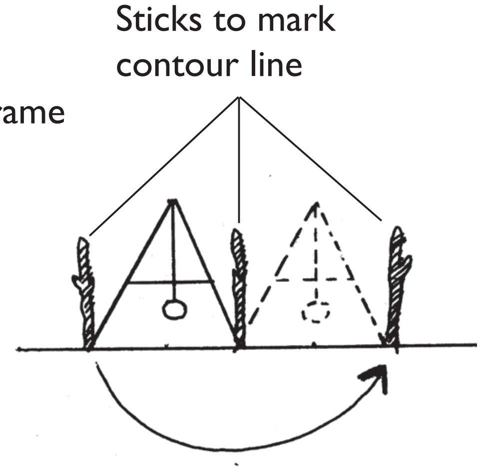
When the two feet of the A are at the same height, the string should hang exactly in the middle. Measure and mark this position in the middle of the horizontal pole of the A frame.

Using the A Frame to Mark a Contour

1. Place a stick or marker at the field boundary and place one foot of the A frame at this point.
2. Swing the other leg slowly round until the string hangs at the central mark. The A frame is now level and pointing along a contour line.
3. Mark the position of the other foot in the ground with a stick.
4. Repeat this operation: walking the A frame along, making sure that the string always hangs in the middle and marking the path of the A frame to form a contour line.

Figure 2

Walking A frame



Point A of the A frame is swung to
Point B keeping C in a fixed position.

Repeat this process at 2m intervals down the hillside to mark out other contour lines.

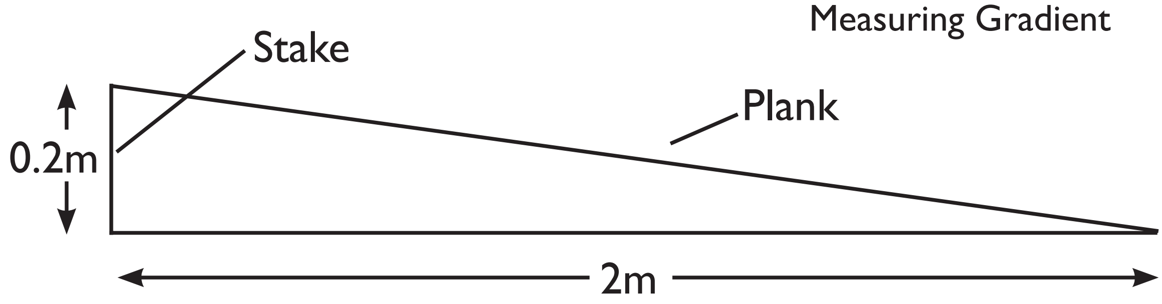
Calibrating the A Frame to Measure Gradient

The gradient is often used to decide on the most appropriate method of rainwater harvesting. Gradient is expressed as a percentage which is defined as Distance up / Distance along x 100. The A frame can be calibrated to measure gradient.

A simple slope is constructed using a plank at least 2 m long balanced on a 0.2 m stake to make a ramp. The stake can be moved so that the distance along the ground is changed to adjust the gradient.

Figure3

Measuring Gradient



For example, the slope above would be 0.2 / 2 x 100% = 10% gradient

Place the A frame on the slope and make a note of the position of the string. Make a note of the gradient next to this mark. Repeat adjusting the ramp to create different gradients (eg 2%, 5%, 10%, 20%, 50%). You should end up with a number of different marks on the A frame that correspond to different gradients. The A frame can now be used as a tool to measure the gradient of a hillside.

Further Reading

Duveskog, D., 2003. Soil and Water Conservation with a focus on Water Harvesting – A Study Guide for Farmer Field Schools and Community-based Study Groups. Version 1.1 FARMESA, Harare, Zimbabwe. http://www.infobridge.org/ffsnet/output_view.asp?outputID=1950

Critchley, W and Siegert, K., 1991. A Manual for the Design and Construction of Water harvesting Schemes for Plant Production. FAO, Rome, Italy http://www.fao.org/docrep/U3160E/U3160E00.htm

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