ORIGINAL

Water-Harvesting

Some General Principles and Methods for Areas of Intensive Human Use and Dryland Cropping from the PELUM Association (July 1995)

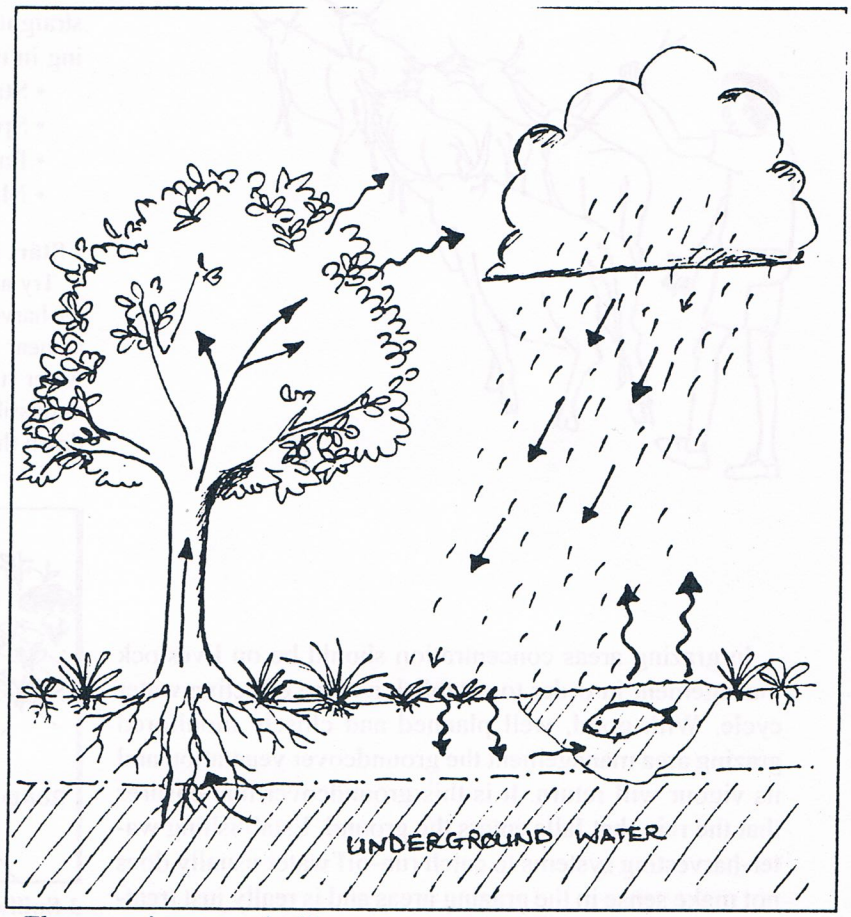
People and the water cycle

There was a time when rivers and streams used to run with cool, clean water; and they ran for most if not all of the year. Now rivers and streams flood for short spells with silt laden water. They dry up quickly after the rains. The state of the rivers and streams is a reflection of the land from which they are fed.

Why has all this happened ? Before today's agricultural practices became the norm and before people were moved around and concentrated by political forces, rain fell and entered the ground. This was because there was good groundcover everywhere.

Once rain water is in the ground it is usually a productive force. It moves slowly within the soil profile, feeding the water-table and seeping into streams and rivers, filtered by its movement through the ground.

Above ground, water is generally destructive, carrying soil with it through the landscape. This is a point that is often missed or ignored. The contour ridge policy, for example, forgets this point. The policy was introduced to prevent gullies and has largely been successful in doing this but due to the bare-soil agriculture that is practised, there is a lot of water run-off between the ridges. In heavier storms a lot of water is lost via the ridges which are actually misnamed because they are not on contour but are, in fact, 1 in 200 diversion drains.



The natural water cycle. *Water evaporates from rivers, soil and plants to form clouds in the sky.. The water returns to earth via rain and seeps into the underground water store or through the soil into streams and rivers. Once in the underground store it is safe from most pollution and evaporation. If the soil is compacted then rain water will not be able to seep into the soil. It will become run-off and could lead to soil erosion. If the soil is well covered with vegetation water will easily sink into the ground.*

The focus of water management is on dams which satisfy a short term need but fail to harvest water in a sustainable way. Dams are a short-term solution that are going to prove very costly as more and more dams silt up. The fine silt that washes continuously into these dams is much worse than course silt (which rivers fill up with) because it makes it almost impossible to pump water out. It is good for growing bananas, very expensive bananas!

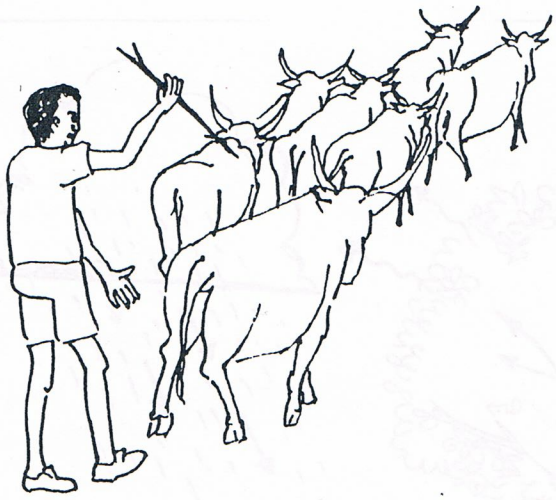
There are no standard solutions to the issue of water-harvesting. That has been the biggest problem with government approaches in the last few decades. They have tried to develop a standardised approach and in so doing have taken away the initiative of farmers and perhaps the responsibility as well. Water-harvesting has become the realm of experts, with their specialised equipment. Those without this equipment often feel helpless in the face of growing degradation.

There seems to be some evidence that rainfall is getting less, but only marginally so. The volume of rain is still great, even in the drier parts of the country, if only maximum use can be made of it. The challenge is to bring the whole issue of water-harvesting down from its "expert" pedestal. Every piece of land is highly unique and has to be tackled in that way. The task is to empower land-users to take up the whole issue of water-harvesting themselves in order to find techniques and strategies for their own specific situations. The general principles are fairly straightforward and there are enough methods and examples around to draw on.

Water-Harvesting Principles

When looking at general principles of water-harvesting it is useful in most cases to separate the landscape into:

i) Grazing Areas



In grazing areas concentration should be on livestock management in order to establish a more effective water cycle. With good, well planned and closely monitored grazing area management the groundcover vegetation and its vigour will return. It is this groundcover that ensures that the rain that falls enters the ground. Establishing water-harvesting systems to catch run-off water usually does not make sense in the grazing areas and is really just treating a symptom.

In order for effective livestock management to be established, there has to be full community understanding of the issues. It is the community that must analyse the situation and plan what has to be done themselves. Grazing systems usually fail because they are imposed from outside as a package solution. They are not the beginning of a community process, as should be.

Furthermore, there may be a number of misunderstandings that have to be tackled if grazing management is going to start to become effective. Foremost among these is the whole issue of numbers of animals. Overstocking and overgrazing are terms which are often used synonymously when they most certainly should not be. Overgrazing is a question of the time plants are exposed to grazing animals. It only happens when animals graze in the same place again before plants have had time to recover.

Dryland environments (seasonal rainfall) need large animals in order to restore and maintain the natural processes; they have always been an intricate part of such environments. They are the primary agents of decay in the carbon cycle and their behaviour can help sort out the problems of capped soils and oxidising grasses.

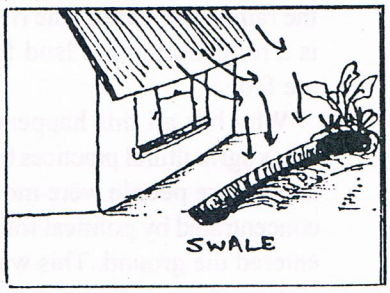
ii) Agricultural and Human Dwelling Areas

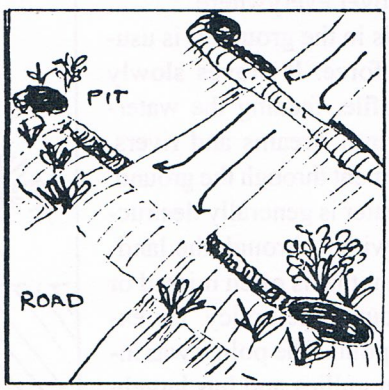
These areas are the main focus of this paper. The following straightforward principles (or guidelines) are well worth keeping in mind at all times:

- Start at the source
- Spread and sink
- Pay special attention to spillways
- Maximize groundcover

1 Start at the source >

Try and start with water-harvesting techniques as near to the source of water run-off as possible as possible and then work down the slope.



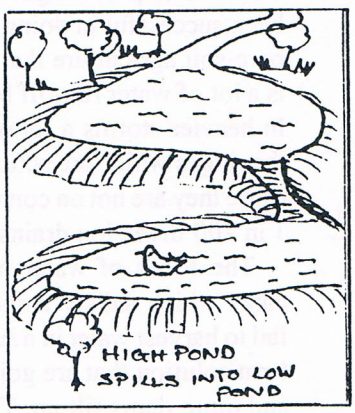


< 2 Spread and sink

The aim is to spread the water across the surface and sink it into the ground, by any appropriate means. Where water is being diverted to a storage (such as from a road to a pond or small dam) then the slope of this diversion should be gentle, something like 1 in 400.

3 Spillways >

Always pay special attention to spillways. These are weak points in heavy storms. People often think of spillways only in connection with dams but a 1 metre deep pit filled with organic matter and harvesting water run-off from the roof of a house also needs a spillway into another pit or into a ditch on contour for those extra heavy storms.



4 Maximize Groundcover

Earthworks should not be an excuse to avoid this most important aspect of water-harvesting.

Mr. Zephaniah Phiri from Zvishivane is well known to some for the water- harvesting he has managed to achieve. For years he has been paying particular attention to the first 2 princi ples above,Starting at the source of run-off and spreading and sinking water. He has worked in many different ways to get the water into the ground. By focusing on this and through trial and error he has put in a successful water-harvesting system for his small farm.

Assessing Run-off

The first step in designing any water-harvesting strategies is to make a thorough assessment of the existing water run-off situation.

- Where are the sources of run-off and how much water is involved?
- How well does water infiltrate into the soil?
- What is the vegetation cover like both in terms of mulch cover and underground root systems?

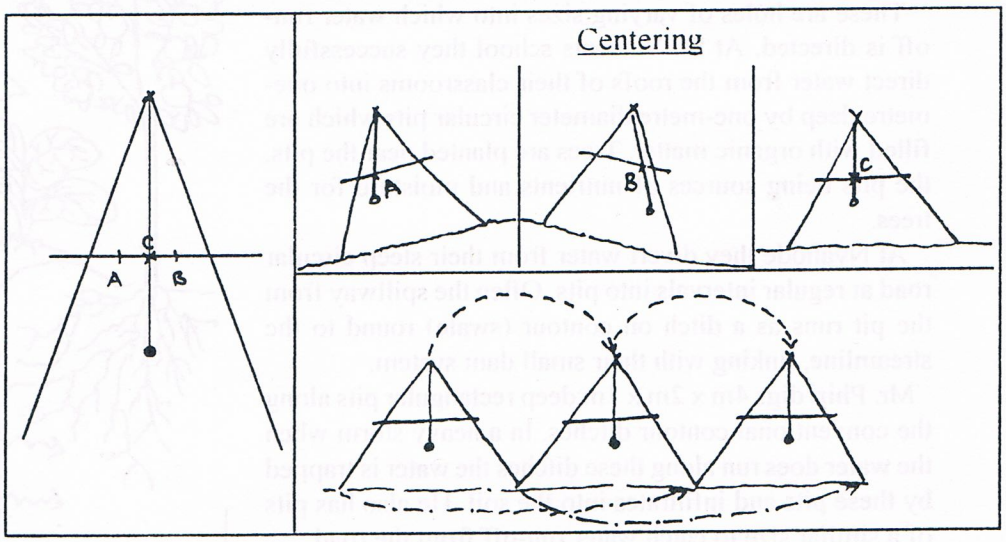
These and other questions need to be asked. It also needs lots of discussion amongst those involved. A deep and growing understanding of the patterns of water movement in the landscape is essential for effective planning of water-harvesting strategies. Any methods to increase this will help.

Extension workers dream about theodolites while farmers get the job done

Spreading ideas about Water-Harvesting

Using the principles above, appropriate strategies can be designed. Some of these are listed below as suggestions. Perhaps the most important prerequisite to start people on the road to experiment with water-harvesting is to help them realise that one does not have to be an "expert" to talk about and carry out water-harvesting. There are endless numbers of ways to achieve the aim of getting water into the ground.

An example from Chikukwa illustrates the block that sometimes exists over people doing things for themselves. When asked about putting in contour ditches (on contour) farmers said that they were waiting for the government extension worker to come and mark the contour. The extension worker in turn stated that he was waiting for a theodolite; there was a shortage, and more needed to be imported into the country. Farmers were then taught how to make and use an "A" frame to mark contours. If one visits Chikukwa now it is quite common to see "A" frames outside the homes of farmers. And the most enthusiastic person about this all was the extension worker.



The "A" Frame is a useful tool for measuring contours. It is usually made from two long poles with a shorter one attached across the middle. A string holds a weight which dangles between the two long poles and across the short centre piece. This "pendulum" action allows contours to be measured.

Of course, there are dangers with using an "A" frame. The centre-point may be marked incorrectly and therefore a contour pegged wrongly. The farmer will realise this and correct it in future. Farmers should be allowed to make mistakes and learn from them. It is only by this process that effective water-harvesting systems will be established. There must be trust in farmers' abilities.

One of the most important ways to increase water-harvesting activities is through exchange visits between those who are or will be involved in water-harvesting themselves. Mr. Phiri has visited farmers in Chivi through ITDG and a number of them are now using some of his methods. The same happened with farmers in Buhera. Farmers from Mozambique have visited Chikukwa to learn and get inspiration from how they are tackling their massive water run-off problems. The farmers in Chikukwa, facilitated through the Natural Farming Network, had previously visited Nyahode Union Learning Centre, as had farmers from Marange working with MDA. Seeing and discussing between practitioners will probably be one of the main tools in future years.

Sharing ideas through visits

Methods of Water Harvesting

A few ways in which run-off water can be harvested are briefly mentioned here as the beginning of a checklist. As mentioned earlier the possibilities are endless, open to the creativity of practitioners. The headings used to divide these methods up are very arbitrary. They all have many similarities.

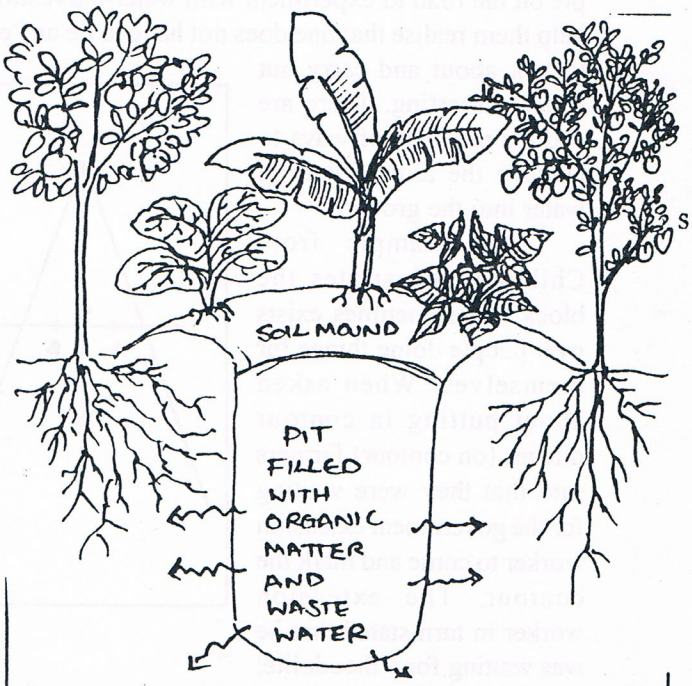
• Pits

These are holes of varying sizes into which water run-off is directed. At St. Vincents school they successfully direct water from the roofs of their classrooms into one-metre deep by one-metre diameter circular pits which are filled with organic matter. Trees are planted near the pits, the pits being sources of nutrients and moisture for the trees.

At Nyahode they divert water from their steep circular road at regular intervals into pits. Often the spillway from the pit runs as a ditch on contour (swale) round to the streamline, linking with their small dam system.

Mr. Phiri digs 4m x 2m x 1m deep rectangular pits along the conventional contour ditches. In a heavy storm when the water does run along these ditches the water is trapped by these pits and infiltrates into the soil. He also has pits of a similar size to catch water run-off from the road.

Joe Made in Harare is on soil which does not allow water to infiltrate easily. In his system he digs trenches of about one metre wide and one-and-a-half metre deep and then refills them with manure (it could be compost) and top-soil. Water from the gutters is then directed to these trenches where it infiltrates easily and is held by the organic matter for the benefit of fruit trees.



The idea is to slow down the flow of water not to stop it

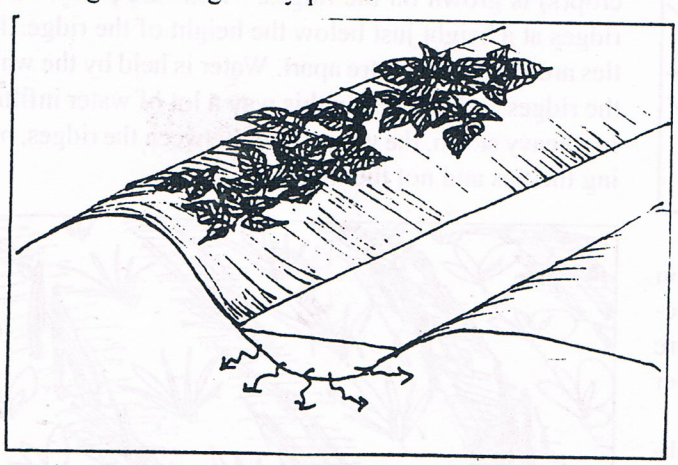
• Water force breakers

The force of water is broken by a physical barrier. This barrier can be a line of rocks on contour or a ditch reinforced with rocks. Another method growing in popularity is using tightly planted bunch grasses on contour. Because of its density vetiver grass is appropriate for this. It is planted at 15-20cm spacing. Many farmers in Chikukwa are trying it out. Other grasses such as bana and some of the indigenous bunch grasses are also suitable. Farmers in Kenya have been using napier fodder like this for years. Where cattle are controlled, napier may be more appropriate because it is also a good fed for them. Where they are not controlled they may overgraze and kill it. Vetiver grass may be better in such instances as it is tougher and not nearly as palatable.

The water hits the barrier, is slowed down. Some, if not all, of it sinks into the ground. The silt that may be carried by the water is deposited. In time these barriers help form terraces. In the Biriiri area (Chimanimani District) there are examples of stone terraces formed like this. Mr. Phiri also makes extensive use of rock barriers.

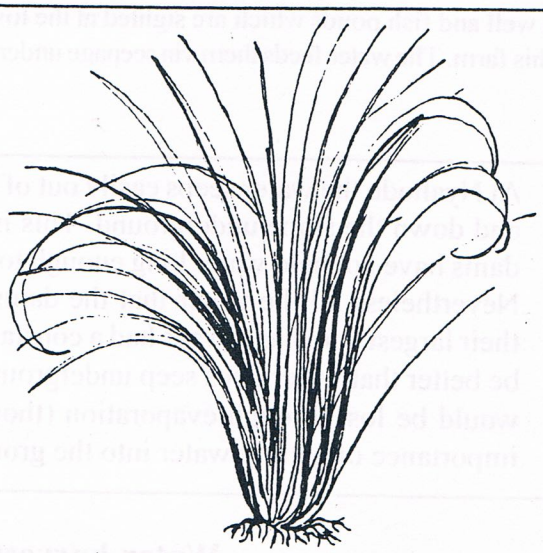
• Ditches

There are a variety of ditches used. The conventional contour ridge is an example. It is usually sloped 1 in 200. In this way it slows down water which is rushing down a slope and so prevents rills and gullies. In heavy storms excess water is carried away to streamlines so as to avoid the ridge breaking at any point.



Diversion drains carry water on a gentle slope to some kind of storage. This may be a dam or a wetland or somewhere where the water can be safely spilled to infiltrate immediately into the ground. Nyahode help fill some of their dams in this way.

In the higher rainfall areas of Kenya a lot of use is made of the "funya juu" system on gentle slopes. This is a ditch from which soil is thrown up the slope. This allows terracing to form gradually.



Vetiver grass — a tough species that is not very palatable to livestock so ideally suited to erosion control.

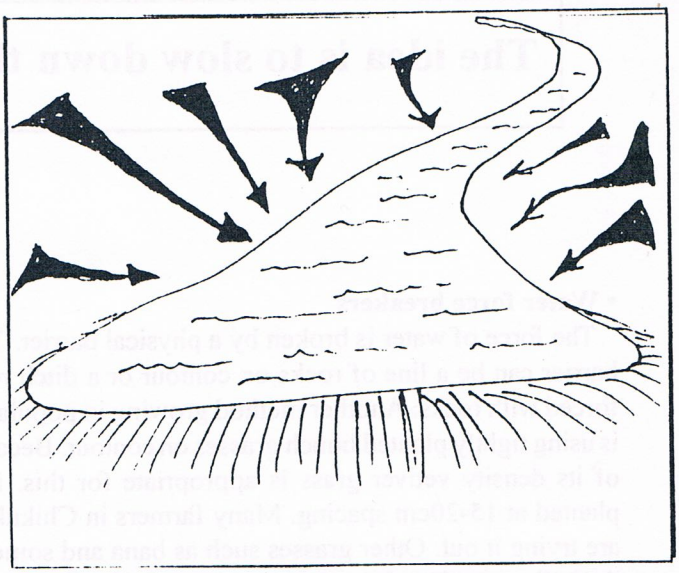
< A **swale** (a ditch truly on contour) can be used to spread water from where it has concentrated. This may be from a road or the roof of a house or from the clear swept area that people often have around their homes in rural areas. In the keyline system, used by Nyahode, the spillway from a dam becomes a swale, running round the landscape to the next streamline. Some of the water sinks into the ground and the rest spills in the next streamline to help fill a dam below, which in turn can bring water back to the first streamline via a swale spillway.

• **Dams and Ponds**

These are an obvious form of water harvesting but as mentioned earlier they are too often used as the only method and end up filled with silt. In a dryland environment the safest place to store water is in the ground. None is lost through evaporation. This water becomes available through seepage and via wells. With a concerted effort to get water into the ground rather than running it off into dams, the perennial springs, streams and rivers can be returned to many landscapes.

Of course the short-term needs must be balanced with longer term aims such as that of restoring perennial water systems. But if the longer term aim is lost sight of then the problem will only compound itself.

Mr. Phiri's water-harvesting methods all assist to feed his well and fish ponds which are sighted at the lower part of his farm. The water feeds them via seepage underground.

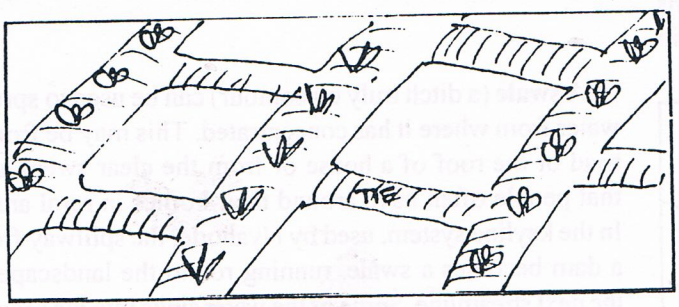


Fine silt washed into dams from surrounding lands. This natural process is exaggerated by bare ground in the catchment and poorly managed stream bank cultivation.

At Nyahode the water seeps easily out of some of the dams, not through the walls but into the ground and down the slope underground. This is partly because, due to low rains in the last few years, the dams have not held water long enough to be able to establish a sealed layer at the bottom of the dam. Nevertheless all the water that the dams do catch replenish the underground water. A well below their largest dam has always had a constant supply of clean water. In terms of water-harvesting it may be better that water does seep underground rather than be held by the dam from which a lot of water would be lost through evaporation (though they do lose out on not being able to keep fish). The importance of getting water into the ground cannot be over-emphasized.

Water-harvesting in dryland cropping areas

A number of methods mentioned above would be appropriate for dryland cropping areas but there are some other methods also worth mentioning which are specifically aimed at dryland cropping areas:



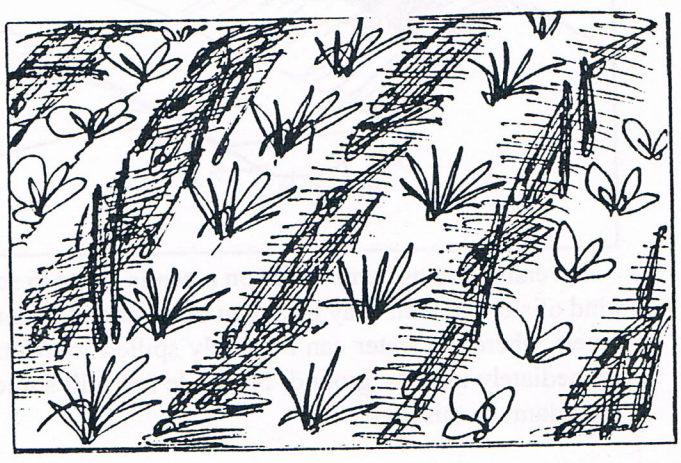
• **No-till mulch cropping >**

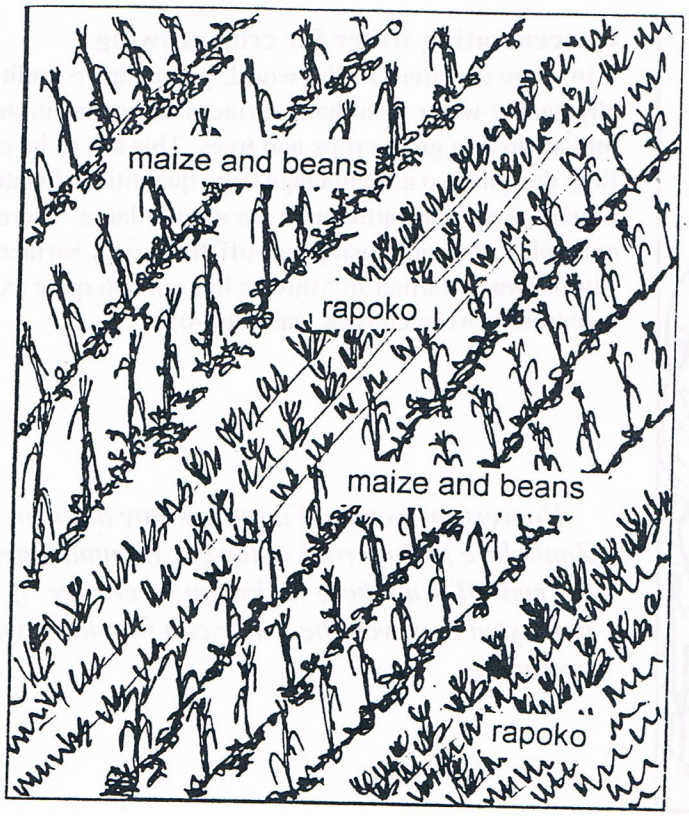
In this approach mulch from previous crops is left on the surface and the next crop is planted into this. It is recommended that there is at least 30% soil-cover but there are also indications that even with as little as 10% cover zero-tillage may be preferable.

A standard recommendation these days is winter ploughing. If one is going to plough then it is probably better to do so when the soil is slightly moist (ie: winter ploughing) rather than early in the warm season when the soil is dry. But the main problem with winter ploughing every year is that the soil is left bare for many months of the

< • **Tied ridging**

This involves making ridges at a 1 in 200 slope. The crop(s) is grown on the ridges. "Ties" are put in between ridges at a height just below the height of the ridge. These ties are about one metre apart. Water is held by the walls of the ridges and the ties. In this way a lot of water infiltrates. In a heavy storm, the water flows between the ridges, breaking the ties and not the ridges.





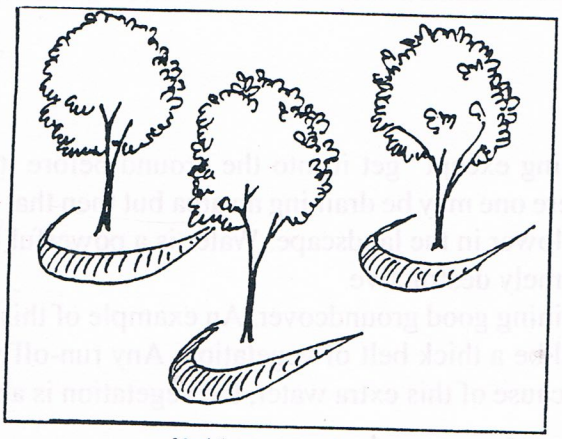
year.

As mentioned above groundcover is an extremely important part of designing water-harvesting systems. This cover breaks the destructive impact of raindrops on the soil. It prevents organic matter being lost from the soil through oxidation. In both these ways it assists the structure of the soil which has a direct bearing on the ability of the soil to allow water to infiltrate. With good structure there are many airspaces and it is into these airspaces that water permeates. The little work that has been done with no-till mulch cropping indicates a great potential in water conservation.

• Strip cropping

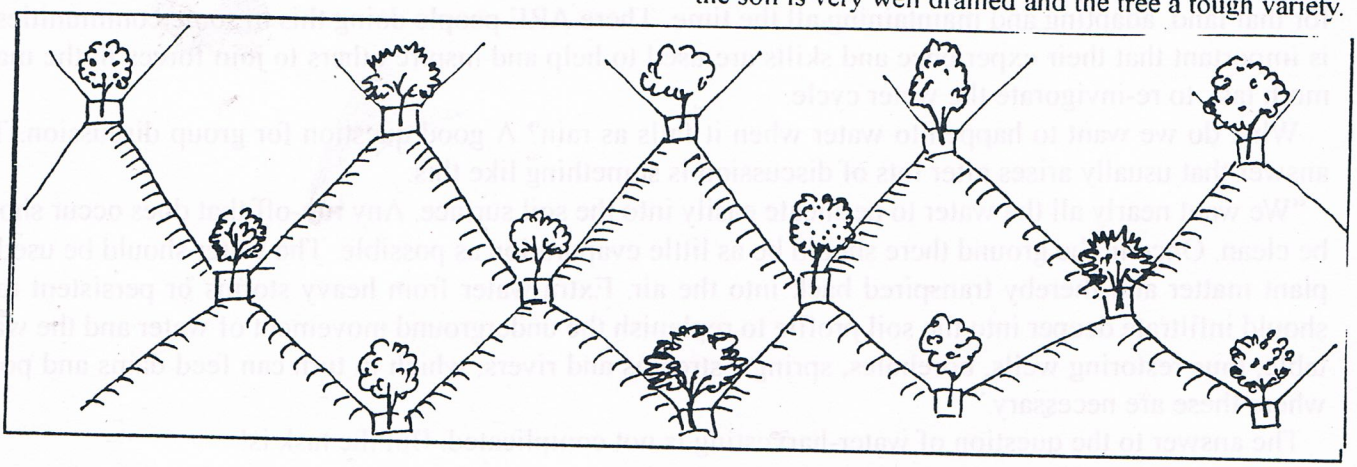
This involves growing crops in strips, usually 3 to 7 metres wide. As well as being a good way to increase biodiversity in the cropping areas it helps control water run-off. Dense planted crops are interspersed with row crops. This means that a crop like maize which is usually grown in rows is grown in a strip next to something like rapoko which is densely planted. The densely planted strip will catch any run-off from the row crop. And some crops such as soya beans or sorghum which are usually grown in rows can be grown as a dense crop.

Water-harvesting with tree-planting

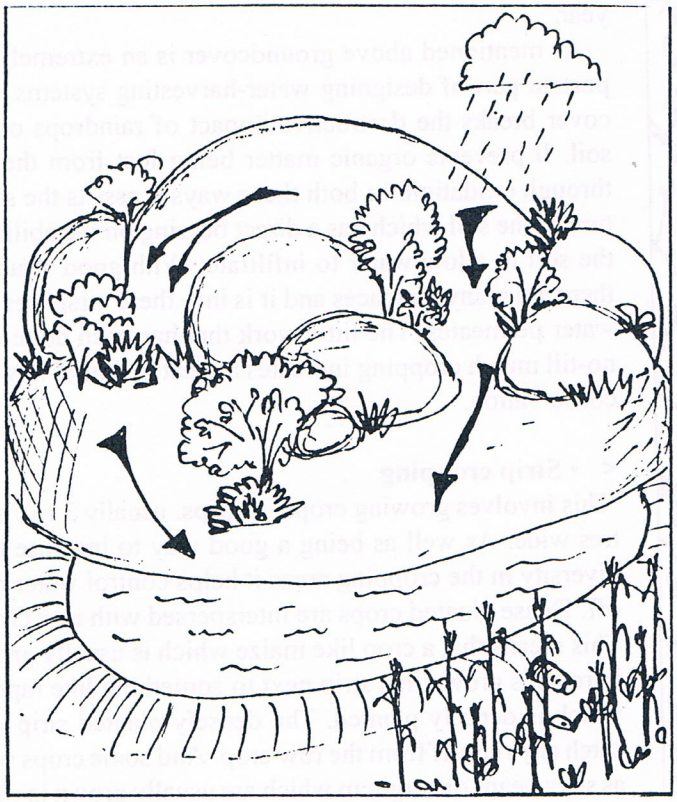


Half-moon ridges

There are a number of ways in which micro water catchments can be established with trees. Half-moon ridges below the tree will help catch some run-off and sink it in the ground for the benefit of the tree. The net and pan system takes this a step further, running ridges up the slope a small way above the tree. These can be interconnected across the slope in such a way that any water that spills goes into the next net and pan. This is suitable for dry areas and gentle slopes. This system can be combined with pits to help more water infiltrate. In very dry areas the tree can be planted at the bottom of a small pit and the water concentrated into this pit. To do this it is important that the soil is very well drained and the tree a tough variety.



Net and pan



Harvesting water off a rock. Many areas in Zimbabwe feature rock outcrops. If unmanaged, the run-off from these rocks can be erosive. If harvested however, the water can provide a vital resource.

Concentrating water for crop growing

In some dry areas of the world, people have traditionally caught water from hard surfaces and concentrated it into an area to grow crops and trees. This has to be carefully designed so as to manage large quantities of water in a small area. The earthworks are usually large. There are examples of people using run-off from rock surfaces in Zimbabwe. A farmer in Murewa has gone to quite extensive trouble to catch rock water run-off.

There are no standard solutions to water-harvesting except "get it into the ground before it can be destructive". Of course there are exceptions where one may be draining an area but then that drained water must be sunk into the ground somewhere lower in the landscape. Water is a powerful force of nature. If not controlled, tamed, and directed it is extremely destructive.

In a natural situation, nature controls water by maintaining good groundcover. An example of this is what one sees at the foot of rocks and small hills. There will be a thick belt of vegetation. Any run-off water is caught by this vegetation and goes into the soil. And because of this extra water, the vegetation is able to be thick.

A farmer is an integral part of her/his land. Only (s)hé can develop appropriate ways of harvesting water for that land, adapting and maintaining all the time. There ARE people doing this in some communities. It is important that their experience and skills are used to help and inspire others to join forces in the mammoth task to re-invigorate the water cycle.

What do we want to happen to water when it falls as rain? A good question for group discussion. The answer that usually arises after lots of discussion is something like this:

"We want nearly all the water to permeate easily into the soil surface. Any run-off that does occur should be clean. Once in the ground there should be as little evaporation as possible. The water should be used by plant matter and thereby transpired back into the air. Extra water from heavy storms or persistent rains should infiltrate deeper into the soil profile to replenish the underground movement of water and the water table, thus restoring wells, boreholes, springs, streams and rivers, which in turn can feed dams and ponds where these are necessary."

The answer to the question of water-harvesting is not complicated. But the task is!