

**SUSTAINABLE TECHNIQUES
AND PRACTICES FOR
WATER HARVESTING AND
CONSERVATION AND THEIR
EFFECTIVE APPLICATION IN
RESOURCE-POOR
AGRICULTURAL PRODUCTION**

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SUSTAINABLE TECHNIQUES AND PRACTICES FOR WATER HARVESTING AND CONSERVATION AND THEIR EFFECTIVE APPLICATION IN RESOURCE-POOR AGRICULTURAL PRODUCTION

VOLUME 2 OF 2: FARMER AND EXTENSION MANUAL

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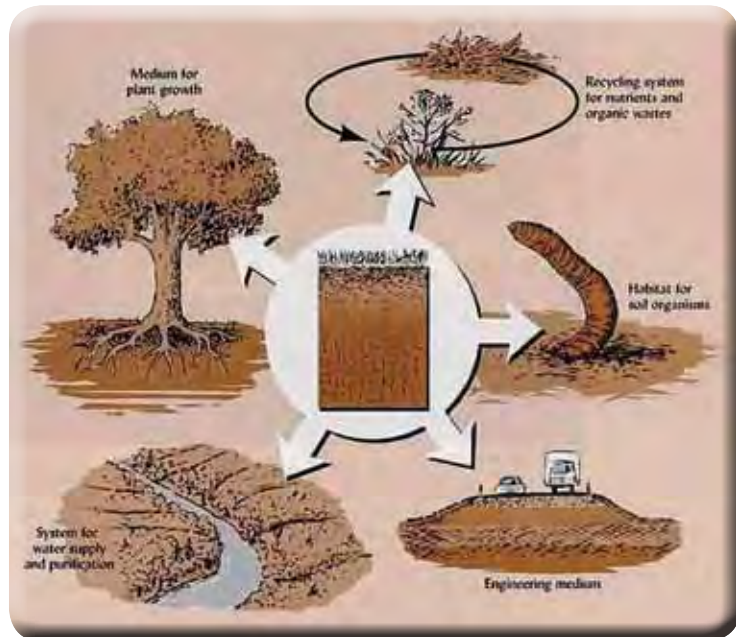
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IMPORTANCE OF SOIL

Soil provides five basic needs:

- Provides growth medium and nutrients required by plants for sustained food production
- System for water supply and purification
- Nutrients and organic waste recycling system
- Habitat for living organisms
- Engineering and construction medium

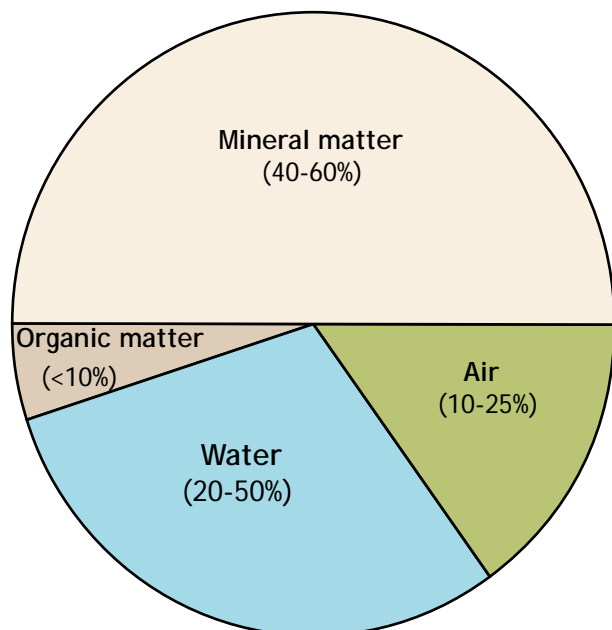


Soil components

Soil consists of mineral matter, water, air and organic matter

How do we take care of the soil?

- Prevent erosion
- Maintain soil fertility



Soil classification

Soils are classified (named) according to the unique sequence of certain layers and is expressed as soil type. Each soil has different uses. The properties of soil horizons are important to:

- Predict the rate of water movement through it
- Indicate the soil potential to store water for plants during droughts
- Provide the right combination of chemicals to plants
- Indicate how well the soil will filter wastes
- Provide a habitat for organisms

How?

An experienced extension officer or soil expert from the Department of Agriculture can classify and characterize soils

Topsoil horizons (O, A):

O: Mostly organic material

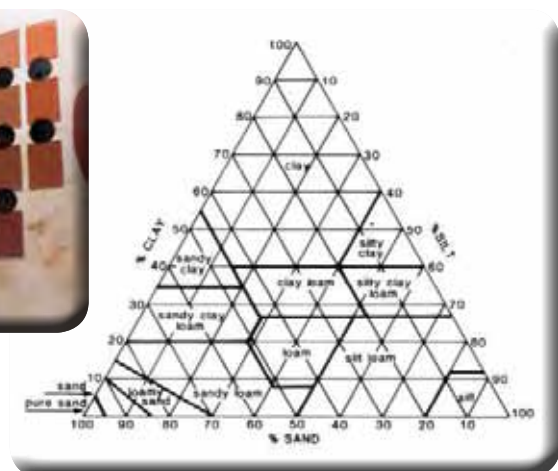
A: Topsoil mineral horizon

- Near the soil surface and the major zone for root development
- Carries most of the nutrients and large share of the water for plant growth

Subsoil horizons (E, B):

- Zone of accumulation
- Serve as a reservoir for water and nutrients
- Determine land use

C: Partially weathered parent material (bedrock)



IMPORTANCE OF SOIL

How to take soil samples for analysis



1. Go to the place you want to test



2. Dig a hole, the depth and width of a spade



3. Using the spade, cut a thin slice of soil from one of the sides of the hole. Put this into a bucket



4. Take samples from different places in your garden or field, each time placing samples in the bucket



5. When you have several samples, mix the soil in the bucket well



6. Place a small quantity of soil (± 1 kg) from the bucket into a paper bag



RAINWATER HARVESTING

What is rainwater harvesting?

Rainwater harvesting is the process of concentrating rainfall as runoff from a larger area for its productive use in a smaller target area. The collected runoff can be applied either directly to an agricultural field for crop production or be stored in some type of storage facility for domestic use and/or supplemental irrigation.

In other words, rainwater that could have been lost through runoff is now collected and used productively for crop production and domestic use.

What is sustainability?

Sustainability describes the appropriate use of crop systems and agricultural inputs supporting those activities that maintain economic and social viability while preserving the high productive quality of land. The requirements for sustainable crop production are:

- Increase in agronomic productivity / production
- Reduction in production risk
- Conservation of natural resources
- Economic viability
- Social acceptability

In other words, rainwater harvesting increases production with higher profit margins without harming the natural resources and is socially acceptable to rural community members.

What is conservation?

The White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (1997) defines the term conservation as both "conservation of biological diversity", and the "sustainable use of its components". This reflects the importance of sustainable use of natural resources. Therefore, using water harvesting techniques that are both conserving and contributing to the sustainable environment is ideal.

CLASSIFICATION OF RAINWATER HARVESTING SYSTEMS

Macro-catchment (Ex-Field Rainwater Harvesting. Outside the farm/field/land boundary)	Micro-catchment (In-Field Rainwater Harvesting. Inside/within the farm/field /land boundary)	Roof-top Micro-catchment (Non-Field Rainwater Harvesting. Artificial/ man-made runoff area)
Characteristics		
<ul style="list-style-type: none"> Overland flow harvested from catchment areas outside the farm/field/land boundary Runoff stored in soil profile/ below-surface reservoir Provision for overflow of excess water Can be practised in arid and semi-arid areas below 450 mm annual rainfall 	<ul style="list-style-type: none"> Overland flow harvested from short catchment lengths within the farm/field/land boundary Runoff stored directly in the soil profile No provision for overflow of excess water most of the time Can be practised in semi-arid areas with rainfall between 450-700 mm 	<ul style="list-style-type: none"> Generally smaller catchment area compared to ex-field Runoff stored in reservoir above/below ground surface Tap / outlet normally attached to reservoir to access water Can be practised in arid and semi-arid areas with annual rainfall of less than 450 mm
		
Advantages		
<ul style="list-style-type: none"> Makes crop production possible in arid / semi-arid areas Reduces risk of crop failure Harvested water can be used for supplementary irrigation Recharges aquifers 	<ul style="list-style-type: none"> Increases crop production in semi-arid areas No ex-field runoff from the field No erosion from the field Low maintenance Only dependent on rainwater from own field Can be practised on small or large areas Low implementation cost No high-tech structures needed 	<ul style="list-style-type: none"> Used to obtain water for irrigation purposes as well as domestic purposes Has potential to supply drinking water when no water is available Reduces risk of crop failure
Examples		
<ul style="list-style-type: none"> Jessours Contour stone bunds Stone dams 	<ul style="list-style-type: none"> Small pits Small runoff basins Runoff strips interrow system In-field rainwater harvesting 	<ul style="list-style-type: none"> Rooftop water harvesting
		



EXAMPLES OF CONSERVATION TECHNIQUES

Water conservation

Examples of water conservation techniques

- *No-till*
- *Minimum tillage*
- *Mulching*
- *Basin tillage*
- *Crop rotation*
- *Proper weed control*
- *Crop and cultivar selection*

Soil conservation

Examples of soil conservation techniques

- *Mulching*
- *No-till*
- *Minimum tillage*
- *Basin tillage*
- *Green manure*
- *Cover crops*

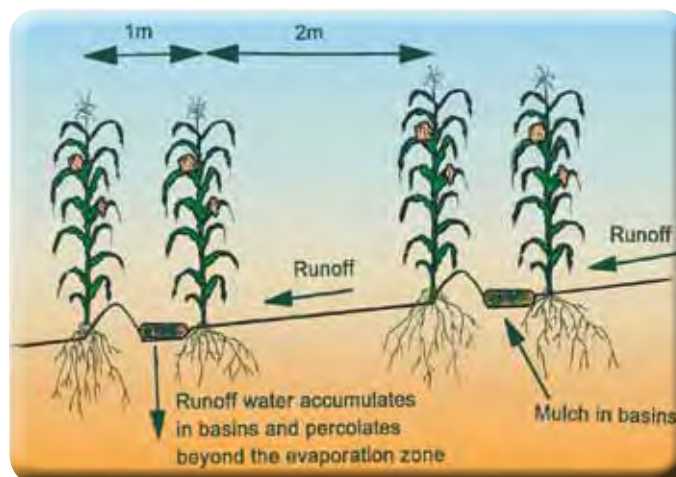
IN-FIELD RAINWATER HARVESTING (IRWH)

Principles of IRWH

According to Oweis (2004) in-field rainwater harvesting (IRWH) falls under the international classification of rainwater harvesting as being part of “On-farm Micro-catchment methods”. IRWH combines the advantages of water harvesting, no-till, basin tillage and mulching on high drought risk clay and duplex soils (Hensley *et al.*, 2000; Botha *et al.*, 2003). This innovative water conservation technique has the potential to reduce total runoff to zero and surface evaporation (E_s) considerably. This result in an increased plant available water and thus for increased yields.

The specific principles of IRWH are considered to lead to the following advantages:

- **Basin tillage** minimizes runoff from the land
- **Water harvesting from the untilled, crusted soil** on the 2-m wide inter-crop row area serves to concentrate runoff water in the basins. This promotes infiltration of water beyond the surface evaporation zone and therefore minimizes E_s losses
- Applied **mulch** on the runoff area minimizes E_s losses and prevents erosion or soil movement



The IRWH technique promotes rainfall runoff on a 2-m wide strip between alternate crop rows and stores the runoff water in the basins. Water collected in the basin can infiltrate deep into the soil beyond the surface evaporation zone. After the basins have been constructed, no-till is applied to the land. Since there is no cultivation that is done on the runoff area, a crust forms and this enhances runoff.

In other words IRWH is a risk-free socially acceptable technique that combines rainwater harvesting and conservation techniques to increase crop yields which is economically viable without any damage to our scarce natural resources.

IN-FIELD RAINWATER HARVESTING (IRWH)

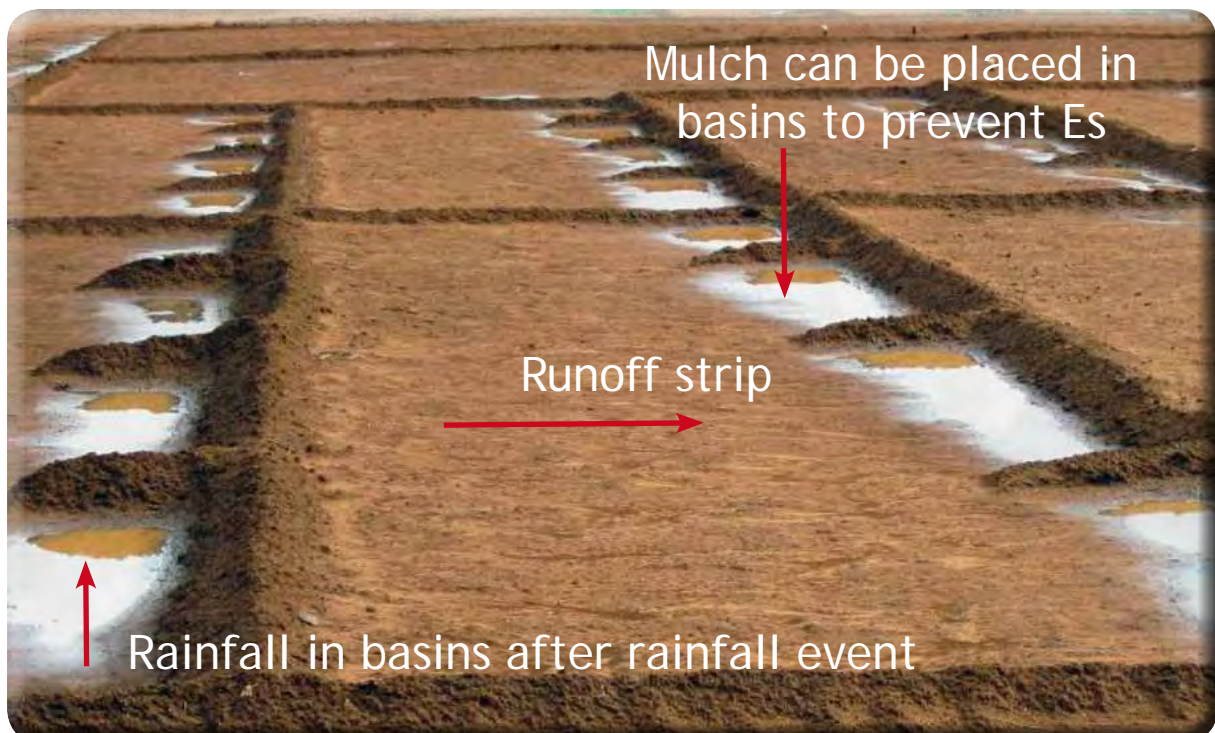
Functions of IRWH

Basin area

- Stops in-field runoff
- Maximizes infiltration
- Stores harvested water in the soil profile (primary water storage facility)
- Minimizes evaporation
- Application of mulches in basins minimizes Es

Runoff area

- Promotes in-field runoff
- Acts as secondary water storage facility
- Application of mulches on the runoff area minimizes Es and prevents erosion



IN-FIELD RAINWATER HARVESTING (IRWH)

Importance of IRWH

Water conservation

- Reduces loss of rainwater through reduction in Es and ex-field runoff

Soil conservation

- Prevents soil erosion

Crop productivity

- Helps improve crop productivity
- Enables farmers to plant crops in areas that are marginal for crop production

Food security, poverty alleviation and socio-economic status of resource-poor farmers

- Contributes to household food security
- Contributes to poverty alleviation
- Helps improve the socio-economic status of resource-poor farmers
- Contributes to improving the health status of community members
- Helps farmers to be profitable with minimal or no risk





IN-FIELD RAINWATER HARVESTING (IRWH)

Requirements for IRWH

- The slope should not exceed 8% on non-erodible soils
- The effective soil depth should be at least 700 mm
- The annual rainfall must be between 450-700 mm
- Preferably clay (more than 10%) or duplex soils
- Avoid sandy soils

IN-FIELD RAINWATER HARVESTING (IRWH)



Suitability of soil for IRWH

1. Determine the clay content by the feel/field method: Take a sample of soil, wet it, roll into a worm and try to form a C-shape with both hands and then estimate the clay content



2. Take your soil sample to a laboratory for texture analysis



3. Ask an extension officer from the Department of Agriculture to auger and determine the soil depth

IN-FIELD RAINWATER HARVESTING (IRWH)

Preparation of cropping area

1. Identify or select an area for crop production
2. Fence the area



3. Clear weeds from the area
4. The field/homestead garden where the IRWH technique is to be implemented must not be on too steep slopes. The slope (3%) must be maintained and corrected as illustrated on the following pages.
5. If the slopes are steeper, inter-ridges should be created at a shorter distance within the basins
6. Prepare IRWH basins ACROSS the slope, NOT ALONG the slope

IN-FIELD RAINWATER HARVESTING (IRWH)

Prevent the following mistakes

- Incorrect layout (slope direction, measurements, etc.)
- Too small ridges
- Inter-ridges too far apart within the basin
- Redirect or keep excessive runoff water from other areas out of IRWH plots (redirect to dam or pit)



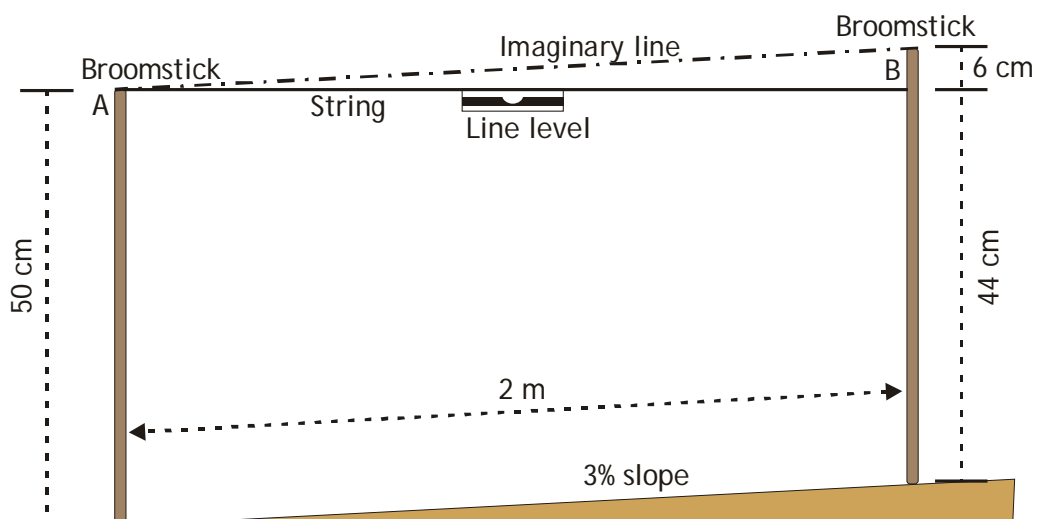
Results of basins not constructed properly

IN-FIELD RAINWATER HARVESTING (IRWH)

How to modify the slope on the runoff area

EXAMPLE FOR A 3% SLOPE

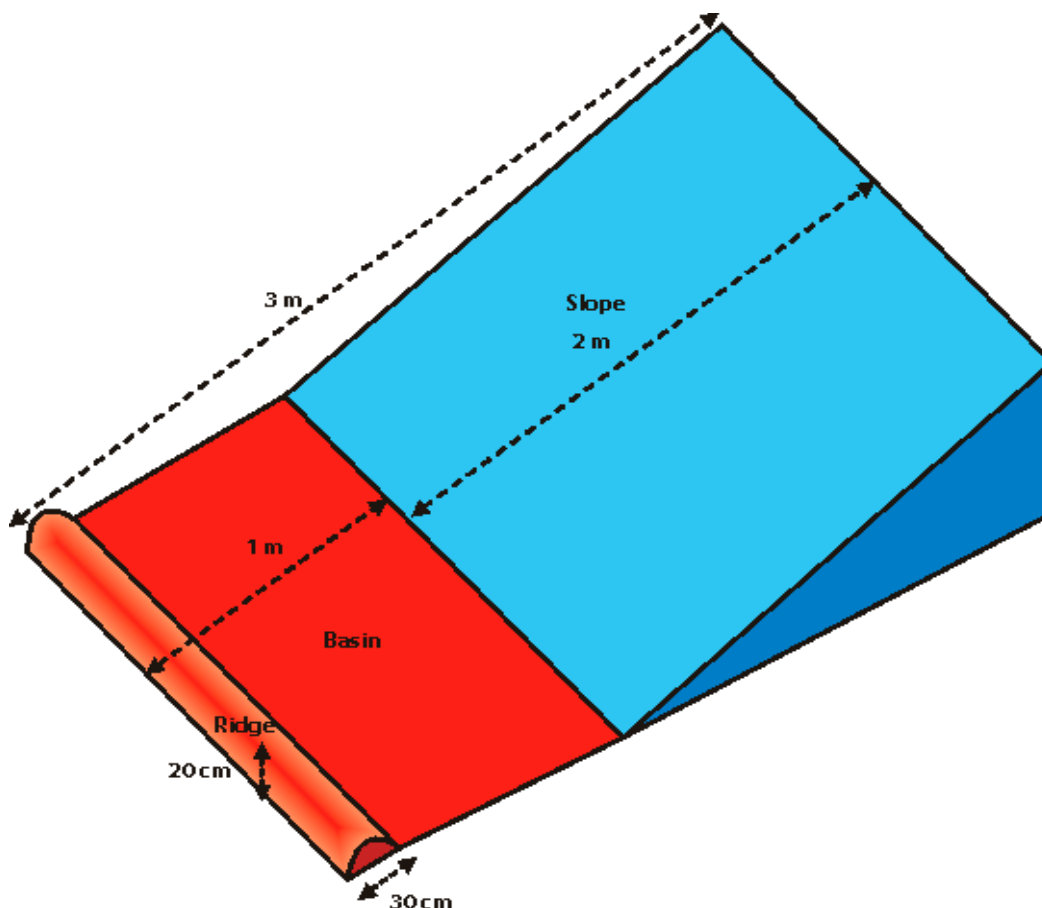
- Place broomstick A at the bottom of the line of slope. Another person takes broomstick B up the line of slope until the string is tight at 200 cm (2 m)
- The string should be tied at 50 cm on broomstick A and at 44 cm on broomstick B
- A third person must examine the line level. The bubble will be in the centre when the slope is 3%, if not the right slope can be prepared (by moving soil gently to the upper or lower levels) until the bubble is in the centre
- Follow the same procedure for the whole length of the field or garden to obtain the correct slope for the runoff area
- If natural slope of land < 2% increase as shown to 3%
- If natural slope is 3-5%, just make furrows and basins on the contour
- If natural slope is 5-8%, precautions need to be taken to prevent soil erosion (e.g. apply mulch on the runoff area; decrease distance between inter-ridges in the basins)



IN-FIELD RAINWATER HARVESTING (IRWH)

Slope on the runoff and basin area

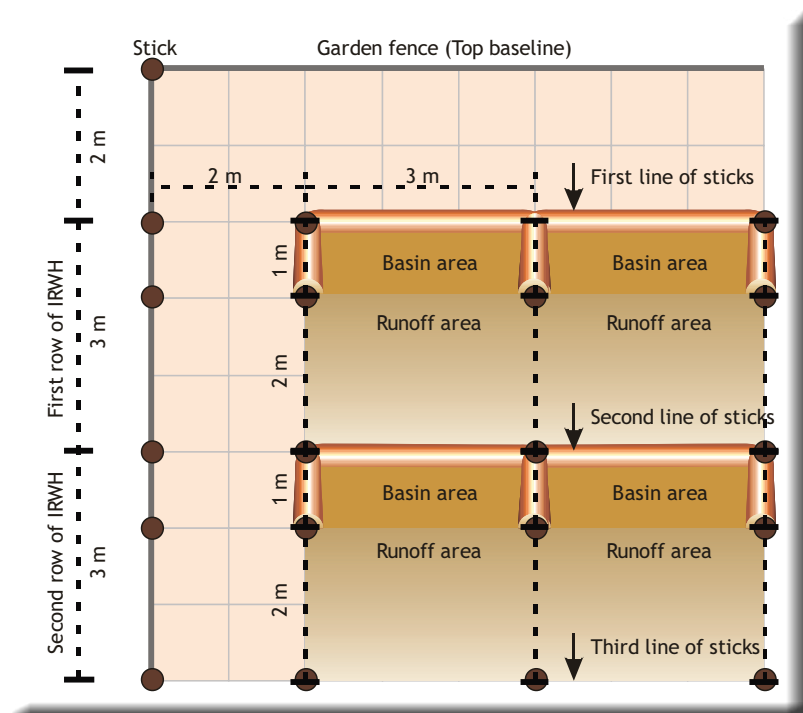
- The basin area should be leveled
- There should be no slope in the basins (red block)
- The slope on the runoff area should preferably be about 3% (blue block)
- If the basin area is not constructed properly water will concentrate on the lower side of the basin area
- Basins must be ± 10 cm deep in shallow soils and must not go beyond the A-horizon
- The ridge should be approximately 30 cm wide and 20 cm high (see diagram)



IN-FIELD RAINWATER HARVESTING (IRWH)

Marking out the field or garden

Remember to bring your measuring tape, string, plenty of sticks, spade and rake, then follow the next 6 steps carefully:



1. If you have a straight fence that runs across a slope in your garden, use it as a baseline that runs across the slope. Fix one tight string 2 m from the baseline and parallel to it
2. Make measurements along the string at 1 m, 2 m and 3 m as shown in diagram. Mark the string and knock a stick into the ground at each mark
3. Follow these steps carefully: Move the string 1 m down from your first line of sticks. Put sticks against the marks to mark out your basin area
4. Move the string 3 m down from your first line of sticks. Put more sticks against the marks on the string
5. Move the string down another 3 m and put the third line of sticks. This will give you your second row of plots
6. Repeat the steps, moving the string until all the plots have been marked out



IN-FIELD RAINWATER HARVESTING (IRWH)

Maintenance of the IRWH system

Keeping plot free of weeds

- Control the weeds either manually or chemically

Maintaining the basins

- Repair damaged ridges caused by heavy rainfall events using a rake and spade. Do not attempt to repair the basins while the soil is too wet
- Use a rake to remove silt from the basins. Rake silt towards the runoff area (2 m area). The runoff area must have a smooth surface with a slight slope towards the basins
- Avoid walking on the ridges; this will reduce the basin capacity
- Avoid walking in the basins; this can cause soil compaction that can result in slow germination of seeds and low infiltration rates

General tips

- After the crop has been harvested the remaining stalks can be cut and put in the basins as organic mulch; the mulch will minimize Es
- It is not necessary to remove the maize roots after harvesting; roots will decompose and act as organic matter
- Do not disturb the crust that developed on the runoff area; this will promote runoff towards the basin area
- Maintain plots throughout the year in order to ensure good yields

Importance of maintaining your plots

- Planting will be done easily and quickly
- More water will be available for crop growth resulting in higher yields
- There will be no competition with weeds for available water and nutrients
- Healthy cropping environment is created



IN-FIELD RAINWATER HARVESTING (IRWH)

A summary of getting started with IRWH

- Familiarize yourself with the technique by consulting/meeting with somebody who is familiar and knowledgeable with regard to IRWH
- Determine whether your soil is suitable to plant the desired crops (ask a local expert for assistance)
- Select a suitable site
- Remove all the weeds from the selected site
- Determine the direction of the slope by pouring water on the ground and see in which direction it flows – the direction of water flow is the direction of the slope
- Direction of the slope can also be seen by just looking at your land
- If necessary the slope must be corrected
- Mark out the runoff and basin area
- Create basins and ridges and rake the runoff area
- Plant your desired crops as shown in this manual

Request professional assistance from an ARC-ISCW expert or your local extension officer

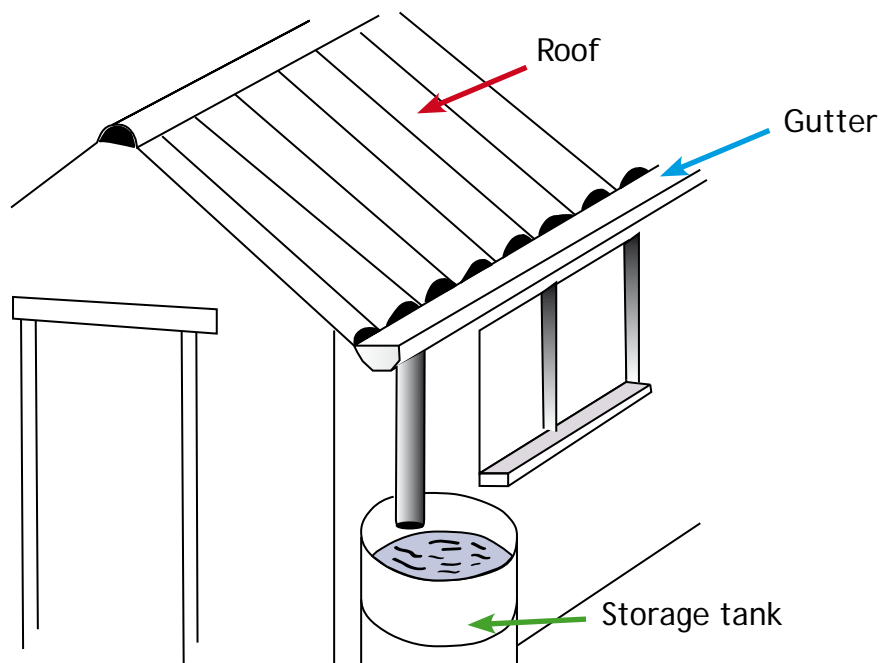
ROOF WATER HARVESTING

Collecting water from roofs for household and garden use is widely practised across South Africa. Tanks and containers of all types – from large brick reservoirs to makeshift drums and buckets are a common sight in rural areas

Advantages of collecting water from roofs are:

- Roofs are physically in place and runoff is immediately accessible
- Water collected from roofs is much cleaner than from land runoff
- Most of the rainwater falling on the roof can be collected, as there is little absorption or infiltration on the roof surface

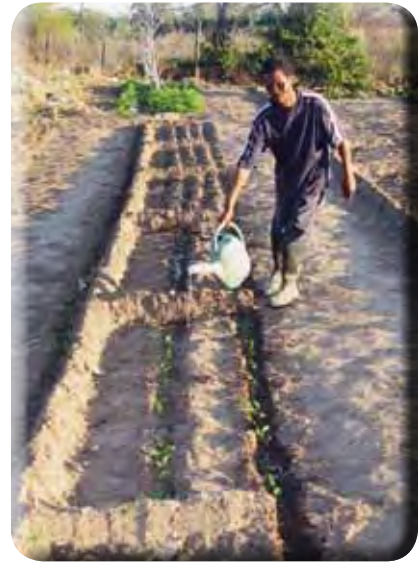
There are three main components to roof water harvesting: the **roof**, the **gutter** and the **storage tank**



ROOF WATER HARVESTING

Uses of roof water harvesting

The common purposes: Provide water for household use and supplemental irrigation



Maintenance of roof water harvesting structures

- Gutters and roof catchment areas should be regularly inspected and kept clean and clear of unwanted objects such as dust, leaves, vegetation, animal and bird droppings, dead animals and insects, chemicals and other pollutants
- Check your tank for sludge at least every two to three years
- If sludge is covering the bottom of your tank, you will need to remove it by siphoning it out or completely emptying your tank
- Excessive sludge build up is a sign of inadequate roof and gutter maintenance
- Remove build up of dirt collected on top of the tank
- Check for small animals that can fall into the tank and drown

Setting up a roof water harvesting system

- Make sure that the gutters have a slight slope towards the tanks to eliminate damming of stagnant water and accumulation of sludge, which will provide a breeding ground for organisms and mosquitoes
- Any over-hanging branches should be removed
- It is a good idea to use screens or guards, which should be regularly cleaned
- Keeping your rainwater screened and flowing cleanly and quickly from your catchment area into your tank, reduces the build up of sludge as well as the risk of mosquitoes breeding in your tank
- Chemical drift from spraying can land on the roof and then be washed into the tank. Do not spray on a windy day
- After a large fire in the area, ash and debris can settle on the roof which are then washed into the tank, thereby clogging the taps. Clear the roof after this occurs

Water tank safety measures

- Lock the tap to control access to the water tank
- The water should not be drunk unless it has been boiled, filtered and/or treated with bleach ($\frac{1}{4}$ cup per 5000 litres)
- Rainwater tanks can also present a health risk by providing breeding sites for mosquitoes
- Various paints can leach contaminants into water and can poison children and animals if consumed and therefore a safe paint should be used
- There should be no climbing on the tank as people could fall in and drown

CROP PRODUCTION

Preparation for planting

- Before crops can be planted, the land has to be properly prepared. The aim is to provide the best conditions for seed germination and growth
- Prepare a suitable tilth. Use a fork, a spade, a hoe and a rake. These tools will help you to work properly
- For vegetables the seedbed must be fine, but for field crops (e.g. maize and beans) the seedbed does not have to be as fine, because the seeds are larger
- Soil with a coarse tilth is less likely to be eroded than one with a fine tilth. This is important in the summer because heavy rain can easily damage a fine tilth
- Soil should be moist and fertilizer must be applied before or during planting
- A string, measuring tape and some sticks should be used to ensure that planting is done in straight lines



Planting


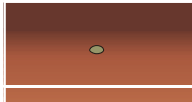



- Plant when conditions are favourable. Planting can be done once the first rainfall event of 20 mm or more has occurred. This will mean the soil has enough water for the seeds to germinate
- Plant at the correct depth and spacing. If you plant at the right depth you will get uniform germination, in other words, all the seedlings emerge about the same time. You need to see that the spaces between the plants are correct. Then the plants will have enough air, water, nutrients and light. Fertilizer recommendations are made for these plant spacings
- Crops can either be planted directly (seeds or cuttings) or transplanted (seedlings)



Direct planting (seeds)

- Mark out the planting row (furrow) using a piece of string tied between two sticks. Make sure the string is pulled tight
- Check the amount of fertilizer needed for the crop. Apply the fertilizer as recommended, making sure it is mixed well with the soil
- Use a hoe, or edge of a rake, to make the planting row. A planting row for large seeds should be deeper than one for small seeds. [A good tip is to make the depth five times the diameter of the seed]. If the seeds are planted too deep they may not be able to push their way through the soil after germination and may rot. If they are planted too close to the surface they may be eaten, washed away, or dried out by the sun
- When you plant the seeds, make sure they are planted evenly along the row. For good germination rather plant two or three seeds at each planting hole in the row. Later these can be thinned out to leave one plant. Leave a stick in the ground to show where you planted
- Water the furrow (row), then rake the soil back over the seed and firm the soil using the back of the rake
- Water regularly after planting to ensure good emergence



		1 cm
Carrots		2 cm
Beetroot		3 cm
Beans		4 cm
Maize		5 cm

Planting vegetables in seedbeds (seedlings)

MAKING A SEEDBED

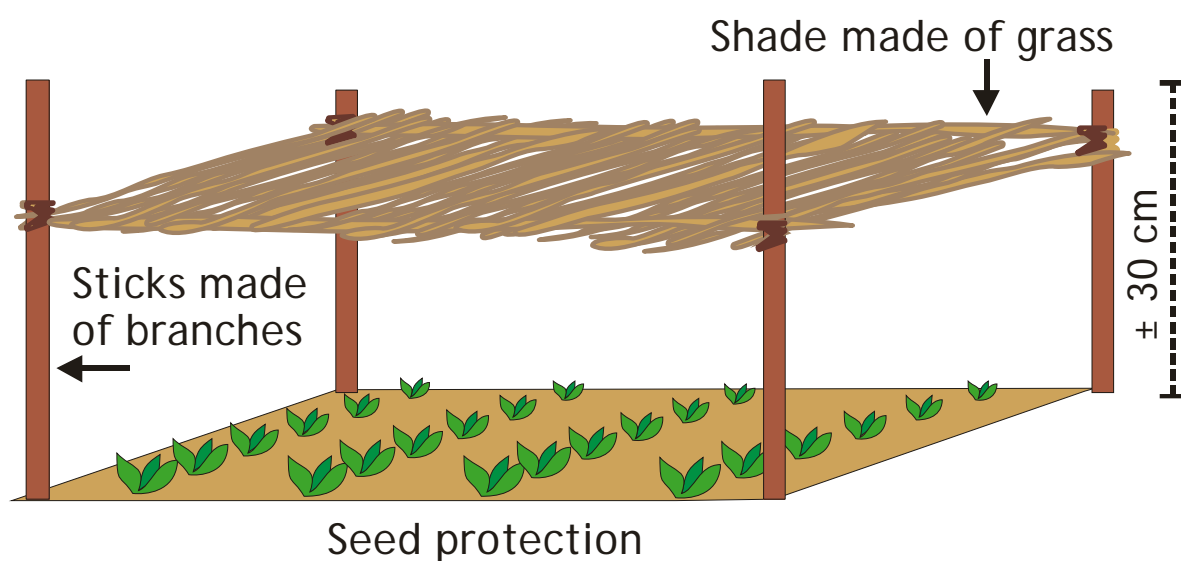
- Choose a sunny site with good soil, near your water source
- Mark out a square seedbed (1 m x 1 m) so that you can work from both sides without standing on it
- Add one bucket of manure or compost (5 kg) for each square metre and dig it in. Work the soil until you have a fine tilth
- Add 2 full matchboxes and one bottle top of 3:5:1 fertilizer per 1 m x 1 m and rake it in
- Mark out shallow rows about 15-20 cm apart, using a stick or a trowel
- Plant the seeds thinly. Cover the seeds with soil and make sure that the seeds are in contact with the soil
- Water the seedbed well (using a watering can with spray funnel) and cover the bed with a thin grass mulch to keep the soil moist. Mark and label the rows





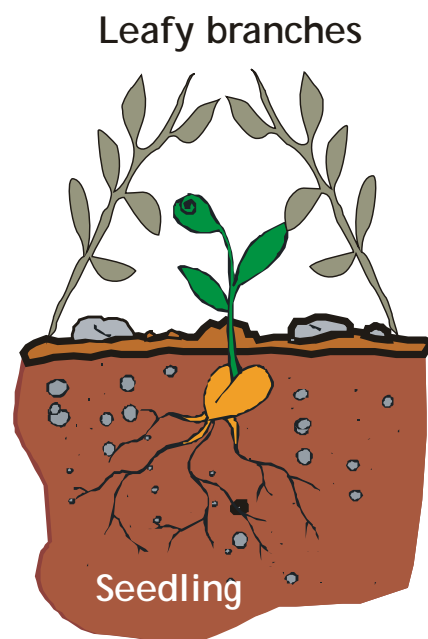
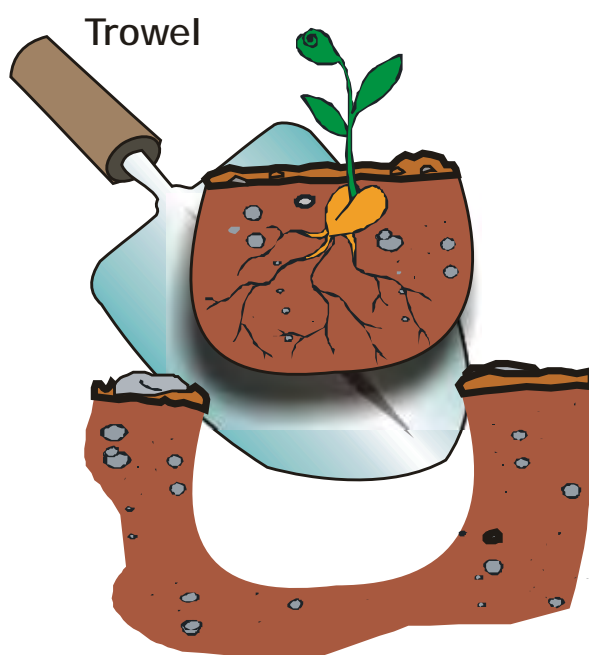
Taking care of seedbeds

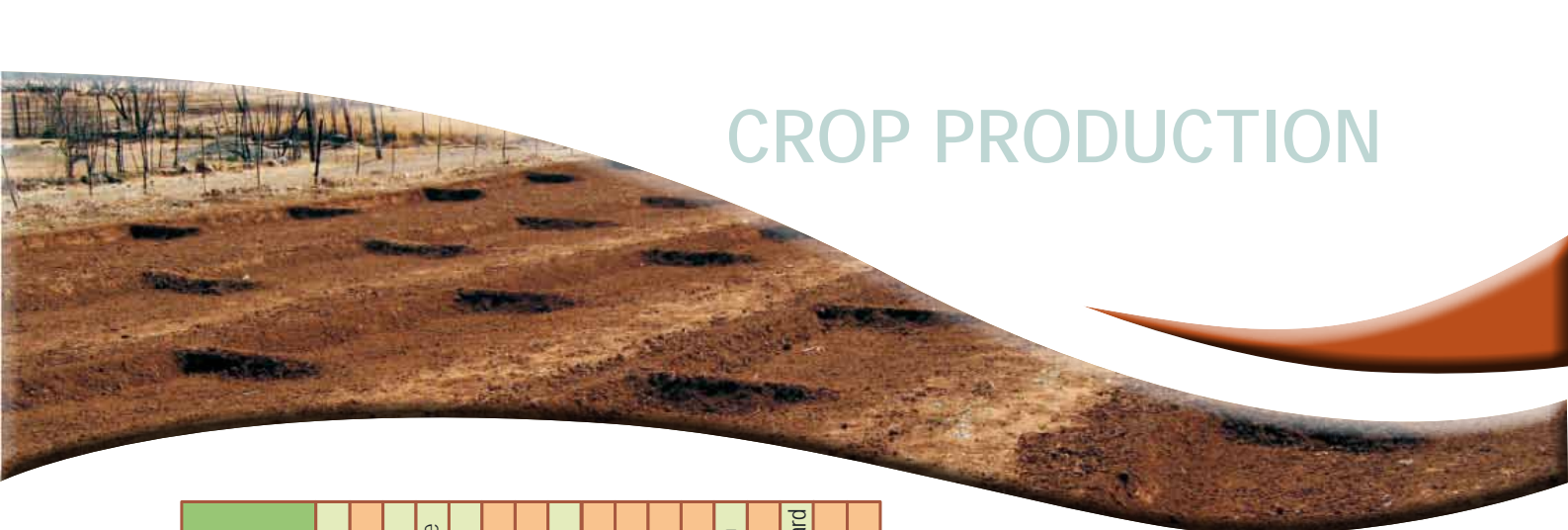
- Check the seedbed every day. When the seeds start to germinate, remove the mulch. After germination, thin them to at least 1 cm apart within the rows. You may have to thin more than once
- Shade the seedbed with a raised cover on sticks to protect it from direct sunlight and heavy rains. After a week, remove the shade from mid-morning up to noon each day. Start with about two hours and build up to having no shade at all just before transplanting
- For the first two weeks, unless it rains, water the seedlings everyday. If it is very hot, water them twice a day. Avoid watering in the late afternoon, as this reduces the chances of damping off. After 2 weeks the seedlings should be watered less often. Watering less often and reducing the shade hardens off the seedlings before they can be transplanted
- Pest and diseases may attack seedlings. To prevent this, spray with a mixture of Malathion and Dithane



Transplanting

- Transplanting means moving seedlings from the seedbed and planting them in the field or garden
- Water the seedbed a few hours before transplanting
- Check how much fertilizer is needed and how it should be applied
- Mark out the rows and the planting holes. Apply the fertilizer as directed and mix it well with the soil
- Fill the planting holes or rows with water. The water will drain away leaving the holes wet
- Choose the strongest seedlings. Use a trowel or spade to lift them from the seedbed. Take care not to damage the roots. Only lift a few seedlings at a time to prevent them from drying out
- Put the seedlings into the planting holes. Hold the leaves and not the roots during this exercise
- The hole should be big enough for the seedling to be planted
- Firm the soil around the seedling and irrigate
- If the day is hot and dry, shade the seedlings with leafy branches
- For the first few days water at least twice a day
- [NB: The best time to transplant is during cool cloudy days or late in the afternoon]





CROP PRODUCTION



VEGETABLE SOWING CALENDAR (EASTERN CAPE)

- 28

Planting methods

FURROW METHOD

- Dryland crops and vegetables are mostly planted in furrows when using the IRWH technique and most are planted directly. [Furrows are also known as drills or rows]
- Bigger seeds like beans, maize, water melon, pumpkin and squash are planted at least 3-5 cm deep
- Smaller seeds like onions, beetroot, spinach, carrots, cabbage and tomatoes are planted at a depth of 2-3 cm. This should be done at the correct spacing
- Seeds can also be planted in a continuous stream and should be thinned later. Planting in rows or furrows makes weeding easier



INTERVAL METHOD

- All crops can be planted this way. Interval planting is when seeds or seedlings are planted in holes per planting interval
- Instead of making a furrow, make a hole at the correct spacing and drop one or two seeds in
- After germination, leave the strongest seedling and pull the others out
- This method uses a lot of seed; only use it if poor germination is expected





PLANTING SPINACH

(*Spinacea oleracea*)

Varieties:

Springer, Splash, Fordhook Giant, Viroflay, Resistoflay, Lucellus

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole or planting station

Plant spacing:

Intra-row: 30 cm
Inter-row: 50 cm

Pests and diseases:

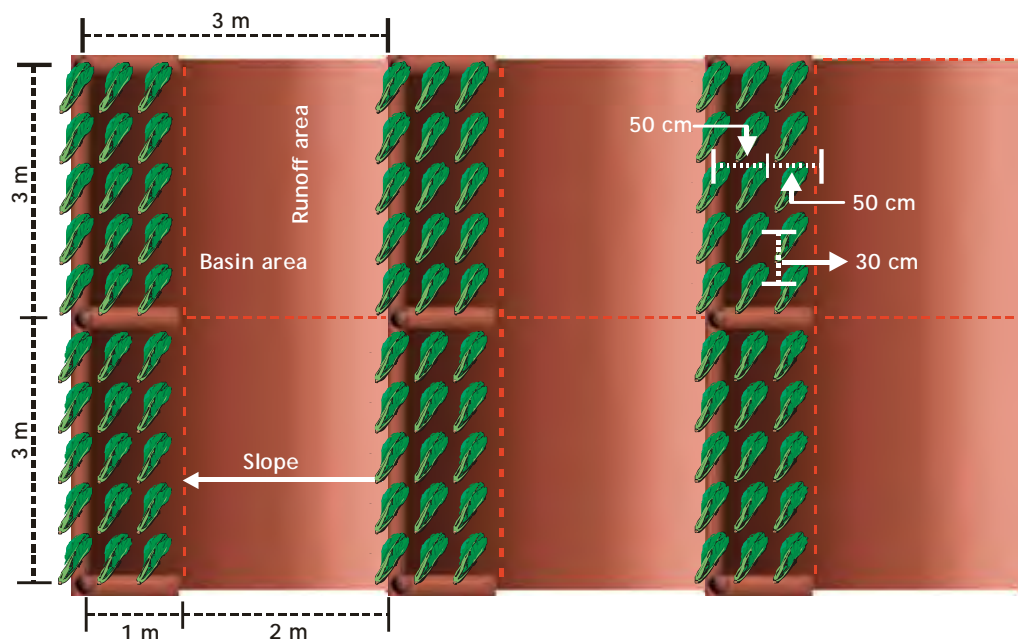
Name of pest or disease	Control method	When to use	Safety period to harvest
Leaf spot	Spray with Dithane 80% WP, 1 MB (10 g) in 5 litres of water or copper oxychloride, 2 MB (20 g) in 5 litres	Once a week after the disease is identified and after rainfall events	2 days

Harvesting:

Leaves are ready 50-60 days after planting. Cut the outer leaves, leaving the inner ones to continue growing. It may only be possible to get one cutting in summer because of disease problems. Spinach does not keep long and should be eaten soon after harvesting

Growing tips:

Spinach likes soils rich in organic matter



- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING BEANS [Dwarf] (*Phaseolus vulgaris*)

Varieties:

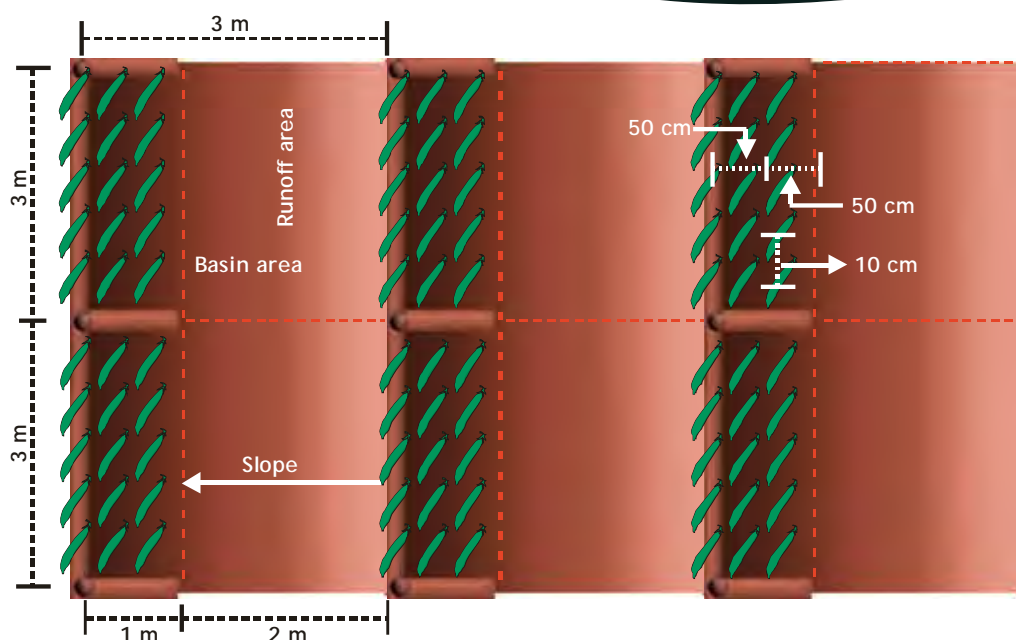
Seminole, Wintergreen,
Provider, Nelson,
Paulista, Alberta,
Derby, Distinction,
PAN 148

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole or planting station

Plant spacing:

Intra-row: 10 cm
Inter-row: 50 cm



Pests and diseases:

Name of pest or disease	Control method	When to use	Safety period to harvest
CMR beetle	Pick off by hand and kill; spray with Malathion 25% WP, 1 MB (10 g) in 5 litres of water	Only use pesticide if there are too many to collect	2 days
Rust	Spray with Dithane 80% WP, 1MB (10 g) in 5 litres of water	Every week in hot weather	3 days
Halo blight (more common in warm conditions)	Spray with copper oxychloride, 2 MB (20 g) in 5 litres of water	When seen and then every week	14 days

Growing tips:

Beans like organic matter. Dig in compost or kraal manure before planting. Beans will not stand frost; therefore, avoid winter months. Avoid waterlogged conditions

Harvesting:

Pick pods before the seeds start to swell (about 50-60 days after planting). If they are left too long, the pods become stringy and are not good to eat. Fresh bean pods should break easily. Pods that bend and do not break have been kept too long

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING ONIONS

(*Allium cepa*)

Varieties:

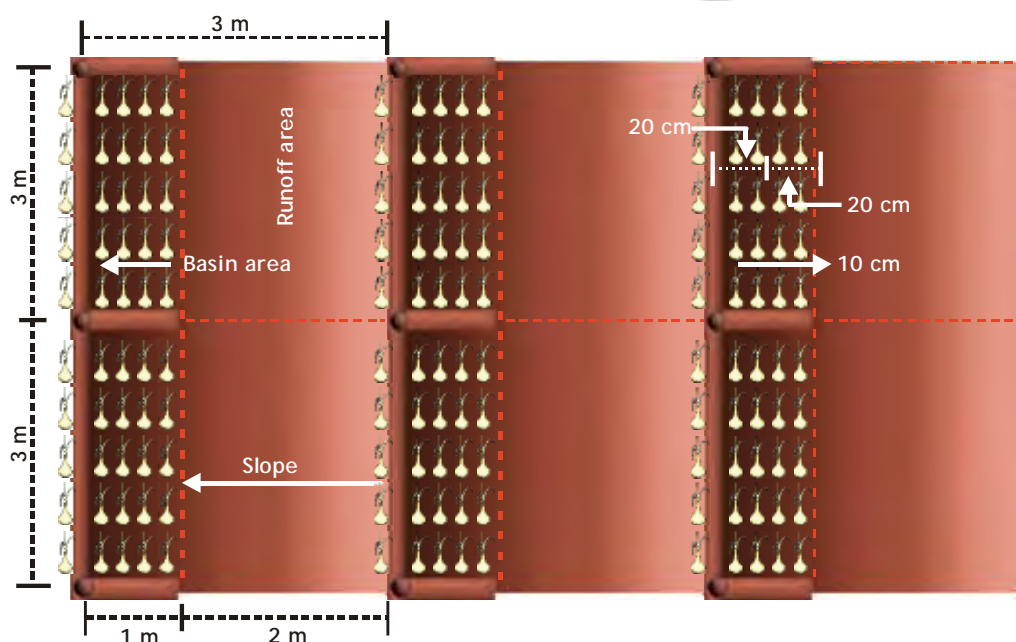
Texas Grano 502 PRR,
Pyramid, Australian
Brown, Bon Accord,
Red Creole

Fertilizer:

The recommended
compound fertilizer is
3:2:1 of NPK and is
applied during planting
at about 3.57 g (1 BT)
per hole or planting
station

Plant spacing:

Intra-row: 10 cm
Inter-row: 20 cm



Pests and diseases:

Name of pest or disease	Control method	When to use	Safety period to harvest
Blast (small manwhite spots on the leaves)	Spray with Dithane 80% WP, 1 MB (10 g) in 5 litres of water	When seen and every week	3 days
Downy mildew	Spray with Dithane 80% WP, 1 MB (10 g) in 5 litres of water	When seen and every week	3 days
Thrips	Spray with Malathion 25% WP, 1.25 MB (12.5 g) in 5 litres of water or Bulldock 20 ml per 20 litres of water	When seen	14 days

Growing tips:

Onions produce soft bulbs and do not keep well in soils with a lot of nitrogen. They should not be grown after beans or in soil that has manure added

Harvesting:

Onions are normally ready 120-180 days after planting, depending on the variety. When bulbs reach the ripening stage, watering should be reduced to allow them to dry out. When the leaves turn brown and fall over, the onions should be lifted and stored in a dry place

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING CARROTS

(*Daucus carota*)

Varieties:

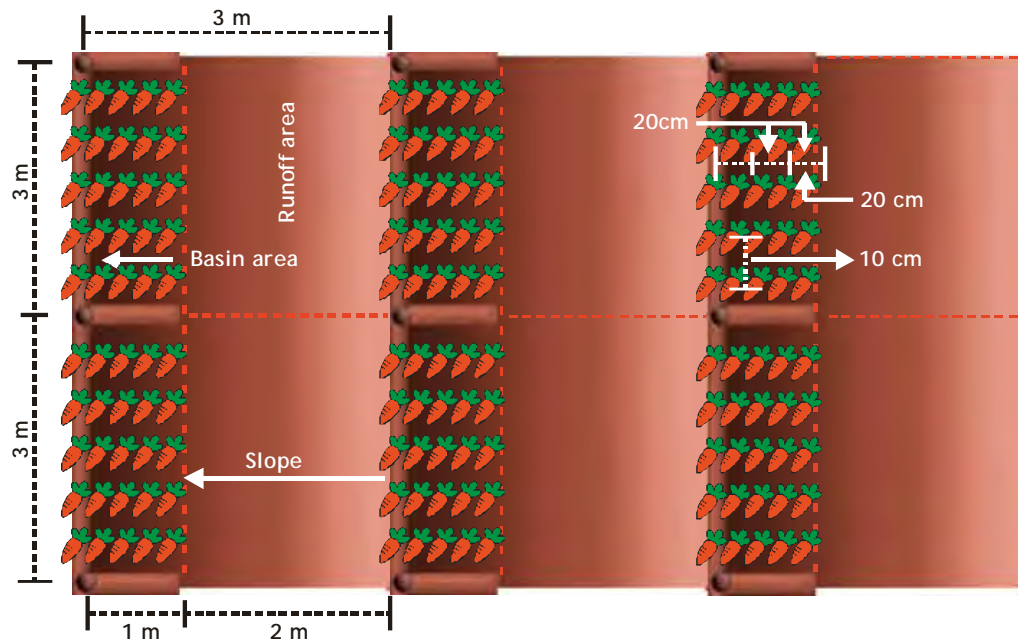
Chantenay Red Cored,
Cape Market, Kuroda,
Duke, Prospector

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole or planting station

Plant spacing:

Intra-row: 5-10 cm
Inter-row: 20 cm



Pests and diseases:

Name of pest or disease	Control method	When to use	Safety period to harvest
Blight	Use resistant varieties, e.g. Kuroda, or spray with Dithane 80% WP, 1 MB (10 g) in 5 litres of water	When seen	2 days
Aphids	Spray with Malathion 25% WP, 1 MB (10 g) in 5 litres of water or Metasystox 20 ml per 20 litres of water	When seen, then every week and after rain	14 days

Growing tips:

Do not add fresh organic matter to the soil before planting, as it makes the roots split. Carrots should be thinned when they have their first true leaves. Other thinning may be needed to get a final spacing of 4-5 cm between plants. Weed carefully, as the roots are easily damaged

Harvesting:

Carrots are ready in 70-120 days. They should be well watered before harvesting so that they lift easily. They do not store well and should be eaten soon after harvest

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING BEETROOT (*Beta vulgaris*)

Varieties:

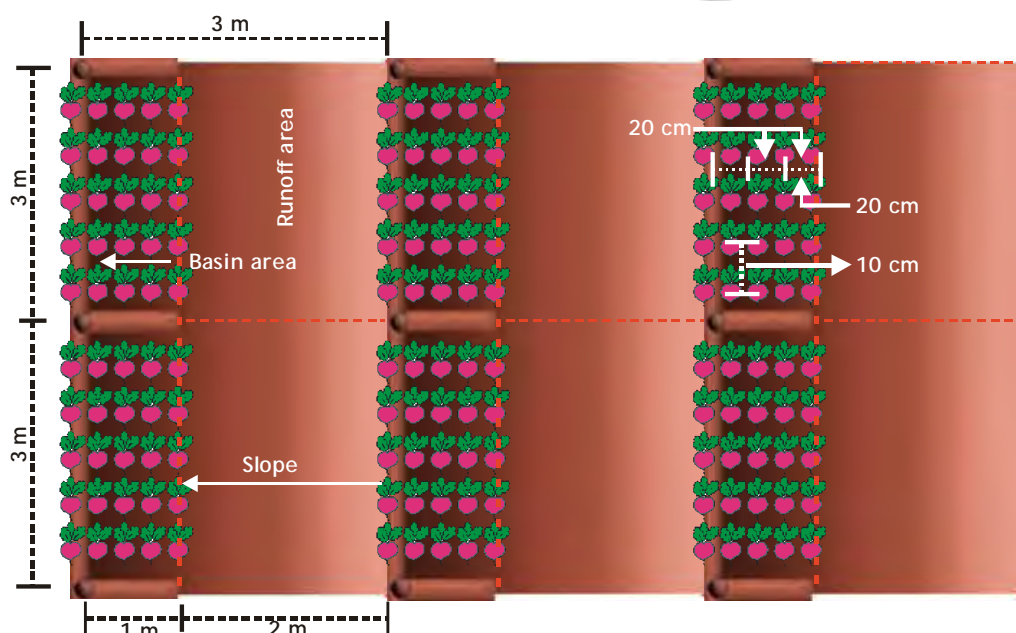
Detroit Dark Red,
Crimson Globe,
Early Wonder, Red Ace
Warrior, Scarlet Supreme

Fertilizer:

The recommended
compound fertilizer is
3:2:1 of NPK and is
applied during planting
at about 3.57 g (1 BT)
per hole or planting
station

Plant spacing:

Intra-row: 10 cm
Inter-row: 20 cm



Pests and diseases:

Name of pest or disease	Control method	When to use	Safety period to harvest
Leaf spot	Spray Dithane M45, 1 MB (10 g) in 5 litres of water or use copper oxychloride, 2 MB (20 g) in 5 litres of water	Apply once a week after the disease is seen and after rain	2 days

Growing tips:

Beetroot does not like acidic soils and should not be planted soon after liming. The latter can cause dark patches on the bulbs and spoil quality

Harvesting:

Depending on the variety, beetroot is ready for harvesting 55-70 days after planting. The roots should be harvested when they are 6-8 cm across. Older beetroot becomes woody and is not pleasant to eat

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING MAIZE

(*Zea mays*)

Varieties:

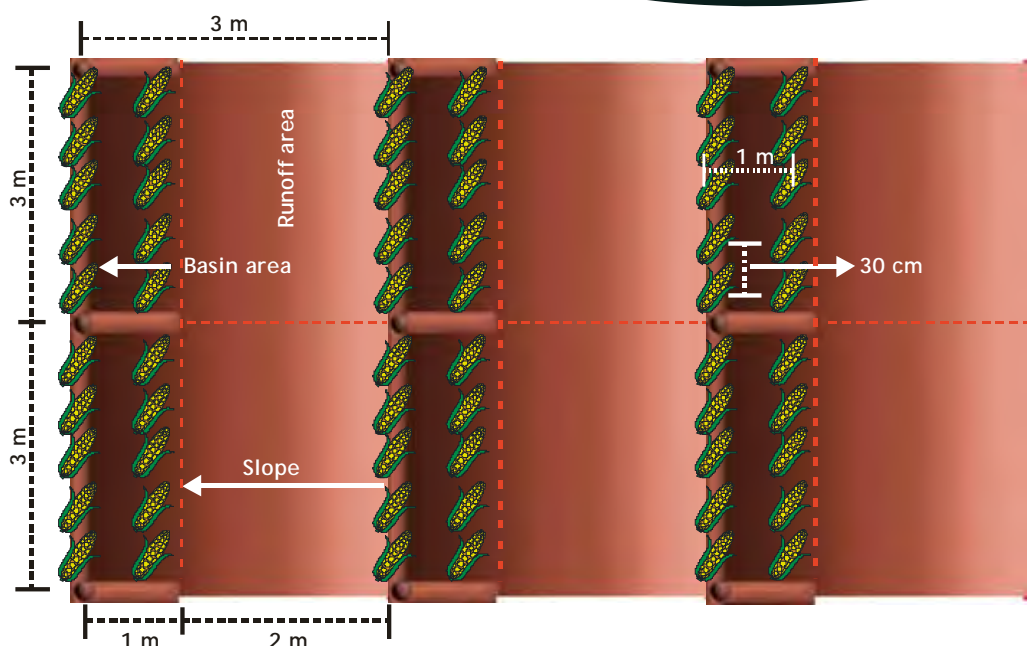
PHB 33V08, PHB 3394,
PHB 33A14

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole per planting station

Plant spacing:

Intra-row: 25-30 cm
Inter-row: 100 cm



Pests and diseases:

Name of pest or disease	Control method	When to use
Cutworm	Use cutworm bait: 0.2 MB (2 g) of Dipterex 95% WP mixed with 1 litre of water and 750 g of mealie meal or Bulldock 20 ml per 20 litres of water	Apply to soil 2 days before or at planting. Always apply if cutworms have been present in the past or if maize has been grown for a long time in the same field
Stalkborer A white caterpillar that eats out stems. It can be recognised by shot holes (row of holes) in new leaves as they open	Early planting or by dropping a pinch of Dipterex 2.5% granules down the funnel (top) of the plants	When more than 5 out of 100 plants have shot holes
Maize streak The leaves have yellow streaks and plants are small	Early planting. Use resistant varieties	

Planting depth: 5 cm

Harvesting:

Maize can be harvested as green mealies or when the cobs have dried. Green mealies are ready 90-110 days after planting, and dried cobs 140-180 days after planting, depending on variety

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING CABBAGE

(*Brassica oleracea*)

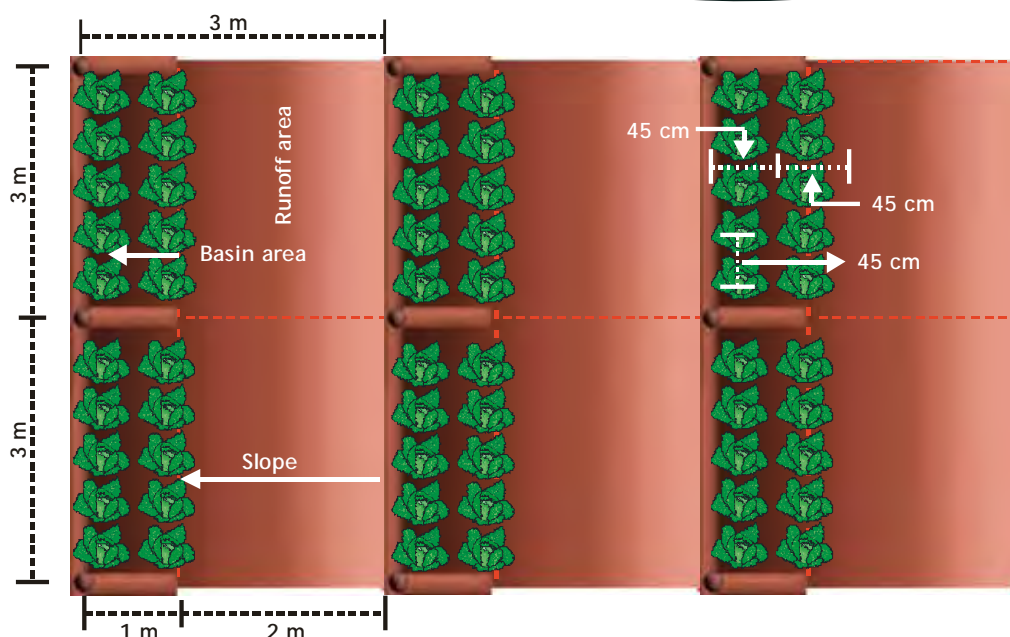
Varieties:

Victor, Tropicana, Gloria, Riana, Green Crown, Beverly Hills, Rotan, Hercules, Marcanta, Millennium

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole or planting station

Pests and diseases:



Name of pest or disease	Control method	When to use	Safety period to harvest
Cutworm	Use cutworm bait. Mix ½ a BT (2.5 g) of Dipterox 95% WP with 750 g of mealie meal in 1 litre of water or Bulldock 20 ml per 20 litres of water	Apply to the soil 2 days before transplanting	
Aphids	Spray with Malathion 25% WP, 1 MB (10 g) in 5 litres of water or Metasystox 20 ml per 20 litres of water	When you see more than a few aphids	2 days
Diamond back moth	Spray with Dipterox 50% WP, 2½ MB (25 g) in 5 litres of water	When you see the caterpillars	7 days

Growing tips:

Cabbages like organic matter. If you have kraal manure or compost, dig it into the bed before transplanting. Cabbages do not like acid soils with a pH below 5.5. Water them regularly as drying out retards growth. Cabbages should only be grown on the same land once in three years. This rotation will prevent pests and diseases building up in the soil

Harvesting:

Depending on the variety, cabbages are ready for harvesting 75-140 days after transplanting. A few weeks before harvesting, watering should be reduced. This helps the cabbage heads to firm up. Cabbage heads should be harvested when they are ready. If left too long they crack and split. Cabbages do not store well and should be eaten soon after harvest

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



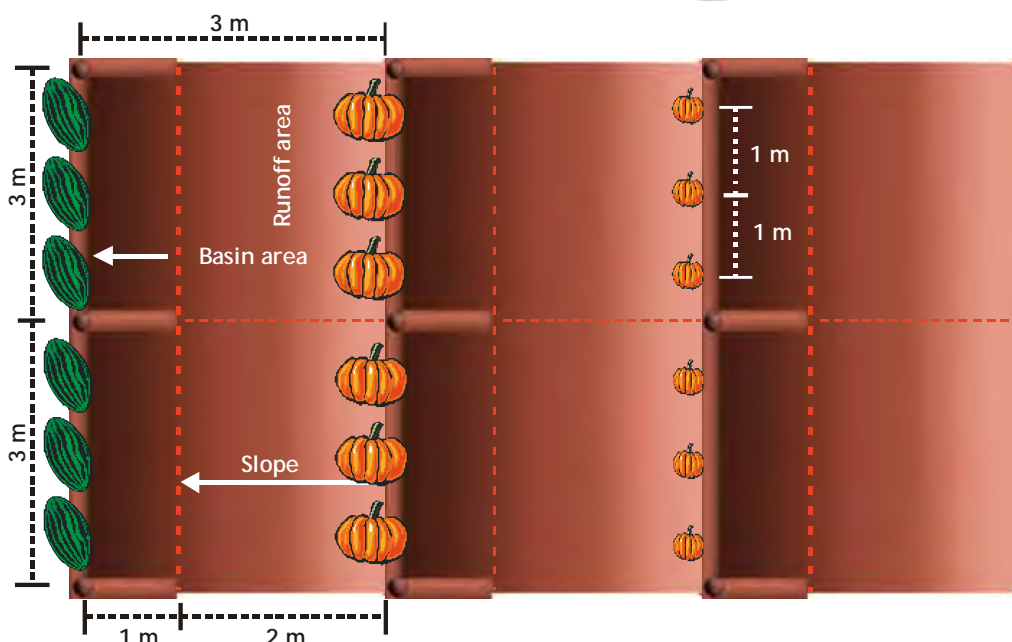
PLANTING MELONS, PUMPKINS AND SQUASHES (*Cumulus melo & Citrullus vulgaris*)

Varieties:

MELONS [Royal Sweet, Tempo, Carmen, Crimson Glory, Vista, Sugar Baby, Congo, All Sweet, Sweet Princess, Crimson Sweet, Mickylee, Crimson King, Orange Sunshine, Orchid Sweet]

PUMPKINS [Royal Crown, Plat Wit Boer van Niekerk, Queensland Blue, Rovaal]

SQUASHES [Butternut Supreme, Early Butternut, Ambassador, President]



Pests and diseases:

Name of pest or disease	Control method	When to use
Pumpkin fly A small black fly that lays its eggs in the fruit. The larvae, little white maggots, eat the fruit and cause it to rot	Spray with Malathion 25% WP, 1 MB (10 g) in 5 liters of water with 500 g of sugar	When flowering starts, then once a week
Powdery mildew A white fungus seen on the leaves; it makes them turn brown and die	Spray with Bayleton 5% WP, 1 MB (10 g) in 5 litres of water	When seen
Downy mildew Appears as brown spots on the leaves, causing them to curl and die	Spray with Dithane 80% WP, 1 MB (10 g) in 5 litres of water	When seen

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole or planting station

Plant spacing:

Intra-row: 100 cm (only one line on the ridge)

Growing tips:

The runners should be directed mostly towards the runoff area

Harvesting:

Pumpkins and melons are ready 120 days after planting. They store well, but should be checked regularly. Bad ones should be thrown away

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder



PLANTING LETTUCE

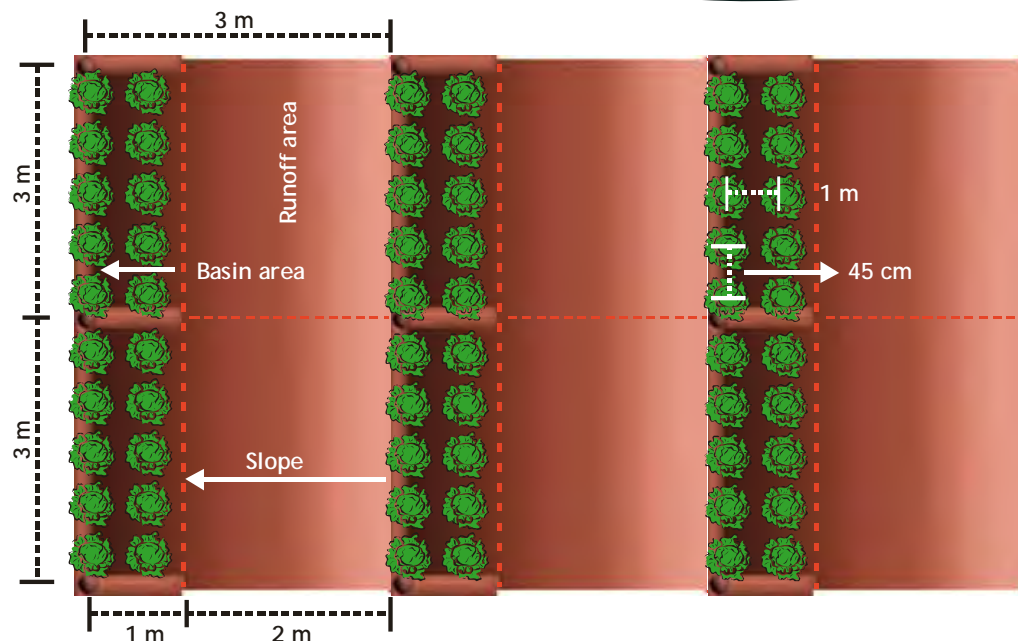
(*Lactuca sativa*)

Varieties:

Great Lakes, Wintercrisp, Empire 2000, Tropical Empire, Summertime, Commander, Mohawk, Victory, Target, Del Oro, Del Rio, Robinvale, Iceberg

Fertilizer:

The recommended compound fertilizer is 3:2:1 of NPK and is applied during planting at about 3.57 g (1 BT) per hole or planting station



Pests and diseases:

Name of pest or disease	Control method	When to use	Safety period to harvest
Aphids	Spray with Malathion 25% WP, 1 MB (10g) in 5 litres of water or Metasystox 20 ml per 20 litres of water	When seen	2 days

Plant spacing:

Intra-row: 35-45 cm
Inter-row: 35-45 cm

Growing tips:

Lettuce grows best in soils rich in organic matter and in rotation with beans. In hot weather lettuce may bolt (go to seed), then the leaves become bitter and unpleasant. Bolting can be avoided by using the right variety

Harvesting:

Lettuces are ready after about 65-90 days. Crisp-headed lettuce should be harvested as soon as the heart (the firm centre) has formed. Lettuce loses freshness soon after harvest and should be eaten as soon as possible

- Key: BT = Bottle top (e.g. Coke); MB = Matchbox; WP = Wettable powder

CROP PRODUCTION

Example of a crop production diary

	DATE	ACTIVITY	REMARKS
(1)	15/12/2008	Planted maize cultivar PHB 3394R	Soil was moist enough because it rained 25mm on the 7/12/2008
(2)	2/1/2009	Sprayed glyphosate (Roundup)	Forecast showed no rain expected for 3 days. Sprayed at 6L/ha.
(3)	14/1/2009	Noticed insect infestation	Sprayed pesticide Bulldock.
(4)	3/3/2009	Harvested 50 heads to sell as green mielies	The heads formed well
(5)	7/6/2009	Harvested all maize	Good yield, \pm 3 tons/ha.

Farmers are encouraged to always have their crop production diary with them whenever they go to their backyard gardens

Weed control

Methods of weed control

There are 4 methods of weed control:

1. **Mechanical / manual:** Tractor with implements as well as hand weeding, i.e. using spades, garden forks and hoes
2. **Chemical:** Herbicides to control weeds
3. **Biological:** Natural pests, such as insects
4. **Integrated:** This is a combination of (1) and (2) and is the most effective method of weed control

Herbicides are very expensive and as a result you may have to resort to using only hand weeding or mechanical weeding methods. Even though herbicides are very effective there is nothing as effective as mechanical or manual control.

So always remember – when you see a weed, pull it out or chop it off immediately!

When to start controlling weeds

- Monitor your garden every day to check for weeds and also for pests and diseases
- Weeds should always be removed before they produce seeds

Mixing chemicals, safe use and safe storage

- Always wear protective clothing (rubber boots, protective aprons or suits, rubber gloves and safety glasses or goggles) and a face mask and always read the herbicide or pesticide label very carefully
- Applicators **MUST** wear all protective gear required on the label of the herbicide or pesticide they are using
- Always fill the knapsack halfway with water and then add the herbicide or pesticide
- Then fill the knapsack further (i.e. to the amount of water required), ensure that the lid is tightly closed and then shake the knapsack
- When storing any chemicals, ensure that they are labeled correctly
- Chemicals should be stored in labeled, sealed containers, and locked away in a dry box or cupboard away from seeds, fertilizers, and feedstuffs
- Keep chemicals in a safe place out of reach of children
- Always use the amounts recommended and follow the safety rules when spraying
- Be careful how you dispose of unwanted or out-of-date chemicals
- Do not empty or wash the sprayer in rivers, streams, or near drinking sources

How to use a sprayer

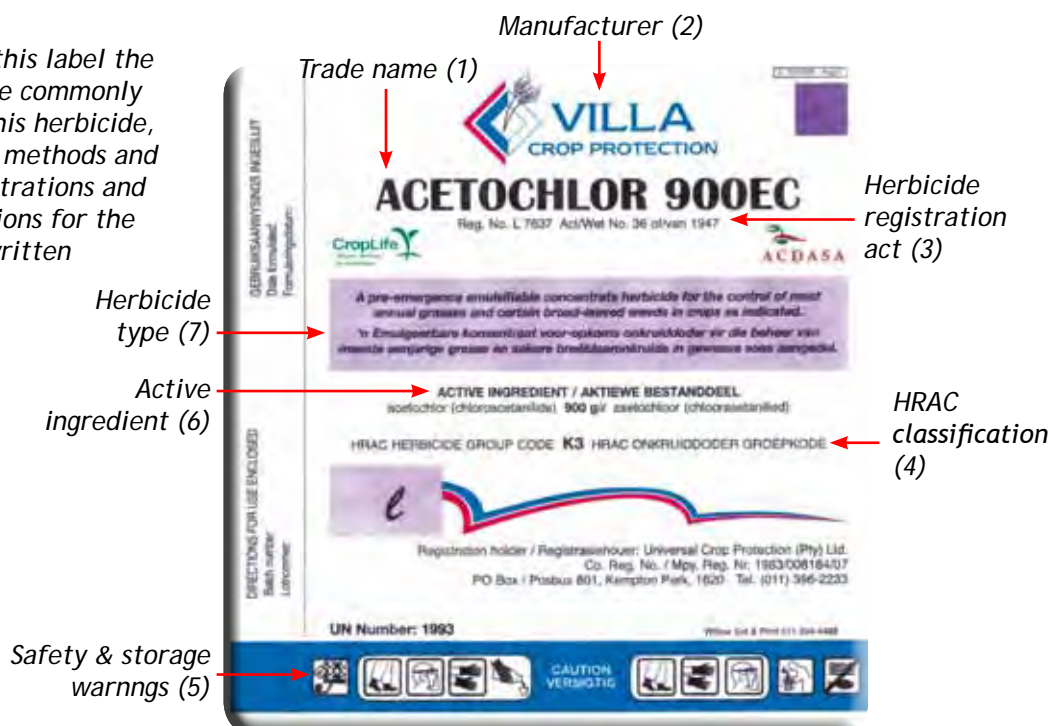
1. Check that no liquid was left in the sprayer the last time it was used. If you find some liquid, wash the sprayer out
2. Make sure you pour the liquid down a drain or get rid of it in a safe place
3. Fill the sprayer to the correct level with water. Dry the outside. Pump it to the correct pressure. When it is at the correct pressure, air escapes from the safety valve. Point the sprayer away from yourself and check that it sprays correctly. If the sprayer has any leaks, do not use it
4. If the sprayer is working correctly, pull the pressure valve to release the pressure. Open the sprayer and empty out the water. Refill it with about 1 litre of water
5. Measure out the correct amount of herbicide or pesticide and pour it in. Put the cap back onto the sprayer and shake it well to mix it
6. Remove the cap and fill the sprayer with water to the correct level. Replace the cap and shake again
7. Pump to the correct pressure. Check that the spray is coming from the nozzle. If there are no problems, the sprayer is ready to use
8. Only start spraying when you reach your plot
9. Do not spray in the wind: the spray may be blown onto you. Do not spray if it is raining or about to rain. Most of the chemical will be washed off the plants and wasted
10. Do not eat when spraying
11. Spray the whole plant. There is no need to spray until liquid is running off the plant; this is only a waste
12. After spraying wash the sprayer
13. Use soap and water to wash your hands and any part of your body that may have chemicals on it. Change your clothes

WEED AND PEST MANAGEMENT

Information on the herbicide label

1. The name given to the herbicide by the company which produces it
2. The company which manufactures the herbicide (e.g. Villa, BASF, AgroChem, Monsanto, etc.)
3. The act according to which all herbicides must comply
4. This states how each herbicide is classified; it therefore helps with herbicide rotation so that there is no build up of resistance because the same type of herbicide has been used over and over again
5. This indicates the safety and storage warnings associated with the herbicide. This herbicide, for example, must be locked away out of reach of children and animals. Protective clothing must be worn. Always wash your hands after working with the herbicide and ensure that it does not contaminate streams, dams and rivers
6. Indicates the active ingredient of the herbicide (acetochlor), the type of chemical (chloroacetanilide) and the concentration at which it occurs (900 g/l)
7. This indicates the type of herbicide (pre-emergence, post-emergence) and the type of weeds which are controlled (grasses and/or broadleaf weeds)

At the back of this label the weeds which are commonly controlled by this herbicide, the application methods and also the concentrations and mixing instructions for the herbicide are written



Common weeds and herbicides used for control

NAME: Common pigweed (*Amaranthus hybridus*)

TYPE: Broadleaf weed

CHEMICALS: 2,4-D; Acetochlor; Atrazine; Bromoxynil; Dicamba Linuron; Glyphosate

TRADE NAMES: Wenner; Relay; Guardian; Harness; Bullet; Lasso; Brominal; Terbo; Marksman; Roundup



NAME: Yellow-flowered Mexican poppy (*Argemone mexicana*)

TYPE: Broadleaf weed

CHEMICALS: 2,4-D; Acetochlor; Atrazine; Bromoxynil; Dicamba; Linuron; Glyphosate

TRADE NAMES: Wenner; Relay; Guardian; Harness; Bullet; Lasso; Brominal; Terbo; Marksman; Roundup



NAME: White goosefoot (*Chenopodium album*)

TYPE: Broadleaf weed

CHEMICALS: 2,4-D; Acetochlor; Atrazine; Bromoxynil; Dicamba Linuron; Glyphosate

TRADE NAMES: Wenner; Relay; Guardian; Harness; Bullet; Lasso; Brominal; Terbo; Marksman; Roundup



NAME: Scotch thistle (*Cirsium vulgare*)

TYPE: Broadleaf weed

CHEMICALS: 2,4-D; Acetochlor; Atrazine; Bromoxynil; Dicamba Linuron; Glyphosate

TRADE NAMES: Wenner; Relay; Guardian; Harness; Bullet; Lasso; Brominal; Terbo; Marksman; Roundup



NAME: Flax-leaf flea bane (*Conyza bonariensis*)

TYPE: Broadleaf weed

CHEMICALS: 2,4-D; Acetochlor; Atrazine; Bromoxynil; Dicamba Linuron; Glyphosate

TRADE NAMES: Wenner; Relay; Guardian; Harness; Bullet; Lasso; Brominal; Terbo; Marksman; Roundup



NAME: Yellow nutsedge (*Cyperus esculentus*)

TYPE: Sedge

CHEMICALS: Halosulfuron, EPTC; Bentazon

TRADE NAMES: Servian; Eptam Super; Basagran



NAME: Large thorn apple (*Datura ferox*)

TYPE: Broadleaf weed

CHEMICALS: 2,4-D; Acetochlor; Atrazine; Bromoxynil; Dicamba Linuron; Glyphosate

TRADE NAMES: Wenner; Relay; Guardian; Harness; Bullet; Lasso; Brominal; Terbo; Marksman; Roundup



Pests (insects) and disease control

- **Pest:** Any living organism that is harmful to crops
- **Plant disease:** Sickness which affects plant growth and can also kill plants
- Included in this manual are indications for controlling the most common pests and diseases on each crop. This can be found on each page of the planting methods for the different crops
- It is very important that pests and diseases be correctly identified as treating for the wrong pest or disease could worsen the problem
- Conditions suited to each pest and disease should also be well known. For example, late blight which is a disease that occurs in tomatoes spreads quickly in wet conditions but not so fast in dry conditions, therefore spraying should occur more often in the rainy part of the season



Common pests and diseases

Listed below are some of the more common types of pests (insects) and diseases. Use this table to identify these correctly as the symptoms are also given

Crop	Pest/disease	How to recognize the pest/ disease
Cabbages Cauliflower Broccoli	Cutworm (pest)	A grey or dull green caterpillar 3-4 cm long which lives under the soil surface. It cuts seedlings and young plants at the base of the stem, making them fall over. It attacks other seedlings also
	Aphids (pest)	Small green or black insects, often in large numbers on the underside of leaves. Aphids feed on plant juices and slow down plant growth. They attack many different kinds of plants
	Diamond back moth (pest)	The caterpillar of this moth is small and green. It feeds on the underside of leaves, cutting holes in them
Tomatoes Potatoes	Early blight (disease)	Appears as dark brown or black spots. Later dark circular rings develop round the spots. The leaves turn yellow and fall off. Wet weather helps the disease to spread
	Late blight (disease)	Soft, dark green to black spots develop on the edges of leaves. The leaves shrivel and die. The spots spread to the stem and the fruit. The disease spreads quickly in wet weather
	Bacterial wilt (disease)	Plants die suddenly. If the plants are cut near the roots and squeezed, white drops containing bacteria can be seen
	<i>Fusarium</i> wilt (disease)	Lower leaves turn yellow. The plant looks as though it needs water. Infected plants die
Beans	Bollworm (pest)	A green caterpillar 3-4 cm long with a yellow stripe on each side. The moth lays eggs on the flowers and the caterpillars grow inside the fruit
	Halo blight (disease)	Small yellow or brown spots each with a yellow circle round it. Found on leaves, stems and pods
	Rust (disease)	Small white spots that first appear under leaves. They later turn brown and spread to the rest of the plant
Spinach Beetroot	CRM beetle (pest)	A large black and yellow striped beetle which eats the flowers
	Leaf spot (disease)	Small light brown spots with dark edges that appear on the leaves. Very common on summer crops
	Thrips (pest)	Small grey insects that cause the leaves to look silvery. Later the leaves wilt and die
Maize	Downy mildew (disease)	Pale green spots appear on the leaves. The leaves turn yellow and die
	Stalkborer (pest)	A white caterpillar that eats out stems. It can be recognised by shot holes (rows of holes) in new leaves as they open
	Maize streak (viral disease)	The leaves have yellow streaks and the plants are small
Pumpkins	Pumpkin fly (pest)	A small black fly that lays its eggs in the fruits. The larvae, little white maggots, eat the fruit and make it rot
	Powdery mildew (fungal disease)	A white fungus seen on the leaves; it makes them turn brown and die
	Downy mildew (disease)	Appears as brown spots on the leaves, causing them to curl and die

Definition of fertilizer

- **Inorganic (chemical) fertilizers:** Compounds used to deliver at least one or more of the nutrients which are essential for plant growth
- **Organic fertilizer (manure, compost):** Organic material that is worked into the soil and releases nutrients when it decomposes. This can be produced organically in the garden (see the section below on how to make your own compost)

Crops need to be fertilized because the soil does not provide all the nutrients required for plant growth in sufficient quantities. Previous crops grown remove nutrients from the soil

Inorganic fertilizers

The main nutrient requirements of crops are nitrogen (N), phosphorus (P) and potassium (K). For example, the numbers 3:2:1 on a fertilizer bag represent the concentrations at which the respective nutrients are present. The numbers are always in the order N:P:K. Therefore N = 3, P = 2 and K = 1. This differs for different types of fertilizers/mixtures

Organic fertilizers (Compost & Animal manure)

Definition of compost

- **Compost:** Biologically active material that results from microbial decomposition of organic matter under controlled conditions
- **Benefits:** Nutrient recycling, soil improvement and enhanced crop growth

How to make your own compost

It is easy to create your own compost heap in your homestead garden.

You will require a pitchfork, a spade and water. Good compost has three important ingredients which can be classified according to colour. These are:

- **Brown** — materials such as dead leaves, twigs and branches
- **Green** — materials such as grass cuttings, fruit and vegetable waste or scraps
- **Water**



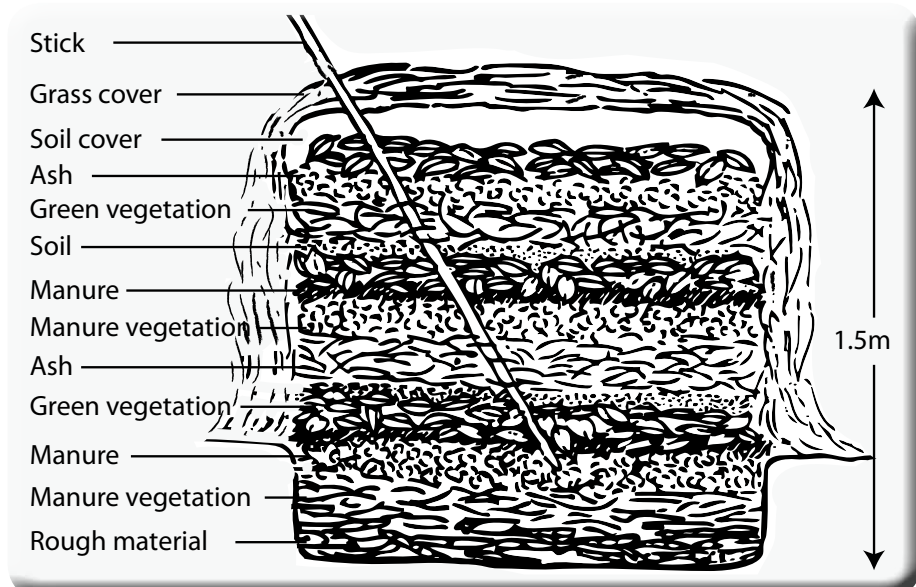
Method 1

1. Choose a dry area in the shade near a source of water
2. Cut or shred pieces which are very large
3. Cover your selected area with a layer of brown material, approximately 15 cm thick
4. Then add a 8 cm layer of green material and a little soil over the top
5. Mix the green layer and the soil lightly
6. Cover this with an 8 cm layer of brown material and water the heap until it is moist. DO NOT SOAK
7. Turn your heap weekly using a garden fork, always remember to bring the dry material from the sides and top into the middle
8. Your compost will be ready for use in about four months

Method 2

1. Choose a dry area in the shade near a source of water
2. Add brown and green material as you collect it. Remember that large pieces should be cut or shredded smaller
3. Moisten every time you add dry material. DO NOT SOAK
4. When your heap is well on its way, mix in green waste and place fruit and vegetable waste under about 25 cm of compost
5. When the material at the bottom turns a dark colour then the compost is ready

If possible the heap should be covered to keep it moist. This can be done by using a tarpaulin, dry plant material such as long grass or a black plastic bag



What should go into a compost heap

- Fruits and vegetables
- Grass cuttings
- Branches and twigs from plants and trees (remember to cut these smaller)
- Straw and veld grass
- Hair and fur
- Animal manure (cow, horse, sheep, donkey)
- Clean paper
- Cardboard (toilet) rolls
- Cotton and cotton cloth
- Used tea bags
- Saw dust and pieces of wood
- Torn up newspaper
- Leaves and garden trimmings
- Eggshells
- Ash (wood)

What should NOT go into a compost heap

- Weeds
- Coal or charcoal ash
- Plants which are diseased or infested with insects
- Eggs and dairy products
- Fat, oil, grease or lubricants
- Plants or garden cuttings which have been treated with chemicals such as herbicides and pesticides
- Meat of any kind, bones and scraps
- Pet waste (from dogs and cats)

Animal manure

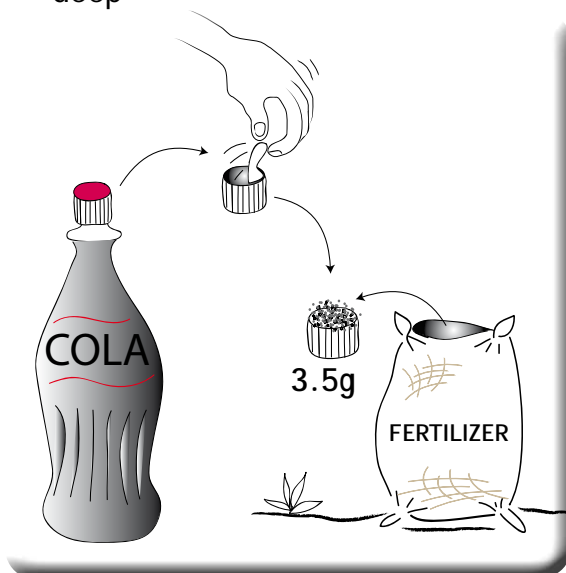
- Animal manure can be a valuable source of nutrients
- Animal manure can be used to maintain and to improve soil fertility. It contains all the macro-nutrients that the plants need, namely nitrogen, phosphorus, potassium and most micro-nutrients (trace elements)

Fertilizer application

Band placing

This is mostly done by a mechanical planter which pours out a steady stream of fertilizer next to the plants. This method is not recommended as it does not concentrate the plant's food supply at the roots of individual plants. To do band placing in the garden, for example, follow these steps:

- Use a plastic bottle top (3.5 g) to apply fertilizer (quantity depends on the crop and fertilizer recommendation results)
- Make a hole (approximately the size of a man's thumb) with a stick next to each plant and apply 1 bottle top of fertilizer in each hole and cover the hole with soil
- The hole must be 4 fingers (8 cm) away from the stem of the plant and 4 fingers deep



A "cola" or any other cold drink bottle top full of fertilizer per plant



Apply fertilizer four fingers away from the plant stem, as deep as a man's thumb, into the ground

Broadcasting

The fertilizer is broadcast over the land and then covered by a harrow or disc. This is not recommended as the farmer does not have control of the quantity applied

Guide to symptoms of plant nutrient deficiencies

- Many nutrient deficiencies may look similar
- It is important to know what a plant species looks like when it is healthy in order to recognize symptoms of distress, for example some plants were bred to have variegated patterns in the leaves when they are healthy
- Many micro-nutrients are used by plants to process or work together with other nutrients, so a deficiency of one may look like another (for instance, molybdenum is required by legumes to complete the nitrogen fixation process)
- If more than one problem is present, e.g. if water stress, disease, or insect pressure occurs simultaneously with a nutrient deficiency, or if two nutrients are deficient simultaneously, the typical symptoms may not occur
- Follow the steps below to ensure that your plants remain “well fed”.
Use the tables to identify which nutrients might be deficient
 - Know the characteristics of the plant when healthy to identify symptoms of distress
 - Identify where symptoms are appearing (new leaves, old leaves, edge of leaf, veins, etc.)
 - Identify pattern of symptoms
 - Compare symptoms to tables
 - Follow directions on label of product for applying fertilizer if warranted

MACRO-NUTRIENTS

<i>Replenish macro-nutrients regularly (at least once per growing season)</i>			
Nutrient	Deficiency symptoms	Comments	Fertilizer sources
Calcium (Ca)	New leaves (top of plant) are distorted or irregularly shaped. Causes blossom-end rot	Desert soils and water generally have plenty of calcium, so deficiency problems are rare. Excessive calcium can limit the availability of other nutrients	Anything with the word "calcium"; also gypsum
Nitrogen (N)	General yellowing of older leaves (bottom of plant). The rest of the plant is often light green	Most plants absorb nitrogen in the form of ammonium or nitrate. These forms readily dissolve in water and leach away	Anything with the words "ammonium," "nitrate," or "urea". Also manures
Magnesium (Mg)	Older leaves turn yellow at edge leaving a green arrowhead shape in the centre of the leaf	Plants absorb magnesium as an ion (charged particle), which can be readily leached from soil. May be readily leached from soil if calcium is not present	Anything with the word "magnesium"; also Epsom salts (magnesium sulphate)
Phosphorus (P)	Leaf tips look burnt, followed by older leaves turning a dark green or reddish-purple	Plants absorb phosphorus in the form of phosphate. This form dissolves only slightly in water, but pH strongly affects uptake	Anything with the words "phosphate" or "bone"
Potassium (K)	Older leaves may wilt, look scorched. Interveinal chlorosis begins at the base, scorching inward from leaf margins	Plants absorb potassium as an ion, which can be readily leached from soil	Anything with the words "potassium" or "potash"
Sulphur (S)	Younger leaves turn yellow first, sometimes followed by older leaves	Plants absorb sulphur in the form of sulphate. This readily leaches from the soil. Sulphur may acidify the soil (lower the pH)	Anything with the word "sulphate"

MICRO-NUTRIENTS

<i>Replenish when deficiency symptoms are evident</i>			
Nutrient	Deficiency symptoms	Comments	Fertilizer sources
Boron (B)	Terminal buds die, witches' brooms form	Plants absorb boron in the form of borate. Problems are seen in intensely cropped areas	Anything with the words "borax" or "borate"
Copper (Cu)	Leaves are dark green, plant is stunted	Plants absorb copper as an ion. Problems are rare	Anything with the words "copper," "cupric," or "cuprous"
Iron (Fe)	Yellowing occurs between the veins of young leaves	Plants absorb iron as an ion through their foliage as well as their roots. Uptake is strongly affected by pH. Chelated iron is readily available for use by the plant, other forms of iron may be tied up in the soil	Anything with the word "iron chelate"
Manganese (Mn)	Yellowing occurs between the veins of young leaves. Pattern is not as distinct as with iron. Palm fronds are stunted and deformed, called "frizzle top". Reduction in size of plant parts (leaves, shoots, fruit) generally. Dead spots or patches	Plants absorb manganese as an ion through their foliage as well as their roots	Anything with the words "manganese" or "manganous". Often required with zinc application
Molybdenum (Mo)	General yellowing of older leaves (bottom of plant). The rest of the plant is often light green	Plants absorb molybdenum in the form of molybdate. Problems are rare but are occasionally seen on legumes where it mimics nitrogen deficiency	Anything with the words "molybdate" or "molybdic"
Zinc (Zn)	Terminal leaves may be rosetted and yellowing occurs between the veins of the new leaves	Plants absorb zinc as an ion through their foliage as well as their roots. High pH may limit availability	Anything with the word "zinc"

CONSERVATION PRACTICES

Mulching

Covering the soil between plants with a layer of material.

This is achieved by spreading plant and other organic material such as compost, straw, manure, dry leaves, dry grass clippings and wood chips onto the surface of the soil, usually concentrated around the plants.



What to use as mulch

- Materials that cost little or nothing
- Fairly coarse material
- Crop residues
- Veld grass without seeds, leaves, soft cuttings, straw, tree bark and manure
- Stones



The organic mulches can be dug into the soil when the season is over. The mulches must be fairly decomposed before they are dug in.

Advantages

- Increases water infiltration
- Reduce evaporation from the soil surface
- Weeds do not grow well because the sunlight is blocked out
- Soil does not spatter on leaves during watering and rainfall events
- Keeps roots and bulbs cool in summer and warm in winter
- Provides food for the micro-organisms in the soil and for the plants
- Reduces greening of roots and bulbs
- Reduces soil erosion

Disadvantages

- Cutworms and other insects may shelter in the mulch
- May prevent seeds from germinating if it is placed too soon
- Some organic mulches or crop residues can be toxic to other crops (allelopathic)

Cover crops

Definition of cover crop

A cover crop is any crop grown to provide soil cover

Advantages

- Prevents soil erosion by wind and water especially on erodible soils on steep areas
- Adds organic matter to the soil
- Improves the texture and structure of the soil
- Improves infiltration by reducing runoff
- Nitrogen fixation (provided that the selected cover crop is a legume)
- Can be cut and applied as mulch
- Cuttings can be used as fodder for animals



Examples of some good cover crops:

Vetiver



Green leaf desmodium



Lucerne



Disadvantages

- If not properly managed (regular cutting) there is high competition for available water and nutrients with the cash crop
- Competes with the cash crop for sunlight, especially after emergence
- Management of cover crop requires a high level of knowledge and skill

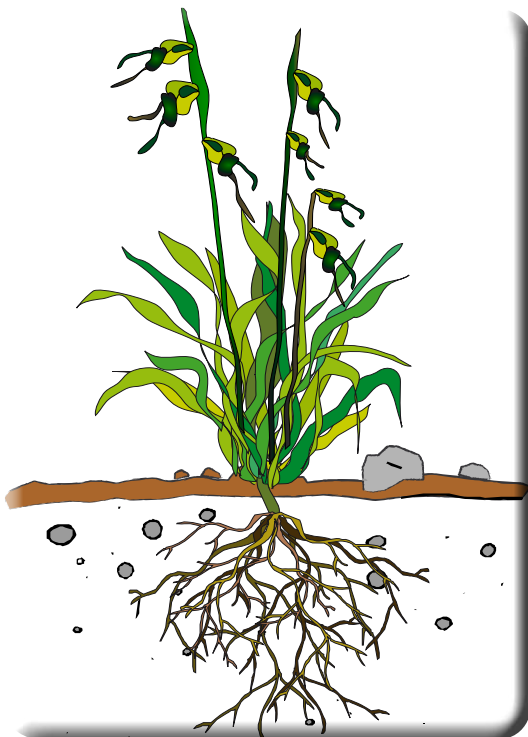
Cover crops are only recommended in areas with sufficient rainfall to sustain two crops or in areas that have access to irrigation water

RANGELAND MANAGEMENT

- The proper and wise management of the rangeland starts with being able to identify the species within the rangeland which are desirable for livestock production and soil protection
- Grasses which are best suited to animal production are those which are not only palatable to the animals but must also produce sufficient grazeable material (foliage)
- Some of the most favoured grasses by animals produce very little foliage and are perennial in nature

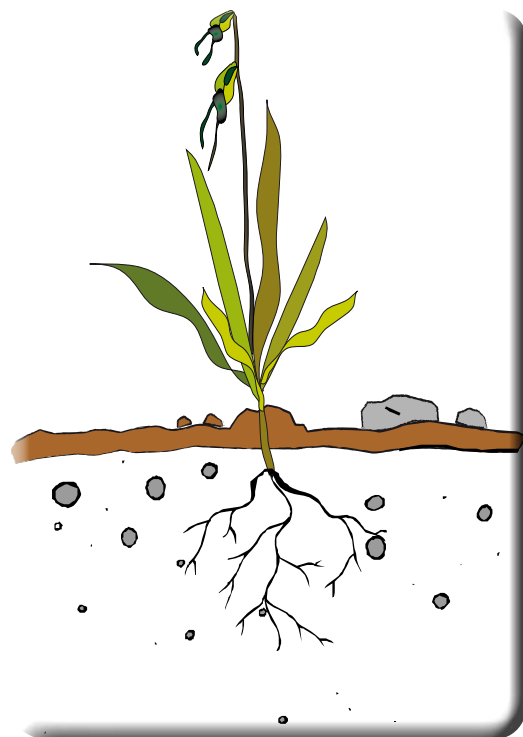
Perennial grass:

- High leaf material
- Indicates good management if dominant in the rangeland



Annual grass:

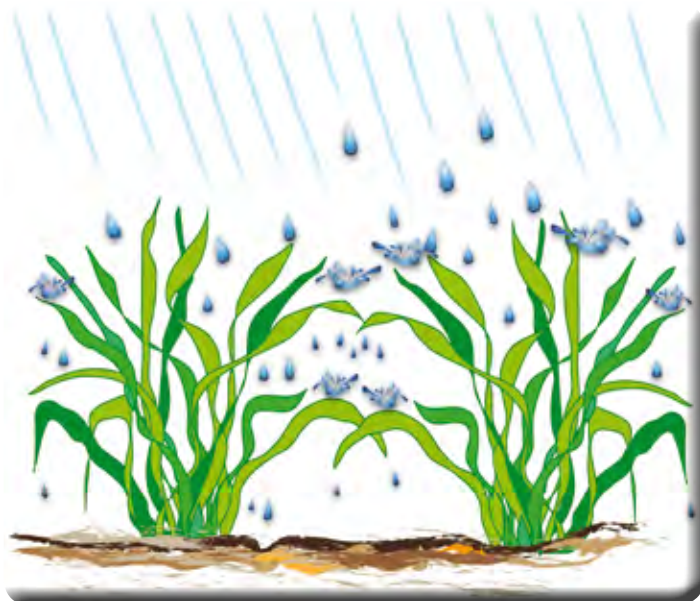
- Low leaf material
- Indicates poor management if dominant in the rangeland



RANGELAND MANAGEMENT

- Certain grasses have developed self defence mechanisms against grazing, but produce vast amounts of foliage. These species are less valuable for animal production but play a role in soil protection
- Some important grass species that should be encouraged on the rangeland (see table)
- Soil protection role of grasses is provided by the leaves as an aerial cover against the rain drops
- Protection against runoff is provided by basal cover
- To keep the rangeland in good condition, conservation (cover bare patches on the rangelands) and management (e.g. rotational grazing, re-seeding) practices should be implemented

Scientific name	Common name
<i>Themeda triandra</i>	Red grass
<i>Panicum maximum</i>	Guinea grass
<i>Heteropogon contortus</i>	Spear grass
<i>Fingerhuthia africana</i>	Thimble grass
<i>Cenchrus ciliaris</i>	Blue buffalo grass
<i>Setaria incrassata</i>	Vlei bristle grass
<i>Pennisetum sphacelatum</i>	False bristle grass



MARKETING

- In order to sell your produce you have to find a market for it. A market in this sense means a group of people (consumers)

who want to buy what you have to sell

- You will have to prepare your produce for a particular market requirement. For example, if a farmer wants to sell maize, it must be dry with a moisture content below 13%, clean, free from disease and packed in clean bags or trucks. To meet this requirement a farmer must:
 - a) harvest at the right time,
 - b) shell,
 - c) clean,
 - d) grade,
 - e) pack and
 - f) transport maize to buyer(s)

This is all part of marketing. Therefore, marketing can be described as including all the processes that take place in getting or moving goods from the point of production (farmer's field) to the consumer



Marketing operations

1. **Market research:** Market research gathers information about what consumers want, what they will buy, and the price they are prepared to pay
2. **Assembling:** Harvesting and collecting produce at the right time is critical to the quality of product and profitability of an enterprise
3. **Grading:** Grading separates produce according to its quality. Higher prices are paid for top grade produce
4. **Processing or value adding:** Processing involves changing the form of the product before it is sold, for example drying, freezing or canning. Often this is done so that the product will last longer. For example, dried pumpkin seeds last much longer than fresh ones. They can be sold later at a higher price
5. **Packaging:** Packaging makes the product easier to handle and more attractive. Use environmentally-friendly packaging material
6. **Storage:** Storage is necessary for many crops that are seasonally produced. Consumers in general want produce to be available throughout the year. Make sure your storage facilities for the various crops are ready at harvest
7. **Transport:** Transport is an essential part of marketing, as most goods need to be taken to a market from the point of production. Arrange or organize transport well in advance to avoid unnecessary losses
8. **Advertising:** Advertising helps you sell your goods, and lets the customer find out what is available. This can be done through the Water Harvesting Interest Groups. Visit your nearest market to see what you can supply to the consumer or vendor on the street
9. **Selling:** When you sell crops, convince consumers that they want the goods offered at the price you are asking, otherwise you will make less income/ profit

10. Record keeping

This is a very important act and should be done not only to keep track of finances but also of sales

EXAMPLE OF KEEPING RECORDS

Date	Costs	Amount
XXXX/XX/XX	Fertilizer	R 200
XXXX/XX/XX	Seeds/seedlings	R 100
XXXX/XX/XX	Equipment / Tools	R 50
XXXX/XX/XX	Transport	R 25
XXXX/XX/XX	Total	R 375

Date	Returns	Amount
XXXX/XX/XX	Cabbage Sales	R 300
XXXX/XX/XX	Spinach Sales	R 150
XXXX/XX/XX	Maize Sales	R 200
XXXX/XX/XX	Beans Sales	R 200
	Total Returns	R 850

Total Returns	R 850
Total Costs	R 375
Profit /Loss	R 475

What is communication?

“ ... the process by which two or more people exchange ideas, facts, feelings or impressions in such a way that each gain a common understanding of the meaning, intent and use of messages.”

Communication can be

- a one-way process, like mass media (pamphlets, radio programmes, newspaper articles, etc.) basically aiming at downloading information
- a two-way process (personal interviews, group discussions, etc.) involving interaction between communicators (e.g. extension workers) and receivers (e.g. farmers)

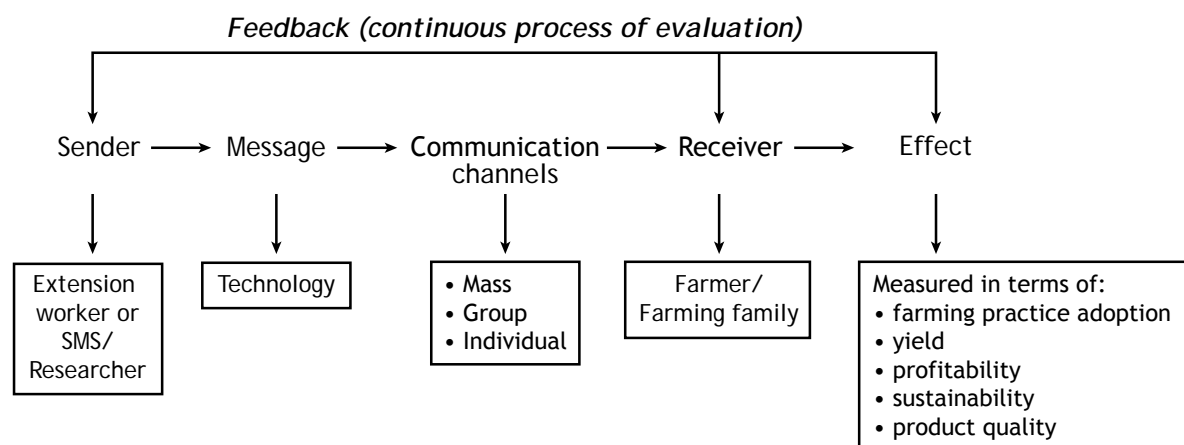


Basic elements of communication process

(see the SMCRE model below):

- **Sender** (extension worker, scientist, etc.): Responsible for designing the idea and wants to express the idea
- **Message** (contents of the lecture, group discussion, pamphlet, etc.): Contains the meaning of the idea that is conveyed to the receiver with the purpose of motivating the receiver to receive, accept, interpret and react upon that meaning
- **Channel** (farmers' day, demonstration, oral discussion, etc.): Instrument that is used by the sender to ensure that the message reaches the receiver
- **Receiver** (farmer): The target for the message and who is expected to react on the meaning of the message
- **Continuous process of feedback evaluation**: Assess progress with the communication

SMCRE MODEL OF COMMUNICATION



- Communication is the main tool through which agricultural information is distributed throughout communities and is mainly a two-way process
- The task of the communicator is to promote good understanding of knowledge, attitudes and skills among people to help them make social and economic improvements
- Success in agricultural communication comes only when people act on new knowledge and not only hear about it

General aims of the message

- Providing information about a specific aspect, e.g. “Water harvesting can be planned on a scale suitable for the small-scale farmer”. It is neutral in content but can have a persuasive effect
- To persuade with regard to a particular issue, e.g. “Only water harvesting allows the farmer to overcome water shortages”. It is not neutral but aims at addressing and neutralizing a specific objection
- Acting instructional when the messages are used to support the implementation of a particular support programme. This is mainly with regard to procedures and actions necessary for the effective and efficient implementation of the programme
- To educate with regard to the use of particular technology in solving problems, e.g. “unique possibilities for using water harvesting in maize production”. The idea is to teach farmers to use the technology in their own problem solving without prescribing to them
- A combination of above mentioned intentions with regard to a particular issue, e.g. “Water harvesting can allow the farmer to plan for production on a larger scale” (information giving and persuasive)

What makes communication sometimes so difficult?

- Respect for tradition holds the attitude that old ways of farming are the best. Fear of criticism and the new often underlies much of this resistance to change
- Belief in one's own culture often results in an unwillingness to try out something new ("We know what is best for us")
- Pride and dignity prevent farmers from using practices that they believe will possibly lead to other farmers looking down on them. Agriculture is often perceived to be either associated with poverty or with women's work
- Different values placed on technology between farmers and extension workers often lead to serious communication problems
- Preoccupation with own thoughts causes people to be so preoccupied with their own objections to a situation that they cannot concentrate. It could be very useful for successful communication to give such people an early opportunity to speak their minds
- Stereotyping sometimes leads to the belief that once a problem has been solved in a particular way, all problems should be solved in the same way and follow the path of least resistance
- Past experience, especially experience of failed extension programmes, will make it nearly impossible to involve farmers in any similar activities in future. This emphasizes the importance of communication and other skills when working with communities

Role of extension workers in the process of change

- Confirming the change that has already taken place
- Facilitating the continuation of the process of change
 - As catalyst, the extension worker basically aims to assist farmers to overcome the resistance to change. Farmers will not change their production methods (and therefore also their agricultural practices) unless the extension worker can convince them that they will benefit sufficiently from the change.
 - As decision-making helper the extension worker assists the farmer in problem solving and reaching decisions in the process of changing their production (agricultural) practices. In this process the extension worker helps the farmer in evaluating alternative practices against possible outcomes, to make decisions and to act upon it, to monitor the results and to make changes if necessary.
 - As solution giver the extension worker will assume the more traditional role of providing answers to farmers' questions. This is not a simple role since answers may not be readily accepted. Good timing, sensitivity and inter-personal communication skills are essential to achieve success.
 - As resource linker the extension worker assists the farmer to obtain and make the best of all possible resources. The inputs made by the extension worker to ensure sufficient access to essential support systems are very important in ensuring that the process of change that has been started continues in a sensible way.

How to ensure successful communication

It is important to understand that successful extension officers:

- Spend more time and energy in getting their message across and have greater contact with farmers
- Consider farmers' needs and recommend technology which farmers can use in their own environment
- Act with empathy and visualize themselves in the situation of the farmers in order to be understood
- Are able to plan the right mix of communication channels and technology to reach different target groups
- Work mostly through local formal and informal leaders to relay messages to others
- Have high credibility with farming communities that they serve
- Aim to enhance independent decision-making and action by individual farmers, groups and local organizations

It is therefore essential that extension officers, in their activities, establish themselves as credible people with integrity through proper planning of their communication activities



Conflicts refer to situations described by an expressed struggle between two or more interdependent parties with apparent incompatible goals, limited resources, and a perception of interference

Type of conflicts

Destructive conflict

Occurs when there is no decision taken and the problem remains which results in:

- Diversion of energy away from important tasks and issues
- Barriers to co-operation
- Decreased productivity
- Low morale and self-esteem
- Irresponsible behaviour
- Separation of groups and creating a “them-versus-us” scenario

Constructive conflict

Occurs when issues are open for discussion and leads to:

- Problem solving
- Building group cohesion
- Helping groups and individuals to grow
- Preparing opportunities for applying the knowledge to future conflicts
- Enhancing creativity
- Promoting higher levels of understanding
- Improved communication between individuals and groups



Dealing with conflict

- Always be calm and get both sides of the story in a controlled fashion
- Accept the people but not necessarily their behaviour
- Ensure that inflammatory language is limited to the absolute minimum to prevent further provocative behaviour
- Formulate a clear definition of what the problem seems to be and get consensus on it
- In a participatory discussion process identify possible solutions to the problem
- Do not create the impression that you want to dominate the process
- Use your authority as leader to set standards for acceptable behaviour
- Make use of formal structures like Quality Assurance or Grievance Procedures if necessary (usually as a last resort) to emphasize the importance of compliance to disciplined and acceptable behavioural codes

Dealing with someone who is out of control

- Remain very calm and recognize the other person's outcomes
- Should the discussion continue now or later in a private setting?
- Don't interrupt the person and give up your immediate right to make your own point. Rather focus on reducing anxiety and installing "normality"
- Always maintain a listening mode and keep rephrasing the comments made to make known that you have heard them
- Implement formal policies if necessary to maintain unity of the group
- Do not raise your voice or change your physical presence – it could send the message that tension levels are rising – just leading to increased anxiety

Dealing with failure

- How you deal with failure will have a definite impact on the long-term success of the group
- It is not wise to brush off failure and to get on with the next stage
- Any failure should be explored by the group
- Delegate the agreed solution to the individual or sub-group who made the original mistake

Dealing with a deadlock

- Let each sub-group debate from the other sub-group's viewpoint in order to create better understanding for the other's point of view
- Emphasize common ground and present the differences as possible middle or alternative strategies
- Debate each viewpoint in the light of the original task. Let each group decide how much time the debate actually merits. Diligently stick to that time
- If the issue is not critical, toss a coin

Practical tips in managing group conflict resolution

Sign posting:

- Keep track of everything that is discussed to prevent the larger picture being obscured
- Frequently remind the group where the discussion comes from; where it is now and where it should be going

Avoid single solutions:

- Generate, evaluate, implement and monitor alternative solutions

ROLE AND FUNCTIONS OF COMMITTEES



A committee can be defined as:

1. A formal working group within a larger organization, often formed by election, having authority or legitimacy of some specific kind. A committee is not a team, but there may be a limited number of distinct roles, such as chair, secretary, treasurer and so forth, which contribute towards ensuring that an effective group may be formed. A committee is small enough to ensure that informal discussion is possible without recourse to formal meeting procedure.
2. A group of persons, usually appointed by a larger group or legislative body to define and/or carry out a purpose or respond to an issue; it can also be a group of one or more persons who are appointed or elected to carry out a charge to investigate, to recommend, or to take action; or a select group of members with a defined scope of responsibility.

What is a group or a team?

A group can be defined as:

Two or more people who share certain values and whose social roles are interrelated. A group in the broad sense is a collection of people belonging to an institution, ideology or race. A group in the narrower sense comprises people who interact directly.

A team can be identified as:

A group of people who have a specific purpose, have clearly defined and shared objectives, are organized, have a fixed number of members and share a common strategy, act inter-dependently, understand, analyze and improve their procedures.



STEPS TO IMPLEMENT THE IRWH TECHNIQUE

1. Contact the ARC-ISCW Research Group at Glen
Tel: 072 036 9080
E-mail: BothaC@arc.agric.za

2. Register with or seek information from the locally Community-Based
Water Harvesting Interest Group (CB:WHIG) or
Municipal-Based Water Harvesting Interest Group (MB:WHIG).
These are farmers already involved with the IRWH technique in and around
Alice [Eastern Cape Province] and Thaba Nchu [Free State Province]

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