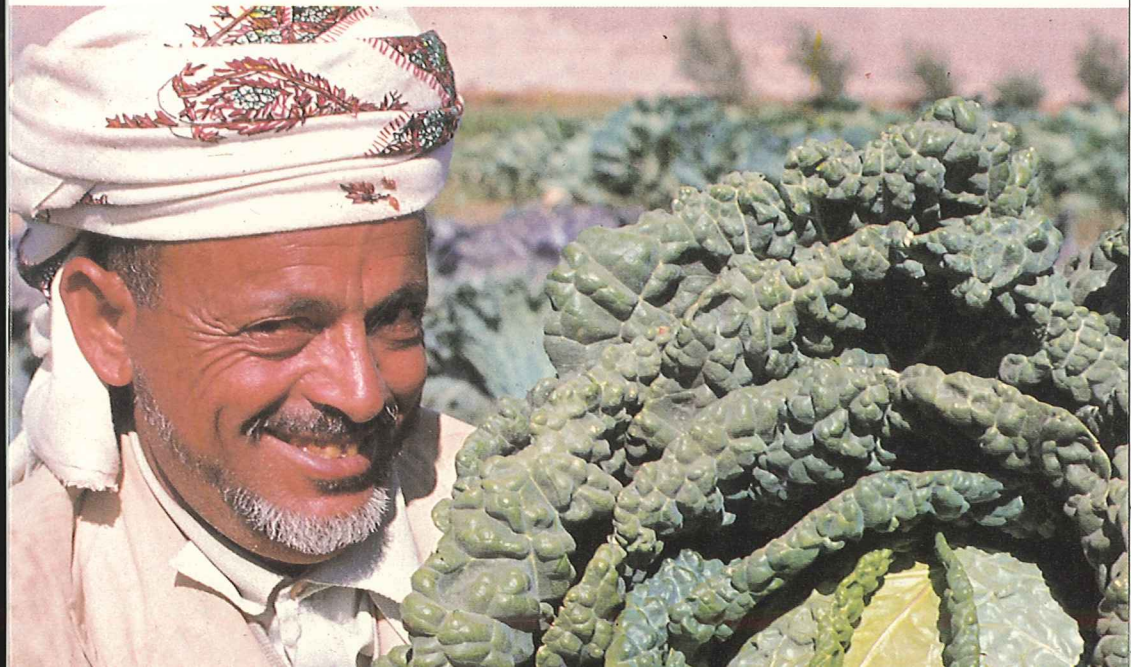
Vegetables — for the family and for cash

Basic techniques for growing them in arid and semi-arid areas

Dieter Lippmann



Basin and furrow sowing

Crop	Spacing in the row in cm	Spacing between rows in cm
Radish	15	30
Small radish	5	15
Carrots	5	30
Turnips	15	30
Spring onions	5	30
Swiss chard	30	40
Beetroot	15	40
Spinach	10	30
Okra	60	100
Broad beans	20	60
Beans, common	10	50
Cucumber	30	160
Sweet melon	30	160
Watermelon	60	200
Squash	60	100
Pumpkin	250	250

How to do it:

It is not always necessary to make new basins – we can usually use existing ones. But a suitable crop rotation must be used. In this case the soil is loosened using a single axle tractor with a cultivator attachment. The soil can also be loosened with a spade or hoe (see figures on page 14, 15, 16).

After loosening by spade, hoe or rotary cultivation the soil must be levelled very carefully.

If the surface of the basin is not carefully levelled we will get problems. Here we can see what happens when a basin has not been levelled properly. At the front there is still water lying in the basin, the area at the back of the basin has allowed the water to percolate through the soil. The growth of the seedlings is better where the water is not standing; where the water is standing, germination has been irregular.

Rows for sowing are made with a marker, after very careful levelling.

A small area can be sown by hand. The marker usually makes drills deep enough for sowing the smaller seeds straight into the drills.

If the seeds are bigger, eg beans, deeper drills will have to be made with a hoe.

Seeds such as beans, okra, etc. should be soaked in water for 24 hours before sowing.

After sowing the seeds in the drills they must be covered with soil by using a hoe.

After covering the seeds the basins are ready for irrigating. Syphon pipes lift the water from the ditch to the basin.

Looking after the growing vegetables

During the growth period between sowing, planting and harvesting vegetables need some attention to speed up vegetative growth and produce high yields and good quality.

They need:

- Cultivating and weeding,
- Irrigating,
- Fertilising,
- Singling,
- Plant protection.

This applies to all planting methods, like growing in fields under large-scale conditions, in basins, furrows or on ridges.

Cultivating

Cultivation of the top soil with a hoe is one of the most important needs.

Why?

- When we hoe the soil it opens it up to allow oxygen into the plant roots. This assists development of the microorganisms in the soil and thus the growth of the plants. Hoeing also helps prevent compaction.
- Small capillary tubes conduct moisture to the soil's surface; if these are broken by cultivation (hoeing) it will interrupt the flow of moisture and will reduce the evaporational loss which will reduce the amount of irrigation water needed. Although the loose surface of the soil looks dry it is quite moist underneath. With regular hoeing we can cut irrigation by at least half. Saving water is one of our most important aims in arid regions.
- Germinating weed seeds and weed growth are destroyed.

Cultivation with a hoe. The soil is loose and the capillary action of the soil has been destroyed. All weed seedlings have been removed.

Irrigating

Usually vegetables do not grow without irrigation in arid and semi-arid regions. There are, of course, some exceptions, like the growing of watermelons in dry river beds where the roots still find enough water during the dry seasons. Water is a basic need for growing vegetables. It must be available throughout the period of growth. But there is not always rain when it's needed and in any case, there is usually not enough of it for vegetable growing. This is why vegetables can't be grown without there being irrigation in these regions all the time.

Most smallholders use gravity irrigation. That means water is pumped from wells or rivers and led through feeders to the irrigation fields. The feeders might have to be so long that loss of water between the source and the fields becomes critical. Several examinations have shown that as much as half the water can be lost.

Water is lost by it trickling away and evaporating. We must consider the high costs of irrigation water, in particular when it's pumped out of deep wells. To avoid these losses, feeder channels can be equipped with concrete or with black polyethylene sheets.

A feeder channel equipped with concrete, with shelter belts on both sides.

When polyethylene sheets are used they must be 2 mm thick. Thinner sheets will soon be destroyed. And the sheets must be black. They can be blackened by using lamp-black. Lamp-black is the best ultra-violet ray stabiliser and will prolong the life of the polyethylene sheet.

A feeder channel equipped with a black polyethylene sheet.

In regions with low relative humidity it is recommended to use feeder pipes made of plastic or steel to avoid high evaporation as well.

The number of times to irrigate depends on many factors like soil, climate, type of vegetable, stage of growth, etc. In general we have to irrigate heavy soils every 7 - 10 days. On sandy soils irrigation twice a week might be necessary. Less may be needed if the top soil is cultivated after each irrigation. This could reduce costs and it helps to prevent salt building up in the soil.

The amount of irrigation water ranges from 50 to 100 mm per term. If possible, irrigation should be done in the evenings to reduce water losses through evaporation.

Fertilising

It is not possible to give an exact recommendation for fertiliser rates. Nutrients needed in the soil for vegetable growing vary from region to region and sometimes even from farm to farm. Moreover, there is only a limited supply of mineral fertilisers available. This is why the advisor or the village level worker should be contacted. They might decide if a soil analysis for a smallholder is of any value. They also know about research results for that specific region and are experienced.

The following is a rough estimate only for some vegetable crops.

Crop	Nitrogen kg/ha	Phosphorus kg/ha	Potash kg/ha
Tomatoes	180	100	150
Peppers	180	100	150
Eggplant	180	100	150
Cabbage	200	100	150
Cauliflowers	200	100	150
Broccoli	200	100	150
Cucumbers	180	100	150
Melons	100	100	150
Watermelons	45	160	140
Squash	50	160	140
Pumpkin	80	160	140
Asparagus	100	140	200
Onions	120	120	120
Sweetcorn	95	80	90
Spinach	150	120	120
Swiss chard	150	120	120
Kohlrabi	100	100	100
Lettuce	100	120	120
Sweet potatoes	80	80	120
Carrots	80	100	100
Parsnips	75	140	190
Beetroot	150	75	120
Radish	80	100	100
Turnips	60	140	190
Beans	50	80	80
Broad beans	50	80	80
Peas	80	100	120
Leeks	150	120	120

In most cases our soils have a strong phosphorus deficiency. The recommended amount of phosphorus is based on experience. If the phosphorus content in the soil is fairly normal, the recommended amount can be reduced by half.

If you have farm manure, distribute it on your vegetable fields. It is best for maintaining the organic content of the soil. Green manures are also highly valuable to increase organic matter in the soil. Unfortunately all green plants as well as dry parts of plants are very expensive and used as fodder in arid and semi-arid regions.

Arid region soils often contain a lot of salt. High application rates of mineral fertilisers might increase the salt content and thereby reduce rigorous growth of plants. Many elements, for example, phosphorus, react with others in the soil and will be fixed after a short time. Given these experiences, the temporary shortages and the high prices of mineral fertilisers, we should use them only sparingly and very cautiously.

How to use fertilisers:

- Apply mineral fertilisers only as top dressings in small quantities as often as possible.
- Divide a fertiliser rate into at least three parts.
- Apply part one soon after the seedlings have emerged in the field or seedbed.
- Apply part two at the end of the first third of the vegetation period.
- Apply part three at the end of the second third of the vegetation period.

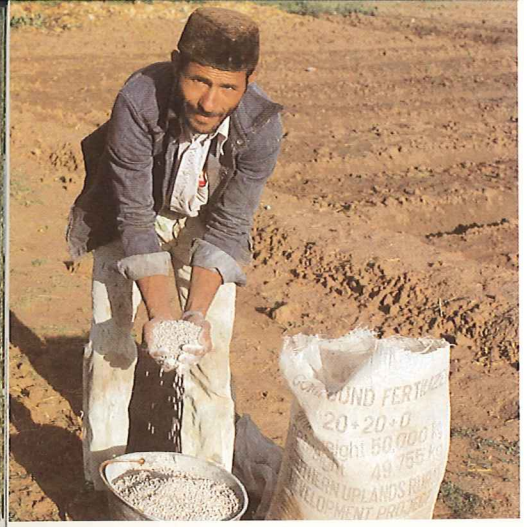
Never apply mineral fertiliser with only one nutrient. For example urea, ammonium sulphate or superphosphate.

Try to find on the market a compound fertiliser with at least two nutrients like nitrogen and phosphorus.

Two to three tablespoons of these fertilisers should be broadcast per square metre at each application.

In case only mineral fertilisers with a single nutrient are available on the markets you can mix both mineral fertilisers with nitrogen and with phosphorus one to one part. Also 2 - 3 tablespoons of this mixture should be applied per square metre.

Immediately after the fertiliser has been broadcast it must be hoed into the top of the soil. This is absolutely necessary to avoid loss of nutrition which occurs if fertiliser is left in the open air.



A farmer with a bucket of mineral fertiliser to be broadcast in a basin.

The broadcast fertiliser between the plants.

Immediately the fertiliser has been broadcast, we must hoe the soil to prevent loss of nutrition.

Several mineral fertilisers are on the market. They differ in their content of important nutrients like nitrogen, phosphorus and potash and in the speed of their efficiency.

For example:

Urea	c. 45% nitrogen
Ammonium sulphate	c. 20% nitrogen
Ammonium phosphate	c. 11% nitrogen plus 48% phosphorus
Superphosphate	c. 20% phosphorus
Triple Superphosphate	c. 45% phosphorus
Sulphate of potash	c. 50% potash

20% nitrogen in ammonium sulphate means:

in 100 kg of this fertiliser, 20 kg of nitrogen are the actual nutrition.

Assuming the recommendation for a nitrogen rate is 60 kg per ha for a crop and you want to apply ammonium sulphate which contains 20% pure nitrogen and you want to fertilise an area of 1,500 square metres = 15 are, you could use the following calculation for the correct solution:

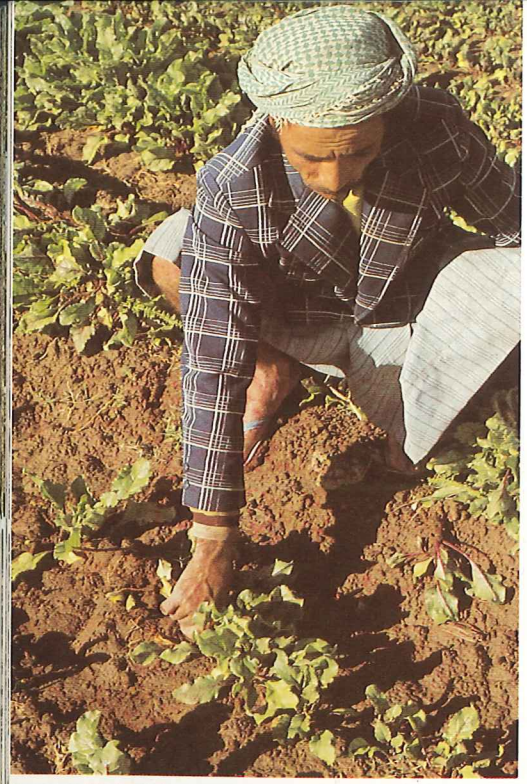
First step:

$$\text{Weight of ammonium sulphate per hectare} = \frac{\text{Weight of pure nutrition recommended}}{\text{\% nutrient of ammonium sulphate}} \times 100$$

$$\text{300 kg ammonium sulphate per hectare} = \frac{60}{20} \times 100$$

Second step:

300 kg ammonium sulphate / hectare x 0.15 (1,500 m^2) = 45 kg ammonium sulphate for 1,500 m^2.



A farmer singling beetroot to the best distance of about 12 cm. The plants removed are excellent stockfeed.

After singling.

After the plants have been singled it is advisable to apply the third top dressing. If the plants look a little disturbed after singling do not worry. They will recover very quickly.

Protecting plants from damage

Many problems affect vegetable plants. Before we can control them we must know exactly why they have occurred. In most cases it is not necessary to use chemicals which we can buy in the agricultural shops because, for physiological reasons they can usually be controlled with better plant husbandry.

For example:

- soil management,
- shelter belts,
- fertilisation,
- irrigation, etc.

Protection with chemical products can be very expensive and if we make a mistake it can be dangerous. For those reasons we should carefully consider what is causing the damage to the plants and use chemicals only when necessary.

What could be the cause of damage to vegetable plants?

- physiological and mechanical,
- diseases caused by virus,
- diseases caused by fungus,
- pests, in particular insects.

Let's look first at environmental problems able to do the vegetable plants physiological and mechanical damage:

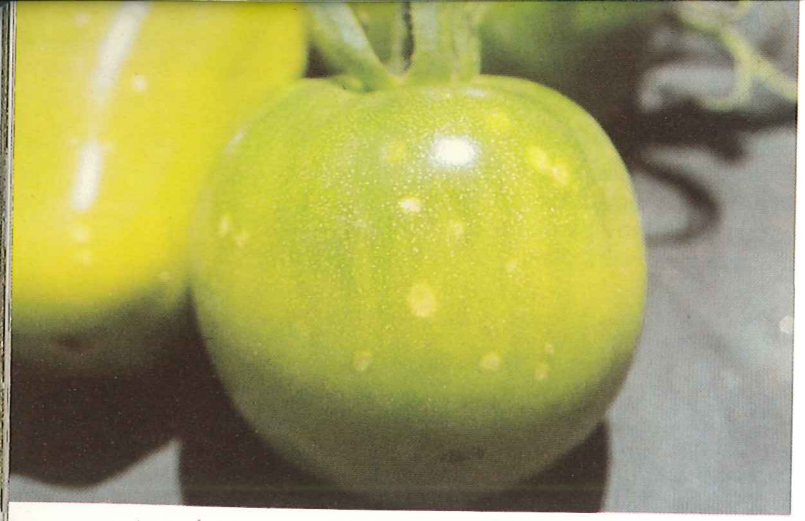
For example:

- not enough water,
- too much water,
- soil compaction,
- starved soil and not enough trace elements,
- too much fertiliser,
- excessive application of chemical plant protectants,
- high salt content in soils,
- wind, hail, rain and frost,
- careless use of implements on the soil.

Very often physiological and mechanical damage leads directly to other diseases because the plants are weak and unhealthy. To avoid this we have to protect the plants from these effects.

How can we do this?

- Different crops need different things, so we should select our crops carefully so that when they are sown or transplanted they grow well.
- Always plant out strong and healthy seedlings.
- Always give the correct amount of water and fertiliser.
- Use varieties adapted to your area.
- Always buy healthy seeds.
- Keep weeds under control.
- Practise crop rotation.



Example of mechanical damage. It looks like a disease. Hailstones caused the spots on the tomato fruit.

Let's now discuss pests attacking and diseases infecting vegetable crops and also look at the different controls available to us:

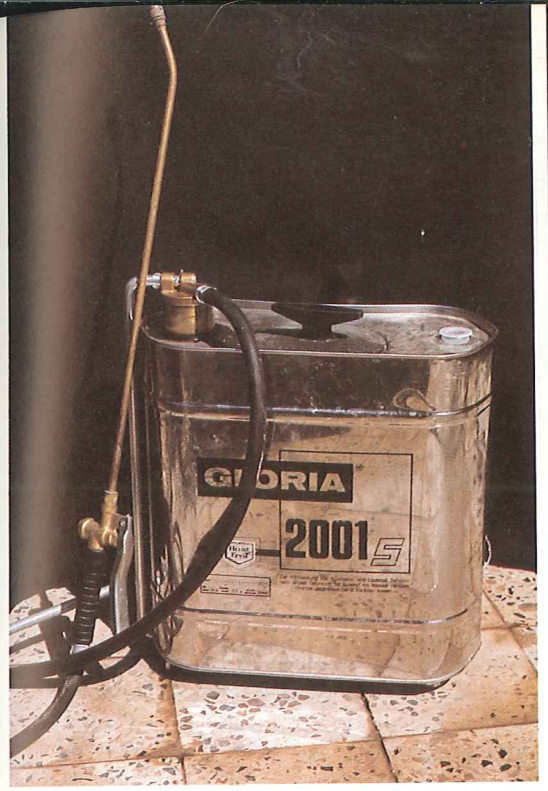
There are several methods:

- mechanical,
- biological,
- chemical.

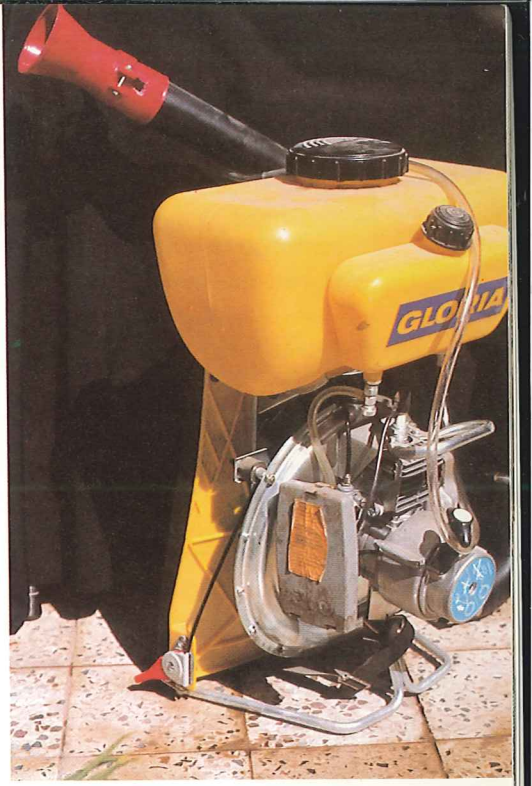
Traps are a mechanical method successful to some extent with some crops – and some pests. But mechanical methods of pest control cannot really be recommended without research in a specific area.

Biological control methods are still in the research stage. We cannot yet influence or regulate biological factors enough for really good protection of our vegetable crops. All we can do is to try to protect the natural enemies of the pests.

Chemical control is the most successful and economical method. But it requires knowledge and a sense of responsibility. Many chemicals used are poisonous to humans and animals and we have to learn to handle them with great care. Mistakes can cause great damage and inflict harm on people and livestock. Contact an agricultural advisor or village level worker for further information and instructions. Most of these chemicals are applied to the crops in liquid form.



For small areas we can use this knapsack sprayer to apply liquid mixtures.



For bigger areas an engine-driven portable sprayer is more economical.

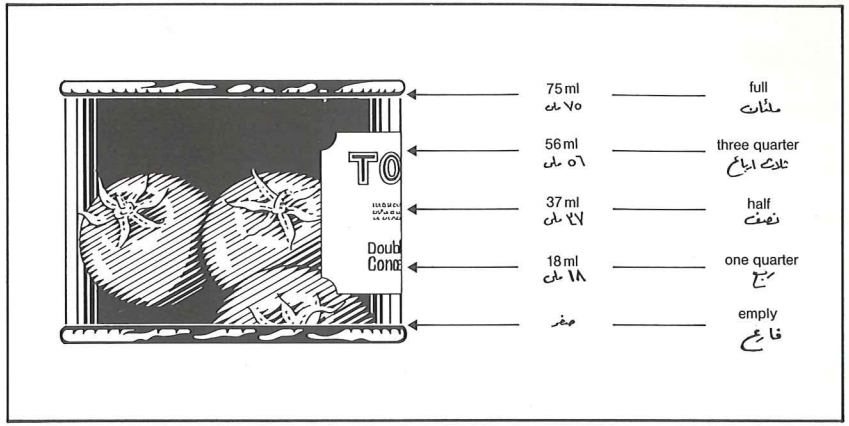
Example of a simple application of a chemical dust with a bag made of nylon or a similar material. With each slap against the bag filled with dust a small amount of dust drops down into the treated plants.

Personal safety precautions:

- All chemicals must be kept in locked boxes in dry and cool places.
- You must study the instructions on the chemical container or contact somebody who is to able to explain the instructions to you.
- Make sure you understand the instructions.
- Make sure a proper measuring instrument is available.
- Gloves made of polyethylene must always be used when handling chemicals.
- Put on a protective overall made of plastic, a mask, boots and safety goggles before broadcasting any chemicals in larger quantities.
- Smallholders applying small quantities of chemicals must wear at least:
  - boots,
  - polyethylene gloves,
  - mask,
  - safety goggles.
- Now spray against the wind.
- After use the equipment must be rinsed very carefully to avoid any corrosion of the materials.
- At the end of the procedure hands, face and all parts of the skin that come into contact with dust or liquid must be carefully washed with water and soap.
- It is forbidden to smoke, drink or eat when handling any plant protection materials. This is only allowed after washing.

How to do it:

A fairly good measure for chemicals are these small tins of tomato paste from different manufacturers but all of the same size of 75 ml. The match box gives an idea of the real sizes of the tins. These tins of tomato paste are available in nearly all countries.



Using a small tin of tomato paste as a measure:

This tin contains when full	75 ml
This tin contains when three quarters full	57 ml
This tin contains when half full	38 ml
This tin contains when one quarter full	19 ml

Concentrations for 16-litre knapsack sprayer:

For all recommended concentrations of 0.1 % of a fluid chemical approximately one quarter of this tin is enough for one knapsack sprayer of 16 litres.

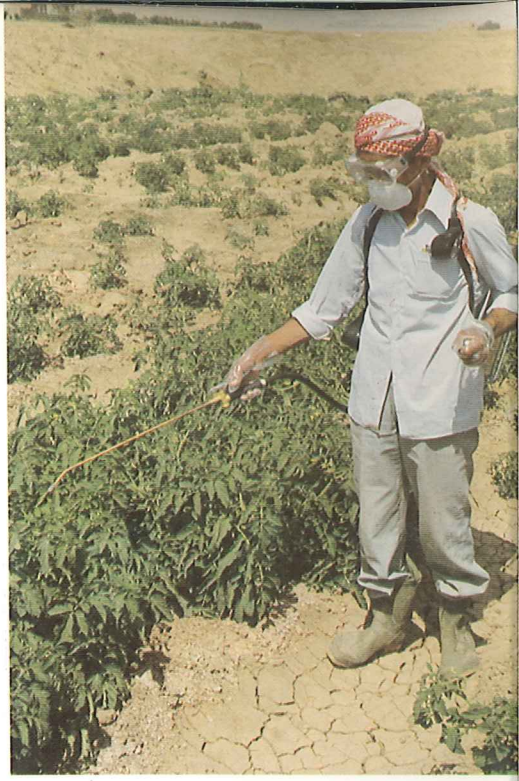
For all recommended concentrations of 0.2 % of a fluid chemical approximately a little less than one half of this tin is enough for one knapsack sprayer of 16 litres.

For all recommended concentrations of 0.1 % of a powdery chemical a little more than half of this tin is enough for one knapsack sprayer of 16 litres.

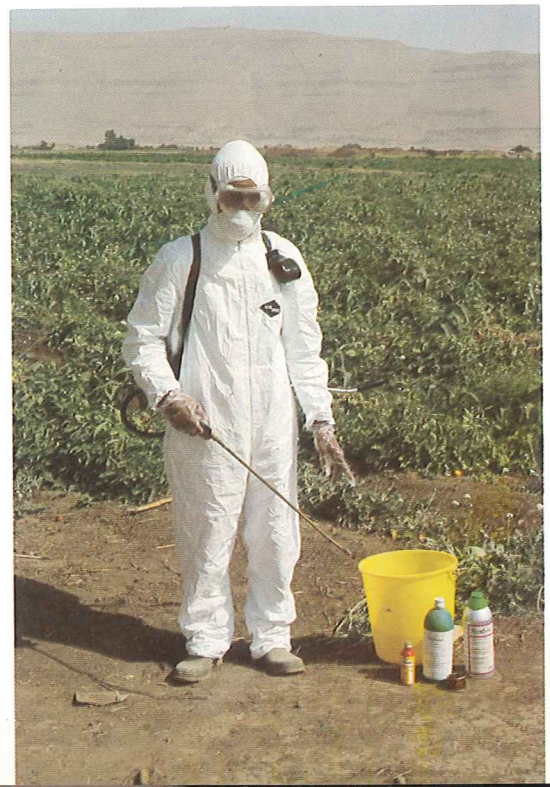
For all recommended concentrations of 0.2 % of a powdery chemical a full heaped tin is enough for one knapsack sprayer of 16 litres.

Measuring a pesticide. Note the gloves made of polyethylene for personal protection.

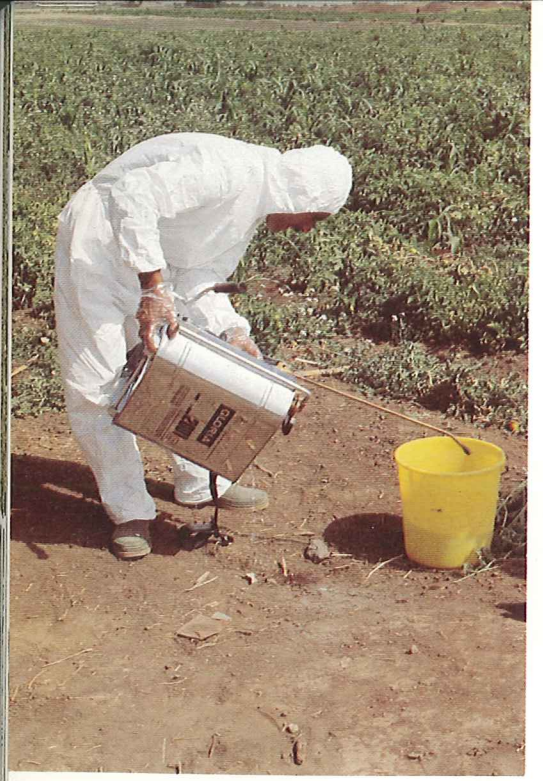
A few drops of this speader sticker should be added to all mixtures to increase the effect.



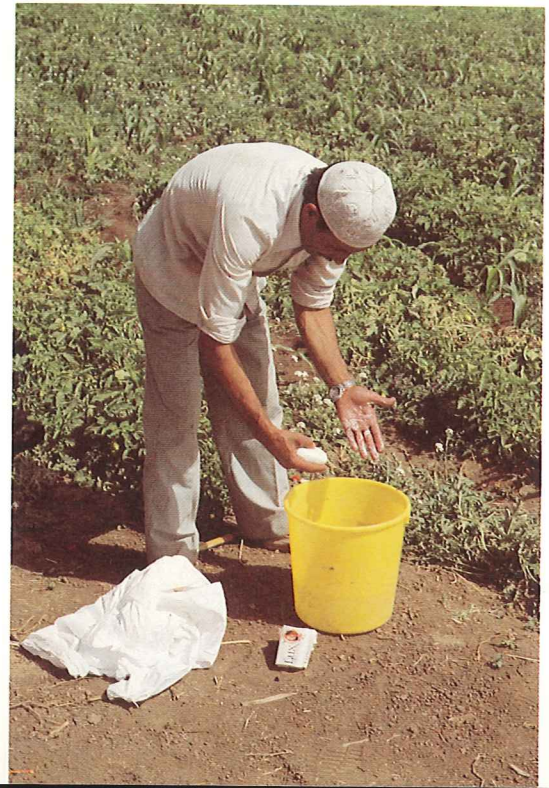
A smallholder with the least personal protection applying a pesticide.



A fully protected farmer applying a pesticide.



Rinsing the equipment after use.



Wash hands and face when the job has been done in a clean bucket.

Two crops at once

To get the heaviest crop from a field, intercropping is useful. It increases the yield without increasing the need for irrigation water.
Intercropping means planting a second crop between the rows of the first (main) crop. Before the slower growing main crop needs the whole area to develop, a faster-growing intercrop has already been harvested. Basins, furrows and ridges can all be used when intercropping.

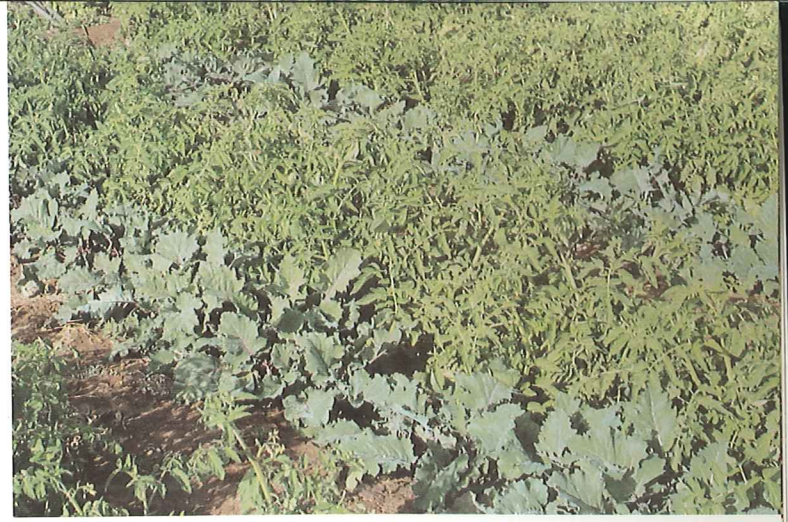
These vegetables are suitable intercrops:

- Lettuce
- Small radish
- Kohlrabi

Curly kale as the main crop has been planted on one side of the main ridge and kohlrabi as the intercrop on the other side. The kohlrabi is almost ready for harvesting.

Cabbage and lettuce. The lettuce is almost mature enough to harvest. After the lettuce has been harvested the cabbages will have plenty of room to continue growing until they are ready.

On the right of these furrows tomato plants have been planted and on the left kohlrabi and lettuces were planted as intercrops.
The main crop was planted on the right side of the ridge because the prevailing wind blows mainly from the left. The tomato plants are pushed from the left and lie on the dry soil of the furrow. If the left side was also planted with tomato plants they would be pushed into the furrow and lie on the moist soil. The distance between the furrows are kept smaller for that reason.
It is also possible to grow intercrops like lettuce or kohlrabi on the same furrow as the tomatoes, i. e. between two tomato plants, plant one lettuce or kohlrabi plant.



Lettuce and kohlrabi will have been harvested. The tomato plants will remain and go on.

Tree belts to protect vegetables from wind

In most arid regions we face the problem of very strong winds. The growth of the vegetables can be depressed and we can see a lot of damage caused by the strong, dry and warm winds. Very often these winds carry a lot of dust, sand and grit which can burn the crops and make them dusty. To control these winds a little and to reduce the damage shelterbelts are a help. They can be planted in different ways.

Trees will grow into permanent shelterbelts and are very effective. And they are not only a shelterbelt for crops but also provide firewood which is becoming more expensive and harder to come by.

The trees forming this shelterbelt were planted a long time ago. It is probably no coincidence that this area has also grown vegetables for a long time. Without doubt the existing shelterbelts encourage vegetable growing.

Tamarix is the tree that is always used. It is resistant to drought and gives a good effect when the strips of trees are planted 50 metres apart.

To take Tamarix cuttings a piece 40 - 50 cm long should be planted deeply in the soil (only 5 - 10 cm should be left showing above the surface) in a ditch and the cuttings placed about 60 cm apart. If the soil is kept moist the cuttings root easily and grow very quickly.

To get a quick shelterbelt effect, maize can be planted in strips 5 metres wide. Behind these strips of maize, watermelons, cucumbers and tomatoes have been sown.

A similar method is to grow the maize in single rows 3 - 5 metres apart, in rectangles.

The maize is well grown and makes a very good shelterbelt. This method has been found most suitable for cucumber growing as there might be a positive side effect, as the maize screen could help control fruit flies which attack cucumbers.

Harvested vegetables for the market.

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH

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