



THE SAFE AND EFFICIENT USE OF PESTICIDES

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Department of Primary Industry-Port Moresby, March 1983

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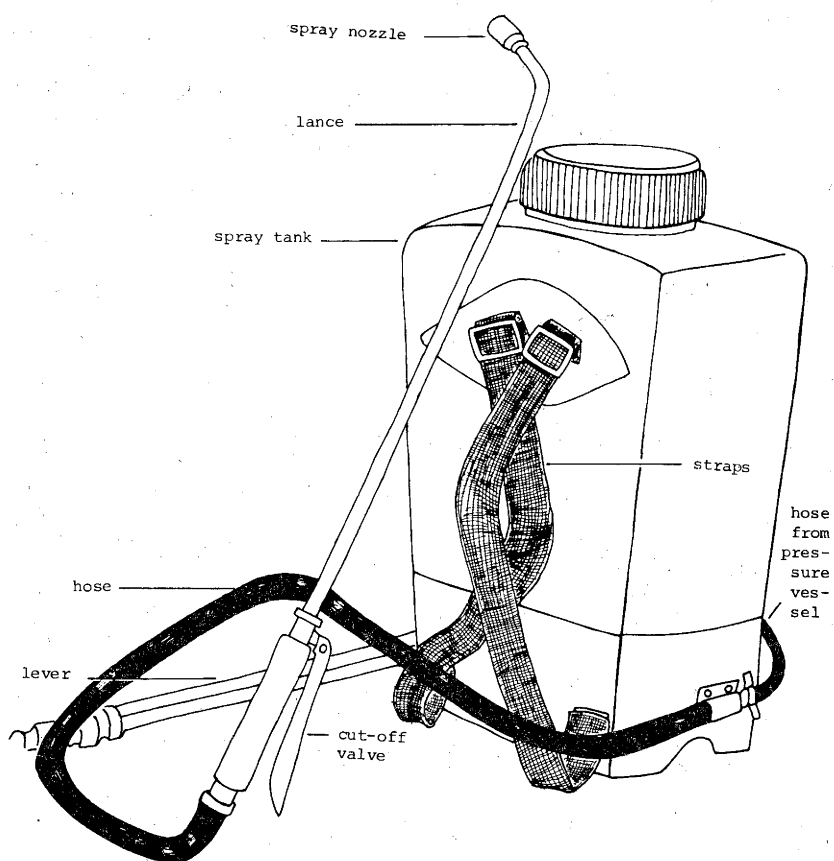
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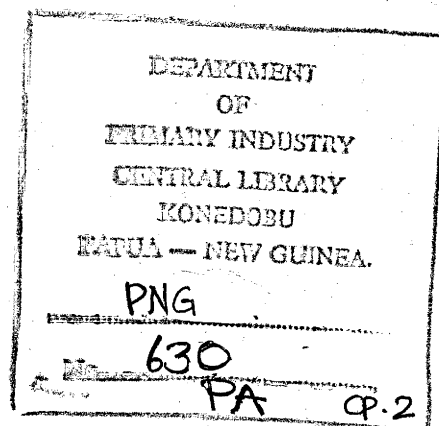
THE SAFE AND EFFICIENT USE OF PESTICIDES

BY

J.A. SUTHERLAND

HANDBOOK NO. 18

PORT MORESBY, MARCH 1983



CONTENTS

	Page
INTRODUCTION	1
PESTICIDES	1
Composition of Pesticides.....	1
Forms of Pesticides.....	2
Names of Pesticides.....	2
SPRAYERS	3
How the Knapsack Sprayer Works.....	3
How to Use a Knapsack Sprayer.....	3
Nozzles.....	4
THE METHOD OF SPRAYING	7
HOW TO CALCULATE THE AMOUNT OF CHEMICAL TO BUY AND MIX	9
An Example of a Problem.....	9
Calculation of the Amount of Product to Buy.....	10
Calculation of the Amount of Product to Mix in Each Sprayer tank.....	11
USING PESTICIDES SAFELY	12
Stages of Safety Measures.....	12
BEFORE HARVESTING	17
FIRST AID IN CASE OF ACCIDENT	17
Accident Involving a Pesticide.....	18
ADDRESSES	19
FURTHER READING	19
GLOSSARY	20

INTRODUCTION

Animals, plants and fungi which may damage a crop are known as pests. The pest may cause a disease, it may feed on the crop directly or it may compete with the crop and reduce the yield. For example, very tiny worm-like animals known as nematodes may cause the plant to look diseased, leaf eating beetles can reduce or prevent crop growth and fast growing weeds may stop the crop obtaining nutrients from the ground. A pest may be controlled in four ways.

1. Physically - by picking the insects or diseased plants or weeds out of the crop.
2. Culturally - by using good planting material, special growing methods or varieties which are not affected by the pest.
3. Biologically - by introducing animals or plants that attack and kill the pest.
4. Chemically - by putting a pesticide on the crop.

The purpose of this booklet is to explain what a pesticide is, how to apply it, the types of nozzle to use, how to set about buying the right quantity of pesticide, how to calculate the right amount to mix with water, how to use the pesticide safely and what first-aid steps to take in an emergency. It is intended for use by trained DPI staff, in the field.

PESTICIDES

Pesticides are chemicals which will destroy pests. They should be used only when the pest problem is serious and other methods have either failed or are not suitable. The pest may be a weed, an insect, a rat, a snail, a fungus, a mite or a nematode. Each of the pesticides used to kill these has a different name.

1. Herbicide controls weeds
2. Insecticide controls insects
3. Rodenticide controls rats and mice
4. Molluscicide controls snails
5. Fungicide controls fungi
6. Acaricide controls mites and ticks
7. Nematicide controls nematodes

COMPOSITION OF PESTICIDES

A bottle of pesticide contains several ingredients but they can be split into two separate parts. These are:

- a) An Active Ingredient
- b) A Non-Active Ingredient

The active ingredient (commonly abbreviated to a.i.) is the chemical which is the poison to destroy the pest. The non-active ingredient will not destroy the pest on its own but it helps the active ingredient to be more effective. The non-active ingredient is composed of some or all of the following parts:

- Emulsifiers help the active ingredient mix with water.

- Spreaders help the mixed spray spread out over the waxy surface of the plant or insect.
- Stickers help the mixed spray stay on the plant and reduce the amount which is washed off by rain.
- Fillers are used in dusts and granules (see below) to dilute the active ingredients.

FORMS OF PESTICIDES

A pesticide which is for sale is made up of all these different things and is known as the product. The product may be a liquid or a solid, and it depends on the way the active ingredient behaves which form is chosen by the manufacturers. The type of product is known as the formulation. The two most common formulations for water based sprays are:

- A. Emulsifiable Concentrates (commonly abbreviated as 'EC') which are liquids and mix with water to form a milky solution.
- B. Wettable Powders (commonly abbreviated as 'WP') which are dry powders that are mixed with water to form a solution which may be clear or milky.

Also available, but less common, are Colloidal Suspensions which are solid particles of the active ingredient in a special liquid in which they float like mud particles in water.

Some pesticides are made into special formulations known as dusts or granules. These are never mixed with water but are applied to the pest as they are. The manufacturers of the pesticide dilute these solid formulations with powders called inert fillers and the product which is sold is very weak and ready for use. Some pesticides for use in the soil are formulated as granules. Not many dust or granule formulations are used in Papua New Guinea.

NAMES OF PESTICIDES

A pesticide has at least three names. Two are internationally recognised. These are the chemical name and the common name. The chemical name is generally used before a common name has been agreed upon and is not often referred to except in specialised books and articles. It is usually long and complicated. The common name of a pesticide always starts with a small letter and is accepted by all manufacturers. Each manufacturer who produces a pesticide has a trade name for its product. The trade name always starts with a capital letter and may be in quotation marks. Although each pesticide has only one chemical name and one common name it may have several trade names. Usually the amount of active ingredient and the type of formulation are incorporated onto the trade name. The amount of active ingredient in the formulation is the concentration of the product. An example of these names for two of the commonest pesticides in Papua New Guinea are:

- A. Chemical name: OS-dimethylacetylphosphoramidothiocate
Common name: acephate
Trade name: Orthene 75 WP (a wettable powder formulation of acephate containing 75% of the active ingredient).
- B. Chemical name: 1,1'-dimethyl-4,4'-bipyridylium ion (I)
Common name: paraquat
Trade name: Gramoxone, Dextrone X, Weedol (note that none of these trade

names contains the amount of active ingredients, but it is written on the label).

SPRAYERS

Machines which are used to put the mixture of pesticide and water on the crop are known as sprayers. The most common type of sprayer used in Papua New Guinea is carried on the back of the sprayman and is operated by a lever which is attached to a pump, this is the lever-operated knapsack sprayer.

Although there are many other types of sprayers, only knapsack sprayers will be dealt with in this booklet. Figure 1 shows a typical sprayer of this type. If you wish to find out about the other types of sprayers, see the list of books and articles for further reading at the end of this booklet.

HOW THE KNAPSACK SPRAYER WORKS

The spray liquid is placed in the tank of the sprayer and the lever is moved up and down. When the lever is moved the pump takes the spray liquid from the tank into a special chamber inside the tank called the pressure vessel. As more liquid goes into the pressure vessel the pressure increases. One side of the pressure vessel is attached to a hose which comes out of the sprayer to a handle which the sprayman holds. On the handle is a switch known as the cut-off valve, to turn the spray on and off. From the handle there is a long tube known as the lance. When the cut-off valve is opened the pressure in the pressure vessel forces the liquid down the hose to the end of the lance where it reaches the nozzle. The nozzle is where the liquid from the sprayer tank is changed into a cloud of spray droplets. It is the droplets which are spread over the crop to destroy the pest.

HOW TO USE A KNAPSACK SPRAYER

The faster the handle is moved the higher the pressure inside the sprayer. High pressure has two effects on the spray. It makes the droplets smaller and increases the speed at which the chemical comes out of the nozzle. This is known as the "flow rate". Twelve to fifteen pump strokes per minute is a good rate for spraying insecticides and fungicides. For herbicides the pump rate should be lower, about five or six strokes per minute. The handle should move about 30 cm on each stroke. The higher pump rate for insecticides and fungicides is used to make a fairly fine spray which will go into the crop and give good coverage of the leaves. The lower pump rate for herbicides is to make fairly coarse spray with larger droplets to prevent the wind carrying the chemical onto other plants and away from the weeds. It is important to pump at the right speed. If the rate is too fast the pressure will be too high, droplets will be very small and may drift away with the wind and never reach the crop. The sprayer may also be damaged by the high pressure. If the pump rate is too low the pressure will also be too low, droplets will be very large and will not give a good coverage of the crop (when using insecticides and fungicides).

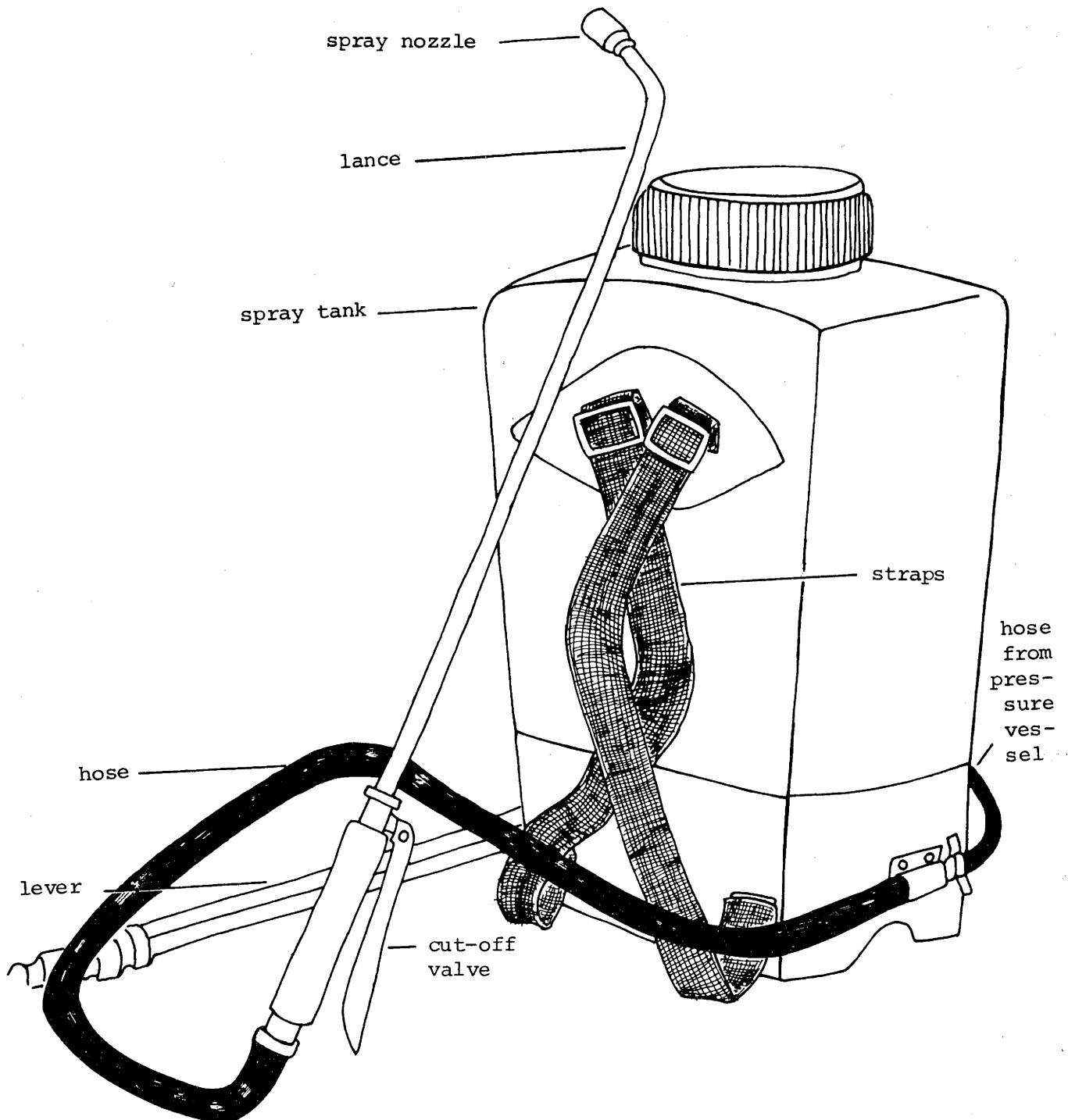
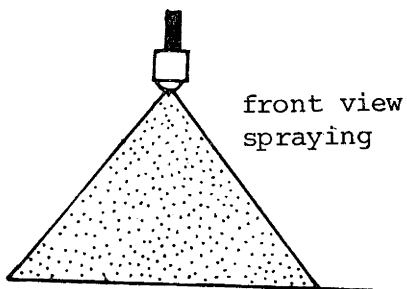
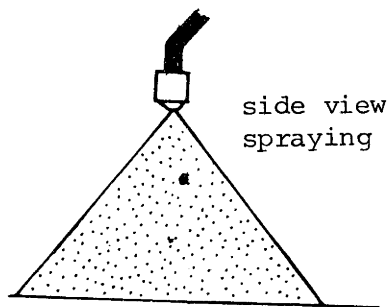
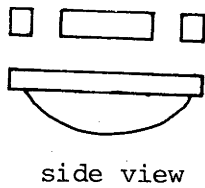
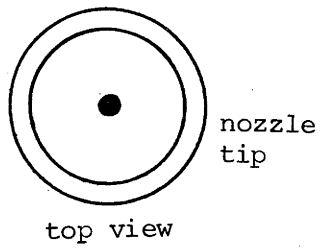
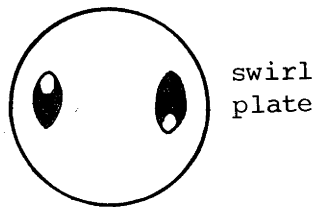


FIGURE 1 GENERALISED SPRAYER

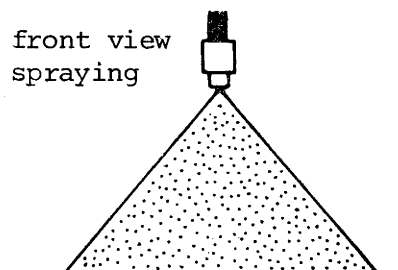
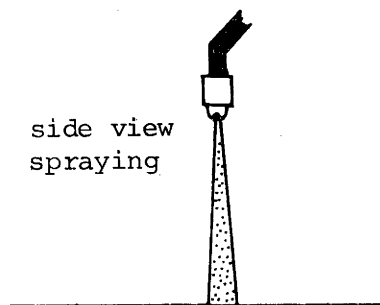
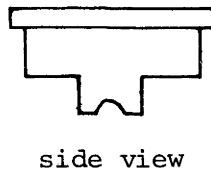
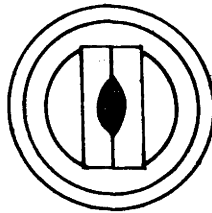
NOZZLES

The nozzle of the sprayer is where the mixture of the pesticide and water is turned into spray. Therefore this is a very important part of the sprayer. There are three types of nozzle which can be used (see Figure 2).

CONE NOZZLE



FAN NOZZLE



IMPACT NOZZLE

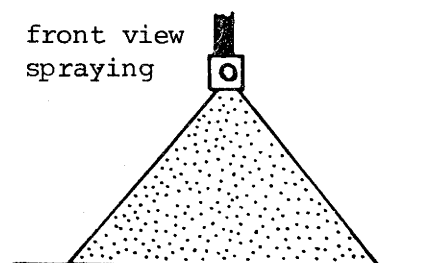
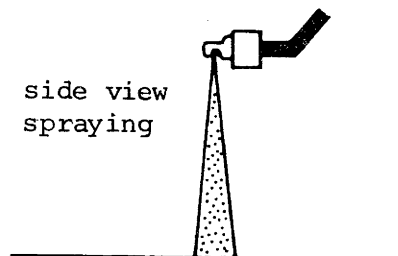
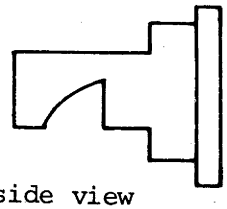


FIGURE 2 THE THREE TYPES OF SPRAY NOZZLES

Cone nozzles

The cone nozzles are used for spraying crops with insecticides, fungicides and acaricides at normal pressures. They are not used for herbicides because they produce too many small droplets.

Fan nozzles

These are used for spraying flat surfaces such as walls, when an even spray is needed. When they are used at low pressure, with only five or six pump strokes per minute, they can be used for herbicides. They are not used for insecticides, fungicides or acaricides on crops.

Impact nozzles

These are only used for herbicides and are used at low pressure. They produce a spray with large droplets that do not blow onto other plants. This is the best type of nozzle for applying herbicides.

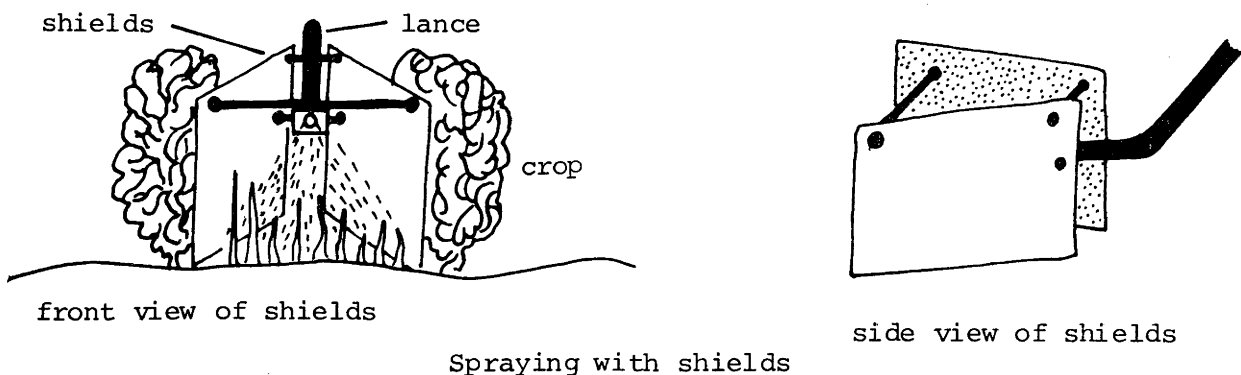
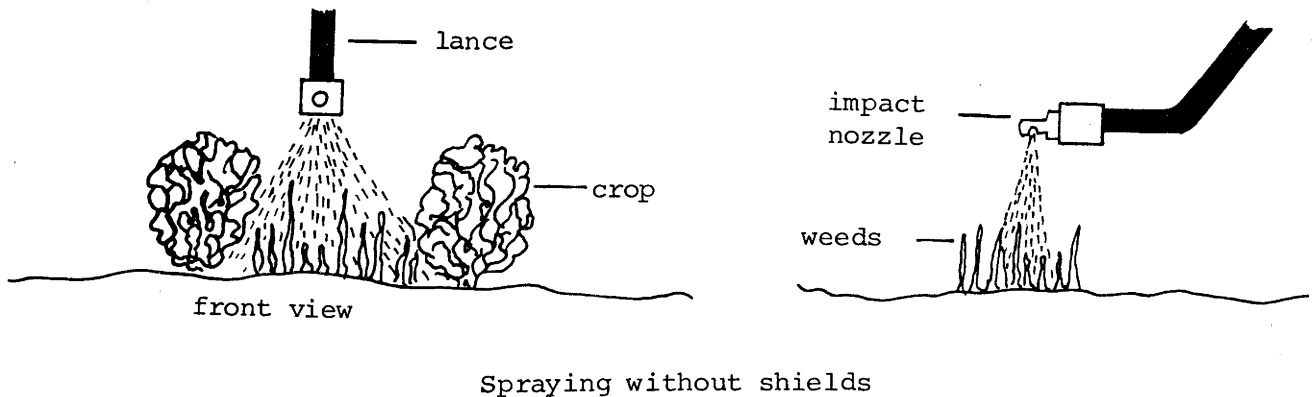


FIGURE 3 SPRAYING WITH AND WITHOUT HERBICIDE SHIELDS

Sometimes when spraying a herbicide to the space in between rows of a growing crop, special protectors known as herbicide shields can be used (as in Figure 3). The shields prevent the spray falling on to the growing plants and damaging them.

THE METHOD OF SPRAYING

The type of spraying that is done with a knapsack sprayer is called high volume spraying. This is because the pesticide is mixed in a large volume of water. The volume of water is approximately 1000 litres on every hectare (100 x 100 metres). With high volume spraying the sprayman points the nozzle at the plant and covers the surface of it with the mixed chemical until the leaves are completely wet and the spray starts to drip off them. This is known as spraying to run-off.

Pesticides are poisonous chemicals and because of this it is very important that the sprayman does not get the chemical on his skin (see section 5 on page 9). One of the ways to increase the safety of spraying is to make sure the method of applying the chemicals is correct. Figures 4 and 5 show how to spray correctly with one or more spraymen.

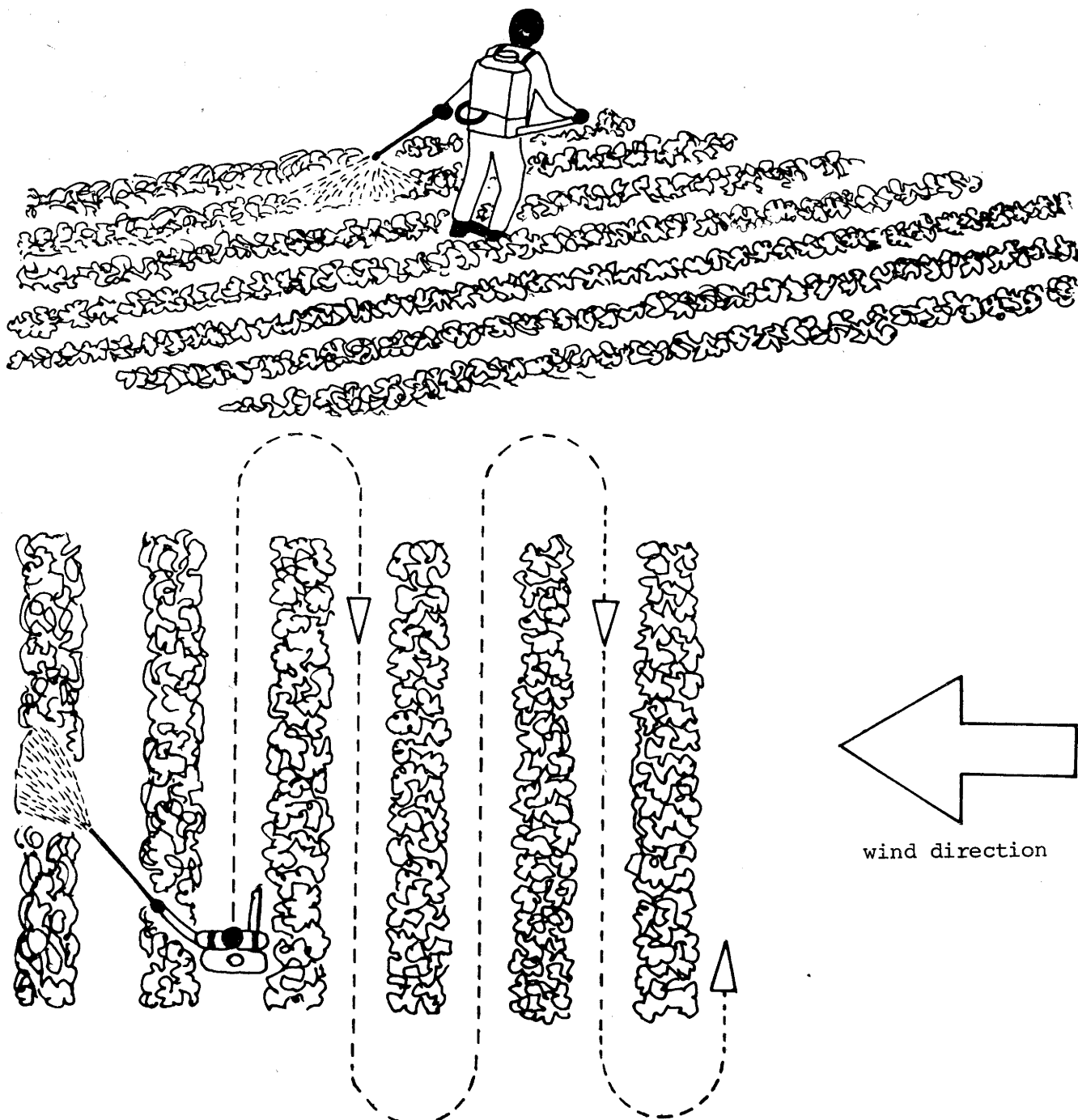


FIGURE 4 SPRAYING OVER-ROW WITH ONE SPRAYMAN

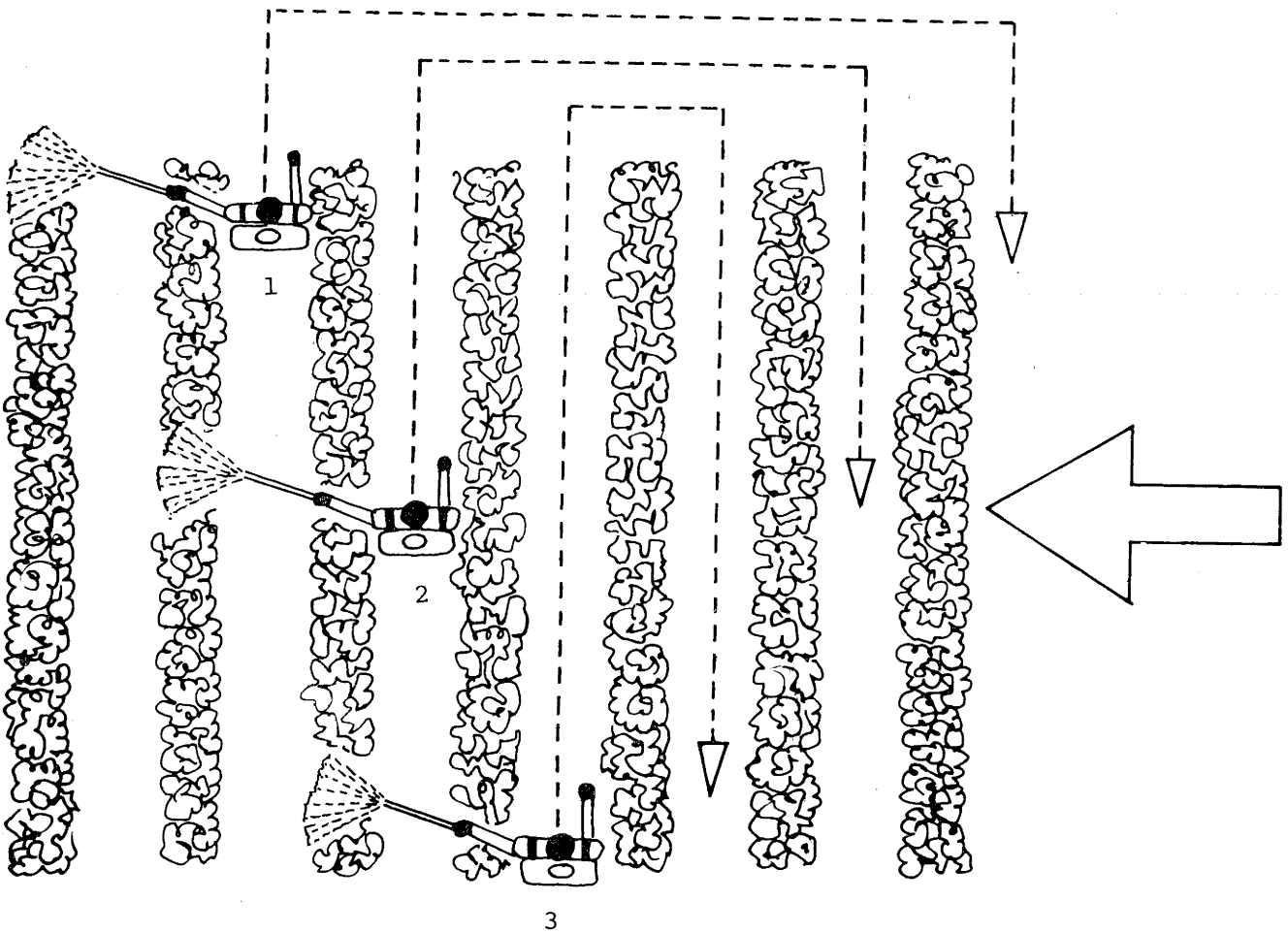
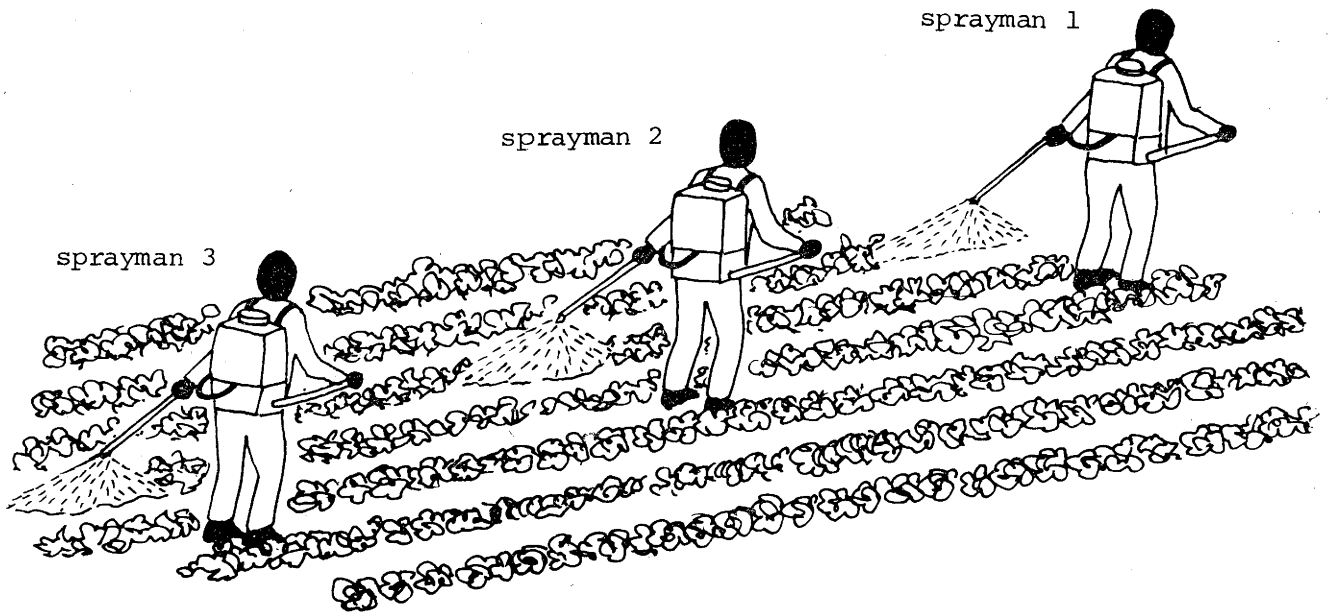


FIGURE 5 SPRAYING IN ECHELON WITH MORE THAN ONE SPRAYMAN

When spraying always remember the following points:

1. Always start spraying on the downwind side of the field. In other words place your side to the wind so that any spray which is blown off the crop travels away from you. If you are planting in rows, try and arrange for the rows to run across the most common wind direction. That is at 90 degrees (right angles) to the wind. This makes spraying much safer and easier.
2. Always spray the row next to the one you are walking down. This is so that the chemical on the plants is not brushed off onto the legs of the sprayman. This type of spraying is known as over-row spraying and is the safest way of high volume spraying (Figure 4). On some crops it is not possible to use this method because they are too tall. If this is the case it is best for the sprayman to spray behind or to one side of himself as he walks along the row.
3. Never spray if the wind is too strong. A strong wind is one that can move the tops of tall trees or which raises dust and moves small and medium sized trees. It is all right to spray in light and medium strength winds but as the wind force increases the nozzle should be held closer to the crop to prevent the droplets drifting away.
4. Downwind sprayman starts first. When more than one sprayman is spraying in a field use the method shown in Figure 5. Each sprayman is spraying over-row. Sprayman 1 starts walking and spraying, when he has gone 10 paces sprayman 2 starts down the next row, also spraying over-row. When he has gone 10 paces sprayman 3 starts, and so on. As each sprayman finishes his row he waits for the others to finish as well. When they have all finished they move along and start spraying the next rows in the same way. This type of spraying is known as echelon spraying. It is very important that the downwind man starts first and that the distance between spraymen is kept at 10 paces.
5. When spraying always be aware of the wind speed and direction. If the wind direction is varying a lot or it is blowing along the rows, do not spray.

HOW TO CALCULATE THE AMOUNT OF CHEMICAL TO BUY AND MIX

If it is necessary to spray a pesticide onto a crop you will need the following information before you can begin to spray:-

1. What pesticide does DPI recommend to control the pest?
2. How much pesticide to buy?
3. How much pesticide to mix in the sprayer tank?

AN EXAMPLE OF A PROBLEM

To show how this is done, let us use an example:

Suppose we are growing cabbages on a plot 30 metres x 40 metres (m) (an area of 1200 square metres). There are a large number of caterpillars eating the leaves of the crop. We need to control them with a spray because the damage is serious, and we have a sprayer with a 15 litre (L) tank. The pesticide recommended by DPI in this situation is written '0.1% acephate, spray weekly "as necessary".'

What does this mean in terms of mixing and buying the product?

'0.1% acephate' means a solution of chemical with the common name acephate, mixed in water so that the concentration of the active ingredient is 0.1% (1 part in 1000). At present, unless otherwise stated, DPI recommendations assume that 1000 litres of mixed chemical are applied to 1 hectare, this is the volume of application. 'As necessary' means as long as there is a problem. In our example let us assume that we will need 3 sprays (applications) and the product we can buy is Orthene 75 WP, which is a trade name for acephate. We now have the following information:-

1. Common name - acephate
2. Trade name - Orthene 75 WP
3. Product concentration - 75% active ingredient
4. Recommended concentration - 0.1% active ingredient
5. Number of sprays required - 3
6. Spray tank size - 15 litres
7. Area of ground to be sprayed - 1200 square metres.

This is all the information we need to calculate how much product to buy and how much product to mix in each sprayer tank.

CALCULATION OF THE AMOUNT OF PRODUCT TO BUY

In this calculation we use the following formula:

$$B = \frac{A \times R \times S}{10 \times C}$$

Where:

B = the volume in litres or the weight in kilograms of product to buy.

A = the area of the crop to be sprayed in square metres

R = the recommended concentration of active ingredient as a %

S = the number of sprays required

C = the concentration of the product as a %

In our example:

B = this is what we wish to find out

A = 1200 m² (square metres)

R = 0.1%

S = 3

C = 75%

$$\begin{aligned} B &= \frac{A \times R \times S}{10 \times C} \\ &= \frac{1200 \times 0.1 \times 3}{10 \times 75} \end{aligned}$$

$$B = \underline{0.480 \text{ kg}} \text{ (kilograms)}$$

Since the formulation is a wettable powder the final amount of product required (=B) is a weight in kilograms. In this example we will require 0.480 kilograms of product to spray our cabbage 3 times, at the recommended concentration. If the formulation had been an emulsifiable concentrate or any form of liquid, the final amount would be in litres.

CALCULATION OF THE AMOUNT OF PRODUCT TO MIX IN EACH SPRAYER TANK

In this calculation we use the following formula:

$$P = \frac{1000 \times V \times R}{C}$$

Where:

P = the volume in millilitres, or weight in grams, of product to mix in one spray tank.

V = the volume of the spray tank in litres, or the volume of mixed spray required.

R = the recommended rate of active ingredient as a %

C = the concentration of the product as a %

In our example:

P = this is the amount we wish to find out

V = 15 litres

R = 0.1%

C = 75%

$$P = \frac{1000 \times V \times R}{C}$$

$$= \frac{1000 \times 15 \times 0.1}{75}$$

$$P = \underline{20 \text{ grams}}$$

Since the formulation is a wettable powder the final amount of product required is a weight in grams. In this example we will need to mix 20 grams of Orthene 75 WP in each 15 litres of spray. If the formulation had been a liquid the final amount would have been in millilitres.

The conventional spraying described in this booklet uses 1000 litres of mixed spray per hectare (10,000 m²). This is 1 litre of spray for every 10 m². We know the size of the area we are spraying (A) in square metres (m²), we can calculate the total volume of spray required by dividing the area (A) by 10. This then gives the volume (in litres) needed to spray the area.

In our example:

$$\text{Area to be sprayed} = 1200 \text{ m}^2$$

$$\text{Volume of spray required} = \frac{1200}{10} \text{ litres}$$

$$\text{Volume required to treat } 1200 \text{ m}^2 = 120 \text{ litres}$$

To take this one step further, we can calculate how many sprayer tanks we require by dividing the total amount of mixed spray needed by the size of the sprayer tank:

Volume of spray required = 120 litres

Volume of sprayer tank = 15 litres

Number of sprayer tanks = $\frac{120}{15}$

15

$\frac{\text{Number of sprayer tanks}}{\text{required}} = 8$

So to summarise for our example, we need to buy 0.480 kilograms of Orthene 75 WP, and to mix 20 grams of product in each sprayer tank, to protect our cabbage from attack by caterpillars. On each spray day we will use 8 sprayer loads of mixed chemical.

It is important to note that when using the two formula shown above the correct units must also be used. Failure to use the units as described above will mean failure to obtain the correct answer.

USING PESTICIDES SAFELY

All pesticides are dangerous chemicals although some are more dangerous than others, and the more dangerous ones are not recommended by DPI for use in Papua New Guinea. Pesticides can enter the body in three ways:

1. Breathed in either as fumes from the concentrated chemical during mixing, or as very fine droplets from the sprayer during spraying.
2. Through the skin during the mixing of the pesticide (as the concentrated product) or during spraying (as the diluted spray). Some pesticides are able to pass through the skin more quickly than others and all will pass through more quickly if the skin is cut.
3. Through the mouth if the chemical is accidentally swallowed.

STAGES OF SAFETY MEASURES

The safety measures mentioned in this book cover the three stages of pesticides use. The stages are:- before spraying, during spraying and mixing and after spraying.

During each of these stages there are three parts which must be attended to. These are:- the chemical, the sprayer and the clothing.

Before spraying

Chemical - If you feel it is necessary to use a pesticide, always make sure you really need to. Then before buying the chemical and using it you must do the following:-

1. Find out the DPI recommendation for the crop and pest you have. These are published in Harvest, DPI Entomology Bulletins and the Information Bulletins of the various DPI Research Stations. The recommendation will give details of the name of the pesticides, the concentration to use and the waiting

period (see page 17) before harvest. It will also say how often to spray the chemical.

2. Read the label on the chemical you have bought and make sure you understand any special instructions. Sometimes the recommended concentration will be different from the DPI recommendation. Always use the DPI recommendation as this will have been worked out for Papua New Guinea and the recommendations on containers may only be suitable for overseas.
3. Store the chemical safely away from where children or animals can reach it.
 - Never put chemical into another container.
 - Never store chemical near food or drink as it might spill or the fumes might get into the food.
 - Never buy more chemical than you can use in two or three months. Pesticides do not work as well if they are old and it is dangerous to store them for long periods.
 - Keep it in a place where there is no food or drink and where children or animals can not reach it.
4. Check that the mixing equipment you need during the spraying period is ready.

This will be:-

- A funnel to pour the concentrated product into the measure.
- Something to stir the chemical with.
- Something to measure the product with.

None of this equipment must be used for anything else. A funnel is easily bought and an ordinary stick can be cut for mixing the chemical. A plastic measure for liquids can be bought from pharmacies in most towns, for 40 to 50 toea. This will measure up to 50 millilitres and is adequate for measuring pesticides. For solid chemicals it is necessary to buy a set of kitchen or letter scales. These should be sensitive enough to measure in at least 10 gram amounts. Pesticides produced by reputable companies should always provide measures, unfortunately this is not always the case. It cannot be over emphasised how important it is not to use measuring equipment for anything else.

- 'Kubota' makes a set of scales to weigh letters, which measure in amounts of 2.5 grams, the cost is about K18.00.

Sprayer - The proper care of the sprayer is important for several reasons but the most important is that leaks of chemical from a badly maintained sprayer can enter the sprayman's body through his skin and poison him, (see page 17, chronic poisoning). Before spraying do the following:-

1. Check seals and washers and make sure they are not badly worn or leaking, if they are they should be replaced.
2. Check the threads of joints for leaks by filling the sprayer with clean water and operating the pump. Tighten any leaking parts and if necessary use plumber's tape or twine to give a good seal.
3. Check the straps to see that they are firmly fastened and not frayed and about to break.

4. Check the hoses to see that they are not brittle or leaking, if they are, replace them.

Clothes - Provided that chemicals are used carefully and correctly and all the guidelines in this booklet are followed, specialised protective clothing is not always essential. Special clothing is expensive as well as heavy and uncomfortable to wear in the lowlands, although it is not such a problem where the temperature is cooler.

Protective clothing is necessary for spray operators who spray regularly on large farms and plantations, but not for small growers who treat small areas occasionally. The main types of protective clothing are listed below.

1. Respirators. These go over the nose and mouth and remove small droplets and vapours from the air. Respirators must be fitted with filters which are suitable for the chemical being used and the filters must be changed or cleaned regularly. A badly looked after respirator is more dangerous than no respirator at all. These are very uncomfortable to wear in the lowlands.
2. Visors and goggles. The visors cover the whole face and are made of clear plastic. Goggles cover just the eyes. The object of these is to prevent chemicals entering the eyes. They should be worn when mixing chemicals.
3. Hoods. These cover the whole head and have clear screens for looking through. These are used with respirators for handling extremely dangerous chemicals. They are very uncomfortable to wear in the lowlands.
4. Overalls. These are one piece garments which should have long sleeves and legs. They are used during all spraying operations and must not be used for other jobs.
5. Gum boots. These are rubber boots which are waterproof and prevent chemical entering the body through the feet.
6. Rubber gloves. Waterproof gloves which are unpleasant to wear if the weather is hot but which are very important if handling concentrated chemical during mixing.

Check that the clothing is in good condition and is ready to wear before spraying begins. Basic clothing for a small scale operation should be:

- long sleeved shirt with the sleeves rolled down.
- long trousers outside gum boots.
- gum boots.
- rubber gloves for use during mixing.

For large scale operations or regular spraying of any size, basic clothing should be:-

- overalls.
- goggles.
- gum boots.
- respirators. The Respirators will be required if the chemical is very poisonous.

Special instructions will be written on the pesticide label if extra protective clothing is required. Always read the label. Gloves and gum boots should always be checked very carefully for holes.

During spraying and mixing

Clothing - Make sure you are wearing the correct clothing. This is described on page 14. For mixing always wear rubber gloves and sometimes goggles, depending on the chemical. Always read the label to find out any special clothes you might need.

Chemical - The following applies when mixing the chemical. Check that the necessary items are at the mixing site. These are:-

1. the pesticide as the product in concentrated form.
2. plenty of clean water to mix with the product and to clean up after any spillages or accidents.
3. soap, for cleaning any spills.
4. mixing stick for stirring chemical.
5. measuring equipment, either a measuring jug or a set of scales.
6. and the sprayer for applying the chemical.

Choose a mixing site in the shade if it is possible, because the pesticide will not work as well if the bottle which contains the concentrated chemical gets too hot.

Never eat, drink or smoke when mixing or spraying chemicals. Always wash and change your clothes before doing any of these things, if you have been handling pesticides. It is very easy to accidentally swallow chemicals and become sick and die.

Mix the spray in the sprayer tank because this way, you will not mix too much. Chemical which is already mixed cannot be stored and is difficult to get rid of.

Fill the tank of the sprayer one third full of water. Always use a filter. The filter is usually in the top of the sprayer tank, but if it is missing or damaged make one out of a piece of mosquito screen or a piece of cloth.

Measure out the pesticide and add to the tank. Always wear gloves when measuring out the chemical into the tank. If it is required, also wear goggles, (see page 11 for details of how to calculate the amount of chemical to mix). If you are not sure of the rate to use then ask your local didiman or contact the nearest DPI Research Station. Too much chemical may damage the plants you are spraying and will waste chemical which is expensive. Too little chemical will not control the pest you are spraying, the crop will be damaged and the chemical will be wasted. Pesticides cost money so use them thoughtfully.

Mix the chemical in the tank with the mixing stick or the sprayer lid may be tightened and the sprayer rocked from side to side.

Fill the remainder of the tank with clean water, using the filter. Never fill the tank to the very top as the pesticide mixture may spill down the back of the sprayman as he walks over an uneven field.

Rinse the outside of the sprayer with a little water after the top has been fitted to remove any accidental splashes of chemical on the outside.

Begin spraying, the exact way you spray will depend on the crop and the number of spraymen. See page 6 and 7 for further details.

Do not spray if the wind is strong enough to move the tops of tall trees, to stir up dust or to bend small and medium trees. Do not spray if the wind is gusty. If you do, the wind will blow the spray away from your crop and it may go into areas where there are animals or children. If this happens the spray is wasted and may poison someone.

Do not finish spraying until the sprayer is empty. Time your walking speed so that you have enough chemical to spray your field. It is difficult to get rid of mixed spray. If you reach the end of the field and still have spray liquid in the tank, spray it on the waste vegetation or if you wish to get rid of it, dig a hole at least 1 metre deep, and away from streams and ditches, and pour the contents of the sprayer into it. This hole is best dug in solid clay if there is any nearby.

Sprayer - If something is wrong with the sprayer stop spraying immediately. There are several things which might go wrong with the sprayer but if it has been checked properly before the start of spraying then these should be minor. The most likely fault is a blocked nozzle. If this happens;

1. stop spraying.
2. remove the nozzle and rinse it in clean water.
3. clean out the nozzle with a piece of straw or small stalk.
4. never blow out a blocked nozzle.
5. never use wire to clean the nozzle as this will increase the hole and interfere with the formation of spray droplets.

If something else goes wrong, the sprayer should be cleaned before any repair work is done. The way to do this is given below.

After spraying

After spraying the most important thing to do is to clean everything that has been used and come into contact with chemical. Do not wash the spray equipment near drinking water.

Chemical and sprayer. These can be considered together.

Find a suitable place to wash out the sprayer. There should be plenty of water but it should not be near any drinking water. It is best to carry water to somewhere away from human activities. There should be soap at the washing site.

Fill the sprayer with clean water and a little soap powder. Place the lid on the tank and shake it. Then:-

1. spray the soapy water which contains a small amount of pesticide onto waste vegetation for a few minutes.
2. remove the nozzle and rinse in clean water.
3. pump the sprayer with the nozzle removed until the tank is empty.
4. refill the tank with clean water, shake and empty the tank

5. replace the nozzle tip.
6. wash down the outside of the sprayer and clean the straps.

Remove the sprayer to storage. Leave the lid of the tank loose so that air can circulate. Hang the sprayer up by the straps.

Clean all mixing equipment in soapy water, rinse and dry. Never use the mixing equipment for anything else. Store the pesticide, the sprayer and the mixing equipment in the same place.

Tighten the top of the pesticide container and clean the outside to remove any traces of chemical that have been spilt. The pesticides should be stored with the rest of the spraying equipment, out of the reach of children and animals and also away from food and drink.

Destroy old pesticide containers. Old containers must never be used for anything else. If a pesticide container is empty it must be destroyed. It is impossible to remove all the chemical from bottles. Dig a pit at least 1 metre deep away from creeks or ponds, bottles and tins should then be crushed and broken and placed in this. Plastic containers may be burnt but do not stand in the smoke as this can be dangerous. If you do not wish to burn them, they can be cut up and buried in the same way as the bottles and tins.

Clothes - Wash yourself and your clothes after all the spraying equipment has been cleaned and put away. All the clothes you have worn should be washed. Wash yourself thoroughly.

Smoke, eat and drink only when you have completed all the steps mentioned above. Never do any of these things when you are spraying.

BEFORE HARVESTING

Once a pesticide has been mixed with water and sprayed onto a crop it begins to breakdown and lose its poisonous properties. The time that this takes is different for each chemical, and so in all DPI recommendations there is a waiting period. This is the time from the last spray that must pass before the crop can be harvested. For some chemicals it is short (only 3 days) for others it is much longer (14 days or more). It is very important to observe the waiting period, if you do not then someone may be poisoned.

FIRST AID IN CASE OF ACCIDENTS

If you follow the precautions and suggestions in this booklet then you will be using pesticides safely and there will be little danger. If you do not, then you may find that you, or someone you know, will become ill.

1. You may take in small amounts of chemical all the time because of a leaking sprayer or bad spraying methods. These small amounts add up until there is enough in your body to make you ill. This is known as chronic poisoning.
2. You may accidentally spill, swallow or breath in a large amount of pesticide in one go. This is known as acute poisoning.

The three ways a chemical can enter your body have already been described on page 12 and both chronic and acute poisoning can happen in these ways. If you have been poisoned, the things that will happen to you will depend on the type of

pesticide, the amount of pesticide and the way the chemical has entered your body. You will feel all or some of the following symptoms:

1. Vomiting or wanting to vomit
2. Dizzy
3. Bad tempered
4. Short of breath
5. Physical twitching
6. Diarrhoea
7. General weakness
8. Difficulty seeing, blurred vision
9. Headaches.

If you feel any of these symptoms while you are spraying, stop spraying immediately and do the following:

1. Wash and change your clothes.
2. Rest in the shade.
3. Do no more spraying for several days.
4. Try and decide what you were doing wrong and correct it.
5. If you feel no better take the pesticide bottle with you and go to the hospital.

ACCIDENT INVOLVING A PESTICIDE

If there is an accident involving a pesticide, the following first aid steps should be followed:

Pesticide spilt on the skin

1. Remove all the clothing which has pesticide on it.
2. Use lots of clean water to wash the parts of the skin which have pesticide on them.
3. Wash well with soapy water.

Pesticide in the eyes

1. Hold the eyelids open and pour clean water into the eye for 5 minutes.
2. Rest in the shade after first aid treatment.
3. Go to the nearest hospital and take the pesticide bottle with you.

Pesticide eaten or swallowed

If the person is still conscious:

1. Place him in the shade and loosen any tight clothing.
2. Make him vomit to remove the poison from his stomach. This can be done by placing a finger down his throat, making him drink a glass of water with 5 large spoons of salt in it or, best of all, by giving him some syrup of Ipecac (which can be obtained from pharmacies).

3. When he has finished vomiting give him plenty of clean water to replace the liquid he has lost.
4. Take him to the nearest hospital and take the pesticide bottle with you.

If the person is unconscious:

1. Never make an unconscious person vomit, he may choke to death.
2. Lay him on his side and prevent him from choking by removing any vomit in his mouth.
3. Keep him warm.
4. Take him to a hospital as soon as possible.

Take the chemical bottle with you to the hospital because different pesticides need different medicines.

Pesticide breathed in

1. immediately take the person to fresh air.
2. loosen clothing.

In any case of accidental poisoning take the person to the hospital as soon as you can. Always take the pesticide bottle so that doctors at the hospital know which medicine to give.

If pesticides are treated carefully and sensibly, they are a useful way of increasing the amount of produce from your land, if your crops are attacked by a pest. If you use them foolishly and carelessly, they will endanger the life of yourself and those around you.

BE CAREFUL.....BE SAFE

ADDRESSES

If you would like any extra information or are not sure of anything mentioned in this booklet, contact the entomologist closest to you:

PORT MORESBY

The Chief Entomologist,
Department of Primary Industry,
P.O. Box 417,
KONEDOBU,
National Capital District.

LAE

The Entomologist,
Bubia Agricultural Research Centre
P.O. Box 73,
LAE,
Morobe Province.

MOUNT HAGEN

The Entomologist,
Kuk Agricultural Research Station,
P.O. Box 33, MOUNT HAGEN
Western Highlands Province.

RABAUL

The Entomologist,
Lowlands Agricultural Experiment
Station, KERAVAL,
East New Britain Province.

FURTHER READING

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GLOSSARY

This is a glossary of the terms and abbreviations which are used in this booklet and which may also be found on the labels on pesticide containers.

ACARICIDE	- a pesticide for killing mites and ticks.
ACTIVE INGREDIENT	- the part of a pesticide which is the poison to kill the pest.
ACUTE POISONING	- poisoning which occurs when a large amount of pesticide is taken in a single go.
a.i.	- an abbreviation for ACTIVE INGREDIENT.
CHEMICAL NAME	- a complicated name which is used by specialists for describing a pesticide.
CHRONIC POISONING	- poisoning which occurs when a small amount of pesticide is taken on many occasions, gradually adding up to dangerous levels.
cm	- centimetres, there are 100 centimetres in 1 metre, a measure of length.
COLLOIDAL SUSPENSION	- solid particles of the active ingredient of a pesticide in a special liquid in which they float like watery mud, a type of formulation.
COMMON NAME	- a simple, internationally accepted name for a pesticide which always starts with a small letter.

CONCENTRATION	- the amount of the active ingredient in a formulation or the amount of the product in a spraying mixture. Usually expressed as a percentage.
CONE NOZZLE	- a type of spray nozzle suitable for applying insecticide and fungicides to a crop.
CUT-OFF VALVE	- the on and off switch on the handle of a sprayer lance which controls the spray.
DUST	- solid formulation of pesticides which are diluted by the makers and which are ready for use when bought.
EMULSIFIABLE CONCENTRATE	- a concentrated liquid formulation of a pesticide which must be diluted with water before use.
EMULSIFIER	- one of the components in an emulsifiable concentrate formulation.
FAN NOZZLE	- a type of spray nozzle suitable for spraying flat surfaces and for spraying herbicides when used at low pressure.
FILLERS	- used in dust and granule formulations to dilute the active ingredient and in other formulations to make the correct concentration for the product.
FLOW-RATE	- the speed at which mixed spray leaves the nozzle of a sprayer.
FORMULATION	- the type of product.
FUNGICIDE	- a pesticide for killing fungi.
g	- gram, there are 1000 grams in 1 kilogram, a measure of weight.
GOGGLES	- special see-through protective coverings which go over the eyes, when mixing and spraying.
GRANULES	- a solid formulation of pesticides with larger particles than dust. This type of formulation is diluted by the makers and is ready for use when bought.
ha	- hectare, a measure of land area, 100 metres x 100 metres
HERBICIDE	- a pesticide for killing weeds, sometimes called a weed-icide.
HIGH VOLUME SPRAYING	- normal type of spraying which uses approximately 1000 litres of mixed chemical per hectare.
HERBICIDE SHIELD	- special shields which surround the spray nozzle to prevent the herbicide touching a crop which has already emerged.
HOOD	- a special protective covering with a see-through panel which fits over the head of a sprayman for use with very dangerous chemicals.
HOSE	- the tubing from the sprayer tank to the lance down which the spray travels.
INERT FILLERS	- see FILLERS.
IMPACT NOZZLE	- a type of spray nozzle for use at low pressure with herbicides, not for use with other types of pesticides.
INSECTICIDE	- pesticide for killing insects.

kg	- kilogram, 1000 grams, a measure of weight.
KNAPSACK SPRAYER	- a sprayer which is carried on the back of a sprayman,
L	- litre, 1000 millilitres, a measure of volume.
LEVER-OPERATED SPRAYER	- a non motorised sprayer which is carried on the back of the sprayman and operated by a lever.
m	- metre, 100 centimetres, a measure of length.
m ²	- square metre, a measure of area, 1 hectare = 10,000m ² .
ml	- millilitre, a measure of volume, 1000 ml = 1 litre.
MITE	- a very small pest of agricultural crops.
MOLLUSCICIDE	- a pesticide for killing snails.
NEMATICIDE	- a pesticide for killing nematodes.
NEMATODES	- microscopic (very tiny) worms which usually live in soil and feed on plants. Some may live inside humans and other animals.
NOZZLE	- the part of the sprayer at the end of the lance where the pesticide is formed into a spray cloud.
OVER-ROW SPRAYING	- a technique of applying pesticides which prevents the sprayman walking through leaves which have already been sprayed.
PEST	- animals and plants which may damage a crop are known as pests; the pest may cause a disease, it may feed on the crop directly or it may compete with the crop and reduce the yield.
PESTICIDE	- a chemical which kills a pest.
PRESSURE VESSEL	- a container inside a lever-operated knapsack sprayer in which pressure is developed when the pump lever is moved. This pressure is what allows the pesticide mixture to be sprayed from the tank, through the nozzle.
PRODUCT	- this is the formulation of the pesticide which is sold. It contains the active ingredient and non-active parts which make it more effective.
RESPIRATOR	- a special mask which is worn over the nose and mouth to remove vapours and small droplets of poisonous chemical from the air. It is worn when working with very dangerous chemicals.
RODENTICIDE	- a pesticide for killing rats and mice.
RUN-OFF	- this is the pesticide which comes off the surface of the crop when it is sprayed at high volume.
SPREADERS	- part of the non-active ingredient of a pesticide formulation which helps the chemical to spread over the waxy surface of the plant or insect.
STICKERS	- part of the non-active ingredient of a pesticide formulation which helps stick the chemical to the leaf surface and prevent it being washed off too easily in rain.
TRADE NAME	- the name which a pesticide maker gives to the product, it may include details of the formulation and the concentration. A single pesticide may have several trade

- names. Trade names always start with a capital letter and may sometimes be in quotation marks.
- VISOR - a type of see-through protective shield which covers the face, for use when handling dangerous chemicals.
- VOLUME OF APPLICATION - this is the total volume of mixed chemical which is applied to a crop. It is usually expressed as litres per hectare (L/ha).
- WAITING PERIOD - this is the time from the last spray which must pass before it is safe to harvest the crop.
- WETTABLE POWDERS - a solid formulation of pesticides which is mixed with water to form a solution or suspension for spraying.

HANDBOOKS IN THE RURAL DEVELOPMENT SERIES

1. Basic Extension Skills (1975), revised)
2. Rural Broadcasters Handbook (1973)
3. Cardamom (1982, revised)
4. Poultry (1976, revised)
5. Pigs (1977, revised)
6. Chillies (1977, reprinted)
7. Pepper (1975)
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14. Know Your Farm Machinery (1978)
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17. Insect and Nematode Pests of Crops (1980)
18. The Safe and Efficient Use of Pesticides (1983)